Climate change and natural disasters

A challenge for Russian policymakers

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Photo: by V.E. Romanovskiy, Geophysical Institute, University of Alaska Fairbanks, USA. Subsidence due to permafrost thaw destroyed this apartment building in Cherski, Siberia, within days of the appearance of the first cracks. Section of the residential building in Cherskiy, in the lower Koluma River valley, which collapsed in June 2001 as a result of the weakening of the foundations, built on permafrost. The incident illustrates the potentially detrimental impact of permafrost degradation.

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Sammanfattning

Ett antal allvarliga naturkatastrofer har inträffat i Ryssland under de senaste åren, som översvämningar och stora skogsbränder. Frekvensen och intensiteten hos sådana naturkatastrofer och tekniska incidenter kopplade till extrema väderhändelser har ökat under de senaste tio åren och bedöms komma att fortsätta öka. Detta beror troligtvis på klimatförändringarna. Effekterna av framtida klimatförändringar i Ryssland har undersökts och diskuteras i rapporten. Klimatet i norra Ryssland, inklusive Arktis, förändras så snabbt att farliga klimatförändringar redan kan förekomma. Klimatförändringarna och minskningen av den arktiska havsisen kan nu ske snabbare än vad ekosystemet kan anpassa sig naturligt till. Lufttemperaturen i norra Ryssland förväntas öka dubbelt så snabbt som den globala medeltemperaturstegringen. Klimatmodellerna förutspår att det till 2100 sker en kraftig minskning av områden med permanent permafrost. Minskningen av permafrost kommer att försvaga markens bärighet för byggnader, vägar, järnvägar och rörledningar. Dessutom förändras den säkerhetspolitiska situationen i Arktis på grund av den snabba avsmältningen av havsisen och en konsekvens kan komma att bli en ökad närvaro av den ryska försvarsmakten inom det arktiska området.

Rysslands roll i de internationella klimatförhandlingarna har begränsats till att ratificera Kyotoprotokollet. Målet har främst varit att uppnå diplomatiska eller inrikespolitiska vinster inom andra politikområden snarare än att sträva efter konstruktiva lösningar på de internationella klimatförhandlingarna. Det finns en rysk klimatdoktrin på plats, men genomförandet går långsamt. Åtgärder för att förebygga naturkatastrofer och anpassning till klimatförändringar är inte välutvecklade och Rysslands ansträngningar ligger efter de flesta andra stater. Skepsis om klimatförändringarna är fortfarande utbredd i Ryssland liksom uppfattningen att klimatförändringarna främst kommer att ha positiva effekter för Ryssland. Det finns inga tecken på att den nuvarande ryska politiken för klimatförändringar kommer att förändras inom en snar framtid.

Nyckelord: Klimatförändringar, naturkatastrofer, tekniska incidenter, UNFCCC, växthusgaser, metangas, arktisk havsis, permafrost, Roshydromet, Räddningsministeriet, Emercom, Ministeriet för naturresurser och miljön, klimatdoktrin, norra Ryssland, Arktis.

Summary

There have been a number of serious natural disasters, such as floods or major forest fires, in Russia in recent years. The frequency and intensity of large-scale natural and technological incidents linked to extreme weather events have increased in the past ten years and will continue to increase. This is probably due to climate change. The impact of future climate change on Russia is reviewed and discussed. The climate of northern Russia, including the Arctic region, is changing rapidly, to the extent that 'dangerous' climate change might already be occurring. The rate of climate change and the decrease in the Arctic sea ice could now be faster than the rate at which ecosystems can adapt naturally. The air temperature in northern Russia is expected to increase by roughly twice the global rate and climate projections indicate substantial loss of permafrost by 2100. The increased thawing of permafrost will weaken the capacity of the ground to bear buildings, roads, railways and pipelines. In addition, the security environment in the Arctic is changing due to the rapid melting of sea ice, one consequence of can be an increased presence of the Russian Armed Forces in the Arctic region.

Russia's role in the international climate negotiations has been limited to ratifying the Kyoto Protocol. The aim has been mainly to achieve diplomatic or domestic policy gains in other policy areas instead of a constructive solution to international climate change issues. There is a climate doctrine in place, but its implementation is not actively pursued. Mitigation and adaptation policies are not well developed and Russia's efforts lag behind most other countries. Scepticism about climate change is still widespread in Russia, as well as the view that climate change will have mainly positive effects for Russia. There are no signs that current policies on climate change will change in the near future.

Key words: Climate change, natural disaster, technological incidents, UNFCCC, greenhouse gases, methane, Arctic sea ice, permafrost, Roshydromet, Ministry of Emergencies, Emercom, Ministry of Natural Resources and the Environment, climate doctrine, northern Russia, Arctic zone.

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1 Introduction

In recent years, Russia has experienced several extreme weather events that have caused serious incidents. As the number and frequency of these have increased, the cause of these disasters can possibly be traced to the effects of global warming and climate change. Average temperatures in Russia, especially in the North, are rising at double the rate of the global average temperature increase, resulting in both positive and negative impacts for Russia.

Since the collapse of the Soviet Union, Russia, like most states, has had to face a wider array of non-military security threats and to improve its civil protection capabilities. Russia's approach in the 1990's focused only on preparedness and response, in dealing with natural disasters or technological incidents. Russia had to cope with a number of non-military challenges and disasters which its existing security structures were not well equipped to deal with. This required change, such as the establishment of the Ministry of Emergencies (Emercom) in 1994. This need for change was addressed for the first time in the first Russian National Security Concept, adopted in 1993.[1] Awareness of the issue of disaster risk reduction has slowly developed over the years and the need to focus also on prevention and lack of safety in industries. The protection of critical infrastructure against human-induced, naturally generated or terrorist threats was identified by the Russian President, Vladimir Putin, as an urgent task in 2003. In addition, run-down infrastructure is prone to malfunction, and the risk of human-induced catastrophes is further aggravated by widespread indifference to safety rules.[2]

Many hazards that lead to disasters cannot be prevented, but their consequences can be limited. Hazards may be natural or technical in origin, but it is the way in which societies develop that causes them to become disasters.[3] Measures are needed at all levels to prevent disasters, reduce exposure to different hazards, curb disaster losses, enhance mitigation and the adaptive capacities of vulnerable populations and minimize the suffering of those effected. It is well known that response and disaster mitigation based only on past vulnerabilities is not sufficient to handle the natural disasters forecast as a result of climate change. Climate change projections provide an insight into potential future risks but are usually scenario-based and therefore contain uncertainties.[4]

[1] Streltsina, Milanna (2004) 'Russian Emercom: Participation in internal and external conflict resolution' in Alexander Nikitin (ed.) *Peace Support Operations, Parliaments and Legislation, Geneva*: DCAF/CIPS, p. 131.
[2] The joint session of the Security Council and the State Council in November 2003.
[3] O'Brien, Geoff, Phil O'Keefe, Joanne Rose and Ben Wisne (2006) 'Climate Change and Disaster Management', *Disasters*, 2006, Vol. 30, No. 1, pp. 64−80, Blackwell Publishing, Oxford, UK.
[4] *Ibid*.

Russia covers more than one-eighth of the Earth's land mass and is already experiencing the impacts of more frequent extreme weather events, as well as the effects of climate change in the form of increasing average temperatures, more frequent wildfires, an increased incidence of drought, thawing permafrost, retreating Arctic sea ice, changing precipitation patterns, and increasing numbers of floods and other weather-related events. Many of these observed climate impacts are already having concrete, negative effects on the Russian economy and people's quality of life.

Adaptation to climate change and disaster risk management provides a range of complementary approaches to managing the risks of climate extremes and disasters. Prevention, preparedness, response, rehabilitation and recovery are crucial points for risk reduction, with the aim of building resilience to future hazards. There has generally been a shift in focus in recent decades from disaster response to disaster risk reduction.

1.1 The aim and outline of this report

Russia is the world's fourth largest carbon dioxide emitter and has the largest national carbon sink, given its huge forests and wetlands.[5] The negative effects climate change can have on northern parts of Russia could also increase the rate of global warming. Russia is a country that is already experiencing the effects of global warming – and more so than many other countries. Russia has a potential to play a more prominent role in international climate policies but has refrained from this so far, since agreeing to the Kyoto protocol. Russia's role in international climate change negotiations have not been much discussed. This, in spite of the fact that Russia's commitments will be essential for any future climate change agreement on binding emission targets to be finalised. The aim of this report is to give an insight into Russian climate change policies and analyse how climate change already is affecting different parts of Russia.

Russia has experienced several extreme weather events in recent years which have led to serious disasters. As the number and frequency of these events have increased, it has been suggested that the causes can be traced to the effects of global warming and climate change. The type and frequency of natural disasters and technological incidents in Russia are discussed as well as how the authorities have been able to respond to such disasters. The impact on agriculture and forestry is also described.

[5] Lioubimtseva, Elena (2010) 'Russia's Role In The Post-2012 Climate Change Policy: Key Contradictions and Uncertainties', Forum on Public Policy, September; Vol. 3, pp. 1-11; and The Statistics Portal (2013) 'The largest producers of CO2 emissions worldwide in 2013, based on their share of global CO2 emissions', on the Internet: http://www.statista.com/statistics/271748/the-largest-emitters-of-co2-in-the-world/ (retrieved 8 August 2014).

Average temperatures in Russia, especially in the North, are rising at double the rate of the global average temperature increase. A more detailed overview is provided of the effects of climate change in northern parts of Russia, including the negative effects on infrastructure and problems associated with the increased exploitation of oil and gas reserves off the Arctic coast of northern Russia. The changing security situation and its implications in the North are also discussed.

One major issue examined is whether there is general agreement in the literature on how climate change will affect different regions in Russia. In addition, does the official view on vulnerability to climate change differ from the international scientific community's views on the situation? What is the Russian position or Russian policy on the international climate change negotiations? How is this reflected in domestic policy? The report also describes the responsibilities and functions of the various ministries in coping with natural disasters and dealing with climate change issues.

This study uses both primary and secondary sources, government documents, documentation from the Russian agency on climate change (Roshydromet), government reports to the United Nations Framework Convention on Climate Change (UNFCCC), reports from the Fourth (2007) and Fifth (2013) Intergovernmental Panel On Climate Change (IPCC) Assessment Reports, Russian and international scientific studies of disaster risk reduction and climate change, and media articles where the latter provide added insight into ongoing discussions in Russia of disasters and climate change.

1.2 Definitions of northern Russia and Russia's Arctic region

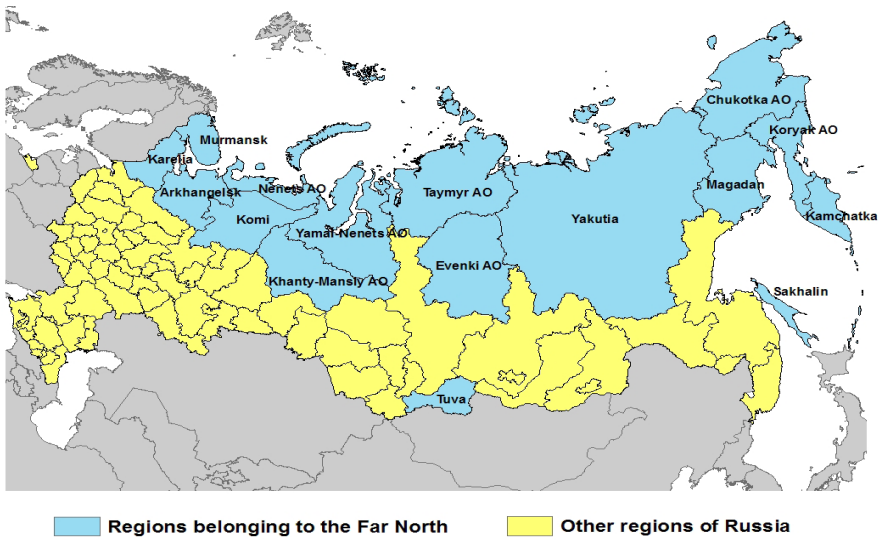
In the report, northern Russia is used as a geographical area which is equivalent to the Russian term, the Far North. For the purposes of planning, economic development and the collection of statistics, the Russian government classifies 16 regions as belonging to the Far North. Ten regions are termed Far North[6] and six additional regions are equivalent to the Far North (see Figure 1).[7] These regions encompass 54 per cent of Russian territory but only 6.6 per cent of the country's

[6] The Far North: Nenets Autonomous Okrug, Murmansk Oblast, Yamal-Nenets Autonomous Okrug, Taimyr Autonomous Okrug, Evenki Autonomous Okrug, Republic of Sakha (Iakutia), Chukotka Autonomous Okrug, Kamchatka Oblast, Koriak Autonomous Okrug, and Magadan Oblast.

[7] Regions that are equivalent to the Far North: the Republic of Karelia, Komi Republic, Arkhangelsk Oblast, Khanty-Mansi Autonomous Okrug, Tuva Republic, and Sakhalin Oblast. The city of Norilsk, which is administratively part of the Krasnoiark Kray but physically located in the Taimyr Autonomous Okrug, is also included in the Far North.

population.[8] [9] The perception of the North as well as the boundaries of the region has altered over the years according to changing development priorities.[10]

Figure 1. Russia's regions of the Far North



Source: Heleniak, Timothy (2013) 'Boom and Bust: Population Change in Russia's Arctic Cities', Policy note presented at the Arctic Urban Sustainability Conference May 30-31, Elliott School of International Affairs, George Washington University Washington, DC, on the Internet: http://www.gwu.edu/~ieresgwu/assets/docs/Heleniak_BoomandBust%20PopulationChange.pdf (retrieved 20 January 2014).

The Arctic region in Russia is not clearly defined but differs from the area termed the Far North.[11] The Arctic Zone of the Russian Federation is

[8] Heleniak, Timothy (2013) 'Boom and Bust: Population Change in Russia's Arctic Cities', Policy note presented at the Arctic Urban Sustainability Conference May 30–31, Elliott School of International Affairs, George Washington University Washington, DC, on the Internet: http://www.gwu.edu/~ieresgwu/assets/docs/Heleniak_BoomandBust%20PopulationChange.pdf (retrieved 20 January 2014).

[9] Heleniak, Timothy (2009) 'The role of attachment to place in migration decisions of the population of the Russian North', *Polar Geography*, Vol. 32, No. 1-2, pp. 31-60.

[10] Nuykina, Elena (2011) *Resettlement from the Russian North: an analysis of state-induced relocation policy*, Arctic Centre Reports 55, University of Lapland, Rovaniemi.

[11] The Russian Arctic region stretches for close to 7,000 km west to east, from Karelia and the Kola Peninsula to Nenetsia, the Gulf of Ob, the Taymyr Peninsula and the Chukchi Peninsula (Kolyma, Anadyr River, Cape Dezhnev). Russian islands and archipelagos in the Arctic Sea include Novaya Zemlya, Severnaya Zemlya, and the New Siberian Islands.

approximately 9 million km^2 in size and has a population of about 2.5 million.[12] The three most heavily populated centres within the Arctic Circle are in Russia: Murmansk (population 325,100), Norilsk (135,000) and Vorkuta (85,000). There are no permanent settlements above 78° north latitude.[13] The strategy for development of the Arctic territories includes a definition of the Arctic Zone.[14]

The Ministry of Regional Development approved a list of territories officially acknowledged as part of the Russian Arctic zone in 2013. New legislation led to a considerable restriction on the areas entitled to favourable Arctic benefits. The Russian Arctic territories now officially include Murmansk Oblast, the Nenets Autonomous Okrug AO, the Yamal-Nenets AO, the Chukotka AO, parts of the Yakutia region, as well as the three northernmost municipalities of the Krasnoyarsk Kray. A final decision on the zone is expected to be made by the federal government in 2014. The Republic of Karelia now falls completely outside the zone along with the Republic of Komi. In Arkhangelsk Oblast, only seven municipalities are included in the zone.[15] For a further discussion on the definition of the Russian Arctic see Carlsson and Granholm.[16] In this study, the term Arctic is used when Russian official documents use the term or when a reference cited uses the term.

[12] Neretin, Lev (2013) 'Environmental Security in the Russian Arctic: Drivers, Pressures and Responses', Scientific and Technical Advisory Panel (STAP) Secretariat, Global Environment Facility. c/o United Nations Environment Programme, Regional Office for North America, Washington DC 20006 USA.

[13] The Russian Geographic Society (2013) 'The Arctic, population', on the Internet: http://arctic.ru/geography-population/population (retrieved 20 January 2014).

[14] The Arctic zone of the Russian Federation is understood as the part of the Arctic which includes, either fully or partially, the territories of the Republic of Saha (Yakutiya), Murmansk and Arkhangelsk regions, Krasnoyarsk Krai, Nenets, Yamalo-Nenets and Chukotka Autonomous Okrug, as defined by the decision of the Government Commission on Arctic Issues under the Council of Ministers of the USSR on April 22, 1989, as well as landmasses and islands included in the Decision of the Presidium of the Central Executive Committee of the USSR on April 15, 1926; Russian Federation (2008) 'The Foundations of Russian Federation Policy in the Arctic until 2020 and Beyond', 18 September, (The full text of the strategy appears by courtesy of the American Foreign Policy Council. It was translated from the Russian by Maxim Rusnak and Ilan Berman), *The Journal of International Security Affairs*, on the Internet: http://www.securityaffairs.org/issues/2010/18/russia's_new_arctic_strategy.pdf (retrieved 30 November 2013) and Laruelle, Marlene (2014). Russia's Arctic Strategies and the Future of the Far North. Armonk, New York, M.E. Sharpe, Inc.

[15] Barents Observer (2014) 'The Russian Arctic now redefined', 11 February, http://barentsobserver.com/en/arctic/2014/02/russian-arctic-now-redefined-11-02

[16] Carlsson, Märta and Granholm, Niklas (2013) *Russia and the Arctic. Analysis and Discussion of Russian Strategies*, FOI Report-R--3596--SE, FOI, Stockholm.

2 Background: Russian natural and human-induced disasters

In order to assess the effects of future climate change on the risk of natural disasters and technological incidents it is necessary to know more about the types of disaster that currently occur in Russia. Disasters, either technological or natural, are defined in Russia as disturbances to the current activity of a populated region due to abrupt technological or natural impacts (catastrophes or accidents) resulting in socio-economic or ecological damage, which require special management efforts.[17] Data on hazards are collected in a national database of environmental data by the Research Institute of Hydrometeorological Information, World Data Centre. According to the 2012 annual report of the Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), 2012 saw a record number of extreme weather events (Figure 2). In the period May to June 2012, the number of extreme weather events increased by 65 per cent compared with the same period in 2011, but was on a par with the number of events that occurred in the same period in 2010.[18] According to Roshydromet, the total number of hazardous weather events in Russia is increasing despite annual variations (see Figure 2).[19]

More than 70 per cent of disasters in Russia are technological incidents of which the most frequent are breakdowns in power supply systems. The rest 30 per cent of disasters are natural disasters.[20] For example, in 2006 there were 2,541 technical incidents but only 261 natural disasters. Of the technological incidents, 80 per cent were due to fires. In addition, 98 per cent of fatalities were linked to technological incidents.[21] Russia also experiences landslides, and there are about

[17] Petrova (2008) 'Natural hazards as pre-conditions ..., p. 250.

[18] Roshydromet (2013) 'Report on the specifics of climate on the territory of the Russia Federation in 2012', Federal Service for Hydrometeorology and Environmental Monitoring of the Russian Federation, Moscow, p. 64, Figure 8.1, on the Internet: http://meteorf.ru/upload/iblock/606/%D0%94%D0%BE%D0%BA%D0%BB%D0%B0%D0%B4%20%D0%BE%20%D0%BA%D0%BB%D0%B8%D0%BC%D0%B0%D1%82%D0%B5%20%D0%A0%D0%A4%20%D0%B2%202012.pdf (retrieved 3 October 2013); and OXFAM (2013) 'After the drought, the 2012 drought, Russian farmers, and the challenges of adapting to extreme weather events', OXFAM Case Study, September.

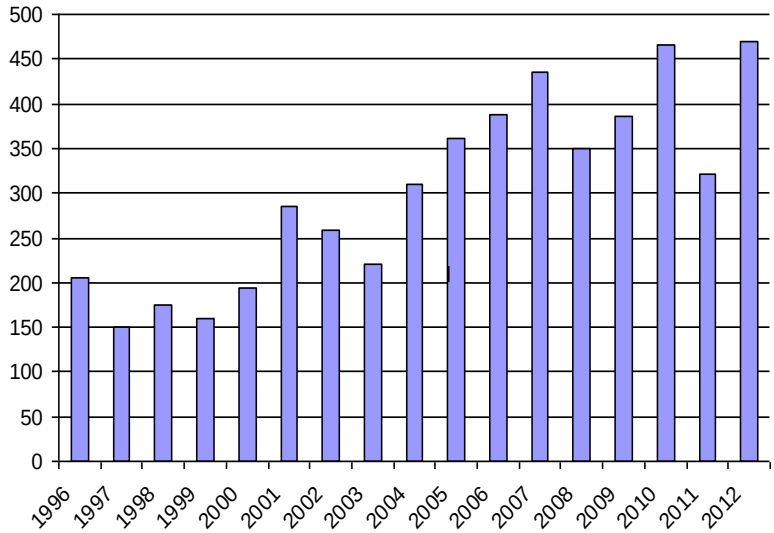
[19] Roshydromet (2013) 'Report on the specifics of climate…'

[20] Petrova, Elena (2011) 'Critical infrastructure in Russia: geographical analysis of accidents triggered by natural hazards', *Environmental engineering and management Journal*, Vol. 10, no. 1, p. 55.

[21] Petrova, Elena (2008) 'Natural hazards as pre-conditions of technological disasters in Russia', *Georisk: Assessment & Management of Risk for Engineered Systems & Geohazards*. December, Vol. 2 Issue 4, p. 250.

700 towns at risk. On average, floods and landslides cause annual economic losses of USD 300 million.[22]

Figure 2. Number of hazardous weather events causing social and economic damage in Russia, 1991–2012



Source: Roshydromet (2013) 'Report on the specifics of climate on the territory of the Russia Federation in 2012', Federal Service for Hydrometeorology and Environmental Monitoring of the Russian Federation, Moscow, p. 64.

The scale and type of disasters in the period 1980–2010 are summarised in Table 1, including the number of fatalities and the extent of the economic losses. Table 2 lists specific disasters and the number of people affected in each.[23] One aspect that stands out is that the frequency and scale of natural disasters and industrial incidents have increased in recent years. Different factors, such as climate change, urbanisation processes, the number of hazardous industries and production facilities as well as aging infrastructure all greatly contribute to the trend.[24]

[22] Pusch, C. (2004) 'Preventable Losses: Saving Lives and Property through Hazard Risk Management - A Comprehensive Risk Management Framework for Europe and Central Asia', *Disaster risk management* working paper series, no. 9, World Bank, 2004.

[23] Information on Disaster Risk Reduction of the Member Countries, Russian Federation, on the Internet: http://www.adrc.asia/nationinformation.php?NationCode=643&Lang=en&NationNum=20 (retrieved 9 March 2013); and Russian statistics regard disasters if it causes four or more fatalities and/or injures 10 or more people and/or cause large damage.

[24] Russian Federation National Platform, Hyogo Framework, Prevention Web, on the Internet: http://www.preventionweb.net/english/hyogo/national/list/v.php?id=142 (retrieved 9 March 2013).

Table 1. Natural Disasters in Russia, 1980–2010, an overview

No of events:	139
No of people killed:	61,120
Average killed per year:	1,972
No of people affected:	4,270,425
Average affected per year:	137,756
Economic Damage (USD X 1,000):	8,267,161
Economic Damage per year (USD X 1,000):	266,683

Table 2. Natural disasters and the number of people affected

Disaster	Year	Affected no. of people
Drought	2003	1,000,000
Flood	1994	775,429
Extreme temp.	1999	725,000
Flood	2002	330,613
Flood	2001	300,000
Flood	1996	220,000
Epidemic	1995	150,000
Wildfire	1998	100,683
Flood	1998	88,000
Flood	1998	78,600

Source: For Table 1 and 2, Russian Federation, Disaster Statistics, 'Data related to human and economic losses from disasters that have occurred between 1980 and 2010', on the Internet: http://www.preventionweb.net/english/countries/statistics/index.php?cid=142 (retrieved 9 March 2013).

Almost every natural disaster is accompanied by some sort of technological one. This type of technological incident triggered or magnified by a natural disaster is regarded as a natural-technological disaster or Natech. These can result from direct destruction of technical infrastructure by a hazardous natural process or the secondary effects of natural disasters leading to actual or potential threats to the environment and society.

Technological incidents can cause severe effects on the environment, for instance, if an oil-pipeline ruptures, an accident results in toxic emissions or oil leaks cause other hazards. Sudden collapses of structures can also produce severe environmental and economic impacts. A database has been created on Russian technological disasters since 1992 at Moscow University. In it, the most prevalent types of technological incident caused by natural disasters are identified and classified into 12 types of Natechs. Climate change to the end of this century may have important consequences for the frequency and distribution of Natechs in Russia.[25]

The Ministry of Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters (Ministry of Emergency Situations or Emercom)[26] records over 100 emergencies in Russia's Arctic zone annually and has noted an increase in the number of industrial incidents, primarily transport-related accidents (30 per cent), and explosions and fires destroying production equipment (24 per cent). The ministry predicts an increased risk of Arctic shipping incidents and related oil spills in 2014, citing the increase in navigation along the northern sea route.[27]

In 2013 there were 332 emergency situations, the most notable of which were floods in the Far East, a meteorite in the Chelyabinsk Region, the derailment of railway carriages in the Rostov Region and a passenger plane crash in the city of Kazan. However, the number of emergency situations decreased by 25.3 per cent, and the number of people killed in them by 25.6 per cent. The number of people saved from emergencies increased 7.5-fold in 2013 compared to 2012.[28]

In terms of economic and social vulnerabilities to natural hazards, Russia is in an intermediate position on a global scale between developing and developed industrial countries. As to economic damage, Russia appears similar to

[25] Petrova (2008) 'Natural hazards as pre-conditions ...', p. 250; and Petrova, Elena, (2009) 'Presentation', Faculty of Geography, Lomonosov Moscow State University, Natechs, on the Internet: http://nexus-idrim.net/idrim09/Kyoto/ElenaPetrova.pdf (retrieved 17 May 2013).

[26] The Ministry for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters (Russian: Министерство России по делам гражданской обороны, чрезвычайным ситуациям и ликвидации последствий стихийных бедствий), also known as The Ministry of Emergency Situations (Russian: Министерство по чрезвычайным ситуациям - МЧС России), or internationally as Emercom, on the Internet: http://government.ru/eng/power/91/ (retrieved 20 July 2013).

[27] *RIA Novosti* (2013) 'Development of Arctic region threatens oil spills, other emergencies', 20 December, on the Internet: http://arctic.ru/news/2013/12/development-arctic-region-threatens-oil-spills-other-emergencies (retrieved 20 December 2013).

[28] Emercom of Russia (2014) 'Emergency Ministry employees in 2013 rescued about 300 thousand people', Web site, on the Internet: http://en.mchs.ru/news/item/648501/ (retrieved 24 January 2014).

developed industrial nations, but material losses are likely to grow by 10–15 per cent annually.[29]

In the past 20 years, it is thought that extreme temperatures have killed over 1500 people in Russia.[30] There were more than 30 severe weather phenomena in the period of 1998–2008 and the annual trend is increasing.[31] How will the forecast climate changes affect the frequency and type of natural disasters? Climate change in Russia over the past 10–20 years has been perceived as linked to extreme weather events, including heat-waves, floods and fires. Floods and storms result in 1000 deaths per year, and the hardest hit regions are where the population is the poorest – in eastern Siberia, the Far East and the southern regions.[32]

In conclusions there has been an increase in the past decade in the number of extreme climate induced phenomena (spring floods, other floods, avalanches, mudflows, hurricanes, heavy rain showers and forest fires, etc.) as well as more frequent unfavourable and abrupt weather changes in Russia. The annual number of such events more than doubled between 1991 and 2008.[33]

[29] Porfiriev, Boris (2012) 'Economic issues of disaster and disaster risk reduction policies: International vs. Russian perspectives', *International Journal of Disaster Risk Reduction*, Vol. 1, 55–61.

[30] Emergency Events Data Base (EM-DAT), on the Internet: www.emdat.be (retrieved 9 July 2013).

[31] Russian Federation (2010) *Fifth national communication 2010 by the Russian Federation to the UNFCCC*, Submission date: 12 February 2010. Revised version: 16 March 2010, RUS/COM/5 E, Interagency Commission of the Russian Federation on Climate Change Problems. on the Internet: http://unfccc.int/essential_background/library/items/3599.php?rec=j&priref=7239&data=&title=&author=%22Interagency+Commission+of+the+Russian+Federation+on+Climate+Change+Problems%22&keywords=&symbol=&meeting=&mo_from=&year_from=&mo_to=&year_to=&last_days=&anf=0&sorted=date_sort&dirc=DESC&seite=#beg (retrieved 30 August 2013).

[32] Kokorin A. (2008) *Expected Impact of the Changing Climate on Russia and Central Asia Countries*, Report No 2 and *Ongoing or Planned Adaptation Efforts and Strategies in Russia and Central Asia Countries*, Report No 3, WWF Russia, 2008.

[33] Roshydromet (2008) *Assessment report on climate change and its consequences in Russian Federation – General Summary*. Moscow.

3 The impacts of future climate change

This chapter covers how extreme climate related phenomenon like extreme high temperatures, high precipitation causing flooding, decreasing areas of permafrost and rapidly decreasing Arctic summer ice will have a negative impact on Russia, such as, agriculture and forestry. The decreasing permafrost might also release large amounts of stored methane enhancing the rate of global warming.

According to calculations by the Russian Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet), Russia will experience global warming to a significantly greater extent than most other countries. Temperatures in Russia are rising and will rise faster than the world average. Most of the observed increase in global temperature is due to the emission of greenhouse gases linked to human activity, such as burning fossil fuels (coal, oil, natural gas). The main greenhouse gas responsible for the rise in air temperature is carbon dioxide (CO_2). The second most important is methane (CH_4) and the third is nitrous oxide (N_2O).

It must be taken into account that scientists use computer models to anticipate possible future changes in the climate. Statements that are based on models are not firm predictions but 'best estimates' based on current understanding of complex processes and interactions. These projections indicate how the climate may change, as well as when and where these changes may occur.[34] There are many uncertainties in future projections of climate change and its impacts.[35] Basic monitoring and observations of climate change in Russia are carried out by Roshydromet.[36]

3.1 Temperature extremes, heat-waves and wildfires

An increase in temperature is viewed as the main indicator of climate change (see Figure 3). According to the IPCC Fifth assessment report (2013), each of the past three decades has been successively warmer at the Earth's surface than any preceding decade since 1850. In addition, in the northern hemisphere, 1983–2012 was probably the warmest 30-year period in the past 1400 years. It is likely that

[34] AMAP (2011) *Snow, Water, Ice and Permafrost in the Arctic: Climate Change and the Cryosphere*, SWIPA Scientific Assessment Report, Oslo, Norway, on the Internet: http://www.amap.no/swipa/ (retrieved 20 February 2013).

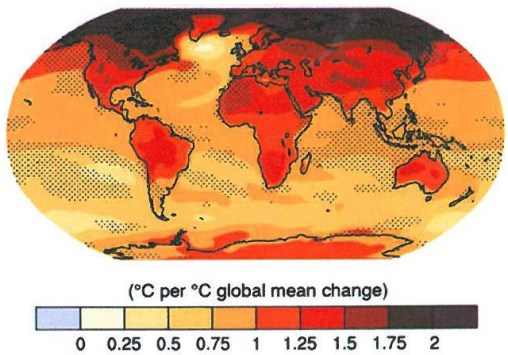
[35] Met Office Hadley Centre (2011) *Climate: Observations, projections and impacts*, Hadley Centre, UK, p. 64.

[36] Federal Service for Hydrometeorology and Environmental Monitoring, on the Internet: http://global-climate-change.ru/index.php/en/roshydromet (retrieved 9 September 2013).

the frequency of heat-waves has increased in large parts of Europe, Asia and Australia.[37]

It is certain that the Global Mean Surface Temperature has increased since the late 19th century. Global combined land and ocean temperature data show an increase of about 0.85 [0.65 to 1.06] degrees in the period 1880–2012 when described as a linear trend.[38] Using four scenarios with different emissions controls, the IPCC fifth assessment report projects that global average temperature will rise by 0.3 to 4.8°C by the end of the century, depending on the scenario.[39] The IPCC findings are in good agreement with Russian scientists' estimates of climate change.[40]

Figure 3. Change in global temperature



Source: IPCC (2013) *Technical Summary, In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* [Stocker, T.F., et al. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, U.S., p. 80. Box TS.6, Figure 1: Patterns of temperature for the CMIP5 (Coupled Model Intercomparison Project Phase 5), of the World Climate Research Programme models average, scaled by the corresponding global average temperature changes. The patterns are computed by taking the difference between the averages over the last 20 years of the 21st century experiments (2081–2100 for CMIP5) and the last 20 years of the historic experiments (1986–2005 for CMIP5) and rescaling each difference by the corresponding change in global average temperature.

[37] IPCC (2013) 'Summary for Policymakers', in: Climate Change (2013) *The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T. F. et al. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 3.

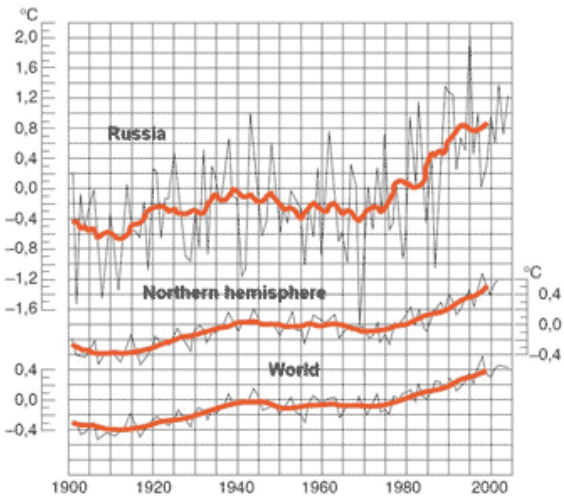
[38] IPCC (2013) 'Technical Summary', in: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T. F., et al. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, U.S., p. 37.

[39] IPCC (2013) 'Summary for Policymakers', in: *Climate Change (2013) The Physical Science Basis*….p. 18.

[40] Russian Federation (2010) *Fifth national communication 2010*…

In the period 1976–2012, the average warming in Russia was 0.43°C/decade, while global temperature increased at a rate of 0.17°C/decade. The most rapid increase in temperature is observed in spring and autumn (about 0.55°C/decade). Most of the average annual temperature increase is observed on the coast of the North Arctic Ocean (more than 0.8 °C/decade) and here the maximum warming is observed in all seasons except summer. In summer the most rapid warming occurs in the west, to the south of 55°N (0.8°C /decade). Warming is observed in the entire territory of Russia in all seasons except winter, where there are areas that are cooling in the far north-east and south of Siberia. The average winter temperature in Russia rose until the mid-1990s but then observed a weak relative decrease.[41] The average mean temperature in Russia compared with that recorded for the northern hemisphere and the global mean temperature is shown in Figure 4 for 1900–2000.

Figure 4. Changes in mean annual surface air temperature.



Source: Graph prepared by the Russian Federal Hydrometeorological Service. The upper curve is Russia, the middle curve is the northern hemisphere and the lower curve the world in general, on the Internet: http://blog.goethe.de/klimablog/index.php?archives/48-English.html&serendipity%5Blang_selected%5D=en (retrieved 9 November 2013).

[41] Russian Federation (2013) *Sixth National Communication of the Russian Federation*, Moscow 2013 (in Russian), p. 32, on the Internet: http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/6nc_rus_2013-12-30[1].pdf (retrieved 20 January 2014).

The 1901–2006 winter temperature trend increase for the entire Russian territory was 1.7°C/100 years, with regional variations.[42] The winter temperature could, according to projections, increase on average by 1ºC in most parts of Russia, but only 0.4ºC during the summer (2000–2015).[43] Increasing temperatures will cause northern Russia's permafrost to thaw and melt glaciers and sea ice. Snow is also expected to melt faster, causing underground water levels to rise. Storms are predicted to increase.[44]

Roshydromet argues that there are only 'minor variations' between the outputs of different scenarios for Russia by the middle of the century.[45] In particular, the annual mean temperature for Russia is projected to rise 1.1±0.5°C by 2020 and 2.6±0.7°C by 2060, above a 1990 baseline, and the winter mean surface temperature is projected to increase by 3.4±0.8°C by 2060.[46] Nonetheless, this means that Russia would cross the 2°C threshold earlier than the world average if significant and effective mitigation is not forthcoming.[47] In a more recent study, Sanderson et al.[48] report that by 2100, at the high end of the SRES (Special Report on Emissions Scenarios, IPCC) A2 scenario family,[49] 'the northern half of Asia', including Russia, is likely to experience a temperature increase of 6–16°C, compared to an approximate 4°C global mean temperature increase relative to preindustrial levels. Simulations by the UK Met Office Hadley Centre, exploring the SRES highest emission scenario family A1FI, demonstrate that the 4°C global average could be reached as early as in 2058 if relatively strong

[42] Dankers, Rutger, Oleg Anisimov, Pete Falloon, Jemma Gornall, Svetlana Reneva and Andy Wiltshire (2010) 'Climate impacts in Russia: changes in carbon storage and exchange', the Met Office Hadley Centre, Exeter Devon UK, p. 12.

[43] Kokorin, Alexey O. and Inna G. Gritsevich (2007) 'The Danger of Climate Change for Russia: Expected Losses and Recommendations', *Russian analytical digest* 23 July, pp. 2-4.

[44] Kokorin, A. (2008) Report No 2. *Expected Impact of the Changing Climate on Russia and Central Asia Countries*.

[45] Roshydromet (2008) [Ocenochnyj doklad ob izmenenijakh klimata i ikh posledstvijakh na territorii Rossijskoj Federacii] in Russian, *Assessment Report on Climate Change and Its Consequences in Russian Federation]: General Summary*. Moscow: Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) 2008.

[46] *Ibid.*

[47] *Ibid.*

[48] Sanderson, M. G., Hemming D. L., Betts R-A. (2011) 'Regional temperature and precipitation changes under high-end (>4◦C) global warming', *Phil. Trans. R. Soc. A: Math. Phys. Eng. Sci.*, Vol. 369, pp. 85–98.

[49] The IPCC published a set of scenarios in 2000 for use in the Third Assessment Report (Special Report on Emissions Scenarios - SRES). The SRES scenarios were constructed to explore future developments in the global environment with special reference to the production of greenhouse gases and aerosol precursor emissions.

carbon-cycle feedbacks are assumed. Other recent analyses warn of the global temperature change trending towards 4°C by as early as 2060–2070.[50]

The average temperature in Russia is rising faster than the world average surface temperature. This means that Russia will pass the +2°C temperature rise before the rest of the world. Heat waves will become more frequent as well as forest fires.

3.1.1 Forest fires due to extreme heat-waves

Heat-waves and forest fires are not uncommon in Russia. In 2010, Central and western Russia suffered its worst heat-wave since records began, 'the Great Russian heat-wave of 2010', since records began, with 33 consecutive days above 30°C in Moscow.[51] The heat-wave caused widespread drought, ruined crops and blanketed Moscow in smog, causing mortality rates to rapidly increase.[52]

There were 7000 natural fires in Russia in 2010, covering 5 to 15 million hectares of land.[53] According to data from the Ministry for Emergency Situations (Emercom) and the Federal Forest Agency, however, the area was ten times smaller. The Government tried to play down how serious the situation was in reality.[54] The fires threatened nuclear facilities and areas where the ground had been contaminated by radioactive fallout from Chernobyl. Russia's forest agency claimed that fires covering an area of 39 km^2 had been registered in radiation-polluted regions.[55] The fires might have resulted in radioactive particles becoming airborne and spreading over large distances. Around 70 per cent of the forest fires were caused by violations of fire safety rules by people in the forest. Russia's heat-wave apparently caused very high mortality rates – at least 56,000

[50] New, M, Liverman D, Schroder H, Anderson K. (2011) 'Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications', *Phil. Trans. R. Soc. A: Math. Phys. Eng. Sci.*, Vol. 369, pp. 6–19.

[51] Barriopedro, D., Fischer, E.M., Luterbacher, J., Trigo, R.M. and R. García-Herrera (2011) 'The hot summer of 2010: Redrawing the temperature record map of Europe', *Science*, Vol. 332, pp. 220-224; and Mokhov, I. I. (2008) 'Possible regional consequences of global climate changes', Russian Journal of Earth Sciences 10, ES6005, doi:10.2205/2007ES000228.

[52] Marshall, Michael and Jessica Hamzelou (2010) 'Is climate change burning Russia?' *New Scientist*, 12 August; and Russian Federation (2010) Fifth national communication....

[53] IFFN (2010) 'Preliminary Assessment of the Fire Situation in Western Siberia in 2010', Global Fire Monitoring Center, 15 August, *International Forest Fire News*, No. 40, July-December, pp. 20-42, on the Internet: http://www.fire.uni-freiburg.de/iffn/iffn_40/03-Russia-I.pdf (retrieved 20 December 2013); and Pynnäniemi, Katri and Irina Busygina (2013) 'Critical infrastructure protection and Russia's hybrid regime', European Security, p. 12.

[54] *Ibid*, p. 12.

[55] *Reuter* (2010) 'Russia's Medvedev cancels fire emergency in 3 regions', 12 August, on the Internet: http://reliefweb.int/report/russian-federation/russias-medvedev-cancels-fire-emergency-3-regions (retrieved 9 March 2013).

people died as a result of heat and air pollution.[56] President Medvedev stated that: 'what is happening now in our central regions is evidence of this global climate change…'.[57]

According to official statistics, by contrast, only 65 people died and 1068 suffered injury due to the effects of the fires. In reality, however, in Moscow alone the daily mortality rate jumped from 360–380 people in July 2009 to 700 people in July 2010. Around 14,000 deaths resulted from the summer heat, half of them in and around Moscow alone.[58] Drought, high temperatures and fires destroyed one-third of Russia's 2010 grain crop and affected over 13.3 million hectares of cropland in 41 Russian provinces. Estimates of total economic losses due to the forest fires vary from USD 15 billion to USD 300 billion.[59] Over 60,000 flights were delayed because of smog and the economy fell in July–August by 20–25 per cent at an estimated cost of 250 billion roubles (almost USD 14 billion) or 0.6 per cent of GDP. Response operations cost 14 billion roubles (USD 777 million).[60]

The heat-wave of 2010 was caused by the normal west-to-east movement of weather systems being blocked, a naturally occurring weather phenomenon common to Eurasia. It is not known whether, or to what extent, climate change will affect the frequency of blocking in the summer.[61] There is some evidence that climate change increases the number of heat-waves and makes them longer.[62] Extremes such as the severe heat-wave of 2010 are likely to occur more

[56] *Reuter* (2010) 'Heat, smoke sent Russia deaths soaring in 2010: govt', 25 October, 2010, on the Internet: http://www.reuters.com/article/2010/10/25/us-russia-heat-deaths-idUSTRE69O4LB20101025 (retrieved 14 June 2013).

[57] Rahmstorf, Stefan and Dim Coumou (2011) 'Increase of extreme events in a warming world', *PNAS*, October 24, pp. 1-5, doi: 10.1073/pnas.1101766108.

[58] Maier, F., A. Obregón, P. Bissoll, C. Achberger , J. J. Kennedy, D. E. Parker , O. Bulygina, and N. Korshunova (2011) 'Summer heat waves in Eastern Europe and western Russia in State of the Climate in 2010', *Bulletin of the American Meteorological Society*, Vol. 92, S210.

[59] Sidortsov, R. (2011) *Russia's perfect firestorm: climate adaptation lessons from the summer of 2010*, Working Paper Vermont Law School - Institute for Energy and the Environment, 29 pp.

[60] Porfiriev, Boris (2012) 'Economic issues of disaster and disaster risk reduction policies: International vs. Russian perspectives', *International Journal of Disaster Risk Reduction*, Vol. 1, pp. 55–61; and UNFCCC (2012) Report of the centralized in-depth review of the fifth national communication of the Russian Federation, Compliance Committee, United Nations Framework Convention on Climate Change, CC/ERT/2012/8, (FCCC/IDR.4/RUS), p. 28, 5 October, on the Internet: https://unfccc.int/files/kyoto_protocol/compliance/plenary/application/pdf/cc-ert-2012-8_idr_nc5_of_the_russian_federation.pdf (retrieved 20 January 2014).

[61] Lupo, Anthony R., Igor I.Mokhov, Merseid G. Akperov, Alexander V. Chernokulsky, and H. Athar (2012) 'A Dynamic Analysis of the Role of the Planetary- and Synoptic-Scale in the Summer of 2010 Blocking Episodes over the European Part of Russia', *Advances in Meteorology*, Vol. 2012, Article ID 584257, 11 pages, doi:10.1155/2012/584257

[62] Marshall, Michael and Jessica Hamzelou (2010) 'Is climate change burning Russia?' *New Scientist*, 12 August; and Trenberth, K. E. and J. Fasullo (2012) 'Climate extremes and climate change: The Russian Heat Wave and other Climate Extremes of 2010', J. Geophys. Res., Vol. 117, pp. 1-12, doi:10.1029/2012JD018020.

frequently in the near future, especially in western Russia where the frequency is expected to double by 2020 and quadruple by 2040.[63]

An examination of Russia's response to the 2010 fires showed that the government's fire-fighting and other emergency services were not capable of effectively preventing and containing the fires, and that ordinary Russian citizens acting in ad hoc volunteer fire-fighting units were essential to combatting the fires. Emercom and the fire service was heavily criticised for their handling of the large forest and peat-bog fires in Central Russia. Emercom responded that it was coping well with its main job of providing disaster relief. It argued that fighting forest fires in their early stages was not its responsibility, as this was the job of the Forest Patrol aerial units whose capability had been severely weakened by new forestry legislation.[64] It has been suggested that the federal government usually finds ways to deflect blame away from the federal level on to local leaders.[65]

The Public Commission of Investigation of the Causes and Consequences of the Wildfires in Russia in 2010 concluded that it was government policy that led to the fire catastrophe. The Russian government responded with more investment in fire suppression and prevention equipment, as well as organisational changes to federal responsibilities for fire prevention and fire-fighting. Officially, the fires were defined as 'uncontrolled (natural) burning' in forest areas, indicating a situation that is unmanageable, in order to avoid being held responsible for not fighting or preventing the fires efficiently.[66] It became clear that in 2010 insurance covered only 10 per cent of the buildings and only 25 per cent of the crops, which is very low compared to Western countries.[67] Following the July heat-wave, in August 2010 a hurricane and thunderstorms caused blackouts in 1500 urban areas in the north-west of Russia.[68] The summer of 2012 also resulted in a severe wildfire season.[69]

One likely consequence of climate change and the related rise in temperature will be an increase in the frequency of forest fires. The size and frequency of forest

[63] Coumou, D. and Robinson, A. (2013) 'Historic and future increase in the global land area affected by monthly heat extremes', *Environmental Research Letters*, Vol. 8, pp. 1-7, 034018. [doi:10.1088/1748-9326/8/3/034018], on the Internet: http://iopscience.iop.org/1748-9326/8/3/034018/article (retrieved 29 August 2013).

[64] Dobrolyubov, Nikolay (2013) 'Emergency at the Defense Ministry', *Moscow Defense Brief*, No. 2, 2013, pp.27-31.

[65] Giuliano, Elise (2013) 'Assigning Blame after Natural Disasters in Russia', *Ponars Eurasia, Policy Memo,* No. 281, September.

[66] Pynnäniemi and Busygina (2013) 'Critical infrastructure protection…', p. 12.

[67] Porfiriev (2012) 'Economic issues of disaster…', p. 60.

[68] Pynnäniemi and Busygina (2013) 'Critical infrastructure protection…', p. 7.

[69] GFMC (2012) 'Forest Fires in the Russian Federation', Global Fire Monitoring Center, 1 August 2012, on the Internet: http://www.fire.uni-freiburg.de/current/GFMC-Russia-Fire-SitRep-01-August-2012.pdf (retrieved 20 December 2013).

fires will increase, as well as the length of the fire risk. Ultimately, even the south Siberian regions will be affected, extending their summer fire-risk period by 30–50 per cent.[70] Fire danger changes linked to climate warming are becoming quite evident in the twenty-first century, but the spatial distribution of the changes across Russia is complicated.[71] In the latest IPCC report from 2014 climate change will increase the risk of wildfires in Russian boreal region (medium confidence)'.[72] Fire emissions significantly affect the Earth's climate system. However, published estimates of areas of wildfires in Russia and the ensuing greenhouse gas emissions vary significantly. The wildfire area estimates were for the period of 1998–2010 and the average burned area was estimated to be at 8.23 million hectares per year.[73]

3.2 Sea level rise, water resources, rainfall and flooding

Over the period 1901–2010, the global mean sea level rise was 0.19 m.[74] The IPCC fifth assessment report increased projections of the rise in sea levels to 0.26–0.98 m by the end of this century depending on model used.[75] However, high levels of uncertainty surround estimates of future global sea levels. Other models predict a rise of 0.9 to 1.6 m above the 1990 level by 2100, with melting Arctic ice making a significant contribution.[76] The net sea level rise has been predicted to be 0.6-0.8 m in the Kaliningrad area up to 2100, and 0.4–0.6 m

[70] Kokorin and Gritsevich (2007) 'The Danger of Climate Change for Russia…', pp. 2-4.

[71] Russian Federation (2013) *Sixth National Communication of the Russian Federation*, Moscow (in Russian), p. 21, on the Internet: http://unfccc.int/files/national_reports/annex_i_natcom/submitted_natcom/application/pdf/6nc_rus_2013-12-30[1].pdf (retrieved 20 January 2014); and Malevsky-Malevich S. P., E. K. Molkentin, E. D. Nadyozhina and O. B. Shklyarevich (2008) 'An assessment of potential change in wildfire activity in the Russian boreal forest zone induced by climate warming during the twenty-first century', *Climate Change*, Vol. 86, pp. 463–474, DOI 10.1007/s10584-007-9295-7.

[72] IPCC (2014) 'Summary for policymakers'. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Field, Christofer. B., et al. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Supplementary material, Table SPM.A1, pp. 30-32.

[73] Shvidenkoa, A. Z., D. G. Shchepashchenkoa, E. A. Vaganovc, A. I. Sukhinind, Sh. Sh. Maksyutove, I. McCalluma, and I. P. Lakydaa (2011) 'Impact of Wildfire in Russia between 1998–2010 on Ecosystems and the Global Carbon Budget', *Doklady Earth Sciences*, Vol. 441, Part 2, pp. 1678–1682.

[74] IPCC (2013) 'Summary for Policymakers' *In: Climate Change 2013: The Physical Science Basis* …, p. 9.

[75] *Ibid*, p. 23.

[76] AMAP (2011) *Snow, Water, Ice and Permafrost in the Arctic: Climate Change and the Cryosphere*. SWIPA Executive Summary, Arctic Monitoring and Assessment Programme, Oslo, Norway, p. 11. http://www.amap.no/swipa/

along the Russian coastline off the Gulf of Finland in the same period.[77] There is an increased probability of flood surges in the estuaries of large rivers flowing into the Sea of Azov and the Baltic Sea, and St. Petersburg will be particularly vulnerable to the forecast sea-level rise.[78] The level of the Black Sea has been rising since the 1920s, and more so since the 1980s, affecting the towns along the Russian, Ukrainian and Georgian coasts.[79] By the end of the 21st century, sea level change will have a strong regional pattern, which will dominate over variability, with many regions likely to experience substantial deviations from the global mean change. Changes in sea level will be up to 50 per cent lower than the global mean in the Arctic region.[80]

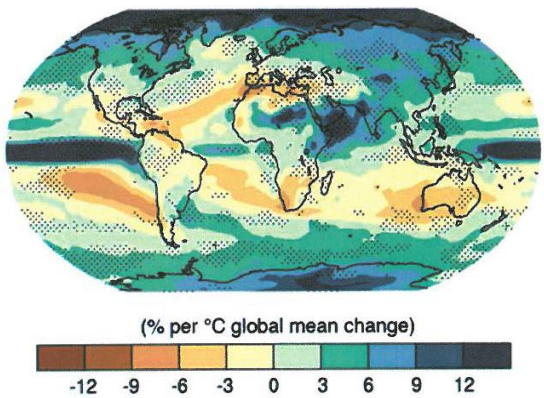
Russia possesses one-fifth of the world's fresh water reserves but this water is unevenly distributed.[81] The central and southern regions of European Russia, where 80 per cent of the country's population and industry are concentrated, have only 8 per cent of the water resources. The West of Russia is the most vulnerable region of the country to water limitations but for the rest of the country vulnerability is currently low. Increasing water shortages are predicted for southern parts of European Russia.[82] On much of the territory, in the north and north-west, in the Volga, the Urals areas, and in most of Siberia the amount of water will increase, while the Belgorod and Kursk Regions, the Stavropol and Krasnodar Regions and Kalmykia will see a serious decline in the amount of water. In the period 2010–2039, the general availability of water resources will increase in the whole country by 8–10 per cent. There will be a reduction in water resources as well as an increase in the amount of water used in some heavily populated regions that already have intensive levels of water use. This is also expected in the Chernozem areas of the central federal district, the southern federal district and in the south-western part of the Siberian federal district.[83]

Changes in precipitation have been studied much less than changes in the surface temperature. Annual precipitation in the period 1976–2012 increased in most parts of Russia, and over the whole country it grew by 9.6 mm/decade. Average annual precipitation ranges from 300–400 mm in the steppe regions of the

[77] CCRM (2008) *Climate Change in Russia: research and impacts*, A report by Climate Change Risk Management Ltd, UK, May 2008.
[78] Russian Federation (2010) *Fifth national communication….*
[79] Roshydromet (2008) *Assessment Report on Climate Change….*
[80] IPCC (2013) *Technical Summary, In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., et al. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, U.S., p. 80.
[81] EEA (2009) *Water resources across Europe – confronting water scarcity and drought*, Technical report European Environment Agency, No 2.
[82] 'Europe in a changing climate, Russia, Fresh water resources', Centre for Climate Adaptation, Web site, on the Internet: http://www.climateadaptation.eu/russia/fresh-water-resources/ (retrieved 30 January 2014).
[83] Russian Federation (2010) *Fifth national communication….*

country and northern Siberia, to 600–700 mm in the European forest zone and 800–1000 mm or more in mountainous areas.[84] It is predicted that an increase in precipitation by 10–15 per cent will cause major flooding in many parts of Russia by mid-century. For the southern regions of Russia, temperatures are expected to rise but precipitation to decrease, which will increase the risk of drought. By 2020, it is predicted that drought will have a significantly negative impact on agriculture in the southern regions, as much as a 22 per cent decrease in cereal production and a 14 per cent loss of forage crops in the North Caucasus.[85] For an overview of global precipitation patterns according to the IPCC see Figure 5.

Figure 5. Change in global precipitation.



Source: IPCC (2013) 'Technical Summary'*, In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* Stocker, T.F., et al. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, U.S., p. 80, Box TS.6, Figure 1: Patterns of percentage precipitation change (right column) for CMIP5, of the World Climate Research Programme models average, scaled by the corresponding global average temperature changes. The patterns are computed by taking the difference between the averages over the last 20 years of the 21st century experiments (2081–2100 for CMIP5) and the last 20 years of the historic experiments (1986–2005 for CMIP5).

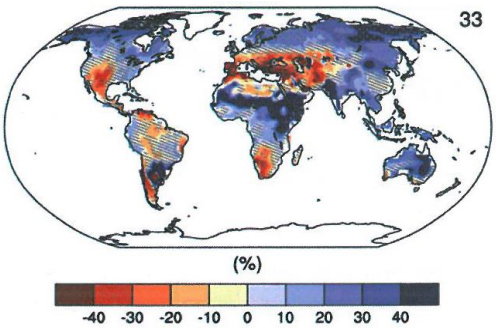
Recent studies suggest that winter precipitation could increase in Russia due to climate change. Increases of above 20 per cent are projected in the north of the country, with most other regions projected to experience increases of between 10 and 20 per cent. In the Caucasus region, projected precipitation change ranges

[84] Russian Federation (2013) *Sixth National Communication…*, p. 31.

[85] Kokorin, A. (2008) Report No 2, *Expected Impact of the Changing Climate on Russia and Central Asia Countries* and Report No 3, *Ongoing or Planned Adaptation Efforts and Strategies in Russia and Central Asia Countries*, WWF Russia.

from an increase of 5 per cent to a decrease of 5 per cent when comparing mean annual precipitation in 2100 with the mean 1960–1990 baseline using CMIP3 models.[86] The most essential changes are the increase in spring precipitation in the western and north-eastern regions of Siberia and in the European part of Russia.[87] The amount of precipitation will also increase during the cold period of the year.[88]

Figure 6. Annual mean changes in runoff, 2081–2100 relative to 1986–2005



Source: IPCC (2013) 'Technical Summary', *In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., et al. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, U.S., p. 45, TFE.1, Figure 3. Annual mean changes in runoff, for 2081–2100 relative to 1986–2005 under the RCP8.5 scenario. The number of CMIP5, of the World Climate Research Programme models to calculate the multi-model mean is indicated in the upper right corner of the panel.

Over the European parts of Russia, terrestrial snow cover is projected to decrease and winter runoff is expected to increase, while in Siberia the accumulated snow mass will increase. In Asian Russia, a combination of the increase in the snow mass accumulated during the winter and an acceleration of its melting in spring will result in increased risks of flooding.[89]

[86] Met Office Hadley Centre (2011) *Climate: Observations, projections and impacts, Russia*, the Met Office Hadley Centre, United Kingdom, p. 1, on the Internet: http://www.metoffice.gov.uk/media/pdf/g/e/Russia.pdf (retrieved 26 March 2013).
[87] Roshydromet (2008) *Assessment report on climate change*….
[88] Kokorin and Gritsevich (2007) 'The Danger of Climate Change…', pp. 2-4.
[89] Kattsov, Vladimir *et al* (2008) 'Climate Change Projections and Impacts in Russian Federation and Central Asia States', North Eurasia Climate Center, February, on the Internet: http://neacc.meteoinfo.ru/research/20-research/91-change-climat21-eng (retrieved 19 August 2013).

Analysis of annual runoff in Russia in the period 1981–2012 shows an average increase of 4.8 per cent compared with the period 1930–1980.[90] Runoff and flooding have increased by up to 15 per cent in many rivers in recent decades, including the Volga and the Ob.[91] Lena, one of the world's 10 longest rivers, has experienced several severe floods – and the 2001 flood was more severe than any previously recorded on the river.[92] According to media reports, Roshydromet provided early warning forecasts of dangerous spring thaw conditions in the river Lena basin in 2001, but local and provincial administrations in the Sakha Republic were too slow in responding.[93] As a result, the population was not well informed and the losses of more than 7 trillion roubles were much higher than they needed to be.[94] The flooding of the river Lena in 2001 demolished most of the buildings in Lemsk. Ice-jam-induced floods in the river Lena basin are expected to nearly double by 2015.[95]

The runoff of northern rivers will increase significantly in the future due to faster snow melt.[96] The largest increase in river runoff will occur in the watersheds of the northern rivers (Northern Dvina, Pechora, Mezen, and Onega) and the Siberian Rivers. On the other hand, runoff will decrease in the watersheds of the southern rivers (Don and Dnieper) due to annual precipitation decreases and evaporation increases in the spring and in the summer.[97] For an overview of the projected global runoff variations to the end of the century see Figure 6.

In the northern parts of Russia, as in the case of the river Lena, increased water discharges occurring earlier in the spring may be blocked by ice jams, causing longer periods of flooded plains.[98] Water flows will increase in the dams along

[90] Russian Federation (2013) *Sixth National Communication…*, p. 31.
[91] Semenov, V. A. (2011) 'Climate-related changes in hazardous and adverse hydrological events in the Russian rivers', *Russian Meteorology and Hydrology*, Vol. 36**,** pp**.** 124-129.
[92] Perelet, Renat, Serguey Pegov and Mikhail Yulkin (2007) *Human Development Report 2007/2008. Fighting climate change: Human solidarity in a divided world, Climate Change, Russia Country Paper,* United Nations Development Program (UNDP).
[93] APN (2005) *Institutional Capacity in Natural Disaster Risk Reduction: A Comparative Analysis of Institutions, National Policies, and Cooperative Responses to Floods in Asia*, Asia Pacific Network for Global Change Research, Final report for APN project 2005-01-CMY-Nikitina, on the Internet: http://www.apn-gcr.org/resources/archive/files/a4adb6376d59bf80f80999396843c8d8.pdf (retrieved 15 July 2012).
[94] WWF Russia and OXFAM (2008) *Russia and Neighbouring Countries: Environmental, Economic and Social impacts of climate change* (Eds. I.E. Chestin and Nicholas A.) WWF Russia, Oxfam GB, M.:2008, 64p.
[95] National Intelligence Council (2009) *Russia: The Impact of Climate Change to 2030*, Special Report, NIC 2009-04D, Joint Global Change Research Institute and Battelle Memorial Institute, Pacific Northwest Division, p. 16.
[96] Mokhov, I.I. (2008) 'Possible regional consequences of global climate changes', *Russian Journal of Earth Sciences* 10, ES6005, doi:10.2205/2007ES000228.
[97] Roshydromet (2008) *Assessment report on climate change*…., p. 14.
[98] Perelet, Pegov and Yulkin (2007) *Human Development Report 2007/2008*….

the Volga-Kamsk Cascade and in the north-west federal district. Managing the increased flows will pose problems due to extreme weather events or springtime ice-clogged rivers. If current trends for climate change in the 21st century continue, the number of floods on many rivers is expected to increase.[99] One consequence of increased precipitation and flooding is that marshy areas in the northern parts of Russia will expand, and this could also result in the increased spread of infectious diseases carried by insects and ticks.[100]

In July 2012 there was severe flooding in the western parts of the Krasnodar region on the Black Sea coast, which killed at least 171 people and left tens of thousands without homes.[101] In Krymsk the water level reached five metres high within hours. Most of those killed were in the town of Krymsk, but there were also fatalities in the two port cities of Novorossiysk and Gelendzhik. The material damage caused was estimated at over USD 100 million.[102] A total of 34,650 people were affected by the disaster. Up to 29,000 people lost all their property and 5,500 people lost some of their assets. A total of 3,910 people sought medical aid. Of them, 400 were diagnosed with serious or moderately serious injuries.[103] The government's poor handling of the situation raised questions about the Russian government's preparedness for the 2014 Winter Olympics in Sochi, on the Black Sea coast near the site of the floods. Meteorologists say they warned Emercom's regional branch of the impending storm in the mountains that surround Krymsk four hours in advance. However, survivors indicate that they received no prior warnings. There was growing pressure from the public to install an emergency warning system and improve weather forecasting.[104] Putin ordered an inquiry into why warnings were not given and who should have given them, and a presidential decree to establish a

[99] 'Europe in a changing climate, Russia, Fresh water resources', Centre for Climate Adaptation, Web site, on the Internet: http://www.climateadaptation.eu/russia/fresh-water-resources/ (retrieved 30 January 2014); and Russian Federation (2010) Fifth national communication….

[100] Revich, Boris, Nikolai Tokarevich, and Alan J. Parkinson (2012) 'Climate change and zoonotic infections in the Russian Arctic, *Int. J. Circumpolar Health*, Vol. 71, Published online July 23, doi: 10.3402/ijch.v71i0.18792, on the Internet: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3417549/ (retrieved 12 October 2013).

[101] *RIA Novosti* (2014) 'Russia Introduces New Emergency Alert System', 1 January, on the Internet: http://en.ria.ru/russia/20140101/186147650.html (retrieved 10 February 2014).

[102] Dzutsev, Valery (2012) 'Government Unaccountability Blamed for Poor Response to Krasnodar Floods', *North Caucasus Weekly.* 7/13/2012, 13 July, Vol. 13 Issue 14, pp. 13-15.

[103] *Interfax* (2012) 'Krymsk still facing problems with power, water, gas supplies', 12 July 12. http://rbth.ru/articles/2012/07/12/krymsk_still_facing_problems_with_power_water_gas_supplies_16315.html

[104] *Reuters* (2012) 'Russia floods spur calls for emergency warnings', 16 July, on the Internet: http://www.trust.org/alertnet/news/russia-floods-spur-calls-for-emergency-warnings/ (retrieved 9 March 2013); and RIA Novosti (2014) 'Russia Introduces New Emergency Alert System', 1 January. http://en.ria.ru/russia/20140101/186147650.html

new disaster alert system was issued in 2012.[105] Fully operational systems have so far been created in 39 Russian regions out of 83, while 40 regions indicated that they were almost ready in January 2014, according to the Russian emergencies ministry.[106]

Extremely heavy rainfall in Russia and China in July and August 2013 caused the river Amur to rise to record levels and flood surrounding areas, the worst in 120 years. In total 120 populated areas were affected and 32,000 people, of whom 17,000 were evacuated.[107] On the other side of the border, in China, 140,000 people were affected and 2,500 houses were destroyed.[108] Meteorologists have blamed the warming Arctic for the record rains in China and Russia. The shrinking ice cover in the Arctic Ocean has caused west-to-east upper-level winds to be replaced by south-to-north winds that have brought tropical rains as far north as Russia's Magadan Region, close to the Arctic Circle.[109] Whether these extreme flooding events are a result of climate change or a natural variation in the weather systems remains to be seen, but climate projections predict that these kinds of extreme weather events will become more frequent.

3.2.1 Implications for agriculture and forestry

Agricultural land occupies 13 per cent of Russian territory, 45 per cent is forest, 3 per cent is water, 19 per cent is reindeer pasture and 19 per cent is 'other land'. Wheat, sugar beet, potatoes and cereals (maize, barley, oats and rye) are Russia's most important crops.[110] The boreal forests and forest-steppe zones of Russia dominate in the North, separating the food-producing agricultural areas in the South.

[105] *Guardian* (2012) 'Russia: government and other national disasters', on the Internet: http://www.guardian.co.uk/commentisfree/2012/jul/09/russia-government-national-disasters-editorial (retrieved 12 August 2013).
[106] *RIA Novosti* (2014) 'Russia Introduces New Emergency Alert System', 1 January. http://en.ria.ru/russia/20140101/186147650.html
[107] *RIA Novosti* (2013) 'Floods in Russia's Far East Claim More Areas – Ministry', 17 August, on the Internet: http://en.rian.ru/russia/20130817/182818988/Floods-in-Russias-Far-East-Claim-More-Areas--Ministry.html (retrieved 19 August 2013).
[108] *DW* (2013) 'China, Russia hit by severe floods', 18 August, on the Internet: http://www.dw.de/china-russia-hit-by-severe-floods/a-17027618 (retrieved 19 August 2013).
[109] Natural disasters news (2013) 23 August, on the Internet: http://www.naturaldisastersnews.net/disaster-news/natural-disasters-events-archive-of-all-natural-disasters-news/floods/1459-2013-08-07-to-09-07-historical-floods-in-far-eastern-russia (retrieved 19 October 2013).
[110] Met Office Hadley Centre (2011) *Climate: Observations, projections and impacts, Russia*, Report Met Office Hadley Centre, p 73.

Russia will start to feel the impacts of climate change in relation to both water and food supply by 2030.[111] In the middle of the 21st century grain harvests in the Black Earth zone will be 10–13 per cent lower than 2010 levels and in the non-Chernozem zone between 11 and 29 per cent lower due to reduced precipitation. In the south of Siberia, crop yields will decrease by 20–25 per cent compared with current levels due to drought and become critical for the economies of these regions.[112] Nationwide, according to Roshydromet, grain yields could shrink by more than 11 per cent by 2020.[113]

Extensive droughts occurred in Russia in 1972, 1975, 1979, 1981, 1995, 1998 and 2002.[114] The droughts of 1975 and 1981 resulted in grain shortages and the total grain harvest in the country decreased by 23 per cent in comparison with the average harvest.[115] Another example of severe drought was 2012, when 22 regions suffered crop losses and a state of emergency was declared in 20 of these. The losses incurred were significant – the annual gross grain harvest was 70.9 million tonnes or 24.7 per cent lower than in 2011. One consequence was that the domestic price of grain and bread increased sharply.[116]

Climate change will mean that it could be possible to grow crops further north as the growing season becomes longer due to increasing average temperatures. It is, however, unlikely that the shift of agriculture to the boreal forest zone will bring significant production increases, due to the inferior soil quality.[117] In addition, plant diseases and pests will become a more serious challenge in many parts of Russia due to climate change.[118]

Russia also possesses the largest forested region on earth and has about half of the northern hemisphere's terrestrial carbon in its permafrost regions.[119] Deforestation and the melting of permafrost as well as a growing amount of black carbon in snow-covered areas, due to the deposition of soot from burning fossil fuels increasing the absorption of the sun's rays, could have considerable

[111] Kokorin, A. (2008) *Expected Impact of the Changing Climate*….
[112] Russian Federation (2010) *Fifth national communication*….
[113] Roshydromet (2005) *Materials for Strategic prognosis for climate change in the Russian Federation in 2010-2015 and its impact on Russian economy*.
[114] Russian Federation (2010) *Fifth national communication*….
[115] Roshydromet (2008) *Assessment report on climate change*….
[116] OXFAM (2013) 'After the drought, the 2012 drought, Russian farmers, and the challenges of adapting to extreme weather events', *OXFAM Case Study*, September,
[117] Russian Federation (2002) *Third National Communication on Climate Change Under the United Nations Framework Convention on Climate Change*, Interagency Commission of the Russian Federation on Climate Change.
[118] Roshydromet (2008) *Assessment Report on Climate Change*….
[119] Goodale, Christine, Michael Apps, Richard Birdsey, Christopher Field, Linda Heath, Richard Houghton, Jennifer Jenkins, Gundolf Kohlmaier, Werner Kurz, Shirong Liu, Gert-Jan Nabuurs, Sten Nilsson, Anatoly Shvidenko (2002) 'Forest carbon sinks in the Northern Hemisphere', *Ecological Applications*, Vol. 12, No. 3, pp. 891–99.

implications for global efforts to effectively mitigate climate change.[120] Extreme events, snowmelt and warmer temperatures have also caused significant tree loss and degradation, which will become more common with rising temperatures.[121]

3.3 Decreasing permafrost and sea ice, the effects of methane releases and climate change in northern Russia

The climate of northern Russia, including the Arctic region, is changing rapidly to the extent that 'dangerous climate change' as defined by the United Nations Framework on Climate Change (UNFCCC) might already be occurring.[122] The rate of climate change and decrease in Arctic sea ice could now be faster than ecosystems can adapt to naturally.[123]

The air temperature in northern Russia, including its Arctic region, is expected to increase by 2.0–3.5°C by 2050, roughly twice the global rate, and climate projections indicate substantial loss of permafrost by 2100.[124] Temperature increases in the central Arctic are projected to be 3–4°C in the next 50 years. Even an optimistic scenario for projecting future greenhouse gas emissions yields a 4°C increase in autumn and winter average temperatures in the Arctic region by the end of this century.[125] In Siberia, the mean annual temperature increase is around 3–4 times higher than that of the global mean temperature.[126] According to Emercom's Antistikhiya centre forecast, by 2100 the average temperature in the Arctic region could have increased by as much as 7°C.[127]

According to the IPCC's Fifth Assessment Report 2013 for RCP4.5, ensemble-mean winter warming will rise by 5.0°C over pan-Arctic land areas by the end of the 21st century (2081–2100) compared with the 1986–2005 period, and about

[120] Russian Federation (2002) *Third National Communication on Climate Change Under the United Nations Framework Convention on Climate Change*, Interagency Commission of the Russian Federation on Climate Change.

[121] Charap, Samuel (2009) 'Russia's Lackluster Record on Climate Change', *Russian Analytical Digest*, Vol. 79, No. 10, pp. 11-19.

[122] Ford, James D (2009) 'Dangerous climate change and the importance of adaptation for the Arctic's Inuit population', *Environ. Res. Lett*., Vol. 4, pp. 1-9.

[123] Lenton, T. M. (2012) 'Arctic climate tipping points', *AMBIO*, Vol. 41, No. 1, pp. 10–22. DOI:10.1007/s13280-011-0221-x; and Duarte, Carlos M., Timothy M. Lenton, Peter Wadhams and Paul Wassmann (2012) 'Abrupt climate change in the Arctic', *Nature Climate Change*, February, Vol. 2, p. 60.

[124] Ministry for Economic Development (2009) *Strategic Action Program for Protection of the Russian Arctic Environment*, Moscow, Government of the Russian Federation, p. 10.

[125] National Intelligence Council (2009) *Russia: The Impact of Climate Change*…, p. 11.

[126] Mokhov, I. I. (2008) 'Possible regional consequences of global climate changes', *Russian Journal of Earth Sciences* Vol. 10, ES6005, doi:10.2205/2007ES000228.

[127] *RIA Novosti* (2013) 'Arctic Temperatures to Grow Twice as Fast – Russian Ministry', 20 March,

7.0°C over the Arctic Sea. The RCP4.5 ensemble-mean warming is more modest in summer, reaching about 2.2°C by the end of the century over pan-Arctic land areas, and 1.5°C over the Arctic Sea. Under the RCP4.5 scenario, in the cold season, ensemble mean precipitation increases by about 25 per cent by the century's end. During the warm season, precipitation increases are smaller, at about 15 per cent.[128] Furthermore, in North Asia, a stronger than global mean warming trend is projected and temperatures will rise more in winter than in summer, while less annual variation is found over Central Asia. In North Asia, all the CMIP5 models project an increase in precipitation in the winter and summer periods.[129]

Climate-related changes in temperature and precipitation in the period 2000–2030 will also affect the flow of rivers. In the northern European parts of the country, flows will increase by 60–90 per cent in the winter and 20–50 per cent in the summer. The overall annual flow into the Arctic Ocean will increase by 10–20 per cent year by year and as much as 150–200 per cent during the winter. In all of the southern regions of the country, river flows will drop by 10–20 per cent.[130]

Permafrost covers 62–67 per cent of Russia.[131] The southern limit of the permafrost moved northwards by 30–80 km in western Russia between 1970 and 2005.[132] Permafrost temperatures have increased in most regions since the early 1980s. Observed warming was up to 2°C in parts of the Russian European North (1971–2010).[133] Model results based on five climate scenarios indicate that the permafrost area in Russia could decrease by 11 per cent, 18 per cent and 23 per cent by 2030, 2050 and 2080, respectively.[134] The southern permafrost boundary is expected to move northwards in western Siberia by 30–80 km in the next 20–25 years and by 150–200 km by 2050.[135] Widespread permafrost degradation

[128] Christensen, J. H., et al. (2013) 'Climate Phenomena and their Relevance for Future Regional Climate Change', Table 14.1, p. 1258 and 1278, In: IPCC (2013) *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., *et al.* (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[129] Christensen, J. H., et al. (2013) 'Climate Phenomena and their Relevance…', Table 14.1 and p. 1269.

[130] Kokorin and Gritsevich (2007) 'The Danger of Climate Change…, pp. 2-4.

[131] Kokorin A. (2008) *Expected Impact of the Changing Climate*….

[132] Dicks, Lynn, Rosamunde Almond and Anna McIvor (2011) 'Changes in Arctic Snow, Water, Ice and Permafrost', Arctic Monitoring and Assessment Programme (AMAP), Arctic Climate Issues, Oslo, Norway, p. 14.

[133] IPCC (2013) 'Summary for Policymakers', in IPCC (2013) *Climate Change 2013: The Physical Science Basis* …, p. 7.

[134] Anisimov, O. and S. Reneva (2006) 'Permafrost and changing climate: the Russian perspective', *Ambio*, Vol. 35, No. 4, pp. 169-175.

[135] Russian Federation (2010) *Fifth national communication*….; and Roshydromet (2008) Assessment report on climate change….

will permanently change local hydrology, increasing the frequency of fire and erosion disturbances.[136]

The extent of the Arctic sea ice in summer has shrunk over the past 30 years, and especially in the past ten years – and this is happening much faster than predicted by computer models just a few years ago. The sea ice is also getting thinner.[137] The extent of Arctic sea ice is rapidly diminishing. The minimum sea ice cover in September 2012 was 3.4 million km^2, 18 per cent below the previous recorded minimum in 2007 and about half the average levels recorded in the 1980s and 1990s.[138] The annual mean Arctic sea ice extent decreased in the period 1979–2012 at a rate of 3.5–4.1 per cent per decade (range of 0.45 to 0.51 million km^2 per decade), and in a range of 9.4–13.6 per cent per decade (range of 0.73 to 1.07 million km^2 per decade) for the summer sea ice minimum.[139] There is high confidence according to IPCC that the average winter sea ice thickness within the Arctic Basin decreased between 1980 and 2008, on average between 1.3 m and 2.3 m.[140] The IPCC Fifth assessment projections for shrinking sea ice in the Arctic are shown in Figure 7.

Impact assessments with respect to the climate change scenarios conclude that half to all of the summer sea ice could disappear by 2100.[141] Some scientists claim that the Arctic Ocean could be ice free in 30–40 years.[142] In the 21st century, under further global warming, an increase in the occurrence of icebergs is possible during periods of warming.[143]

Near complete loss of the summer sea ice, as forecast for the middle of this century, if not before, could shift the jet stream and storm tracks. In addition, loss of Arctic sea ice has been tentatively linked to the slowing down of atmospheric jet-streams which blocks weather systems. This, in turn, could cause extreme cold winters in Europe.[144] There is evidence that Arctic warming may already be

[136] UNEP (2012) *Policy Implications of Warming Permafrost*, United Nations Environmental Programme, Nairobi, p. iii-iv.

[137] IPCC (2013) 'Summary for Policymakers', in IPCC (2013) *Climate Change 2013: The Physical Science Basis* …, p. 7.

[138] Corell, Robert et al. (2013) The View from the Top: Searching for responses to a rapidly changing Arctic, UNEP Year Book, p. 19, on the Internet: http://www.unep.org/yearbook/2013/pdf/View_from_the_top_new.pdf (retrieved 20 January 2014).

[139] IPCC (2013) 'Summary for Policymakers', in: *Climate Change 2013: The Physical Science Basis…*, p. 7.

[140] IPCC (2013) 'Technical summary', in: *Climate Change 2013: The Physical Science Basis...*, p. 40.

[141] Boe, J. L., Hall, A. & Qu, X. (2009) 'September sea-ice cover in the Arctic Ocean projected to vanish by 2100', *Nature Geoscience*, Vol. 2, pp. 341-343.

[142] AMAP (2011) *Snow, Water, Ice and Permafrost…*, p. 7.

[143] Roshydromet (2008) *Assessment report on climate change*....

[144] Livina, V. N. and Lenton, T. M. (2013) 'A recent tipping point in the Arctic sea-ice cover: abrupt and persistent increase in the seasonal cycle since 2007', *The Cryosphere*, Vol. 7, No. 1, pp. 275–

causing a shift in weather patterns and changing the frequency and intensity of extreme weather events.[145] The Arctic is an important part of a large-scale movement of heat energy around the planet – acting as a 'pump' that drives cold seawater south in deep ocean currents and draws warm seawater north at the surface. As the Arctic Ocean receives increasing amounts of fresh water, this pump could weaken. Model results indicate that the discharge of fresh water could increase by a further 28 per cent by 2100.[146] Less saline waters due to the melting of ice may reduce the strength of the Gulf Stream.[147]

One significant risk is that tipping points may be passed. Tipping points are defined as critical points at which a small perturbation could qualitatively alter the future state of the Earth climate system. With respect to climate, tipping points are delicate thresholds where a relatively slight rise in Earth's temperature can cause a more dramatic change in climate. After the tipping point has been passed, a transition to a new state occurs.[148] According to Duarte, the Arctic region shows the largest concentration of potential tipping elements in the Earth's Climate System: Arctic sea ice, the Greenland Ice-Sheet, the North Atlantic deep water formation regions, boreal forests, plankton communities, permafrost and marine methane hydrates, among others.[149] In conclusion, the ability of climate models to realistically project the future of the Arctic sea ice is an important condition for adequately projecting the global climate.[150]

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86. DOI:10.5194/tc-7-275-2013; and Duarte, Lenton, Wadhams and Wassmann (2012) 'Abrupt climate change…', pp. 60-62.

[145] AMAP (2011) *Snow, Water, Ice and Permafrost*…, p. 7.

[146] Lawrence, D.M. and A.G. Slater (2005) 'A projection of severe near-surface permafrost degradation during the 21st century', *Geophysical Research Letters*, Vol. 32, L24401, doi:10.1029/2005GL025080.

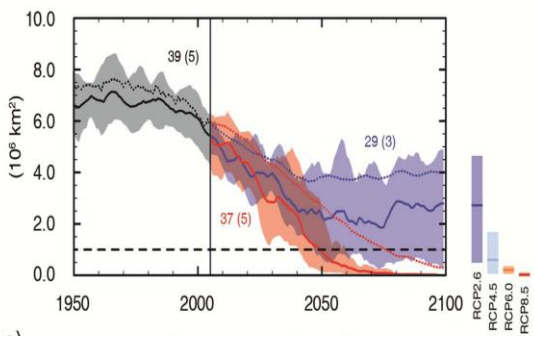
[147] Bethke, I., Drange H. and Furevik T. (2006) 'Towards a more saline North Atlantic and a fresher Arctic under global warming', *Geophys. Res. Lett*., Vol.32.

[148] Wassmann, P. and Lenton, T. M. (2012) 'The Arctic in the Earth System perspective: the role of tipping points', *Ambio*, Vol, 41, No. 1, pp. 1–9, DOI:10.1007/s13280-011-0230-9; Nuttall, M. (2012) 'Tipping points and the human world: living with change and thinking about the future', *Ambio*, Vol. 41, No. 1, pp. 96–105, DOI:10.1007/s13280-011-0228-3; and Young, O. R. (2012) 'Arctic tipping points: governance in turbulent times' *Ambio*, Vol. 41, No. 1, pp. 75–84, DOI:10.1007/s13280-011-0227-4.

[149] Duarte, Carlos (2012) 'Arctic is Already Suffering the Effects of a Dangerous Climate Change', *Science News*, 30 January; and Duarte, Carlos M. and Paul Wassmann (Eds.) (2011) *Arctic Tipping Points*, Fundacion, BBVA, Bilbao, Spain, 96 pages.

[150] Kattsov, Vladimir M., Vladimir E. Ryabinin, James E. Overland, Mark C. Serreze, Martin Visbeck, John E. Walsh, Walt Meier, Xiangdong Zhang (2010) 'Arctic sea-ice change: a grand challenge of climate science', *Journal of Glaciology*, Vol. 56, No. 200.

Figure 7. Extent of northern hemisphere September sea ice extent, five-year rolling mean



Source: IPCC (2013) 'Summary for Policymakers', In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Stocker, T.F., *et al*. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Figure SPM.7, p.19, CMIP5 multi-model simulated time series from 1950 to 2100 for northern hemisphere September sea ice extent (5-year running mean). Time series of projections and a measure of uncertainty (shading) are shown for scenarios RCP2.6 (blue) and RCP8.5 (red). Black (grey shading) is the modelled historical evolution using historical reconstructed forcing data. The mean and associated uncertainties averaged over 2081−2100 are given for all RCP scenarios as coloured vertical bars. The numbers of CMIP5 models used to calculate the multi-model mean is indicated. For sea ice extent the projected mean and uncertainty (minimum-maximum range) of the subset of models that most closely reproduce the climatological mean state and 1979 to 2012 trend of the Arctic sea ice is given (number of models given in brackets). For completeness, the CMIP5 multi-model mean is also indicated by dotted lines. The dashed line represents near ice-free conditions (i.e., when sea ice extent is less than 106 km^2 for at least five consecutive years).

The snow cover in northern Russia has shrunk by 10 per cent in the past 30 years and will shrink a further 10–20 per cent over the next century.[151] Satellite measurements from 1980 show the western regions of European Russia, Transbaikalia and Chukci region have a decrease in snow depth of 10–15 cm in some parts.[152] These changes suggest that deep permafrost layers may disappear far sooner than initially thought – possibly within 100 years.[153] Studies show that black carbon is the second-largest human contributor to climate change, exerts twice as much climate forcing impact as earlier thought and has two-thirds the climate impact of carbon dioxide (CO_2). Black carbon deposits on snow and ice

[151] Vigeland, Rottem, Svein and Arild Moe (2007) *Climate Change in the North and the Oil Industry, Input to Strategic Impact Assessment Barents Region 2030*, Report commissioned by Statoil Hydro ASA, Fridtjof Nansen Institute, November, p. 10.
[152] Roshydromet (2008) *Assessment report on climate change*....
[153] Ignatov G. (2012) 'Reality and myths of thawing of ice', *Oko Planet*.

have a powerful effect in the Arctic as they speed up permafrost and ice melting, thereby accelerating climate change.[154]

Russian Arctic (permafrost) coastlines are prone to erosion due to rising sea levels.[155] In the Laptev Sea area the coastline is receding by 2.5 m/year[156] – and in some parts by 10 metres or more.[157]

Permafrost degradation along the coast of the Kara Sea could lead to intensified coastal erosion, driving the coastline back by 2–4 metres per year.[158] Coastline retreat poses considerable risks for coastal population centres in Yamal and Taymyr as well as other littoral lowland areas.

If the permafrost thaws, large amounts of organic matter will thaw and decay, potentially releasing large amounts of CO_2 and methane into the atmosphere. Permafrost melting could therefore result in large amounts of methane being released this century.[159] This could result in one of the 'tipping points' climate scientists are concerned about, causing massive changes in the process of global warming that are not usually included in standard models. Uncertainties are large, but emissions from thawing permafrost could start within the next few decades and continue for several centuries, influencing both the short-term climate (before 2100) and the long-term climate (after 2100).[160] An estimated 70,000 million tonnes of methane is trapped in the permafrost and frozen marine sediments, which has the equivalent warming potential of 70 times the world's current total annual greenhouse gas emissions.[161]

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[154] Bond T. C. et al. (2013) 'Bounding the role of black carbon in the climate system: A scientific assessment', *Journal of Geophysical Research: Atmospheres*, 15 January 2013; and Schuur, E. A. G. (2013) 'Expert assessment of vulnerability of permafrost carbon to climate change', *Climatic Change* (2013) Vol. 119, pp. 359–374, DOI 10.1007/s10584-013-0730-7.

[155] Forbes, D. L. (ed.) (2011) *State of the Arctic Coast 2010 – Scientific Review and Outlook. International Arctic Science Committee, Land-Ocean Interactions in the Coastal Zone, Arctic Monitoring and Assessment Programme*, International Permafrost Association, Helmholtz-Zentrum, Geesthacht, Germany, 178 p, on the Internet: http://arcticcoasts.org (retrieved 12 March 2013).

[156] CCRM (2008) *Climate Change in Russia: research and impacts*….

[157] Ministry for Economic Development (2009) *Strategic Action Program for Protection of the Russian Arctic Environment, Moscow*, Government of the Russian Federation, p. 10.

[158] Anisimov, O.A. and Lavrov, C.A. (2004) 'Global warming and permafrost degradation: risk assessment for the infrastructure of the oil and gas industry', *Technol. Oil Gas Industry*, Vol. 3, pp. 78–83 (In Russian).

[159] Corell et al. (2013) *The View from the Top*…, pp. 19-35; Morozov, Yury (2012) 'Arctic 2030: What are the consequences of climate change? The Russian response', *Bulletin of the Atomic Scientists*, Vol. 68, No. 4, pp. 22–27; and Anderson, J. (ed.) (2007) *Climate change-induced water stress and its impact on natural and managed ecosystems*, Report European Parliament IP/A/CLIM/ST/2007.06.

[160] UNEP (2012) *Policy Implications of Warming Permafrost*, United Nations Environmental Programme, Nairobi, p. iii-iv.

[161] Anderson, J. (ed.) (2007) *Climate change-induced water stress*….

Methane is a particular concern because it is over 33 times more powerful than CO_2 as a greenhouse gas, although it does not last as long in the atmosphere as most of it eventually turns into CO_2.[162] Higher methane concentrations in the atmosphere will accelerate global warming and hasten local changes in northern Russia, including the Arctic region, speeding up sea-ice retreat and reducing the reflection of solar energy. The methane pulse would bring forward by 15–35 years the average date at which the global mean temperature rise exceeds 2°C.[163]

Along the Russian Arctic coast, including the East Siberian Arctic shelf, extensive methane venting or releases have been reported, and these will rise by up to 50 per cent by mid-century.[164] In western Siberia, where most of the wetlands are located, the future flux will be below 20 per cent, and therefore increases in Russian methane emissions from mid-century by 25–30 per cent.[165] A rapid methane release from stored gas hydrate[166] deposits kept in place on the East Siberian Arctic Shelf by pressure and low temperatures could also increase the rate of global warming.[167] It is, however, still unclear whether this methane will be released suddenly or over 50 years, and how much it will influence the rate of climate change.[168] Attempts have been made to calculate what the financial cost would be of the release of very large amounts of methane in the absence of mitigating action, and the costs could be huge.[169] Knowing the amount of permafrost bound carbon that is expected to be released this century and beyond is a critical consideration when identifying climate change mitigation goals.[170]

[162] Schuur, E. A. G. (2013) 'Expert assessment of vulnerability of permafrost carbon to climate change', *Climatic Change*, Vol. 119, pp. 359–374, DOI 10.1007/s10584-013-0730-7 http://download.springer.com/static/pdf/542/art%253A10.1007%252Fs10584-013-0730-7.pdf?auth66=1390555145_7f6d992ec8e77352d3f8f37d818d4954&ext=.pdf

[163] Whiteman, Gail, Chris Hope and Peter Wadhams (2013) 'Vast costs of Arctic change: Methane released by melting permafrost will have global impacts that must be better modelled', *Nature*, 25 July, Vol. 499, pp.401-403.

[164] UNEP (2013) 'Frozen heat – A global outlook on methane gas hydrates', United Nations Environmental Programme, on the Internet: http://www.methanegashydrates.org/about (retrieved 20 January 2014).

[165] CCRM (2008) *Climate Change in Russia:….*

[166] Gas hydrates are crystalline water-based solids physically resembling ice, in which small non-polar molecules typically gases like Methane are trapped inside 'cages' of hydrogen bonded water molecules, on the Internet: http://en.wikipedia.org/wiki/Gas_hydrate (retrieved 18 January 2014).

[167] Shakhova, N. E., Alekseev, V. A., Semiletov, and I. P. Doklady (2010) 'Predicted methane emission on the East Siberian shelf', *Earth Sciences*, Vol. 430, Issue 2, pp. 190-193.

[168] Russian Federation (2010) *Fifth national communication….*

[169] Whiteman, Gail, Chris Hope and Peter Wadhams (2013) 'Vast costs of Arctic change, Methane released by melting permafrost will have global impacts that must be better modelled', Nature, 25 July, Vol. 499, pp. 401-403.

[170] Schuur, E. A. G. (2013) 'Expert assessment of vulnerability of permafrost carbon to climate change', *Climatic Change* (2013) Vol. 119, pp. 359–374, DOI 10.1007/s10584-013-0730-7

There are three main feedback mechanisms that affect the global climate system:[171]

- The first is the change in reflectivity of the earth surface, as snow cover and ice reflect 80 per cent of the sun's rays. This area of snow and ice will decrease, resulting in an increase in the Earth's surface temperature thus further increasing the thawing of permafrost.
- The second involves the sea level rise due to melting sea ice, causing changes in ocean currents and circulation.
- The third is the increase in greenhouse gases, including methane, released from land and ocean floors due to the melting of permafrost. These emissions will increase the rate of global warming.

As the Arctic warms, these 'feedback mechanisms' will accelerate, thereby hastening and magnifying the effects of global warming not only in this region but throughout the entire planet.[172]

In summary, northern Russia, including the Arctic region, is expected to experience major effects of global warming and these impacts are not limited to this region but will affect the rate of climate change in the rest of the world.

3.4 UN Review of the Russian National Communications on climate change to the UNFCCC secretariat

The Russian government's official views on climate change vulnerability and adaptation in Russia can be found in its National Communications within the framework of the UNFCCC. The UNFCCC and its Kyoto Protocol obliges states that are parties of the agreement to take effective action on climate change. According to the UNFCCC, the UN carries out a centralised in-depth review of states' progress on climate change issues.

In 2000–2010, the total Russian greenhouse gas emissions remained broadly stable with an increase of only 3.5 per cent.[173] The fourth national

[171] UNEP (2013) *New Awareness of and Opportunities for UNEP to Address Climate Change in the Arctic*, Nairobi, Kenya, Report, 18 February, on the Internet: http://www.unep.org/gc/gc27/Docs/se/What%20Future%20for%20the%20Arctic.pdf (retrieved 21 January 2014.

[172] *Ibid.*

[173] UNFCCC (2012) *Report of the centralized in-depth review of the fifth national communication of the Russian Federation*, Compliance Committee, United Nations Framework Convention on Climate Change, CC/ERT/2012/8, (FCCC/IDR.4/RUS), p. 7, 5 October, on the Internet:

communication of the Russian Federation shows that the level of greenhouse gas emissions in the years 2010, 2015 and 2020 in absolute values will be 2,393, 2,638 and 2,908 Tg (million tonnes) CO_2 equivalent, which is below the Kyoto target by 28.0, 20.6 and 12.5 per cent, respectively (see Figure 8).[174] In Russia, over 72 per cent of greenhouse gas emissions are from the use of fossil fuels. In 2010 the Joint Implementation Supervisory Committee approved the first Joint Implementation project within Russia: an energy efficient power plant near Moscow.[175] Russia is expected to surpass its Kyoto Protocol target and the national conditional target by 2020 with the existing measures it has in place. [176]

The Fifth National Communication 2012 from the Russian Federation (NC5) reported limited information on progress made since the NC3[177] and NC4[178] related to vulnerability assessment, climate change impacts and adaptation measures. Despite the recommendations made during the UNFCCC secretariat's previous reviews, Russia does not identify any adaptation programmes or strategic approaches to adaptation that have been implemented and are not just planned. The section below summarises the information on vulnerability and future adaptation to climate change presented to the United Nations by Russia in its NC5.

https://unfccc.int/files/kyoto_protocol/compliance/plenary/application/pdf/cc-ert-2012-8_idr_nc5_of_the_russian_federation.pdf (retrieved 20 January 2014).

[174] UNFCCC (2009) *Report of the centralized in-depth review of the fourth national communication of the Russian Federation*, Compliance Committee, United Nations Framework Convention on Climate Change, CC/ERT/2009/3, (FCCC/IDR.4/RUS), 31 August, on the Internet: http://unfccc.int/files/kyoto_protocol/compliance/plenary/application/pdf/cc-ert-2009-3_report_of_ert_idr_of_the_russian_federation.pdf (retrieved 3 October 2013).

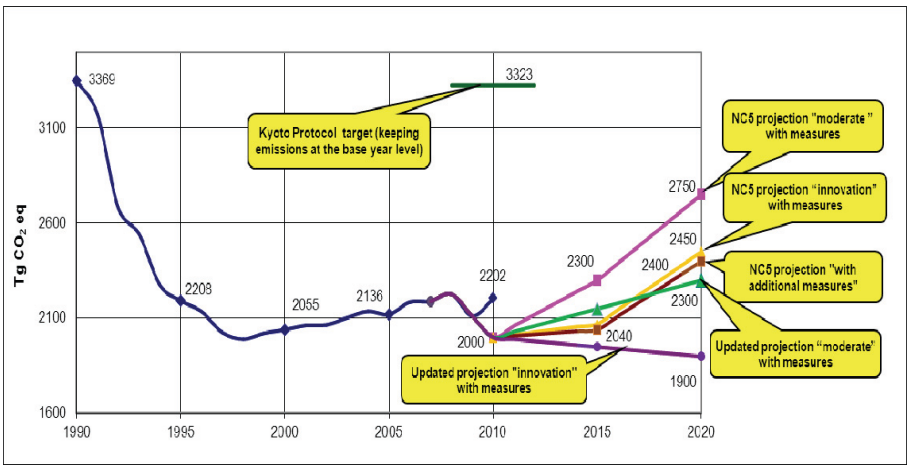
[175] Krukowska, Ewa (2010) 'UN Approves Russian Joint Implementation CO2 Reduction Project by E.ON', *Bloomberg News*, 18 October, on the Internet: http://www.bloomberg.com/news/2010-10-18/un-approves-russian-joint-implementation-co2-reduction-project-by-e-on.html (retrieved 12 October 2013).

[176] UNFCCC (2012) *Report of the centralized in-depth review of the fifth*…, p. 25.

[177] UNFCCC (2004) *Report on the in-depth review of the third national communication of the Russian Federation*, United Nations Framework Convention on Climate Change, FCCC/IDR.3/RUS, 10 June 2004, on the Internet: http://unfccc.int/resource/docs/idr/rus03.pdf (retrieved 15 October 2013).

[178] UNFCCC (2009) *Report of the centralized in-depth review of the fourth*….

Figure 8. Greenhouse gas emission projections, Fifth National Communication of the Russian Federation to the UNFCCC secretariat



Source: *Data* for 1990–2010: the Russian Federation's 2012 greenhouse gas inventory submission; the emissions exclude land use, land-use change and forestry; (2) Data for 2009– 2020: the Russian Federation's NC5. UNFCCC (2012) *Report of the centralized in-depth review of the fifth national communication of the Russian Federation*, Compliance Committee, UNFCCC, CC/ERT/2012/8, (FCCC/IDR.4/RUS), Figure p. 24, 5 October, on the Internet: https://unfccc.int/files/kyoto_protocol/compliance/plenary/application/pdf/cc-ert-2012-8_idr_nc5_of_the_russian_federation.pdf (retrieved 20 January 2014).

Table 3. Summary by the UNFCCC expert group of official Russian information on vulnerability and planned adaptation to climate change[179]

Agriculture and food security

Vulnerability: Pests with a lifecycle strongly dependent on the climate (e.g. locusts and Colorado beetles) become more active in the European part of the country and in Siberia. Warming in arid areas of Russian territory may increase the negative impacts of pests on crop yields. With the present agricultural technologies and geographical distribution of crops, the productivity of cereals in Siberia may decrease by 20–25 per cent. In the European part of the Russian Federation, with current trends, the productivity of grain will reduce by 9 per cent by 2020 and by 17 per cent by 2050.

Adaptation: Adaptation of crop production to warming is to be introduced in areas with sufficient moistening. Other measures include expansion of the use of more late-ripening and more productive varieties of cereal crops, maize and sunflower and of late-ripening varieties of potatoes, etc., a wider use of fertilizers and chemicals that are more efficient in a warm and damp climate, and the cultivation of beet and more

[179] UNFCCC (2012) *Report of the centralized in-depth review of the* fifth…Table 6 pp. 27-28.

heat-resistant types of green crops, soybean and alfalfa. Another adaptation measure is the development of an agro insurance programme.

Forests

Vulnerability: Climate warming will positively affect forest productivity; however, owing to climate warming, the frequency of heat-waves and elevated maximum temperatures, and the risk of forest fires will increase.

Adaptation: Implementation of a comprehensive programme on forest protection, remote operational monitoring of forests, the introduction of more efficient means for the control of forest fires and the strengthening of operative services raise opportunities for effective adaptation to forest fires.

Human health

Vulnerability: Occurrence of viral diseases will have a negative impact on some groups of the population. The impacts of heat-waves and long periods of extremely hot weather have been observed in several cities. The combination of heat-waves and increased air pollution may intensify negative effects under adverse meteorological conditions. Deterioration of water quality may also occur in some regions.

Adaptation: Installation of air-conditioning systems in residential and industrial facilities and an increase in their availability on the market, monitoring of adverse weather conditions and preventive protection measures with regard to vulnerable groups, the development of health and recreation facilities, dissemination of information on forecasting and weather conditions, and continuous monitoring of contagious and parasitic pests, their habitats and affected populations will facilitate efficient adaptation.

Water resources

Vulnerability: In some parts of the Russian Federation in 2010–2039 water resources will increase by 8–10 per cent, which will have a positive impact; however, in the big cities, owing to climate warming, water resources will reduce by 15–20 per cent and the need for water resources will increase by up to 25 per cent, including in the water-dependent agriculture sector of the Central federal region and the South federal region and in the Ob and Irtysh river basins of the Siberian federal region.

Adaptation: In the regions with expected reductions in water resources, adaptation measures are aimed at a search for and implementation of alternative and additional resources of water, in particular for agriculture, irrigation and energy production, as well as optimisation of regional water use and the construction of additional water reservoirs, such as in the river basins of the Ob and the Irtysh.

Source: UNFCCC (2012) *Report of the centralized in-depth review of the fifth national communication of the Russian Federation*, Compliance Committee, United Nations Framework Convention on Climate Change, CC/ERT/2012/8, (FCCC/IDR.4/RUS), Table 6 pp. 27–28.

According to the NC5, water resources, human health, forestry and agriculture could be the sectors most affected in the Russian Federation by the negative impacts of climate change. As reported by the Russian Federation in its NC5, the impacts of climate change could be positive or negative, owing to the geographical locations of particular regions, the territorial spread and the size of the country. Deterioration in water quality may also occur in some regions, including the Kalmyk Republic, Dagestan and the Karachay-Cherkessia Republic. Climate change in the Arctic region may affect the health and way of life of indigenous people, particularly owing to shifts in the ranges of some species on which some indigenous people are traditionally dependent.[180]

According to the United Nations review of Russia's Fourth National Communication (NC4), increased precipitation has already affected water resources such as in the Volga River and the Caspian Sea. With an expected increase in temperature and precipitation, the annual water flow could increase by 30–45 per cent in the Volga river basin, 25–40 per cent in the Dnieper river basin and 15–20 per cent in the Enisei river basin by the end of the century.[181]

According to the forecast in the NC4, some regions of Siberia may suffer from droughts and forests may be affected by increasing temperatures and changing soil conditions in permafrost regions. These impacts may lead to instability in forests, including changes in the composition of tree species and an increase in forest fires. The border of the permafrost zone will shift northwards by 150–200 km by the end of this century as a result of increased air temperatures. This will have negative impacts on the infrastructure, which was built under permafrost conditions. The need to heat buildings during winter is expected to decrease by between 5 and 20 per cent by 2050. This will have a positive socio-economic impact as a result of fuel savings. There are no potential impacts on human health, although vulnerabilities do exist with regard to human health. No information was included on the vulnerability of ecosystems.[182]

It should be noted that adaptation options were identified, but no strategic documents on adaptation were reported as developed, adopted or implemented. The review experts asked for more detailed information on planned and implemented adaptation measures.[183] The expert review of the information provided by the Russian government to the UNFCCC secretariat provides a general overview of how Russia sees climate changes and its impacts on Russia in the future. There is no information on which mitigation and adaptation measures have been implemented.

[180] UNFCCC (2012) *Report of the centralized in-depth review of the fifth*…, p. 28.
[181] UNFCCC (2009) *Report of the centralized in-depth review of the fourth*…, p. 18.
[182] *Ibid.*
[183] *Ibid.*

The Russian Federation also outlined in its NC4 report that limited information was given to the public on climate change through television channels or newspapers. Information on climate change is primarily provided by Roshydromet in scientific and educational publications, in press releases or on specialist websites. A few non-governmental organisations (NGO) such as the Russian Federation Ecological Centre, the Centre of Energy Efficiency and the Energy Carbon Fund carry out awareness-raising activities, according to the NC4 report.[184] In its NC5 report, the Russian Federation reported that NGOs, such as the International Socio-ecological Alliance (ISEA), the Ecological Alliance-Bellona, the CENEf and the Baikal Ecological Wave, prepare and implement a range of climate change awareness-raising and educational activities. ISEA publishes a weekly bulletin, *ISEA News*, which aims to draw the attention of the public and policymakers to human impacts on the biosphere, the climate and the environment. The Regional Environmental Centre, the CENEf and the World Wide Fund for Nature (WWF) developed a specialist website, Global Climate Change, on which they post the latest national and international research findings on climate change, activities undertaken by international organisations to mitigate climate change and analyses of environmental and climate issues. WWF Russia implements a programme entitled Climate and Energy and conducts a public awareness-raising campaign on advanced technology for energy use and transfer. The Russian Geographical Society supports scientific work, information dissemination and awareness-raising among the general public and various social groups.[185] The official view as presented in the framework of the UNFCCC is in general agreement with the results summarised in scientific publications, as noted above.

In conclusion climate models predict that extreme weather events in Russia will increase. The average surface temperature will rise faster in Russia than the world average. Heat waves and forest fires will become more frequent. In northern parts of Russia higher level of precipitation and runoff from rives will increase the frequency of river flooding. In southern parts of Russia there will be decreasing levels of precipitation and increased frequencies of droughts. Crop yields are predicted to decrease by over ten per cent by 2020. Climate change in northern Russia is now approaching tipping points that can cause major negative effects on ecosystems. The areas covered by permafrost and summer sea ice are rapidly decreasing and could result in release of large amounts of stored methane gas accelerating global warming.

[184] *Ibid.*, pp 16-17.
[185] UNFCCC (2012) *Report of the centralized in-depth review of the fifth*…., p. 32.

4 Impact on transport, buildings and the oil/gas industry

The effects of climate change on Russia will increase its exposure to various natural hazards. One area where the effects of global warming are already being observed is in the northern parts of Russia. For northern Russia, depending how it is defined (see the introduction), migration out of the region has been the main driving force of population change. Northern Russia, including the Arctic region, is, however, characterised by a higher population density and greater development of its economic resources than other countries in the far North. The northern parts of Russia are home to less than 10 per cent of the population, but they contributed nearly 20 per cent of the country's Gross Domestic Product (GDP) in 2011.[186]

Up to 60 per cent of raw material exports come from the northern parts of the country. Around 67 per cent of the Russian North is covered by permafrost, including some large urban areas, large ports, and numerous pipelines and oil and gas installations. Thawing permafrost linked to global warming will cause buildings to subside, pipelines to crack and roads to buckle, and this can already be observed.[187] In fact, scientists predict that decreasing permafrost will not only cause major damage to urban areas along the north coast, but the ground could subside and cause land to be claimed by the sea. Furthermore, it may lead to distortions in the terrain and changes in hydrology and vegetation.[188]

Climate-induced changes in permafrost areas will be detrimental to almost all the structures in the northern parts of Russia and may make many of them unusable.[189] Several large cities (Yakutsk, Norilsk and Vorkuta) with populations of more than 100,000 and many large river ports are built on permafrost.[190] In 1992, 10 per cent of buildings were already damaged in Norilsk, 22 per cent in Tiksi, 35 per cent in Dudinka and Dikson, 50 per cent in Pevek and Amderma, 55 per cent in Magadan, 60 per cent in Chita and 80 per cent in Vorkuta. In 1990–1999, the rate of reported damage to buildings increased by 42 per cent in Norilsk, 61 per cent in Yakutsk and 90 per cent in Amderma.[191] Current studies

[186] Pilyavsky, Valery P. (2011) 'The Arctic Russian Geopolitical and Economic Interests', p. 1, *FES Briefing Paper*, March, Friedrich-Ebert-Stiftung, Berlin, Germany.
[187] AMAP (2011) *Snow, Water, Ice and Permafrost*….
[188] Anisimov, O. and S. Reneva (2006) 'Permafrost and changing climate: the Russian perspective', *Ambio* 35(4):169-175.
[189] UNEP (2012) *Policy Implications of Warming Permafrost*, United Nations Environment Programme.
[190] *RIA Novosti* (2013) 'Development of Arctic region threatens oil spills, other emergencies', 20 December, on the Internet: http://arctic.ru/news/2013/12/development-arctic-region-threatens-oil-spills-other-emergencies.
[191] *Ibid*.

show that more than a quarter of residential buildings in the northern cities of Yakutsk, Vorkuta and Tiksi, especially those built between the 1950s and the 1970s, could become uninhabitable in the next 10–20 years.[192]

Figure 9. Residential block in Cherskiy, damaged as a result of the weakening of foundations built on permafrost. Photo: Professor Vladimir Romanovsky.

Pipeline and rail transportation systems that cross major rivers have encountered problems not anticipated when they were designed and railway systems have become deformed.[193] The annual number of incidents on the 350,000 km long network of pipelines in western Siberia has risen to 35,000. About 21 per cent of

[192] Kokorin and Gritsevich (2007) 'The Danger of Climate Change…', pp. 2-4.
[193] CCRM (2008) *Climate Change in Russia:*…, p. 42.

the reported incidents are caused by mechanical failures to the pipelines as a result of increased deformation or weakening of the foundations anchored in permafrost, and thus highly likely to be related to climatic change.[194] Transportation systems in general will experience major impacts from climate change by 2030. For the most part, these impacts will require significant adaptations, which will require substantial investments. This will also be true for Russia's extensive rail networks as well as its more limited road networks.

High voltage power lines, such as the lines serving the Bilibino nuclear power plant on the Arctic coast from the town of Chersk to Pevek, will be susceptible to damage due to thawing permafrost.[195] One positive aspect is that the warming climate means shorter heating seasons and reduced energy demand. The increased water availability in Siberian rivers could be used for hydroelectric power and result in increased power generation.[196]

The storage sites for spent nuclear fuel are a potential danger, including containers with spent nuclear fuel sunk in the sea off Novaya Zemlya.[197] There are other potentially dangerous sources of radiation in several areas, including at the Kola and Bilibino nuclear power plants.[198] There is limited data on how much radioactive material has been dumped in the Arctic, or where.[199] A worst-case scenario would be leakage of radioactive waste stored in the permafrost. This could have serious consequences for the Arctic region.[200]

Over 90 per cent of natural gas and 75 per cent of oil production occurs in areas of permafrost, and climate change could pose a threat to the energy sector.[201] Most of the extraction infrastructure and related structures were built on the assumption that the permafrost would not melt. Up to USD 1.8 billion is spent annually on incidents and the upkeep of pipelines. Overall, according to the Minister of Natural Resources, climate change could lead to a reduction of up to 5 per cent of GDP, while the cost of dealing with extreme weather events will amount to around USD 2 billion annually. Public health could also suffer, since

[194] Anisimov and Reneva (2006) 'Permafrost and changing climate…', pp. 169-175.
[195] National Intelligence Council (2009) *Russia: The Impact of Climate Change*….
[196] *Ibid*.
[197] Roshydromet (2005) [Strategicheskij prognoz izmenenij klimata Rossijskoj Federacii na period 2010-2015 gg. i ikh vlijanija na otrasli ehkonomiki Rossii] in Russian, *Strategic Forecast of Climate Changes in Russia in 2010-2015 and Their Influence on the Russian Economy,* Moscow: Federal service for hydrometeorology and environmental monitoring (RosHydromet).
[198] Ministry for Economic Development (2009) *Strategic Action Program for Protection of the Russian Arctic*…, p. 7; and Charap (2009) 'Russia's Lackluster Record on Climate…', pp. 11-19.
[199] UNEP (2002) GEO-3: Global Environment Outlook, United Nations Environmental Programme, on the Internet: http://www.unep.org/geo/geo3/english/483.htm (retrieved 20 March 2013).
[200] Vigeland, Rottem and Moe (2007) *Climate Change in the North*…, p. 11.
[201] UNDP (2009) *National Human Development Report in the Russian Federation, Energy Sector and Sustainable Development* (Ed. Prof. Sergey Bobylev; editing in English by Ben W. Hooson), Moscow, 2010, 166 pp.

permafrost melt poses a risk to the integrity of the water supply, sewers and engineering systems.[202]

Most hydrocarbon resources (about 70 per cent) are in the seas off the western Arctic coast, the Barents, Pechora and Kara seas. The transportation of oil by sea in this region could increase several times over. Russia has concentrated its production of oil and gas in the Yamal peninsula and the Timan-Pechora oilfield. The ambition is to expand the extraction of natural resources in the Shtockman field in the Barents Sea, the Prirazlomnoe oil field,[203] which is a part of the Timan-Pechora, and the Kara Sea.[204] Exploration of the continental shelf is slow due to the harsh weather conditions, involving considerable investment and high risk. Russia does not have the technology to exploit the continental shelf by itself, but depends on international cooperation.[205]

Current economic trends, especially when it comes to the price of natural gas, are not in Russia's long-term favour, mainly due to the extraction of shale gas and the international economic downturn. In the autumn of 2012, it was decided that the Shtockman gas and oil field in the Barents Sea would not be developed for the time being, due to the decreasing price of natural gas in relation to the relatively high cost of extraction. In order to sustain the level of production against falling volumes from the current major sources in western Siberia, Russia must rely on bringing new fields into production in eastern Siberia and Timan-Pechora.[206]

Currently, regional development of the energy sector seems to be shifting towards the Yamal peninsula. The distances involved in transporting resources from the new production zones to the consumer centres in western Russia and Europe will be greater than for current production.[207] Development of the Yamal Liquefied Natural Gas (LNG) project will be completed in 2016 and produce an annual total of 16.5 million tonnes of LNG, most of it to be transported along the Northern Sea Route. The source of the gas is the South-Tambey field, which has an estimated 1.9 trillion m^3 of natural gas. The Yamal LNG will be connected to the Sabetta port, which is able to handle more than 30 million tonnes of goods per year. The port is planned to be operational year-round, despite the highly complex ice conditions of the Ob Bay. The China National Petroleum

[202] Charap (2009) 'Russia's Lackluster Record on Climate…', pp. 11-19.
[203] Zysk, Katarzyna (2011) 'Military Aspects of Russia's Arctic Policy' in James Kraska (ed.) *Arctic Security in an Age of Climate Change* (United States of America: Manchester University Press), p. 96.
[204] Carlsson and Granholm (2013) *Russia and the Arctic*….
[205] Gerasimova, Tatiana (2012) 'Partnership for the sake of the shelf', *Kommersant Business Guide*, 19 June 2012.
[206] The Oil Drum (2012) 'Tech Talk - Future Russian Fuel Production from the Arctic', 4 March, on the Internet: http://www.theoildrum.com/node/8985 (retrieved 20 February 2013).
[207] Götz, Roland (2007) 'Russia and Global Warming – Implications for the Energy Industry', *Russian Analytical Digest*, 23 July, pp. 11-13.

Corporation has acquired a 20 per cent stake, having secured stakes in three of Rosneft's offshore fields in the Barents Sea. French Total previously had a 20 per cent stake in the Yamal LNG project.[208] There is also a growing Norwegian-Russian industrial cooperation in the oil and gas sector in the Arctic. Rosneft and Gazprom, the state-controlled energy companies, have been granted licences to develop the Arctic continental shelf sectors.[209] (For a discussion see also Carlsson and Granholm).[210]

The oil and gas industry will prospect and develop areas that are currently ice-prone, that is, the North Barents Sea, but also off the coast of Novaya Zemlya.[211] The combination of extreme precipitation events, strong winds and drifting ice by 2030 will have a strong impact on the Pechora Sea, which has an average depth of only 6 metres, where most of the confirmed and expected oil reserves in the Russian Barents Sea are located. This is an ice-prone area today, and both permanent and drifting ice creates serious problems for oil installations. Thinner and less extensive ice will create more open water, allowing stronger wave generation by winds and increasing wave-induced erosion along the Arctic shores.[212]

Damage to installations and incidents leading to oil leaks and gas emissions may become more frequent due to increased runoff and ice-jams in northern rivers.[213] Oil spills are seen by public opinion as the most disastrous consequence of more activity in northern Russia, including the Arctic region.[214] Greenpeace is one of many organisations to have protested against drilling in the Pechora Sea in Russia's Arctic waters.[215] It has been questioned whether offshore drilling rigs can stand up to the severe and frequent Arctic storms, one example being the capsizing of the Kolskaya floating drilling rig off the eastern coast of Russia in December 2011 in which 53 people died and damage exceeded USD 100 million.[216]

Gazprom is one of two Russian companies with drilling rights in the Arctic Ocean. It reported 2626 oil pipeline leaks in 2012. Rosneft is described as Russia's leading petroleum company and has the worst record for oil spills of

[208] Barents Observer (2013) 'New Chinese foothold in Russian Arctic', 3 July.
[209] *UPI* (2013) 'Global Warming Opening up Russian's Arctic Oil', January.
[210] Carlsson and Granholm (2013) *Russia and the Arctic*....
[211] Vigeland, Rottem and Moe (2007) *Climate Change in the North*…, p. 9.
[212] *Ibid*, p. 11.
[213] Chestin I. E. and Nicholas A. Colloff (2008) *Russia and neighbouring countries: environmental, economic and social impacts of climate change*, OXFAM and WWF Russia, Moscow.
[214] Vigeland Rottem and Moe (2007) *Climate Change in the North*…, p. 13.
[215] *New York Times* (2013) 'Russia: Greenpeace Members Held at Arctic Oil Rig', September 18, 2013
[216] *CBC News* (2012) 'Arctic development risks need study, Lloyd's says', 12 April.

any Russian producer. For example, the company was responsible for 75 per cent (2727) of all oil spills in the Khanty-Mansiisk autonomous district in 2011.[217]

Statistics show more than 20,000 incidents annually resulting in oil spills along all pipelines.[218] Environmentalists estimate that at least 1 per cent of Russia's annual oil production, or 5 million tonnes, is spilled every year. That is equivalent to one Deepwater Horizon-scale leak about every two months. Russian research shows that 10–15 per cent of the Russian oil leaked enters rivers. A 2010 report commissioned by the Natural Resources Ministry shows that nearly 500,000 tonnes of oil enters northern Russian rivers every year and flows into the Arctic. The Russian Economic Development Ministry estimated spills at up to 20 million tonnes per year in 2010.[219]

Chemical contamination in the Arctic poses a hazard because of the low assimilative capacity of its marine and terrestrial ecosystems. The concentration of heavy metals in soils, plants and animals, in water and snow, and in sea ice and sediments is increasing in many places. The Kola Bay, the Barents Sea, the Pechora Sea, the lower reaches of the Pechora River and the Ob Bay are among the areas with the highest levels of contamination.[220] Melting ice and snow release contaminants that have been stored for many years, allowing the contaminants to re-enter the environment. Exposure of people and top predators to contaminants that accumulate in food chains is likely to increase.[221]

The Ministry for Economic Development has reported similar observations that deteriorating living conditions of the indigenous population have emerged as a priority problem because of the high levels of contamination of drinking water intakes, poorer air quality in populated areas and hazardous waste dumps, among other things.[222] Of special concern also is the status of rare Arctic species, including endangered species as the polar bear, the Atlantic walrus, whales, snow sheep, certain species of white fish and salmon, waterfowl, geese and waders.[223]

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[217] 21stcentech (2013) 'Headlines: Russia and Arctic Oil Exploration – An Accident Waiting to Happen', 19 October, on the Internet: http://www.21stcentech.com/headlines-russia-arctic-oil-exploration-accident-waiting-happen/ (retrieved 20 October 2013).

[218] Ministry for Economic Development (2009) *Strategic Action Programme for Protection of the Russian Arctic…*.

[219] Walker, Tony R., Peter D. Crittenden, Scott D. Young, Tatyana Prystina (2006) 'An assessment of pollution impacts due to the oil and gas industries in the Pechora basin, north-eastern European Russia', *Ecological Indicators*, Vol. 6, pp. 369–87; and *AP* (2011) 'A Closer Look at the Staggering Ecological Cost of Russia's Oil Industry', 18 December, on the Internet: http://www.businessinsider.com/a-closer-look-at-the-staggering-ecological-cost-of-russias-oil-industry-2011-12 (retrieved 20 February 2013).

[220] Ministry for Economic Development (2009) *Strategic Action Program for Protection of the Russian Arctic…* p. 6.

[221] AMAP (2011) *Snow, Water, Ice and Permafrost…*, p. 9.

[222] Ministry for Economic Development (2009) *Strategic Action Program for Protection of the Russian Arctic…*, p. 9.

[223] *Ibid*, p. 8.

One study based on modelling projects that by 2055, fish catches at high latitudes, including in the Arctic Ocean, could increase by 30–70 per cent.[224] It is also possible that there will be shifts in the species of fish and in fish migration routes. Increasing oil pollution, however, could cause more friction between fishing interests and oil exploration.[225]

According to IPCC fifth assessment report 2014 climate change will negatively impact freshwater, terrestrial ecosystems and marine ecosystems, due to changes in ice, snow cover, permafrost, and freshwater/ocean conditions, affecting species' habitat quality, ranges, phenology, and productivity, as well as dependent economies.[226] Climate change will be a challenge for northern communities due to complex inter-linkages between climate-related hazards and societal factors, particularly if rate of change is faster than social systems can adapt.[227]

Increased Arctic navigability and expanded land- and freshwater-based transportation networks will increase economic opportunities. Opening transpolar sea routes across the Arctic Ocean will reduce the distance for ships travelling between Europe and the Pacific by 40 per cent compared to current routes.[228] However, it is important not to exaggerate the Northern Sea Route's transit potential by 2030. Many factors other than ice must be taken into account. The largest potential is for oil shipments.[229] Predictions are that the Northern Sea Route will carry 65 million tonnes by 2020 as opposed to the hundreds of thousands of tonnes in 2012. The Transport Strategy of the Russian Federation for 2008–2030 recognises the need to develop the Northern Sea Route, including the infrastructure on its shores, for example the ports.[230] For northern Europe, the

[224] Cheung, W. W. L., Lam, V. W. Y., Sarmiento, J. L., Kearney, K., Watson, R., Zeller, D. and Pauly, D. (2010) 'Large-Scale Redistribution of Maximum Fisheries Catch Potential in the Global Ocean under Climate Change., *Global Change Biology*, Vol. 16, pp. 24-35; and UNEP (2013) The View from the Top, Searching for responses to a rapidly changing Arctic, United Nations Environmental Programme, on the Internet: http://www.unep.org/yearbook/2013/pdf/View_from_the_top_new.pdf (retrieved 20 December 2013).

[225] *AP* (2011) 'A Closer Look at the Staggering Ecological Cost of Russia's Oil Industry', 18 December, p. 5.

[226] IPCC (2014) 'Summary for policymakers'. In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Field, Christofer. B., et al. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, Supplementary material, Table SPM.A1, pp. 30-32.

[227] *Ibid*.

[228] AMAP (2011) *Snow, Water, Ice and Permafrost*…, p. 11.

[229] Vigeland Rottem and Moe (2007) *Climate Change in the North*…, p. 10.

[230] Ministry of Transport (2008) 'Transport Strategy of the Russian Federation up to 2030', on the Internet: http://www.mintrans.ru/upload/iblock/3cc/ts_proekt_16102008.pdf (assessed 2012-11-13), pp. 98-99; and Carlsson and Granholm (2013) *Russia and the Arctic*…, p. 26.

Russian Arctic route could cut 7000 kilometres off the standard trip to Asia through Egypt's Suez Canal.[231]

There will be a need for the construction of new road and rail links, which will be difficult to build. Previous techniques, such as the use of seasonal ice roads, will be more problematic due to the shorter cold season.[232] New above-ground pipelines and other elevated installations will have to be constructed using deeper foundations to avoid structural damage from subsidence.[233] Since infrastructure systems, such as buildings, water supply, flood control and transportation networks, often function as a whole or not at all, an extreme event that exceeds an infrastructure's design can sometimes result in widespread failure and a potential disaster.

On land, access to many areas is becoming more difficult as ice roads melt earlier and freeze later and as permafrost degrades. Industrial operations reliant on ice roads will need to concentrate heavy load transport into the coldest part of the year.[234] The Yamal Peninsula will be more difficult to reach by land and harder to develop due to thawing permafrost and shorter winter seasons.[235] New fields are being developed in the Sea of Okhotsk, near Sakhalin Island. Others are being pursued as far west as the area to the north of Lake Baikal (e.g., the Kovykta field) and in the Sakha Republic (Yakutia). All these projects will require major new construction with countless major and minor river crossings.[236]

In April 2012, the Russian government unveiled plans to spend around 1.3 trillion roubles (USD 44 billion) on economic and social projects in the Arctic region before 2020. The private sector is expected to contribute some 80 billion roubles (USD 2.7 billion) to the projects. There will be new regulations designed to boost business activities in Russia's Arctic zone. Some amendments have already been introduced to Russian laws regulating commercial navigation along the Northern Sea Route.[237] In 2014 taxes will be reduced for companies wanting to develop new oil or gas deposits in the Arctic in order to compensate for the higher risks in the area.

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[231] *Voice of America* (2012) 'Climate Change Melts Away Obstacle to Arctic Shipping For China, Russia, November 29.

[232] IPCC (2012) *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change*, Figure SPM1, Intergovernmental Panel on Climate Change, Field, C. B. et al., (Eds.) Cambridge University Press: Cambridge, UK and New York, USA; and National Intelligence Council (2009) *Russia: The Impact of Climate*…, p.21.

[233] National Intelligence Council (2009) *Russia: The Impact of Climate*…, p. 21.

[234] AMAP (2011) *Snow, Water, Ice and Permafrost*…, p. 9.

[235] National Intelligence Council (2009) *Russia: The Impact of Climate*…, p.21.

[236] *Ibid*, p. 25.

[237] *RIA Novosti* (2012) 'Russia to Set Up Naval Infrastructure in Arctic – Patrushev', 6 August.

In conclusion the impact of climate change in the Arctic including environmental changes, demography, culture, and economic development, interact to determine physical, biological, and socioeconomic risks, with rates of change that may be faster than social systems can adapt. Thawing permafrost and changing precipitation patterns have the potential to affect infrastructure and related services like roads and railways, with particular risks for residential buildings, for example in northern Russian cities.[238] The major negative aspect of climate change for northern Russia are its impact on ecosystems, the environment and infrastructure, particularly in coastal areas, as well as on public health and traditional ways of life.[239]

[238] IPCC (2014) 'Technical summary', In: *Climate Change 2014: Impacts, Adaptation, and Vulnerability, Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*, Field, Christopher. B., et al. (eds.), Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 29.

[239] UNDP (2009*) Integrated Climate Change Strategies for Sustainable Development of Russia's Arctic Regions (Case Study for Murmansk oblast,)* Summary, UN Development Programme in Russia, Russian Regional Environmental Centre, Moscow, p. 9; and Russian Federation (2010) Fifth national communication…

5 Implications for security in northern Russia

Russia has the longest coastline in the Arctic Ocean, which is why it will play a central role in how the Arctic area is developed. Russia also has strong economic and security interests in the region.[240] The already occurring climate changes in northern Russia have implications for Russian security and the development of the large new oil and gas fields in the Arctic. New reserves are located in the northern coastal areas of Siberia and in the east of the country.[241]

There is an Arctic strategy in place, the 'Development Strategy of the Russian Arctic and national security for the period to 2020',[242] which is a follow-up to the 2008 Arctic strategy.[243] The 2013 document identifies the key mechanisms and priorities for the sustainable development of the Russian Arctic and for national security. The new strategy has a greater focus on a military presence than the previous one. Key priorities are ensuring military security, defence and protection of the borders of Russia in the Arctic region. This includes providing favourable operating conditions for the Armed Forces in the Arctic zone and maintaining the necessary level of combat readiness of troops.[244]

Furthermore, it points out that key factors influencing the economic development of the Russian Arctic are the extreme climatic conditions and that Russia lacks the modern technical means and technologies for exploration and development of the offshore hydrocarbon deposits in Arctic conditions. There is a need for authorities in Russia to improve forecasting and evaluate the effects of global climate change on the Arctic zone in the medium and long term, monitor ecosystems and flora, and eliminate the environmental damage caused by past economic, military and other activities in Russia's Arctic zone. The strategy also recognises the need to develop a system of comprehensive security to protect

[240] Carlsson and Granholm (2013) *Russia and the Arctic*….
[241] Götz (2007) 'Russia and Global Warming…', pp. 11-13.
[242] Russian Federation (2013) 'Development Strategy of the Russian Arctic and national security for the period up to 2020', developed in response to the 'Principles of State Policy of the Russian Federation in the Arctic up to 2020 and beyond', approved by the President of the Russian Federation, September 18, 2008 № Pr -1969.
[243] Russian Federation (2008) 'Principles of state policy for Russia in the Arctic up to 2020 and Beyond' (approved by the President of the Russian Federation, 18 September, No. Pr-1986, on the Internet: http://www.scrf.gov.ru/documents/98.html (retrieved 4 July 2012).
[244] Russian Federation (2013) 'Development Strategy of the Russian Arctic and national security for the period up to 2020', developed in response to the 'Principles of State Policy of the Russian Federation in the Arctic up to 2020 and beyond', approved by the President of the Russian Federation, September 18, 2008 № Pr -1969.

territories, populations and critical facilities in the Russian Arctic from natural and man-made disasters.[245]

A related Strategic Action Programme to Protect the Arctic Environment does not discuss climate change issues.[246] The importance of the Arctic in relation to natural resources is underlined in the Energy Strategy to 2030.[247] None of these strategic documents takes up the issue of climate change in detail or its effects on northern Russia, including the Arctic region, in particular.

In August 2007, Russia planted the Russian flag on the seabed beneath the North Pole.[248] Russia is claiming a large part of the Arctic shelf, the Lomonosov Ridge,[249] as a 1.2 million km^2 extension of Russia's continental shelf and thus the Russian economic zone under the guidelines of the United Nations Convention on the Law of the Sea (UNCLOS).[250] The federal government will submit its final Arctic territorial claims to the United Nations by 2014, after an initial submission was rejected due to its lack of detail.[251]

Canada is also working on a submission to be filed with the UNCLOS, arguing that the outer limit of Canada's territory includes the North Pole. The submission will further assert that Canada owns the Lomonosov Ridge.[252] A number of overlapping territorial claims such as these by countries in the Arctic might result in enhanced tensions.[253] According to media reports, President Putin responded rapidly to the Canadian decision by ordering the Russia defence ministry to

[245] *Ibid*.; and Ministry for Regional Development (2005) 'Draft concept of sustainable development of the Arctic zone of the Russian Federation', Moscow, on the Internet: www.minregion.ru (retrieved 4 July 2012).

[246] Ministry for Economic Development (2009) *Strategic Action Program for Protection of the Russian Arctic Environment*, Moscow, Government of the Russian Federation, p. 7.

[247] Russian Federation (2009) 'The Energy Strategy of Russia the period up to 2030', 13 November, No. 1715; and Carlsson and Granholm (2013) *Russia and the Arctic*….

[248] *Moscow Times* (2013) 'Russia to Submit Arctic Claims by Year's End', 24 January.

[249] Canada, the Kingdom of Denmark (via Greenland), and the Russian Federation each assert that the Ridge is an extension of their own continental shelf. Proof of its continuation, would give the State access to the sea bed and natural resources beyond the current 200 nautical mile limit. The United States claims it to be an oceanic ridge and thus not an extension of any State's continental shelf, and therefore refutes any claim to its ownership.

[250] *Moscow Times* (2013) 'Russia to Submit Arctic Claims by Year's End', 24 January.

[251] Huebert, R., Exner-Pirot, H., Lajeunesse, A. and Culledge, J. (2012) *Climate Change & International Security: The Arctic as a Bellwether*, Center for Climate and Energy Solutions, Arlington, VA, p. 32, on the Internet: http://www.c2es.org/publications/climate-change-international-arctic-security (retrieved 20 February 2013).

[252] Government of Canada (2013) *Partial Submission of Canada to the Commission on the limits of the Continental Shelf concerning its continental shelf in the Atlantic Ocean, Part 1 Executive Summary*, Report No. FRS 82/1-2013E, on the Internet: http://www.un.org/depts/los/clcs_new/submissions_files/can70_13/es_can_en.pdf (retrieved 20 January 2014).

[253] Carlsson and Granholm (2013) *Russia and the Arctic*…, p. 26.

complete the formation of new military units and infrastructure in the Arctic by 2014.[254]

According to media reports, Russia will enhance its forces in the Arctic in 2014 to ensure military security and protect the country's national interests in the region. President Vladimir Putin has named this development among the government's top priorities.[255] Russia has started the deployment of aerospace defence units in the Arctic and the construction of early warning missile radar in the countries extreme north.[256] The Northern Fleet is restoring to operational condition some of the military facilities and stations on the Arctic coast that were abandoned 20 years ago. They will be jointly used by the Ministry of Defence, Emercom, the Hydrographical service and the Weather Forecasting Service, among others. The Russian government has initiated an integrated monitoring system for the Arctic Ocean, and implemented other measures as part of the State Programme of Arctic Exploration to 2020. The Russian government is determined to enhance its control over critical installations, and retain full control over the Northern Sea Route and the natural resources of the Arctic shelf by giving priority to strengthening the Northern Fleet.[257] Russian military assets in the Arctic are discussed in more detail in an earlier FOI report.[258]

Current plans for a military presence remain modest given the large geographic area to be covered.[259] The Russian focus in the Arctic is to enhance cooperation, particularly in dealing with potential disasters. The Russian Arctic policy of 2008 lists as its goals the creation of a unified regional system for search and rescue, as well as the prevention of technological disasters and the elimination of their consequences, including the coordination of rescue services.[260] To build a functioning border control and rescue service along the Northern Sea Route is a

[254] *RT* (2013) 'Putin orders Arctic military build-up in 2014', 10 December,on the Internet: http://rt.com/news/arctic-russia-military-putin-000/ (retrieved 20 January 2014).

[255] *RT* (2013) 'Putin orders Arctic military build-up in 2014', 10 December, on the Internet: http://rt.com/news/arctic-russia-military-putin-000/ (retrieved 20 January 2014).

[256] *RIA Novosti* (2013) 'Russia Begins Deployment of Aerospace Defences in Arctic', 28 November, on the Internet: http://en.ria.ru/military_news/20131128/185114113/Russia-Begins-Deployment-of-Aerospace-Defenses-in-Arctic.html (retrieved 18 January 2014).

[257] Boltenkov, Dmitry (2014) 'The Russian Northern Fleet', *Moscow Defence Brief*, no. 1, pp. 20-24; *Interfax* (2014) 'Defense sector ready to provide arms for Arctic operations – Rogozin', 21 January, http://rbth.co.uk/news/2014/01/21/defense_sector_ready_to_provide_arms_for_arctic_operations_-_rogozin_33394.html; and *RIA Novosti* (2013) 'Arctic Made Priority for Russian Navy in 2014', 2 December. on the Internet: http://en.ria.ru/russia/20131202/185208917/Arctic-Made-Priority-for-Russian-Navy-in-2014.html (retrieved 20 January 2014).

[258] Carlsson and Granholm (2013) *Russia and the Arctic:…*, p. 26.

[259] Huebert, R., Exner-Pirot, H., Lajeunesse, A. and Culledge, J. (2012) *Climate Change & International Security: The Arctic as a Bellwether*, Center for Climate and Energy Solutions, Arlington, VA, p. 32.

[260] Brzoska, Michael (2012) 'Climate change and the military in China, Russia, the United Kingdom, and the United States', *Bulletin of the Atomic Scientists*, Vol. 68, No.2, pp. 43–54.

priority in both the Arctic Strategy and the Transport Strategy. Emercom and Ministry of Transport plan to establish ten rescue stations along the Northern Sea Route. The first emergency rescue centre on Russia's Arctic coast opened in 2013. It is planned that Border Troops will be based at the stations to form ten border control centres along the coast.[261]

In conclusion Russia clearly focuses on the Arctic region. It is both the exploitation of its natural resources including oil and gas as well as security concerns, that climate change will have a large impact on that is driving this development.

[261] Carlsson and Granholm (2013) *Russia and the Arctic:*…, p. 24.

6 Government policies on climate change

Russian climate policy developed slowly and primarily in response to the emerging international climate regime in the early 1990s. Russia signed the United Nations Framework Convention on Climate Change (UNFCCC) in 1994.[262] Some progress was made, such as the creation of an institutional framework for domestic implementation of its reporting and other UNFCCC commitments, formulation of mitigation and adaptation strategies and measures, greenhouse gas inventory compilation and reporting, and the development of national positions on the international agreements being negotiated.[263] Greenhouse gas emissions dropped rapidly after the break-up of the Soviet Union, to a large part due to the ensuing economic crisis. Russia's emissions will not return to 1990 levels, the limit set in the Kyoto Protocol, before at least 2020 without the need to take any further measures to limit emissions. Russia was concerned that the limits in the Kyoto Protocol would harm its economic growth. In reality, it was easy for Russia to ratify the Kyoto Protocol because Russia had already met its target as a result of its economic collapse and stood to gain financially from the sale of any remaining carbon credits to other countries.[264]

When the United States rejected ratifying the protocol, Russia delayed its ratification to secure diplomatic gains in negotiations with the European Union on support for joining the World Trade Organisation.[265] Russia's ratification in 2004 was required for the Kyoto Protocol to enter into force in 2005.[266] The Complex Action Plan for the Implementation of the Kyoto Protocol in the Russian Federation, 2004–2008, which was adopted in 2005, defines the responsibilities of different government bodies at the federal level. The Interdepartmental Commission on Implementation of the Kyoto Protocol in the

[262] Nikitina, Elena (2001) 'Russia: climate policy formation and implementation during the 1990s', *Climate Policy*, Volume 1, Issue 3, January 2001, pp. 289-308; and Federal law, No. 34-FZ (1994) 'On ratification of the Framework Convention on Climate Change (UNFCCC)', 4 November.

[263] *Ibid.*

[264] Harrison, Kathryn and Lisa McIntosh Sundstrom (2007) 'Introduction, The Comparative Politics of Climate Change', *Global Environmental Politics*, November, Vol. 7, No. 4, pp. 1-18.

[265] Vatansever, Adnan and Anna Korppoo (2012) 'A Climate Vision for Russia: From Rhetoric to Action' *Policy Outlook*, Carnegie Endowment for International Peace, August 1, on the Internet: http://carnegieendowment.org/2012/08/01/climate-vision-for-russia-from-rhetoric-to-action/d4tq (retrieved 26 September 2013).

[266] UNFCCC (2013) 'Status of ratification', United Nations Framework Convention on Climate Change, on the Internet: http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php (retrieved 12 November 2013).

Russian Federation, established in 2005, coordinates the activities of ministries and state agencies.[267]

The Climate Doctrine launched immediately before the 2009 Copenhagen climate summit provided the first signs that the Russian government was recognising that climate change could threaten its future economic development.[268] In December 2009, Russia was still 40 per cent below the 1990 baseline (see Figure 8). The Russian leadership has been slow to initiate implementation of the Kyoto Protocol in Russia.[269]

It is stated in the Climate Doctrine that a considerable part of the territory of the Russian Federation is subject to maximum climate change – both observed and predicted. Current and expected climate change, first and foremost the negative impacts and as their consequences, will have a significant impact on the socio-economic development of the country as a whole, and the life and health of its citizens.[270] The document also identifies climate change as a security threat. It consists mainly of existing rather than new policies.[271] The doctrine states that climate change is one of the major international problems of the 21st century and acknowledges that human economic activity contributes to climate change.[272] The intention is to implement measures aimed at:[273]

a) increasing energy efficiency in all sectors of the economy;
b) developing and deploying renewable and alternative energy sources;
c) reducing market imbalances and realising financial and fiscal policies to encourage anthropogenic greenhouse gas emission reduction;
d) protecting and enhancing the capacity of carbon sinks, including sustainable forestry, forestation, and re-forestation.

There are, however, no figures included – and the document is not binding but states only that climate change is a real problem. According to Shamira et al., only points (a) and (c) have received any attention from the government.[274] The

[267] UNFCCC (2009) *Report of the centralized in-depth review of the fourth….*
[268] Lioubimtseva, Elena (2011) 'Russia's Role in the Post-2012 Climate Change Policy: Key Contradictions and Uncertainties', *Forum on Public Policy*; and Russian Federation (2009) *Climate Doctrine of the Russian Federation for the Period until 2020*.
[269] Kokorin, Alexey and Anna Korppoo (2013) 'Russia's Post-Kyoto Climate Policy: Real Action or Merely Window-Dressing?' Fridtjof Nansen Institute, *FNI Climate Policy Perspectives*, 10 May, on Internet: http://www.fni.no/doc&pdf/FNI-Climate-Policy-Perspectives-10.pdf (retrieved 11 June 2013).
[270] Russian Federation (2009) *Climate Doctrine of the Russian Federation for the Period until 2020*.
[271] Kokorin and Korppoo (2013) 'Russia's Post-Kyoto Climate Policy…'.
[272] Henry, Laura A. and Lisa McIntosh Sundstrom (2012) 'Russia's Climate Policy: International Bargaining and Domestic Modernisation', *Europe-Asia Studies*, Vol. 64, Issue 7, 2012, p. 1312.
[273] Sharmina, Maria, Kevin Anderson and Alice Bows-Larkin (2013) 'Climate change regional review: Russia', *WIREs Climate Change*, Vol. 4, pp. 373–396, doi: 10.1002/wcc.236
[274] *Ibid.*

doctrine has remained as a political declaration rather than a practical policy document.

The Climate Doctrine was followed by a 'Comprehensive Plan for Implementing the Russian Federation's Climate Doctrine for the Period to 2020', launched in time for the 2010 climate negotiation round in Cancun and adopted after modifications in April 2011.[275] The plan consists of 31 items. It outlines key activities, the responsible executive authorities, and implementation timelines for these activities. The plan suggests that between 2011 and 2020, the Ministry of Economic Development will introduce changes to Russia's long-term macroeconomic forecasts to take account of climate risks, the mitigation of anthropogenic impacts on the climate, and adaptation to climate change. For example, two of the 31 activities listed in the Plan concern adaptation by the agricultural sector, but the timeline outlined in the plan and the development of a system of agricultural adaptation measures are currently in the initial stages, and this system is not expected to be in place before 2020.[276] Domestically, Roshydromet has argued for the need for domestic mitigation and adaptation policies.[277] The climate doctrine was signed by President Dmitry Medvedev, but it is questionable whether President Putin still believes that climate change is a priority area.

Russia in 2012 re-established an inter-ministerial working group on climate change and sustainable development. This could perhaps revitalise the limited public debate on climate change in Russia. The working group is formally under the umbrella of the presidential administration, and continues the work done by a similar commission that was dissolved in 2004.[278]

After signing the Kyoto Protocol, Russian policymakers began to frame the question of climate change by merging domestic policies with established international conclusions on the climate change problem. Nonetheless, some Russian policymakers continue to express doubts about the human causes of and ability to impact climate change.[279] There seems to be resistance to proactive mitigation and adaptation measures within Russia's leadership. Frequently cited reasons for inaction are that climate change is a slow process, the country's perceived relatively high adaptive capacity, and its other physical geographic

[275] Government of Russia (2011) 'Comprehensive Plan of Implementing the Russian Federation's Climate Doctrine for the Period until 2020', Government decree, No 730-p, 25 April, 2011.
[276] OXFAM (2013) *After the drought, the 2012 drought, Russian farmers, and the challenges of adapting to extreme weather events*, OXFAM Case Study, September,
[277] Roshydromet (2008) *Assessment report on climate*….
[278] Roshydromet (2008) *Assessment report on climate*….
[279] Wilson Rowe, Elana (2013) 'Climate science, Russian politics, and the framing of climate change', *WIREs Climate Change*, Vol. 4, pp. 457–465.

characteristics such as its large forest carbon sinks and extensive fossil fuel reserves.[280]

Climate change policy is clearly not one of the top 50 priorities for long-term development in Russia, according to the Ministry of Economic Development. Issues directly or indirectly related to climate change, such as energy efficiency and forest management, for example, are recognised and dealt with separately, without linking them to climate change.[281] On the other hand, energy efficiency is mentioned in the climate doctrine, in the 2008–2030 transport strategy and in the 2009–2020 water strategy.[282]

Russia's weak initial implementation of the Kyoto Protocol contrasts with its slightly more active engagement in climate policy during the Medvedev presidency up to 2012. Greater attention to climate policies could be promoted due to their potentially positive impacts on efforts to introduce new technologies and increase energy efficiency.[283] President Medvedev approved a law on improving energy efficiency in 2009 with the aim of reducing the energy intensity of GDP by 40 per cent by 2020 compared to 2007.[284] A three-stage energy strategy to 2030 was approved,[285] aimed at achieving more efficient use of traditional energy and an increased role for alternative energy.[286] These measures were in the national interest because they would enhance the competitiveness of Russian industry and enable it to meet foreign demand for its oil and gas reserves.[287] These goals were linked to the climate policy in

[280] Sharmina, Anderson and Bows-Larkin (2013) 'Climate change regional review…' pp. 373–396.
[281] Dobrovidova, Olga (2013) 'Climate change fails to make Russia's top 50 priorities', RTCC, Responding to Climate Change, 5 June.
[282] Russian Federation (2009) 'Water Strategy of the Russian Federation for the period up to 2020' (approved by the Government of the Russian Federation, 27 August, No. 1235-p).
[283] Henry and Sundstrom (2012) 'Russia's Climate Policy…', pp. 1297-1322.
[284] President of Russia (2008) 'On some measures to improve energy and environmental efficiency of the Russian economy', Decree of June 4, N 889.
[285] Ministry of Energy (2009) 'Energy Strategy of Russia until 2030', No. 1715, 13 November, on the Internet: http://minenergo.gov.ru/documents/zakon/ (retrieved 16 June 2012).
[286] Henry and Sundstrom (2012) 'Russia's Climate Policy:…, pp. 1297-1322; and Charap, S. and G. V. Safonov (2010) 'Climate change and role of energy efficiency' in (A. Åslund, S. Guriev, A Kuchins Eds.) *Russia after the Global Economic Crises*, Peterson Institute for International Economics/Center for Strategic and International Studies, Washington, DC. and New Economic School, Moscow.
[287] Andonova, Liliana B. and Assia Alexieva (2012) 'Continuity and change in Russia's climate negotiations position and strategy', *Climate Policy* 12: 614–629; and Korppoo, A., G. Sakonov and O. Lugovoy (2010) 'Russia and the Post-2012 Climate Regime: Emission Trends, Commitments and Bargains', Nordic Council of Ministers, Copenhagen, on the Internet: http://www.norden.ru/userfiles/file/Publications/Russia%20and%20the%20Post%202012%20Climate%20Regime.pdf (retrieved 20 September 2013).

preparation for the Fifteenth Conference of the Parties to the UNFCCC in Copenhagen.[288]

Russia's economy is the most energy intensive of the G20 countries at three times the intensity of the EU average.[289] Russia is also still the world's third-largest fossil energy subsidiser, although there is a reform under way to reduce these subsidies. Russia has gradually raised domestic energy prices since the early 2000s with the aim to transition to a market-based price for energy.[290] The goal of a 40 per cent reduction in the energy intensity of the economy was announced before the 2012 G8 summit, in order to demonstrate a constructive Russian attitude towards the climate change negotiations.[291] This is, however, only slowly being implemented.[292] The need to increase energy efficiency is widely acknowledged in government policy documents and increasingly referred to by both Putin and Medvedev as a key challenge facing the Russian economy.[293]

Technical background information on climate change in Russia was prepared by Roshydromet.[294] The stated negotiating position was, and still is, that major economies must 'simultaneously make the necessary commitments to tackle climate change, and that 'commitments must not conflict with economic opportunities or, most importantly, the development priorities of each country'. Medvedev further noted 'Obviously global climate change is a very complex issue and there are different points of view…'.[295] Medvedev committed Russia to limit its emissions to 25 per cent below 1990 levels by 2020 if other countries would do the same. Even if Russia was more active at presenting initiatives on climate change before Copenhagen, it did not greatly influence the outcome of the negotiations. Russia has not until recently become more engaged in the

[288] Douma, W. T., M. Kozeltsev and J Dobrolyubova (2010) 'Russia and the international climate change regime', in (S. Oberthur, M. Pallemaerts and C. R. Kelly Eds.) *The New Climate Policies of the European Union*, Brussels University Press, Brussels, pp. 281-308.

[289] Vatansever and Korppoo (2012) 'A Climate Vision for Russia….'

[290] Sharmina, Anderson and Bows-Larkin (2013) 'Climate change regional review…, pp. 373–396.

[291] Kokorin and Korppoo (2013) 'Russia's Post-Kyoto Climate Policy…'

[292] Vatansever, and Korppoo (2012) 'A Climate Vision for Russia…'; and Ministry of Economic Development (2013) 'Projection of long-term social and economic development of the Russian Federation until 2030', 25 March, P.147, on the Internet: http://www.economy.gov.ru/minec/activity/sections/macro/prognoz/doc20130325_06 (retrieved 29 September 2013).

[293] Wilson Rowe, Elana (2013) 'Climate science, Russian politics…', pp. 457–465.

[294] Roshydromet (2008) *Evaluation report on climate change and its consequences in the Russian Federation*, Bedritskiy, A. I. et al, Based on Technical Summary and the main Report (volumes I and II), on the Internet: http://climate2008.igce.ru/v2008/pdf/resume_ob_eng.pdf (retrieved 26 September 2013); and Roshydromet (2005) *Strategic Prediction of Climate Change in the Russian Federation for the period 2010–2015 and its Influences on Different Sectors of Economy*.

[295] Medvedev D. (2009) 'Speech at Climate Change Conference Plenary Session', December 18, on the Internet: http://eng.kremlin.ru/text/speeches/2009/12/18/1840_type82914_2234 31.shtml (retrieved 5 February 2011).

international mechanisms that could provide the country with direct benefits through, for example, trade in so-called 'surplus emission allowances', even though its baseline emissions are significantly lower than the Kyoto targets. In general, climate change policies are seen as less important than economic or energy policies.[296]

It should be noted that cooperation on climate change was identified as an area in the EU-Russia 'Partnership for Modernisation' from 2010, as it was seen as a less politically sensitive area. There is some cooperation between the EU and Russia, but only where Russian commercial interests are not threatened. The EU continues to try to engage Russia on climate change issues, but with limited success.[297] An administrative arrangement was agreed in 2013 between the Emercom and the EU on practical cooperation in the field of civil protection, aimed at enhancing cooperation on disaster resilience, reducing disaster risks and improving international disaster response.[298]

Russia is the fourth largest emitter of carbon dioxide (CO_2), behind only the United States, China and India. Russia's per capita emissions are growing and projected to approach US levels by 2030.[299] In 2010, Russia emitted 2,202 million tonnes of CO_2 equivalent, which does not take into account the amount of CO_2 taken out of the atmosphere by Russia's carbon sinks. The International Energy Agency predicts an 11.2 per cent growth in Russia's energy-related CO_2 emissions between 2009 and 2020. In comparison, CO_2 emissions in China and India are projected to grow by 41.4 per cent and 47.7 per cent, respectively. By contrast, emissions in the United States and the European Union are expected to decline by 0.2 per cent and 4.5 per cent, respectively.[300]

In October 2013, Putin signed an Executive Order to keep its greenhouse gas emissions at least 25 per cent below 1990 levels by 2020. The aim is to implement the Climate Doctrine.[301] Following this, on 18 March 2013, the Ministry of Natural Resources and the Environment published a draft decree on

[296] Henry, Laura A. and Lisa McIntosh Sundstrom (2012) 'Russia's Climate Policy…', pp. 1297-1322; and *UPI* (2011) 'Putin Calls for Global Climate Consensus', July 15.

[297] European Council on Foreign Relations (2012) 'Relations with Russia on climate change', European Foreign Policy Scorecard 2012, on the Internet: http://www.ecfr.eu/scorecard/2012/russia/24 (retrieved 21 March 2013).

[298] Administrative Arrangement between the Ministry of the Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters and the Directorate General for Humanitarian Aid and Civil Protection of the European Commission on Practical Cooperation in the Field of Civil Protection, 22 March 2013, on the Internet: http://ec.europa.eu/echo/files/about/Russia-AdmArr_EN.pdf (retrieved 20 january 2014).

[299] Charap (2009) 'Russia's Lackluster Record on Climate Change'…, pp. 11-19.

[300] This is based on IEA's Current Policies Scenario, energy related carbon emissions will grow by 11 per cent. See *World Energy Outlook 2011*.

[301] President of Russia (2013) 'Executive Order on reducing greenhouse gas emissions', 1 October; and Russian Federation (2013) *Sixth National Communication*….

'the level of greenhouse gas emissions' necessary to facilitate the implementation of the Doctrine. Russia's greenhouse gas emissions were 31 per cent below 1990 levels in 2011, which allows emissions to rise. This is hardly in line with the IPCC's call for 'substantial and sustained reductions in greenhouse gas emissions'. Russia's per capita carbon emissions of 12 tonnes are also nearly three times the world average.[302] A relatively new institutional player in climate change is the Russian Central Bank, acting as the national 'carbon unit operator' for Joint Implementation projects within the first commitment period of the Kyoto Protocol.[303] National policies and measures in the field of climate change are being developed and carried out in three main areas:[304]

- Regulations and targeted interventions, ensuring the implementation of national commitments under the UNFCCC and the Kyoto Protocol;
- National development programmes, providing a set of measures to limit anthropogenic emissions of greenhouse gases, and protecting or enhancing sinks and reservoirs of greenhouse gases; and
- Other national programmes and activities, the implementation of which helps to reduce emissions or enhance the removal of greenhouse gases.

There is no indication that the Russian leadership will support the setting up of a domestic Emissions Trading Scheme (ETS). It is difficult to see that the senior leadership will impose carbon emission caps on the industries on which the economy so heavily depends. Furthermore, setting up a full-scale ETS is likely to be problematic, not least because the Russian actors are used to selling emission quotas instead of buying them.[305]

Russia stated at the seventeenth Conference of the Parties to the UNFCCC in Durban in 2011 that it would not enter into the second commitment period of the Kyoto Protocol. This will provide Russia with a convenient way to postpone future national climate change adaptation or mitigation commitments. This was criticised by Russian business as 'unconstructive' due to the benefits available to influential industrial actors from carbon markets.[306] One positive development was that in August 2012 Russia joined the Clean Air and Climate Coalition coordinated by the United Nations Environment Programme (UNEP). The Coalition intends to serve as a forum for assessing progress in addressing the

[302] Vatansever, Adnan and Anna Korppoo (2012) 'A Climate Vision for Russia….'
[303] Sharmina, Maria, Kevin Anderson and Alice Bows-Larkin (2013) 'Climate change regional review…, pp. 373–396.
[304] Russian Federation (2013) *Sixth National Communication*….
[305] Vatansever, Adnan and Anna Korppoo (2012) 'A Climate Vision for Russia….'
[306] Andonova, Liliana B. and Assia Alexieva (2012) 'Continuity and change in Russia's climate negotiations position and strategy', *Climate Policy* 12: 614–629.

challenge of short-lived climate pollutants and for mobilising resources to accelerate action.[307]

The country's views on climate issues have been unclear. Russian news agencies reported at least three contradictory government positions in the run-up to the eighteenth Conference of the Parties in Doha in 2012, based on 'confidential sources'.[308] Throughout the negotiations on a post-2012 agreement, the Russian delegation has maintained a low profile and maximum room to adjust its position. Russia continues to be relatively cautious about making any commitments in the climate negotiations, a position best described as 'waiting for the best deal'.[309]

In Russia's Foreign Policy Concept of February 2013 it is stated that new trans-border threats and challenges increasingly dominate the international agenda, increasing in proportion and becoming more diversified in form and geography. The Russian Federation is in favour of widening international cooperation with a view to ensuring environmental security and addressing the effects of climate change on the planet, including through the use of advanced energy- and resource-saving technologies in the interests of the entire global community.[310] This document places less emphasis on climate change and environmental issues compared to the previous document. Here again energy saving technologies are the major focus.

At the Intergovernmental Panel on Climate Change (IPCC) meeting in Stockholm in 2013, to present the most authoritative state of climate science to date, the Russian government asked for geo-engineering to be included in the summary for policymakers report, indicating that a 'possible solution of this [climate change] problem can be found in using geo-engineering methods to stabilise the current climate'. Russia also highlighted that its scientists are developing geo-engineering technologies. In the framework of the Convention on Biological Diversity geo-engineering was more generally considered at the 2010 Conference of the Parties calling for studies on the possible impacts of geo-engineering.[311] The IPCC had not included geo-engineering in its major assessments or its summary for policymakers before 2013.

Methods that aim to deliberately alter the climate system to counter climate change are called geo-engineering. Examples include Solar Radiation Management (SRM) and Carbon Dioxide Removal (CDR). Neither have yet

[307] Kokorin, Alexey and Anna Korppoo (2013) 'Russia's Post-Kyoto Climate Policy…'
[308] Sharmina, Anderson and Bows-Larkin (2013) 'Climate change regional review…, pp. 373–396.
[309] *Ibid*.
[310] Ministry of Foreign Affairs (2013) 'Concept of the Foreign Policy of the Russian Federation', Approved by President V. Putin on 12 February 2013.
[311] Secretariat of the Convention on Biological Diversity (2012) *Geoengineering in Relation to the Convention on Biological Diversity: Technical and Regulatory Matters*, Montreal, CBD Technical Series No. 66, September.

been tested or assessed for their impact on limiting global warming.[312] Such ideas are increasingly being discussed by Western scientists and governments as a plan B for addressing climate change. The Russian scientist, Yuri Izrael, who has participated in IPCC geo-engineering expert groups and was an adviser to president Vladimir Putin, conducted an experiment in 2009 by spraying particles from a helicopter to assess how much sunlight was blocked by the aerosol plume. It has been suggested that Russia's admission that it is developing geo-engineering may put it in violation of the United Nations moratorium on geo-engineering projects, established by the Convention on Biological Diversity (CBD) in 2010.[313] The Executive Secretary requested that information should be compiled on the possible impacts of geoengineering techniques on biodiversity and undertake a study on gaps in regulatory mechanisms for climate-related geoengineering relevant to the CBD.[314]

Many scientists are now pessimistic that global CO_2 emissions can be reduced to safe levels within the next 20 years, which means that concentrations of the gas in the atmosphere will rise above 500 parts per million (ppm) by the end of the century. This level could mean a rise in average temperatures of up to 6°C, resulting in major melting of the ice caps and, potentially, the triggering of tipping points in the global environment that would accelerate dangerous climate change. As an indication of this trend, the level of CO_2 in the atmosphere passed 400 ppm in May 2013.

In conclusion it can be stated that in the international climate negotiations Russia has taken either a passive stance or used the issue as a bargaining tool to achieve international policy goals in other areas, It is also clear the Russia so far has failed to or delayed to implement its own domestic policies on mitigation or adaptation programmes for climate change.

[312] IPCC (2011) *Expert Meeting on Geoengineering*, Meeting Report, Lima, Peru, 20-22 June; IPCC (2014) Climate Change 2014: Mitigation of Climate Change, Final Draft Summary for Policymakers, IPCC WGIII AR5, p. 24, April; and IPCC (2013) 'Summary for Policymakers', *Climate Change 2013: The Physical Science Basis*…, p. 21.

[313] Convention on Biodiversity (2010) COP 10 Decision X/33.Biodiversity and climate change.

[314] *Guardian* (2013) 'Russia urges UN climate report to include geoengineering', 19 September; and Secretariat of the Convention on Biological Diversity (2012) *Geoengineering in Relation to the Convention on Biological Diversity: Technical and Regulatory Matters*, Montreal, CBD Technical Series No. 66, September, 152 pages.

7 Ministries responsible for climate change adaptation and handling natural disasters

This chapter gives a short presentation of the ministries and agencies in Russia that primarily are responsible for implementing policies in the areas of climate change and handling of natural disasters. It also gives information on the agencies that monitor and collect data on climate change in Russia.

Overall responsibility for climate change policymaking in the Russian Federation lies with the Ministry of Natural Resources and the Environment and the Ministry of Economic Development.[315] A number of national institutions are involved in the implementation of climate change policy. Implementation of the Kyoto Protocol is underpinned by the Comprehensive Action Plan on the Implementation of the Kyoto Protocol to the UNFCCC in the Russian Federation (2005) and the Decree on Measures to Implement Article 6 of the Kyoto Protocol to the UNFCCC (2009).[316] In addition, the Russian Federation has adopted long-term government policies and legislation, such as the Climate Doctrine (2009),[317] the Decree on Certain Measures to Increase Energy and Ecological Efficiency in the Russian Economy (2008),[318] the federal law on Energy Saving and Energy Efficiency (2009),[319] the Decree on the Main Directions of State Policy in Improving the Energy Efficiency of the Electric Power Industry Based on Renewable Energy Sources until 2020 (2009),[320] among others. Many aspects of the implementation of policies and measures planned for and reported to the UNFCCC are delegated to the regional and local levels.

7.1 The Ministry for Natural Resources and the Environment

The Ministry of the Environment and the Ministry of Natural Resources were combined to form the Ministry of Natural Resources and the Environment (MPR) in 2008. The ministry is responsible for policies on and regulation of the environment, including conservation, regeneration, forestry and wildlife protection. It is also responsible for the exploration, management and

[315] UNFCCC (2012) *Report of the centralized in-depth review of the fifth*…, p. 5.
[316] Russian Federation (2009) Decree of the Government of the Russian Federation of 28 October 2009, No. 843.
[317] President of Russia (2009) 'Decree of 17 December 2009, No. 864'.
[318] President of Russia (2008) 'Decree of 4 June 2008, No. 889'.
[319] Federal law (2009) of 23 November, No. 261-FZ.
[320] Russian Federation (2009) 'Decree on 8 January 2009, No. 1'.

conservation of the country's natural resources, including the management of the water supply and mineral deposits, and exploration of the country's territory and continental shelf. Finally, the MPR is in charge of regulating industrial and energy safety, it monitors geological and earthquake activity, and develops state police and legal regulation in forestry affairs.

The MPR is responsible for the implementation of the climate change action plan and preparing 'guidelines for the development of branch-specific methodologies for estimation and assessment' of particular consequences of climate change, in order to prepare regional and territorial adaptation plans for different industries and ministries. Similar tasks have been given to the Ministry of Health with regard to 'infectious and parasitic diseases'; the Federal Forestry Agency with respect to Russia's forests and peat bogs; the Ministry of Regional Development, regarding infrastructure; the Ministry of Agriculture, regarding harvest forecasts; and Roshydromet, regarding precipitation and ocean level forecasts. The Ministry of Transport has been charged with developing measures to cut CO_2 emissions from civil aviation by 2015 and from commercial sea and river transport by 2020.

The MPR coordinates and supervises the activities of the Federal Service for Hydrometeorology and Environmental Monitoring, the Federal Service for the Supervision of Natural Resource Management, the Federal Agency for Water Resources and the Federal Agency for Subsoil Management that fall under its jurisdiction.

In 2014 a global climate matrix will be developed for the MPR in order to take into account the unprecedented number of climatic factors for each district in Russia, and their impact on all sectors of life. The matrix will help the ministry calculate the effects of global warming and natural disasters, and assist the ministry in the study of the environmental influences on the death rate in Russian regions and on their economies. According to a ministry spokesperson, this is not so much about climate change as a chance to streamline economic processes and justify investment in efforts to prevent disasters. The matrix will take account of diseases, death rates, droughts, fires and environmental imbalances. It will, for example, be able to show how much the death rate for various population groups increase during a drought or a heat-wave.[321]

Roshydromet is the only federal authority in Russia responsible for the collection and dissemination of weather, climate, hydrological, geophysical, environmental monitoring and other data. Like most countries, this information is generated predominantly by the public sector. Roshydromet prepares a special annual

[321] *Izvestia* (2012) 'Russian Ministry of Natural Resources wants a global climate model', (in Russian) 17 December, on the Internet: http://rbth.co.uk/articles/2012/12/17/russian_ministry_of_natural_resources_wants_a_global_climate_model_21189.html (retrieved 20 December 2013).

report on the climate of the Russian Federation, which is published on its website. Its research institutes regularly publish a specialist bulletin, Climate Change in Russia, which contains information about changes in temperature and precipitation, and extreme weather events. Roshydromet also carries out basic observations on climate.[322]

In accordance with the Convention of the World Meteorological Organisation, Roshydromet is responsible for Russia's compliance with international treaties, including the UNFCCC and the Protocol on Environmental Protection of the Antarctic Treaty.[323] The Russian Federation, through Roshydromet, is implementing a number of federal programmes on the climate and climate change research that support research on fundamental and applied science.[324]

Roshydromet and its institutes conduct systematic terrestrial, oceanographic and stratospheric observations related to climate change, including observations of the climate system through a meteorological network of 1,633 stations on land and 37 stations at sea. A large number of programmes and capacities have been developed to deal with the complex scientific and research issues in the area of the environment and climate change, including the physical and chemical aspects of terrestrial and atmospheric processes, climate simulation, and paleoclimate and atmospheric composition and change.[325]

The Institute of Global Climate and Ecology at Roshydromet has overall responsibility for the preparation and management of the greenhouse gas inventory. It collects the necessary data, performs the calculations and compiles the national inventory report and the common reporting format tables. The national system also involves the Russian Federal Service for State Statistics, other agencies providing data for the inventory and the relevant ministries, which support the inventory process by taking part in the annual review of the national inventory report prior to its official submission to the UNFCCC secretariat. Large industrial companies, such as Gazprom, have concluded agreements with Roshydromet to provide data in relation to their activities and associated emissions, and support the review of the quality of the inventory.[326]

The Russian Federation also actively participates in international projects and programmes on climate research and observation supported by the World Meteorological Organisation, UNEP, the Intergovernmental Oceanographic Commission, the United Nations Educational, Scientific and Cultural

[322] UNFCCC (2012) *Report of the centralized in-depth review of the fifth*…, p. 32.
[323] The World Bank (2013) *Second Hydromet Modernization Project*, Report No: 72849-RU.
[324] UNFCCC (2012) *Report of the centralized in-depth review of the fifth*…, p. 30.
[325] *Ibid*., pp. 35-36.
[326] *Ibid*., p. 9.

Organisation and the International Council for Science, among others.[327] The Russian Federation is also participating in a range of other programmes and in activities related to the UNFCCC and the IPCC.[328]

7.2 Ministry for Civil Defence, Emergencies and the Elimination of Consequences of Natural Disasters

The main coordinating body for emergency management is the Ministry for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters (Emercom).[329] At the federal level is the Interdepartmental Commission for Emergency Prevention and Response, which brings together 16 ministries and agencies responsible for disaster policy. The Prime Minister is also the chief of civil defence in the Russian Federation. The head of Emercom is the deputy chief of civil defence and commander of the civil defence force. The Russian Unified System of Prevention and Mitigation of Emergency Situations (RSChS) regulates all relations between governmental, non-governmental, civil and military organisations.[330] Emercom was set up by a Presidential Decree in 1994, based on an earlier Emergency Committee.[331] The failure to cope adequately with catastrophes such as the Chernobyl nuclear reactor incident in 1986 and the earthquake in Armenia in 1988 made its establishment essential.[332]

Emercom was set up to address the need to deal more effectively with the consequences of natural and human-induced disasters. It has approximately 250,000 employees of whom 220,000 are personnel of the State Fire Service and about 23,000 civil defence troops.[333] There have been many changes since the

[327] The WCRP, the GCOS, the World Climate Programme, the Global Ocean Observing System, the Global Sea Level Observing System and the Global Earth Observing System of Systems.
[328] *Ibid.*, p. 31.
[329] The Ministry for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters (Russian: Министерство России по делам гражданской обороны, чрезвычайным ситуациям и ликвидации последствий стихийных бедствий), also known as The Ministry of Emergency Situations (Russian: Министерство по чрезвычайным ситуациям - МЧС России), or internationally as Emercom, on the Internet: http://government.ru/eng/power/91/ (retrieved 20 July 2013).
[330] Government of Russia (2009) Regulation 577, 'On amending the provision, on an Integrated State System for Emergency Prevention and Response', 16 July.
[331] President of Russia (1994) 'Decree of 10 January 1994 establishing Emercom; Federal law of 1998 on Civil Defence; and ¨'Federal law of 1999 on the status of the Ministry of the Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters'.
[332] Thomas, Timothy (1995) 'Emercom: Russia's Emergency Response Team', *Low Intensity Conflict and Law Enforcement*, Vol. 4, No. 2, p. 227.
[333] Dobrolyubov, Nikolay (2013) 'Emergency at the Defense Ministry', *Moscow Defense Brief*, No. 2, 2013, pp.27-31.

ministry was established. Management is now based more on a model of the prevention and mitigation of emergencies, instead of as previously on only emergency preparedness and response.[334] The budget allocations, however, are still mostly focused on preparedness and response.[335] Both planning and response capabilities have been much strengthened. The organisation is characterised by a centralised management and monitoring system and a subordinate regional structure.[336]

There are five levels of management in the system for disaster management: federal, regional, territorial, local and on-site. Every level of the Russian Unified System of Prevention and Elimination of Emergency Situations (RSChS) has its own coordination units. These units are responsible for the protection of the population and territories in the event of an emergency, managing offices, emergency response units and facilities, financial and material assets, communications systems, and warning and information support.[337] A database covering territorial vulnerabilities and a connected register of potentially hazardous industrial sites has been established.

Under Emercom is the National Crisis Management Centre, which is well-equipped and also has subordinate regional centres.[338] In addition, there is the All-Russian centre for monitoring and forecasting of natural and man-made emergencies (VCMP), and the Centre of Antistikhiya, established in 1999. The main tasks of the latter are monitoring emergencies and their sources, forecasting emergencies and their consequences, establishing a database on emergencies in Russia, and carrying out research and scientific activity in the field of monitoring

[334] Shlykova, Elena (2012) 'Social Security Policy for Chernobyl Clean-up and Rescue Workers: Crisis Chronology and Lessons', Chapter 6, p. 177, in Porfiriev, Boris and Greg Simons (Eds.) *Crises in Russia Contemporary Management Policy and Practise from a Historical Perspective*, Ashgate Publishing Ltd., UK.

[335] Akimov, Valery and Boris Porfiriev (2012) 'The Institutional Framework and Governance of Russia's Crises Policy: Disaster Focus', in Porfiriev, Boris and Greg Simons (Eds.) *Crises in Russia Contemporary Management Policy and Practise from a Historical Perspective*, Ashgate Publishing Ltd., UK.

[336] Emercom of Russia (2014) Web site, on the Internet: http://en.mchs.ru/Forces_and_Facilities/National_Emergency_Management_Centre (retrieved 20 December 2013).

[337] MSB (2009) *International CEP Handbook 2009*, Civil Emergency Planning in the NATO/EAPC Countries, the Swedish Civil Contingencies Agency (MSB), MSB 0039-09, AB Danagårds Grafiska, pp. 189-193.

[338] Government of Russia (2011) Order of the Russian Federation No. 424-p., 'On the funding of measures to reequip the Emercom units with the modern models of techniques and equipment', 16 March, on the Internet: http://www.government.ru/gov/results/14520/S (retrieved 15 October 2012); and President of Russia (2008) 'Decree on a Federal Public Institution, the National Crises Management Centre', No. 1515, 23 October.

and forecasting of emergencies and limiting their consequences.[339] Russia, like most countries, aims for an all-hazard approach to risks.

Emercom specialists predict that in the coming decades, global climate change will increase the number of major natural disasters, including floods. The ministry calculates that more than 90 million Russians (or 60 per cent of the country's population) live in areas likely to be exposed to adverse factors resulting from incidents at vital or potentially hazardous facilities. The annual economic damage from various emergencies could be as high as 1.5–2 per cent of the GDP, that is, 675–900 billion roubles (USD 28.1–29.2 billion).[340]

The State Fire-fighting Service (SFS) encompasses the Federal Firefighting Service and the fire-fighting services of the individual Russian provinces. Its tasks are to: (a) develop and take measures to avoid fire; (b) improve the efficiency of protecting populated areas, enterprises, institutions and organisations against fire; (c) organise and provide state fire control; (d) extinguish fires and carry out disaster relief and rescue operations; and (e) train response and rescue teams. The service employs 220,000 people and responds to about 2 million calls each year. The deputy minister for Emercom, currently Aleksandr Chupriyan, is in charge of fire safety.[341]

It can be concluded that there is a fairly well developed system of ministries and agencies with responsibilities to monitor and predict the effects of climate changes in Russia. This is also the case for handling natural disasters where Emercom is well known also outside Russia. There is thus no lack of knowledge on either the effects of climate change or on handling natural disasters. It is first recently, however, that prevention has become more of a priority.

[339] All-Russian centre of monitoring and forecasting of emergencies of Emergency Control Ministry of Russia (Center Antistikhiya), on the Internet: http://en.mchs.ru/document/224109 (retrieved 2 April 2013).

[340] *RIA Novosti* (2013) 'Should Russia fear climate change forecasts?' (in Russian) 1 April. http://rbth.co.uk/science_and_tech/2013/04/01/should_russia_fear_climate_change_forecasts_24441.html

[341] Dobrolyubov, Nikolay (2013) 'Emergency at the Defense Ministry', *Moscow Defense Brief*, No. 2, pp.27-31; and Ministry of the Russian Federation for Civil Defence, Emergencies and Elimination of Consequences of Natural Disaster (2013) 'Fire Control in Russia', on the Internet: http://en.mchs.ru/Forces_and_Facilities/Fire_Control_in_Russia (retrieved 2 April 2013).

8 Discussion and conclusions

There have been a number of serious natural disasters in recent years, such as floods or huge forest fires. The frequency and intensity of large-scale natural incidents linked to extreme weather events have increased in the past ten years and will continue to increase. The cause of these disasters can probably be traced to the effects of global warming and climate change. Even though the IPCC is hoping to limit the Earth's average warming to +2°C by mid-century, models predict a +6–10°C increase for vast territories of northern Eurasia, including much of Siberia. In northern parts of Russia, the rate of climate change is now faster than on the rest of the globe and it is not clear how and to what extent ecosystems will be able to adapt to these fairly rapid changes and pressures.[342] The average temperature in northern parts of Russia is expected to increase at roughly twice the global rate, and climate projections indicate substantial loss of permafrost by 2100. East Siberia and some parts of Russia's Arctic region are likely to experience the most dramatic climate changes on the planet.

The increased amounts of precipitation will cause problems with increased runoff in rivers and flooding, but many parts of Russia, especially those with plenty of water today, will experience increases in the availability of water, including much of Siberia, the Far North and north-west Russia. In southern parts, where water is already limited, there will be less precipitation and current water reserves will shrink and not cover the needs. Moreover, a number of densely populated Russian regions that are already subject to water shortages are expected to face even more pronounced difficulties in the decades to come. Rising average summer temperatures are also expected to cause increased droughts, particularly in areas that currently constitute the core regions for agriculture. It is assessed that grain harvests will decline in the south, where droughts will become a problem by 2030. Food shortages and food stress could potentially increase social tensions in the country in the long term.

Forestry will mainly be negatively affected due to thawing permafrost for example making trees unstable. Forest fires, like those witnessed near Moscow during the summer heat-waves of 2010, will be more frequent and become a growing threat that will cause deforestation and health hazards. By 2030 there will be increasing problems linked to melting permafrost weakening the capacity of the ground to bear buildings and infrastructure in northern Russia. This is likely to have a negative impact on the Russian economy in the longer term. It may also complicate development projects for oil and gas extraction in northern

[342] Murray, M. S., Andersson, L., Cherkashov, C., Forbes, B. C., Gascard, J. C., et al. (2010) *International Study of Arctic Change: Science Plan*, ISAC International Program Office, Stockholm, Sweden, on the Internet: http://www.arcticchange.org/storage/ISAC%20Science%20Plan%20Final%20Publication.pdf (retrieved 20 February 2013).

Russia, including the Arctic region, and increase the number of infrastructure incidents along pipeline networks. More frequent and severe storms and drifting icebergs might also complicate exploration for new oil and gas resources in the Arctic Ocean.

Although scientists disagree about the rate at which the Arctic ice is melting, climate change is expected to alter northern parts of Russia in the coming decades. Some scientists believe that ecological changes linked to climate change combined with poor government management of natural resources could result in a critical situation if adequate measures are not implemented. There is an urgent need for efforts to stabilise and reduce greenhouse gas emissions. One of the biggest concerns for the global climate is that the very large deposits of trapped methane on the seabed or in wetlands might be released due to thawing permafrost, and at what rate it would exacerbate global warming. There are still no good data on this, and more research is needed into the potentially negative impacts this could have on the global climate system.

Due to the impacts of the ongoing effects of climate change, northern Russia, including the Arctic region, is particularly prone to abrupt changes – and transferring these to the global climate system. The Arctic contains the largest concentration of potential tipping elements in the Earth's Climate System, such as the rapidly decreasing Arctic sea-ice, decreasing permafrost and marine methane hydrates that can be released and these needs to be carefully monitored.[343] In the Arctic, temperatures are rising ultimately as a result of greenhouse gas emissions primarily from the burning of fossil fuels, deforestation and other human activities elsewhere on Earth.

The effects of climate change on Russia will significantly increase its exposure to natural disasters and technological incidents. Russia is vast and climate change will affect its different regions in various ways. There is growing recognition among experts that there will be an increasing number of disasters linked to floods, droughts, wildfires, thawing permafrost and other climate influenced events. Russia's ability to cope with natural disasters, technological incidents and future climate change impacts by 2030 and beyond will depend on the nature and extent of the impacts and the extent to which Russia starts to implement adaptation and mitigation measures. This has not yet been done on a large scale. This in turn will depend on Russia's socio-economic and political development in the coming years. There is an urgent need to establish where these various changes could trigger potential tipping points, and where rapid changes might exceed society's capacity to adapt. According to some experts, several tipping elements have already been set in motion and changes are accelerating, but when they will reach their tipping points is not known.

[343] Duarte, Carlos (2012) 'Arctic is Already Suffering the Effects of a Dangerous Climate Change', *Science News*, 30 January.

Russia's role in international climate diplomacy has been limited to ratifying the Kyoto Protocol. Russia's policies have mainly been aimed at achieving diplomatic or domestic gains in other areas instead of contributing to a constructive solution to international climate problems. Russia's policies on climate adaptation and mitigation lag behind those of most countries, although some mitigation measures such as enhancing energy efficiency, mostly driven by economic interests, have been developed and adopted. A review of Russia's National Communications (NC4–6) to the UNFCCC secretariat confirms the view that there are plans and strategies, but the implementation of adaptation and mitigation measures is absent. The government's views on vulnerabilities to climate change are, however, generally in good agreement with what can be found in a review of the scientific literature.

When it comes to policies on climate change adaptation and mitigation, a climate change doctrine has been adopted but its implementation has been slow and is now in question. Most of the policy initiatives in this area have been connected to the international climate change negotiations, to demonstrate that Russia is active in this area. For a short period before the 2009 Copenhagen conference, climate change issues rose higher up on the Russian political agenda, due mainly to the then President Medvedev. He used the climate issue and international negotiations to promote his domestic modernisation agenda by providing incentives and mobilising actors domestically to reduce greenhouse gas emissions and push the economy to become more energy efficient and less dependent on natural resources. It should be noted that there is a gap between Russian presidential rhetoric and the adoption of new laws, and the implementation and enforcement of existing policies. As Prime Minister, Medvedev does not have the same opportunities to promote his own agenda. The views of President Putin on climate change are still unclear, but his adviser on such issues has been a climate change sceptic. Climate change issues are still not high on the political agenda in Russia.

Thus far, Russia has not made any strong promises or resorted to any strong threats in the climate change negotiations but instead waited to see what deals can be made. Russia is running a risk if it continues to treat climate change as somebody else's problem or, even worse, a Western conspiracy. One sign that Russia might favour other options to tackle global warming is that it pushed for geo-engineering to be considered a plan B to limit greenhouse gas emissions in the international climate negotiations, and asked for it to be included in the IPCC's Fifth Assessment Summary Report for Policymakers in 2013. How serious Russia's ambitions are in this area is unclear but research on aspects of geo-engineering is ongoing.

Russian policymakers do not feel any need to take steps domestically to mitigate climate change, and public pressure to tackle the issue is limited. Although climate change scepticism is still alive and well in Russia, the balance has shifted

in the limited public discourse towards at least acceptance of global warming as a fact. The potential benefits of climate change, on the other hand, are widely discussed in the media and promoted by some decision makers. This has prevented policymakers from taking a more proactive stance.

Russia's centralised form of governance, where power rests primarily with key individuals such as President Putin and his close associates, reduces the contacts between scientific experts and policymakers. It is possible to conclude that the Russian leadership's attitude has gone from denying the existence of climate change to seeing it purely as a means of promoting Russia's role in international affairs. Russia's desire to be a global leader in all fields of international relations makes it necessary for it to become more engaged in the field of international climate politics. Russia, however, will probably remain on the outskirts of the international climate policy debate. As can be seen in its most recent foreign policy doctrine it has not increased its emphasis on climate change issues. If Russia's leadership were to commit wholeheartedly to the scientific evidence that the climate is changing and that human-induced greenhouse gases are to blame, they would be left with less room for political manoeuvring in international climate negotiations.

Russia's economy will remain dependent on oil and gas production. This means that Russia will be highly vulnerable to climate change impacts that affect the current or future operations of the oil and gas sectors, especially in the northern parts of the country. Many areas that are currently the focus of exploration and production activity will become more difficult to exploit. The prospect of increased Arctic commerce brings with it competition among countries and companies for control of the area's riches, and international competition always carries the possibility of increasing tensions. This will result in an increased presence of the Russian Armed Forces in the Arctic region.

For Russia, the emphasis in recent years has been on promoting economic and political opportunities, seeing the northern parts of Russia – including the Arctic – as a place where Russia can take the lead and live up to the image it has of itself as a great power. Russia's policy goal is for the Arctic to become its primary resource base by 2020. In addition, global warming may bring certain economic benefits for northern parts of Russia, such as expansion of the area of arable land, a shortening of the cold season, the development of infrastructure, jobs in the oil and gas industry, and the development of shipping in the Arctic Ocean. Shipping activity has already increased along the Northern Sea Route in recent years.

The security situation in the northern parts of Russia, including the Arctic region, is changing due to the effects of climate change. Although the Arctic states commonly emphasise their desire to maintain a cooperative environment, several including Russia have stated that they will defend their national interests in the region if necessary. In response to climate change, many of the Arctic states have

begun to re-examine their military capability to operate in the Arctic region. The widely held notion, in Russia and elsewhere that climate change will occur gradually over the 21st century, allowing ample time for society to adapt is no longer valid. The climate changes seen in northern Russia have already had major impacts on the environment and on economic activities.

The Russian Armed Forces are already adapting to a changing Arctic environment. The military will be affected by climate change in numerous ways. For example, the sea ice will rapidly recede, there will be increased shipping traffic along the Northern Sea Route as well as increased exploitation of oil and gas reserves in the Arctic, and the transport of heavy equipment will become more difficult as ice roads will be open for shorter periods of the year and roads and railways will be damaged by the thawing permafrost. Climate change will be a challenge to the Russian Armed Forces.

For the most part, Russia's implementation of climate change adaptation and mitigation measures is lagging far behind its declared aims in strategies or programmes, and when it comes to addressing the underlying causes of disasters or technological accidents. It is well known from technological incidents that industry safety standards are still not being upheld and many critical infrastructures are still in a poor state of repair. Russian political and administrative leaders are keen to avoid disasters and crises. The denial of crises is not a new phenomenon in Russia, due to the perceived risk that they can generate secondary threats and discontent among citizens. Denial of crises is often related to poor performance by a ministry or agency, and it is common to shift the blame for not managing a disaster well on to other individuals or agencies. There are examples of cover ups by the authorities of both appeals for help and distressing reports from municipalities about the real magnitude of the problem. There is a risk that a natural disaster and the crises it generates will undermine the influence and legitimacy of key actors and leaders. Controlling the flow of information to the public is therefore seen as essential.

The emergency management systems of Emercom still focus on preparedness and response rather than prevention and vulnerability assessments, and the underlying drivers of vulnerabilities to various hazards. Russia needs to move emergency management approaches beyond a response-oriented focus to consider prevention, vulnerability reduction and community resilience. States no longer just respond to disasters, they manage disaster risks – and do so within increasingly sophisticated institutional frameworks. Forecasting and early-warning systems are often the weakest link in the chain for reducing the risks related to disasters or technological incidents. Russia has set up organisational frameworks to handle these aspects. There are, however, still challenges linked to obtaining critical information and sharing it in a timely fashion. There are also organisational and individual behaviours that undermine otherwise sound information-sharing arrangements.

Disaster policy response to climate change is dependent on a number of factors, such as readiness to accept the reality of climate change and willingness to include climate change risk assessment and management in Russian policy. Reducing vulnerability is a key aspect of reducing climate change risks. Responding to problems associated with disaster risk management and climate change adaptation requires a comprehensive approach that relies on work across ministry and agency boundaries. Planning for extreme weather events also supports preparedness for a variety of other emergencies and therefore brings additional benefits. It would be beneficial to mainstream disaster risk reduction policies as well as climate change adaptation policies into an efficient socio-economic development policy focused on improving the living standards of communities and modernising industries. Building community resilience to disasters will be critical to the success of future disaster risk management. Measures for climate change adaptation and mitigation also need to be implemented in Russia. Some argue that from an economic perspective, adaptation is only initiated when the rewards of action are perceived to outweigh the costs of inaction.

It is possible to conclude that the climate change issue has so far been given too low a priority by the Russian authorities. There is still a well-rooted scepticism in the Russian political and scientific communities about the rate of global warming and a low level of awareness of environmental issues. There is a view, including among a significant portion of the country's senior leaders, that climate change will have mainly positive impacts on Russia. The views on climate change of the Russian scientific community are mixed. A review of Russia's policies on climate change does not show any sign of change, and there is not much hope that Russia will play a more active and constructive role in the international climate change negotiations within the framework of the UNFCCC in the near future. With growing scientific evidence of climate change, it is essential that policymakers realise the importance of taking action that can address disaster risk while decreasing the effects of climate change through vulnerability reduction.

Appendix 1 - Abbreviations

CBD	Convention on Biological Diversity
CDR	Carbon Dioxide Removal
CH_4	Methane
CMIP	Coupled Model Intercomparison Project Phase
CO_2	Carbon dioxide
Emercom	Ministry for Civil Defence, Emergencies and Elimination of Consequences of Natural Disasters
ETS	Emissions Trading Scheme
GDP	Gross National Product
GMST	Global Mean Surface Temperature
IPCC	United Nations Intergovernmental Panel on Climate Change
ISDR	International Strategy for Disaster Reduction
ISEA	International Socio-ecological Alliance
LNG	Liquefied Natural Gas
MPR	Ministry for Natural Resources
N_2O	Nitrous oxide
Natechs	Technological accidents triggered by natural hazards
NC4/NC5	Fourth/Fifth National Communication (Russia)
Ppm	Parts per million
RCP	Representative Concentration Pathways
RSChS	Russian Unified System of Prevention and Elimination of Emergency Situations
Roshydromet	Russian Federal Service for Hydrometeorology and Environmental Monitoring
SRM	Solar Radiation Management
SFS	State Firefighting Service

UNEP	United Nations Environment Programme
UNCLOS	United Nations Convention on the Law of the Sea
UNFCCC	United Nations Framework Convention on Climate Change
VCMP	All-Russian centre for monitoring and forecasting of natural and man-caused emergencies
WWF	World Wide Fund for Nature

Appendix 2 - Glossary

Adaptation
In human systems, the process of adjustment to actual or expected climate change and its effects in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate change and its effects; human intervention may facilitate adjustment to expected climate change (IPCC 2012:5).[344] This implies that adaptation measures can be focused on both the reduction of climate risks and utilisation of the potential benefits of climate change.[345]

Arctic
Often defined as the Earth's surface north of 66° N.[346]

Black carbon
A pollutant produced through the incomplete combustion of biomass and fossil fuels. When it settles on ice or snow, it increases its heat absorption capacity, accelerating thawing. In Russia's snow-covered regions, it is brought mainly by air currents from Russia's nearby regions.

Carbon dioxide
The main greenhouse gas released by human activities.[347]

Climate
The average weather over long periods – from months to thousands or millions of years.[348]

Cryosphere
The parts of the Earth's surface that are frozen for at least some part of the year.[349]

Climate change
A change in the state of the climate that can be identified (e.g., by using statistical tests) by changes in the mean and/or the variability of its properties and

[344] IPCC (2012) *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation: A special report of Working Groups I and II of the Intergovernmental Panel on Climate Change*, Field, C.B., *et al.* (Eds.), Intergovernmental Panel on Climate Change, Cambridge University Press: Cambridge, UK and New York, USA.
[345] UNDP (2009) *Integrated Climate Change Strategies for Sustainable Development of Russia's Arctic Regions (Case Study for Murmansk oblast) Summary*, UN Development Programme in Russia, Russian Regional Environmental Centre, Moscow 2009, p. 15.
[346] AMAP (2011) *Snow, Water, Ice and Permafrost….*
[347] *Ibid.*
[348] *Ibid.*
[349] *Ibid.*

that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes or external forcings, or to persistent anthropogenic changes in the composition of the atmosphere or in land use.[350]

Climate change scenarios
These are not predictions, but internally consistent descriptions of possible future climates.

Climate extreme (extreme weather or climate event)
The occurrence of a value of a weather or climate variable above or below a threshold value near the upper or lower ends of the range of observed values for the variable. For simplicity, both extreme weather events and extreme climate events are referred to collectively as climate extremes (IPCC 2012:5).[351]

Climate Impact Assessment
The practice of identifying and evaluating the detrimental and beneficial consequences of climate change on natural and human systems (IPCC WG II).

Climate model
A mathematical model used to calculate elements of past, present and/or future climate.[352]

Disaster
Severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery (IPCC 2012:5).[353]

Disaster risk
The likelihood over a specified time period of severe alterations in the normal functioning of a community or a society due to hazardous physical events interacting with vulnerable social conditions, leading to widespread adverse human, material, economic or environmental effects that require immediate emergency response to satisfy critical human needs and that may require external support for recovery (IPCC 2012:5).[354]

Disaster risk reduction
The conceptual framework of elements considered to have the possibility to minimize vulnerabilities and disaster risks throughout a society, to avoid

[350] IPCC (2012) *Managing the Risks of Extreme Events and Disasters*….
[351] *Ibid.*
[352] AMAP (2011) *Snow, Water, Ice and Permafrost*….
[353] IPCC (2012) *Managing the Risks of Extreme Events and Disasters*…..
[354] *Ibid.*

(prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development (UN-ISDR).

Disaster Risk Management
Processes for designing, implementing and evaluating strategies, policies and measures to improve the understanding of disaster risk, foster disaster risk reduction and transfer, and promote continuous improvement in disaster preparedness, response and recovery practices, with the explicit purpose of increasing human security, well-being, quality of life, resilience and sustainable development.[355]

Emergency
Conditions within a particular territory which are the result of a failure, dangerous natural phenomenon, spontaneous incident or other disaster which may cause or has caused human victims, damage to human health or to the natural environment, or significant damage to property or livelihoods.[356]

Extreme events
A facet of climate variability under stable or changing climate conditions, defined as the occurrence of a value of a weather or climate variable above or below a threshold value near the upper or lower ends ('tails') of the range of observed values of the variable.[357]

Feedback
This is how most snow and ice feedbacks in the Arctic work: warming causes melting/thawing, which causes even more warming, which causes even more melting/thawing.[358]

Frame
Understood here as a loose narrative or a story told in the public arena that is meant to simplify a complex phenomenon and experiences, speak to social, political and cultural understandings and present solutions that 'convey a sense of security and moral order'.

Methane
A potent greenhouse gas produced naturally in the environment.[359]

[355] *Ibid.*
[356] Federal law No. 68-03 (1994) 'On community and area protection against natural and technological disasters', 21 December.
[357] *Ibid.*
[358] AMAP (2011) *Snow, Water, Ice and Permafrost*….
[359] *Ibid.*

Mitigation
Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards (Source: ISDR). Disaster mitigation activities relate to environmental management, land use and urban planning and the engineering protection of critical facilities. The definitions of mitigation measures are different in the context of disaster risk reduction and climate change. The Intergovernmental Panel for Climate Change (IPCC) defines mitigation as 'a human measure to reduce the sources or enhance the sinks of greenhouse gases'. Climate change mitigation measures include energy conservation, enforcement of land use plans, strengthening institutional and legislative mechanisms, energy efficiency measures, waste management, substituting fossil fuels with renewable energy sources, and measures in the transport and agricultural sectors, and sequestering carbon biologically through reforestation or geo-physically.[360] For climate change experts, adaptation means adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm.[361]

Permafrost
Ground that is frozen for two or more consecutive years.[362] The term permafrost refers to any subsurface materials that remain below zero degrees for at least two consecutive years.[363]

Prediction
An event that is more or less certain to occur in the future.[364]

Projections
Possible futures, with some of these futures more likely to happen than others.[365]

Resilience
The ability of a system and its component parts to anticipate, absorb, accommodate or recover from the effects of a hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration or improvement of its essential basic structures and functions (IPCC 2012:5).[366]

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[360] United Nations (2006) *On Better Terms – A Glance at Key Climate Change and Disaster Risk Reduction Concepts, A Product of the Working Group on Climate Change and Disaster Risk Reduction of the Inter-Agency Task Force on Disaster Reduction (IATF/DR*), United Nations, Geneva, Switzerland.
[361] *Ibid*.
[362] *Ibid*.
[363] Anisimov, O. and S. Reneva (2006) 'Permafrost and changing climate: the Russian perspective' *Ambio*, Vol. 35, No.4, pp. 169-175.
[364] AMAP (2011) *Snow, Water, Ice and Permafrost*….
[365] *Ibid.*
[366] IPCC (2012) *Managing the Risks of Extreme Events and Disasters*….

Risk
The probability of harmful consequences, or expected loss of life, injuries and loss of property, livelihoods and economic activity or environment damaged resulting from interactions between natural or human-induced hazards and vulnerable conditions. (Source: ISDR). A function of the probability and magnitude of different impacts (Source: IPCC).

Risk Assessment
A methodology to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that could pose a potential threat or harm to people, property, the livelihoods and the environment on which people depend. The process of conducting a risk assessment is based on a review of the technical features of hazards, such as their location, intensity, frequency and probability, and an analysis of the physical, social, economic and environmental dimensions of vulnerability and exposure, while taking particular account of the coping capabilities pertinent to the risk scenarios.[367]

Technological disaster
A technological disaster is a disturbance of the current activity of a populated region due to abrupt technological impact (catastrophe, accident, crash) resulting in social, economic and/or ecological damage, which requires special management efforts for its elimination.

Tipping points
With respect to climate, tipping points are delicate thresholds where a relatively slight rise in for example the Earth's temperature can cause a more dramatic change in climate. After the tipping point has been passed, a transition to a new state occurs. Tipping points in socio-ecological systems are defined as thresholds beyond which impacts increase non-linearly to the detriment of both human and natural systems.

Vulnerability
Vulnerability to climate change is the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change (IPCC 2012).[368]

[367] United Nations (2006) *On Better Terms – A Glance at Key Climate Change and Disaster Risk Reduction Concepts, A Product of the Working Group on Climate Change and Disaster Risk Reduction of the Inter-Agency Task Force on Disaster Reduction (IATF/DR)*, United Nations, Geneva, Switzerland.
[368] *Ibid.*

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Russia has experienced several extreme weather events in recent years which have led to serious disasters. As the number and frequency of these events have increased, it has been suggested that the causes can be traced to the effects of global warming and climate change. Average temperatures in Russia, especially in the North, are rising at double the rate of the global average temperature increase, which is having both positive and negative effects on Russia.

The Russian leadership has gone from denying the existence of climate change to seeing it purely as a means of promoting Russia's role in international affairs. Russia's role in international climate diplomacy has been limited to ratifying the Kyoto Protocol. Its policies have been aimed at achieving diplomatic or domestic gains in other areas instead of a constructive solution to international climate problems. A climate change doctrine has been adopted but its implementation has been slow and the political leadership's commitment to it has been questioned. Russia's policies and measures on climate change adaptation and mitigation lag behind those of most other countries, although some mitigation measures have been developed and adopted. The issue of climate has thus far been given too low a priority by the Russian authorities.

The security situation in the northern parts of Russia, including in the Arctic region, is changing due to the effects of climate change. Although the Arctic states commonly emphasise their desire to maintain a cooperative environment, several including Russia have stated that they will defend their national interests in the region if necessary. In response to climate change, many of the Arctic states have begun to re-examine their military capability to operate in the Arctic.

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