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Risk management and assessment of costs and benefits of adaptation options for selected economy sectors in Russian Federation

Elena M. Akentyeva

Main Geophysical Observatory

ST. PETERSBURG, RUSSIAN FEDERATION

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Contents

- Climate Risk Management Process (oil and gas pipe lines)
- Selection of Adaptation Options using cost-benefit approach (building construction, road facilities, ,renewable energy)

➢ The Federal Service for Hydrometeorology and Environmental Monitoring (Roshydromet) in collaboration with Russian Academy of Science have prepared a package of documents concerning adaptation to climate change:

- ✓ *an Assessment Report on climate change and its consequences,*
- ✓ *Climate Doctrine,*
- ✓ *Fifth National Communication about adaptation policy.*

However a single adaptation strategy is pendent.

➢ *Main Geophysical Observatory (MGO)* is a scientific unit of Roshydromet that researches impacts of climate change on infrastructure including energy sector, transport, oil and gas pipelines, and building construction and estimates costs and benefits of adaptation options on the basis of risk assessment and probabilities.

➢ The efforts are directed to quantify physical impacts of climate change. MGO fulfills this research for a long period in collaboration with end users. As a result the systems of tailored climate products or impact indexes were created. Expected deviations of these indexes express change of climate conditions and can be used when working out adaptation measures.

➢ The most important impact indexes for infrastructure are connected with the frequency, intensity, and duration of dangerous weather events and anomalous climate conditions, both observed and predicted. Therefore various approaches to climate-related risks assessment were considered.

➢ Risk management at the national level is based on the concept of acceptable risk.

➢ The acceptable risk value is a country-specific solution that differs according to the socio-economic conditions.
In Russia this value is great (10^{-4} -10^{-7}):

- 10^{-4} *for operating capacity);*
- 10^{-5} *for projects under construction and designed projects;*
- 10^{-7} *for nuclear sites.*

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Oil and gas industry: Risk assessment of dangerous weather events and climate anomalies (empiric method and taking into account fuzzy set theory)

Dangerous weather event and climate anomaly	Thunder storm	Wind speed ≥ 20 m/c	Air tempe-rature ≤ – 30⁰C	Air tempe-rature ≤ – 40⁰C	Whirl wind	Complex: Wind speed ≥ 15 m/c, ≥ 22 m/c, ≥ 35 m/c; air temperature ≤ 25⁰C, ≤ - 30⁰C, ≤ – 40⁰C
Risk *(Northern part of Western Siberia)*	$3*10^{-5}$	10^{-5}	$2*10^{-5}$	10^{-6}	10^{-7}	**Fuzzy set method** High weather and climate related risk *(with confidence 0,46);* ***Medium weather and climate related risk***; (*with confidence 0,58*)

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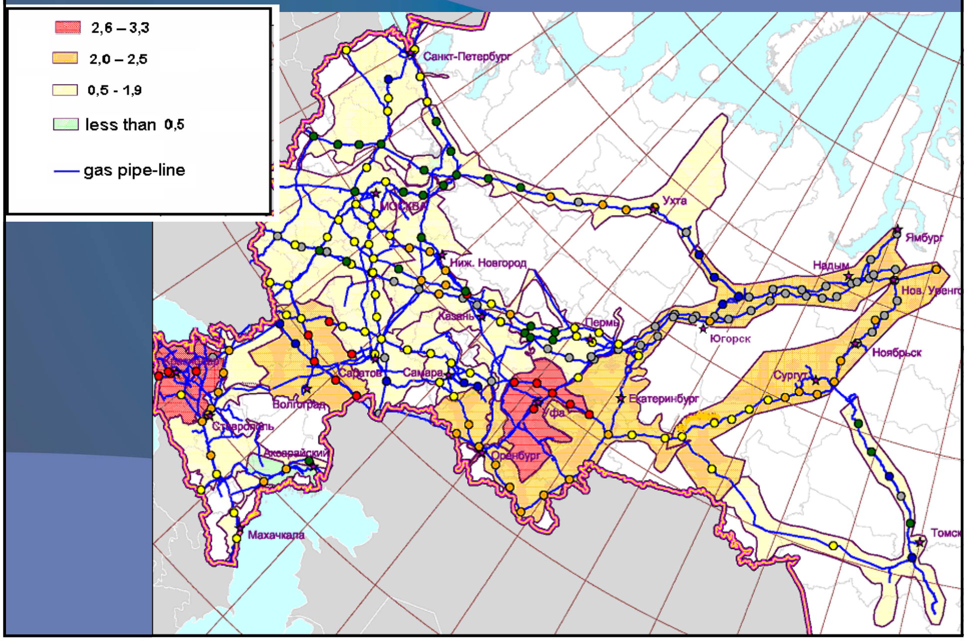
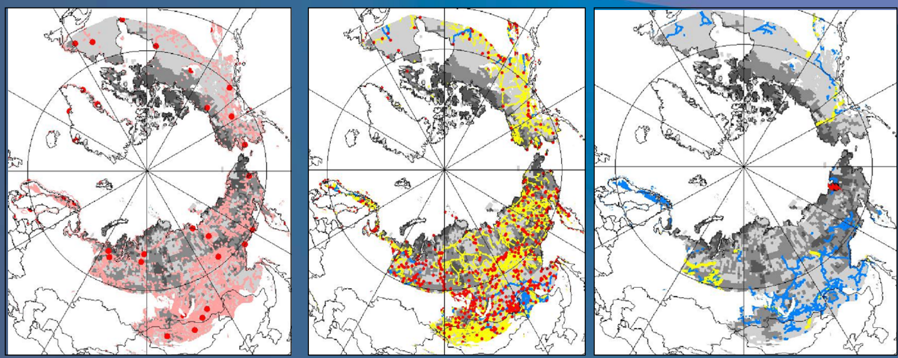
Complex climate related risk for gas pipe lines (%)



Permafrost hazard index for infrastructure by 2050

(Anisimov and Lavrov, 2004)

Cities and settlements | Traffic arteries | Pipelines and power lines



> 100 000
>10 000

Roads
Railways
Airports

Power lines
Pipelines
Nuclear power station Bilibino

The probability of destructive processes by 2050

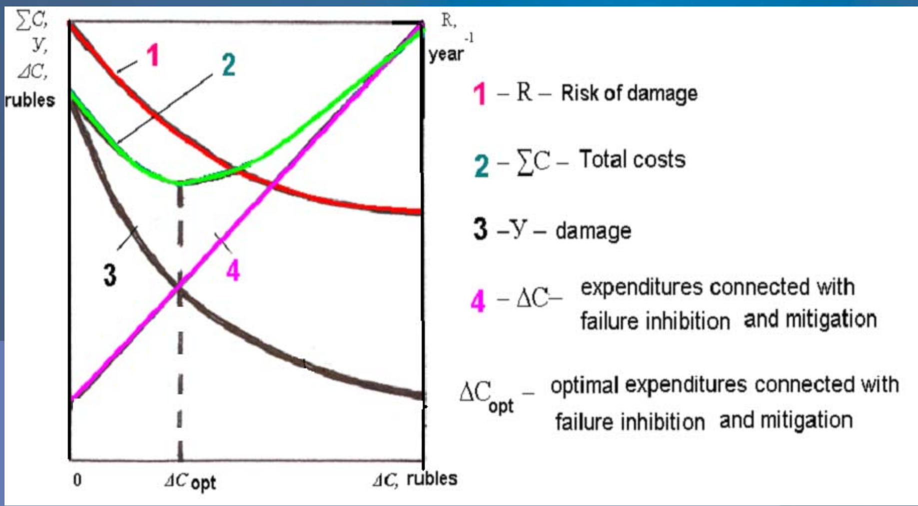
low | mean | high

➢ Spatial analysis in the North of West Siberia indicates that the observed climatic warming has resulted in a substantial decrease in the bearing capacity of permafrost soils, which in turn undermines the stability of infrastructure built during the 1960s and 1970s. The areas with changes in I_g greater than 20% can be considered hazardous with respect to the stability of infrastructure.

➢ Projected warming under any of the IPCC scenarios will further enhance the loss of bearing capacity of the ground. Extensive soil testing and unique building techniques are necessary to ensure the long-term viability of the infrastructure in the permafrost region.

➢ There is a significant economic impact on oil and gas exploration from a shorter tundra travel season. Exploration targets have moved farther away from habitable and populated areas. It requires more time and expenditures for ice road building

Relationship between total costs and expenditures connected with failure inhibition and mitigation



Building construction

- Among positive consequences of expected climate change for infrastructure in Russia reduction of heating period duration and increase of its temperature could be considered.

- On the average anticipated rise of mean winter temperature by 1^0 C causes to decrease thermal resistance of the envelope by factor of 1.2. Decrease of annual heating period values could be considered as opportunity for construction cost reduction. It should seem that this measure is more profitable than fuel saving.

- When using Cost-Benefit approach there were following parameters involved: rising variability of heating period, risks of Insufficient and excessive heating, discounting expenditures of fuel and construction materials. It emerged that reduction of thermal resistance of the envelope was non-optimal measure . Thus specified building parameters in Construction Rules and Regulations were not changed.

Reduction of annual heating period value by 2050 year (mln RUB)

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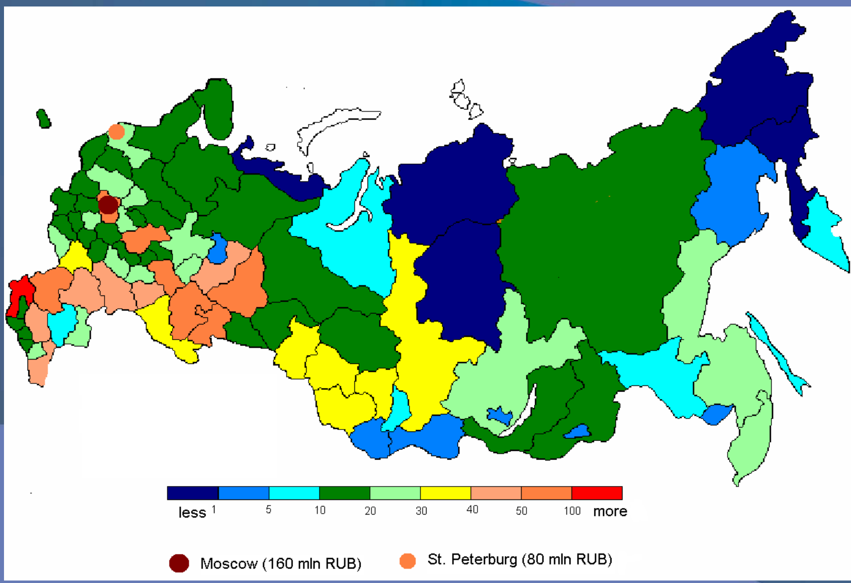

Road facilities

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Cost-benefit approach to preventative measures because of increasing flushing surface condition caused by climate change (ice-slick, black ice, glazed frost, packed snow, friable snow).

Lose matrix:

Predicted climate conditions	Decision-making	
	Appropriate adaptation measures will be taken	Appropriate adaptation measures will not be taken
Flushing surface condition increase	S_{11}	S_{12}
Flushing surface condition do not increase	S_{21}	S_{22}

S_{11} - unavertable losses due to worse climate conditions (*reduction in driving speed, an increase in road accident risk, ecological damage*) **+** prevention costs due to flushing surface condition (*improving roadway covering and deicing agents, additional machinery use*).

S_{21} - prevention costs due to flushing surface condition.

S_{12}– preventable and unavertable losses due to worse climate conditions. Preventable losses approximately are five times larger than unavertable ones.

$S_{22}=0$

$$\Delta E = p\,(S_{12}-S_{11}+S_{21}),$$

Δ E – economic benefit, P - forecast success rate

Renewable energy
can be considered as adaptation and mitigation option.

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- In order to take advantage of positive effects of climate change and develop an adequate adaptation strategy, total, technical and economic potentials of various sources of renewable energy up to date and by mid-21th century were assessed. For this purpose pay-back period, life span, discounting expenditures of conventional and renewable energy sources for different regions were taken into account.

- On Russian territory small hydroenergetics is one of the most promising sources of renewable energy. In 2008 hydro generation on Russian territory was about 156 bln kilowatt-hour. In case of promoting small hydroenergetics, additional energy 6,2 + 1,6 bln kilowatt-hour might be derived by mid-21st century.

- At the present time incremental energy cost connected with small hydroenergetics could be recovered only for independent electric consumers in remote parts of the country without centralized power supply. By using multi – criteria analysis about 20 regions were selected for development of small hydroenergetics. Selection process considered both measured aspects and non-monetary social appraisal (improvement of living conditions in remote parts of the country nowadays and in years to come).

RIVER BASIN, REGION	PROJECTED CHANGES OF THE RIVER FLOW BY MID-21ST CENTURY (%)	PROJECTED CHANGES OF THE TOTAL HYDROPOWER RESURSES BY MID-21ST CENTURY (%)
The Yenisei	***10 ± 6***	***4 ± 2***
The Lena	***17± 7***	***7± 3***
The Chukchi Peninsula	***15 ± 8***	***6 ± 3***
Western Siberia	***11± 4***	***4 ± 2***
Eastern Siberia	***14± 5***	***5 ± 2***
RF	***11± 3***	***4 ± 1***

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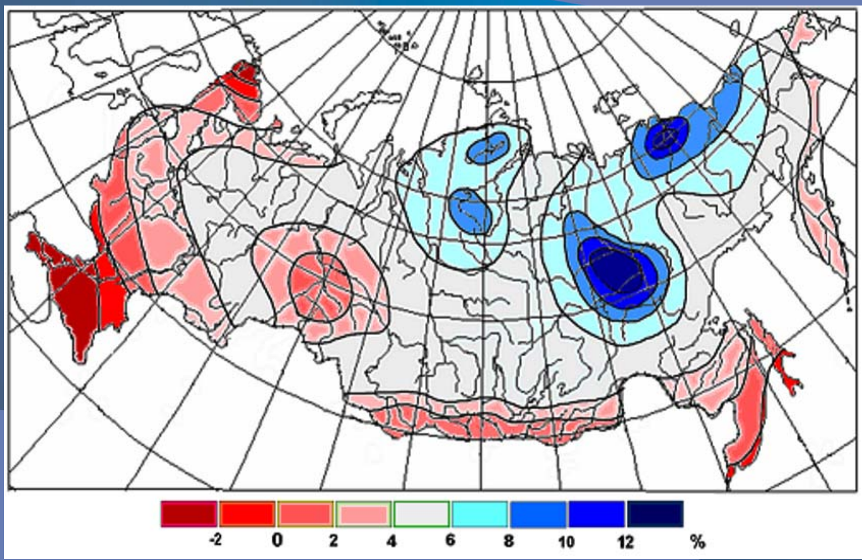
PROJECTED CHANGES OF THE TOTAL HYDROPOWER RESURSES BY MID-21ST CENTURY (%)



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Case study. Economic potential of small hydroenergetics in the Arkhangelsk Region.

There were selected 43 rivers taking into account consumer market, fossil fuel costs and other economical indicators, as well as ecological situation and multi-model ensemble estimates of climate change impacts on runoff in this region.

Potential of small hydroenergetics in the Arkhangelsk Region in 1980-2000 и 2041-2060.

Period	Types of hydroelectric potential, GWh p.a.		
	Total	Technical	Economic
1980-2000	1877.8	845.0	46.5
2041-2060	2181.0	981.4	53.9
Increase, GWh p.a.	303.2	136.5	7.4
Increase,%	16.1	16.1	16.1

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Gaps:

- there are not accurate regional climate models for the most part of the country ;
- there are difficulties in translating physical impacts into monetary values;
- in many instances, costs of implementing adaptation options and their benefits are described in qualitative way;
- the users of climate information often don't take probabilistic tailored climate products in the right way

Conclusion:

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- Risk assessment and management at the national level is based on the concept of acceptable risk.

- Presented Climate Risk Management Process for power-engineering and building construction includes the systems of tailored climate products for different sectors. They can be used to identify above-norm loads taking into account observed and predicted climate change.

- Assessment of cost and benefits connected with reduction of heating period duration and temperature was fulfilled using Cost-Benefit approach. The same approach was also applied for selection of adaptation measures for road facilities.

- Selection of regions that might be best suited for the development of small hydroenergetics was based on multi – criteria approach.

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Thank you for your attention!