Northern Eurasia Future Initiative:

Facing the Challenges of Global Change in the 21st century

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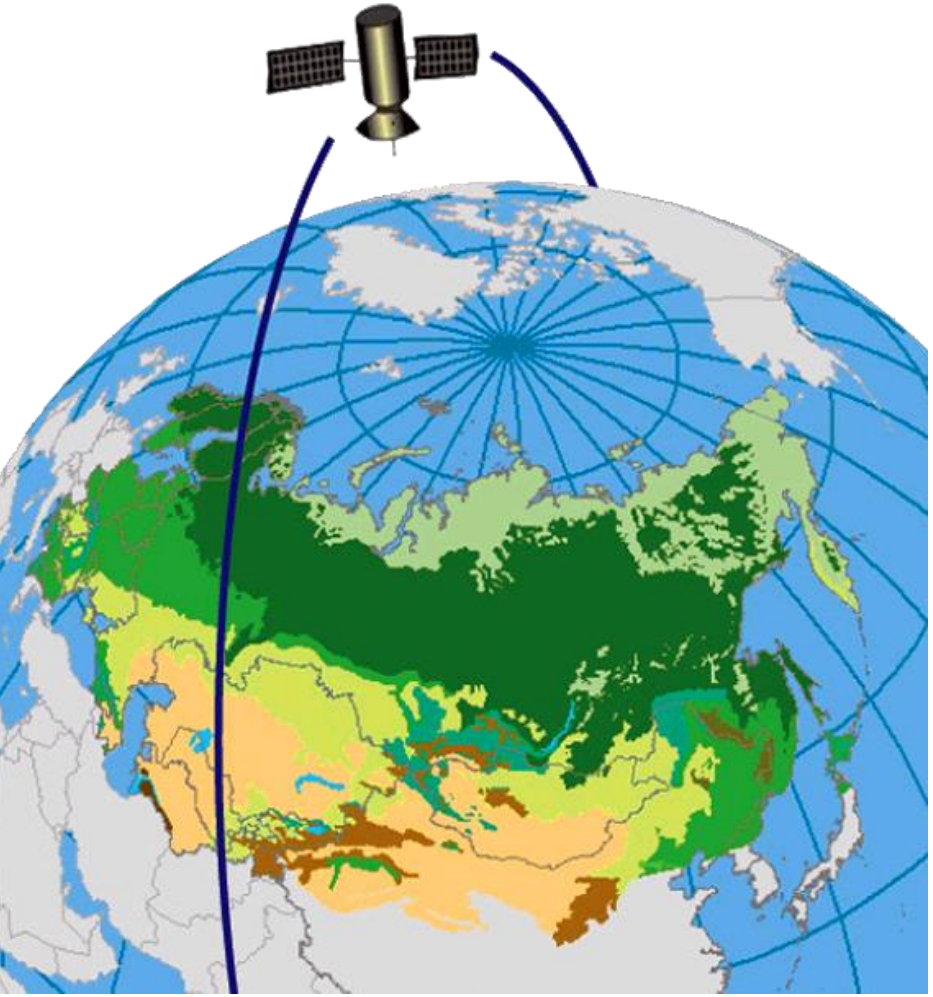

The NEESPI Study Area

http://neespi.org

During the past 10 years, NEESPI has been an interdisciplinary program of internationally-supported Earth systems and science research that addresses large-scale and long-term manifestations of climate and environmental change

NEESPI CONCEPT

We are living in the epoch of large changes in Climate, Environment, and Human Activities. All these changes now have become intertwined and affect each other => they have to be studied in a synergetic manner.

Considering the triad "climate - environmental impacts – socio-economic impacts", NEESPI is currently sufficiently covering diagnostics of regional climate, environmental, and ecosystem characteristics. However, the socio-economic impacts of variability and/or systematic changes in climate and environment are still poorly covered making it difficult to effectively plan future (and to accurately interpret already performed) model experiments.

=> NEFI ADD-ON TO THE NEESPI CONCEPT

The Northern Eurasia Future Initiative (NEFI) objective is to bridge climate and environmental studies with the economic consequences of the observed changes;

NEFI will provide the synergy between them and spurring the advances of physical sciences in quantifying observed and projected climate and environmental changes and the advances of the economic analyses and the impacts.

Northern Eurasia Future Initiative (NEFI) as a successor of the Northern Eurasia Earth Science Partnership Initiative (NEESPI)

- **The Current Poster will provide summation of the past NEESPI achievements and justifications for a new focus study, NEFI**
- **Today. my Presentation will outline the NEFI Science Plan; its draft is at http://neespi.org/NEFI-WhitePaperDraft.pdf.**

End of Poster Introduction

Northern Eurasia Future Initiative (NEFI) as a successor of NEESPI

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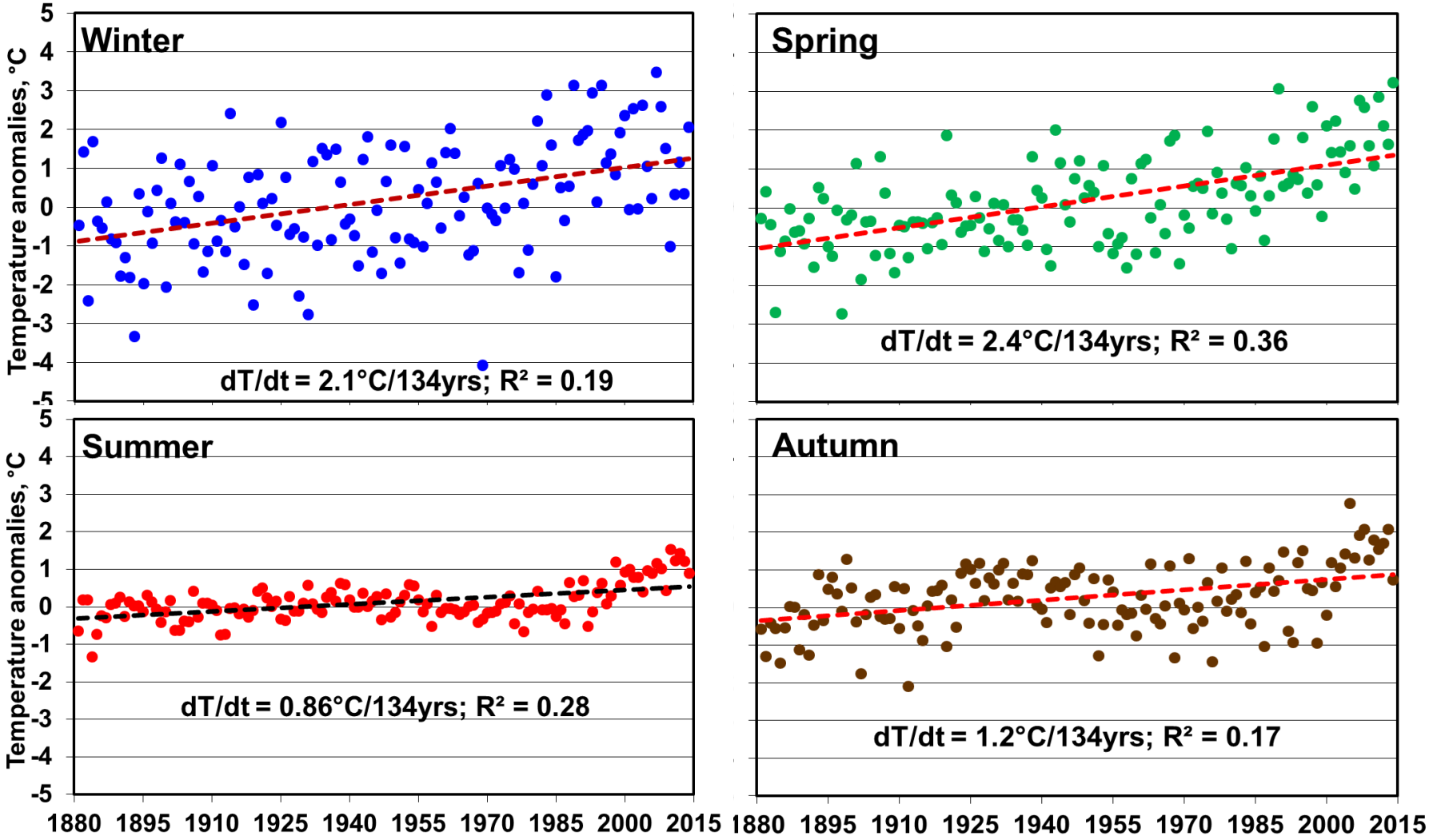
and 45 Co-authors of the NEFI White Paper (Draft of Science Plan)

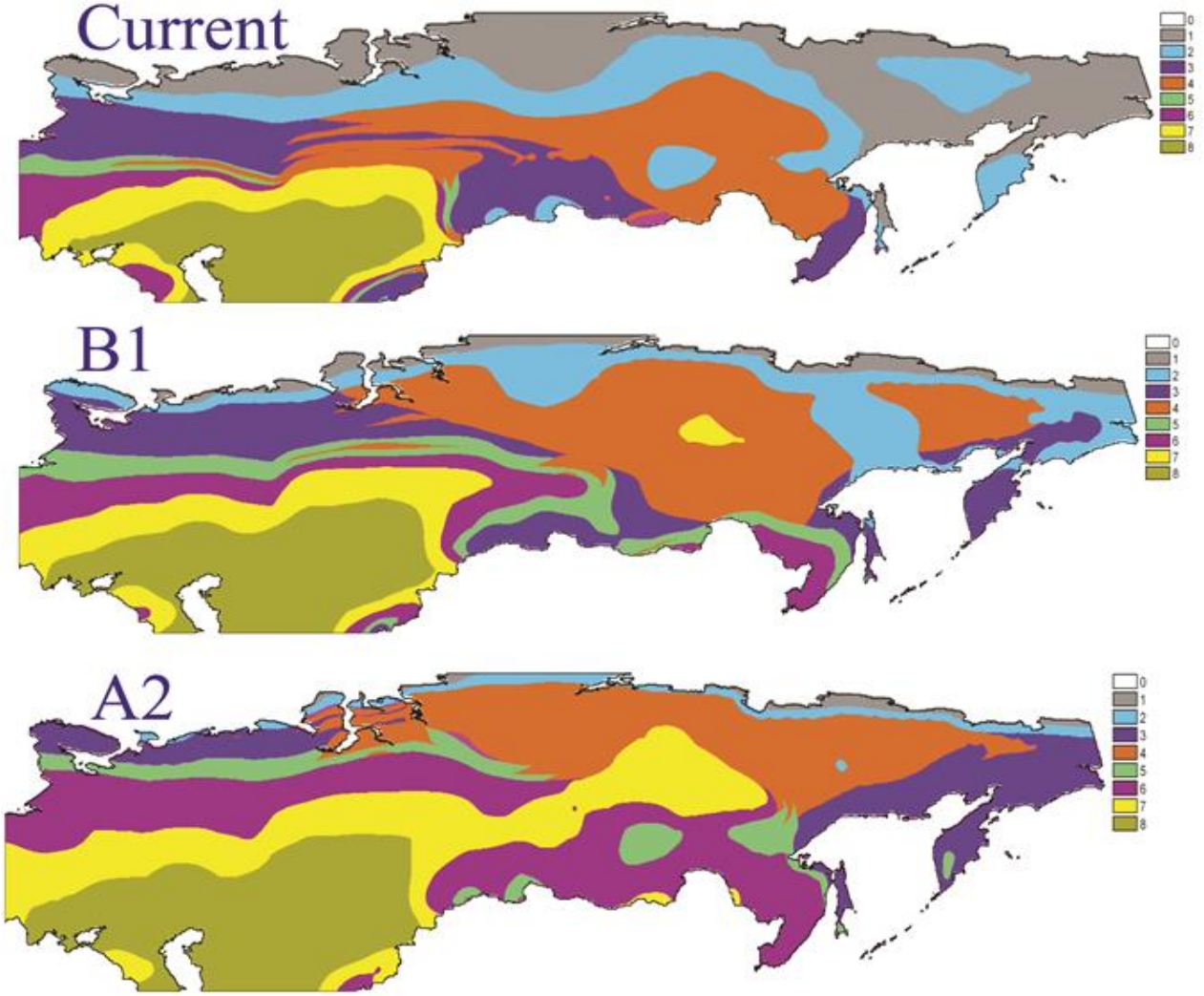
- **The NEFI Science Plan draft is at http://neespi.org/NEFI-WhitePaperDraft.pdf.**

Surface Air Temperatures in Northern Eurasia since 1881



Regional warming here is well above the Globe

Recent Projections of Ecosystems' Shifts



Vegetation classes:

1 – Tundra (*grey*),
2 – Forest-Tundra (*blue*),
3 – Dark taiga (*violet*),
4 – Light Taiga,
5 – Mixed (*green*),
6 – Broad-leaved (*purple*),
7 – Steppe (*yellow*),
8 – Semidesert (*khaki*).

Vegetation distribution under present conditions and equilibrium vegetation distribution under future climate conditions (scenarios) over Northern Eurasia in current climate and by year 2090 (Archive of Shuman et al. 2015)

New/Old Science Questions

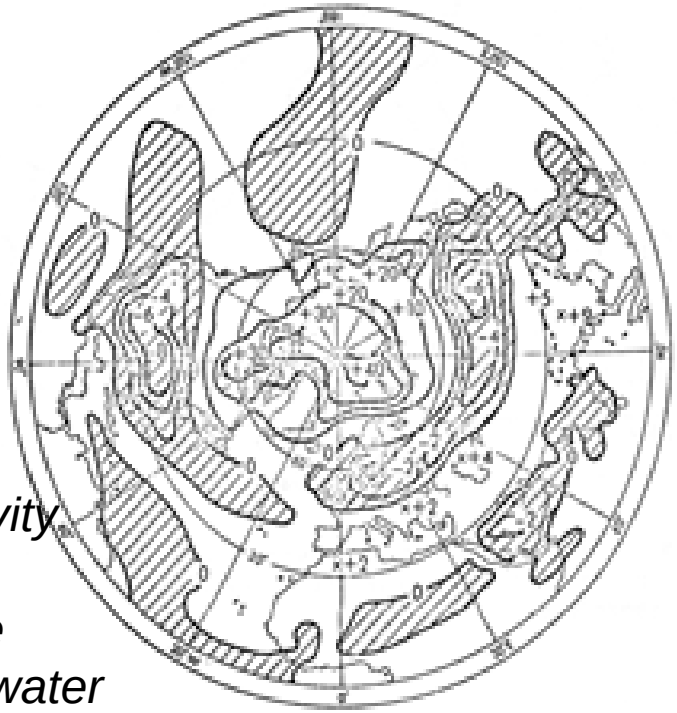
- **How can we quantify and project the ecosystems dynamics in Northern Eurasia that:**
  - *i. are internally unstable (e.g., operate in narrow temperature ranges);*
  - *ii. are interrelated with highly variable components of the cryosphere and/or are vitally controlled by components that have been systematically changing; and,*
  - *iii. have a potential to impact the Global Earth system with unprecedented rates of change over few decades, e.g., due to, for example, catastrophic forest fires, dust storms, and hotly debated future methane release from the frozen ground in high latitudinal land and shelf areas.*
- **What are the major drivers of the ongoing and future changes of the water cycle in Northern Eurasia and how will their changes affect the regional ecosystems, society and feedback to the Global Earth system and economy**
- **How to secure the sustainable development of societies of Northern Eurasia in the near future overcoming the "transitional" nature of their economics, environmental and climatic change challenges, and untying institutional legacies?**

Foci of new research

1. Global change, particularly the warming of the Arctic
2. Increasing frequency and intensity of extremes and changes in the spatial and temporal distributions of inclement weather conditions
3. Retreat of all components of the cryosphere
4. Changes in the terrestrial water cycle
5. Changes in the biosphere
6. Pressure on agriculture and pastoral production
7. Changes in infrastructure
8. Societal actions to mitigate negative consequences of the environmental change and to benefit from positive consequences
9. Quantification of the role of Northern Eurasia in the global Earth and socioeconomic systems to advance research tools with an emphasis on observations and models.

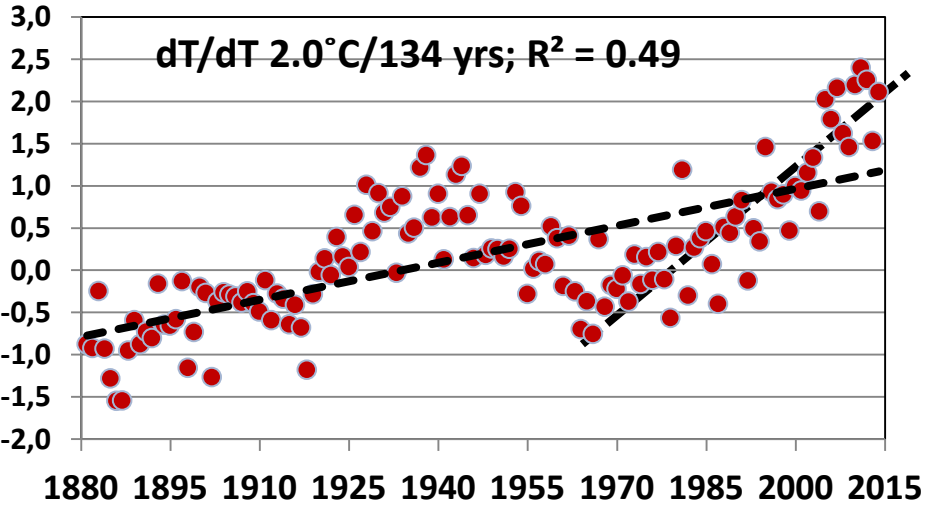
Research Focus: Global Impact of the Arctic Warming

- Direct regional warming/cooling
- Changes in atmospheric circulation
- Social and economic consequences

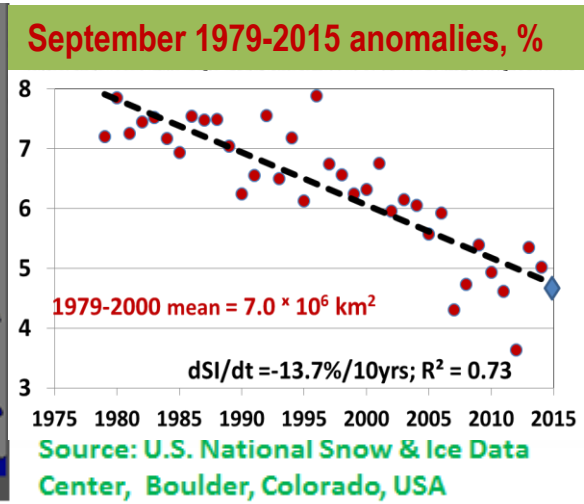


One of the first UCMO GCM sensitivity experiments with polar ice replaced by water at 0℃. Changes in January surface air temperature, ℃ (Newson 1973).

Annual surface air temperature anomalies area-averaged over the 60°N - 90°N latitudinal zone



Northern Hemisphere sea ice extent as of mid-September 2012 and September sea ice extent anomalies, %



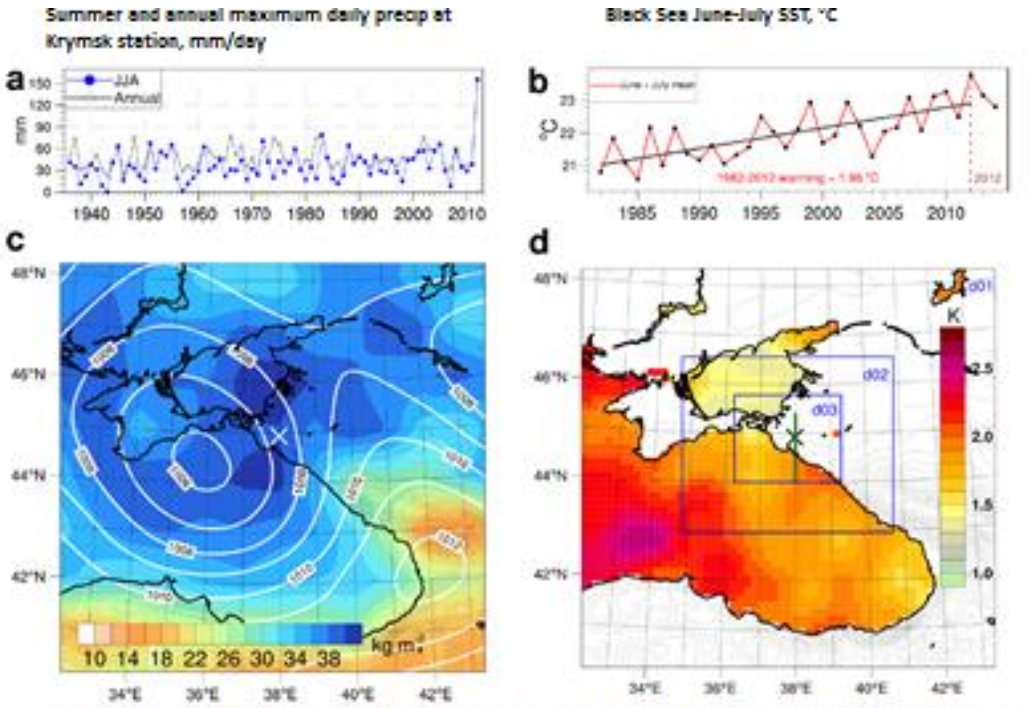
Research Focus:

Extremes frequency and intensity in changing climate.

Krymsk Flood

Russia,

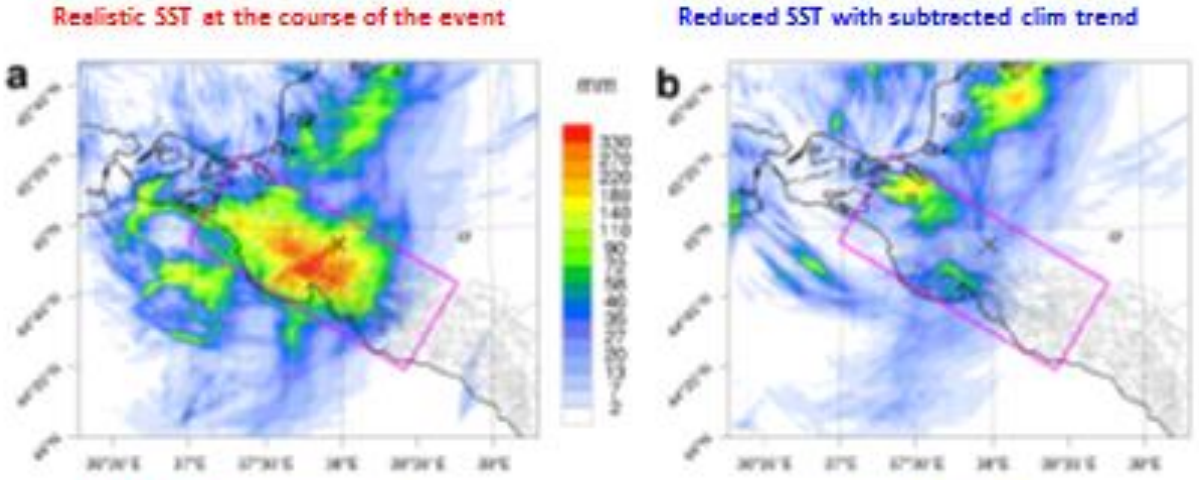
July 7, 2012



Precipitable water (kg/m²) and SLP (hPa) on 6th July at 18Z (day of the event)

Three nested WRF domains used for simulation of the event (inner 600m resolution) and SST trend (°C) for 1982-2012

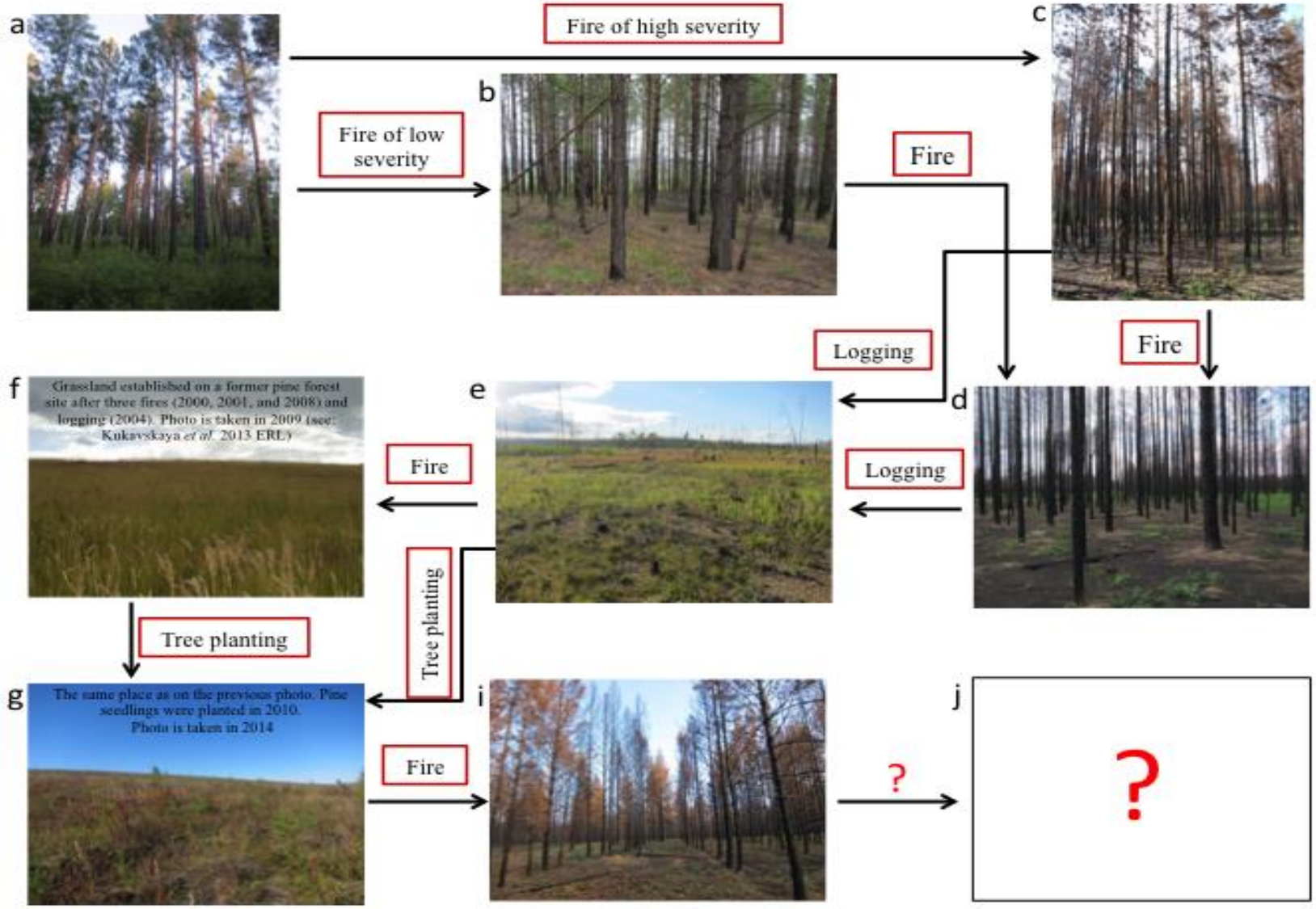
Total simulated precipitation from 6th July at 03Z to 7th July 2012 at 12Z



186 mm (171 mm observed)

23 mm

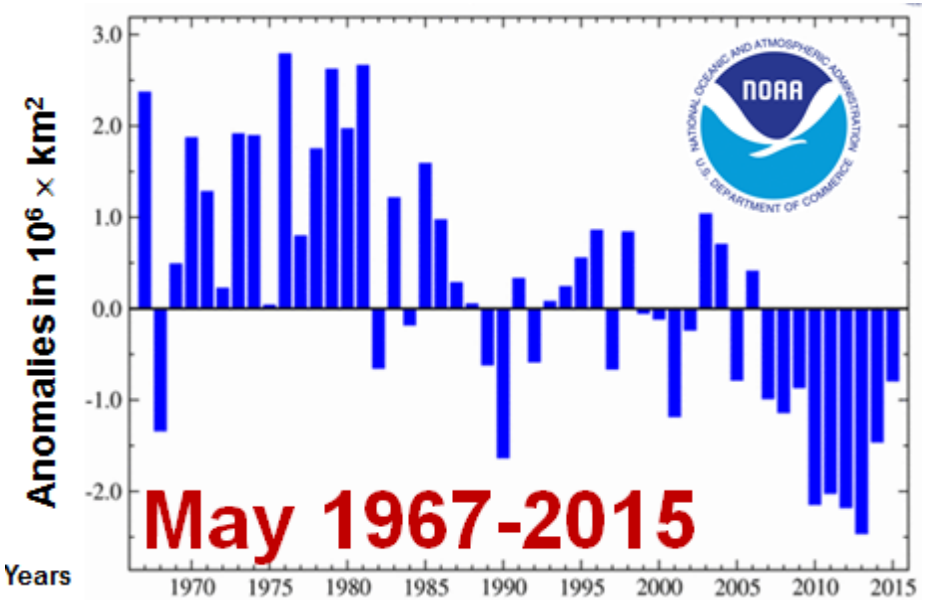
Research Focus: Extremes frequency and intensity in changing environment



- ***Extreme events that affect the biosphere (disturbances)***

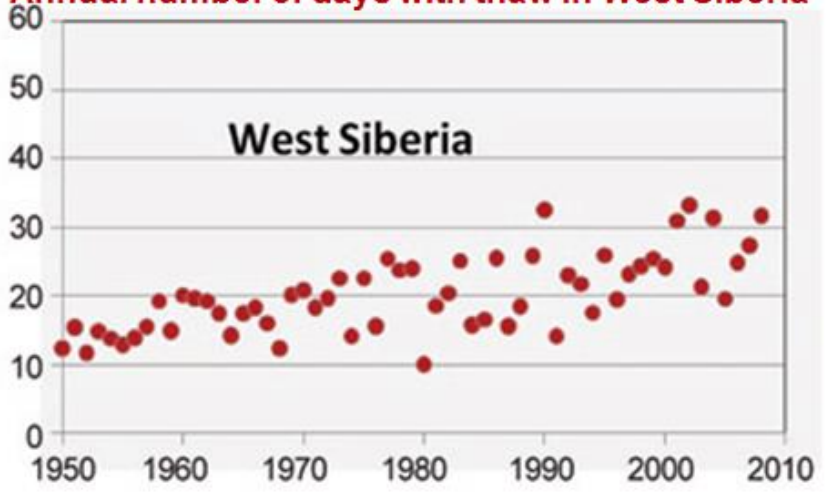
Research Focus: Cryosphere retreat

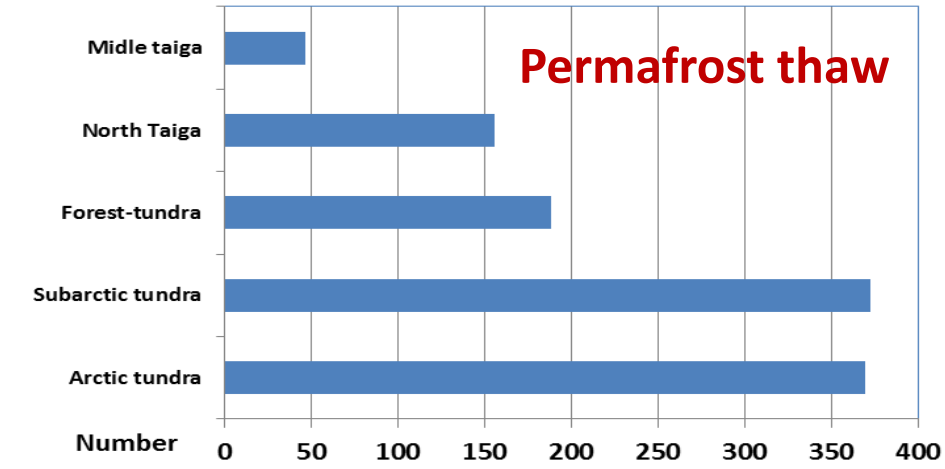
May snow cover over Eurasia



We define "days with thaw" as the days when the mean daily temperature is above -2°C while snow on the ground is above 5 cm.

Annual number of days with thaw in West Siberia

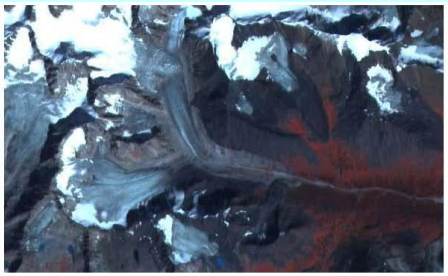




Number of newly emerging thermokarst lakes in W. Siberia, 1973-2013 period, Polishchuk et al. 2015

Upper Khovd River Basin

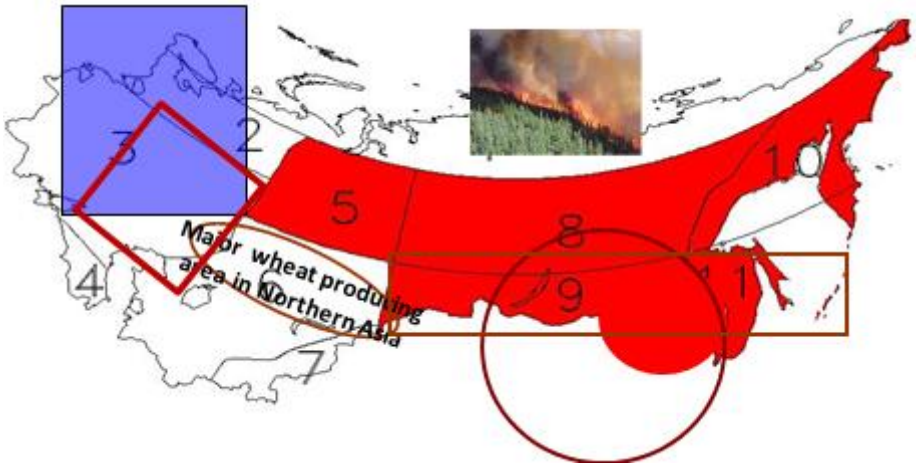
Photo by V.V. Sapozhnikov



Research Focus: Water supply deficit

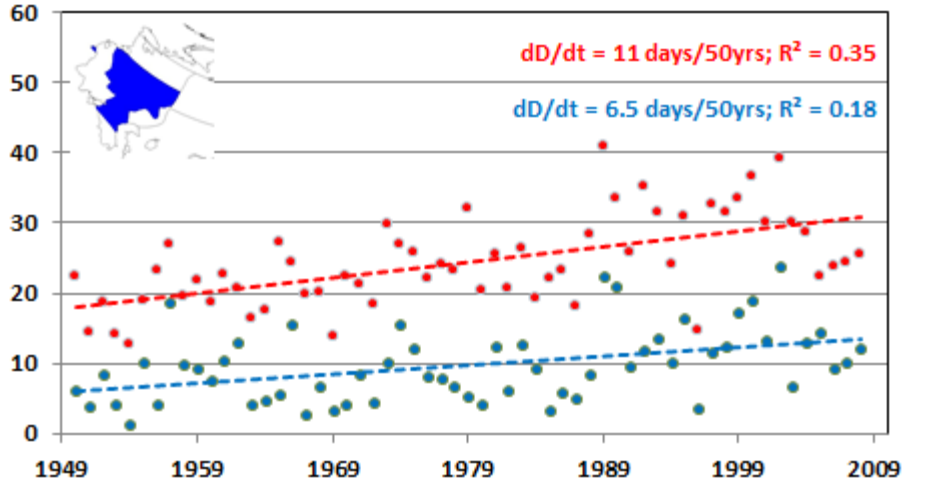
1. Mild winters with frequent thaws
2. Earlier spring onset
3. Longer vegetation season
4. Warmer summers and
5. No significant change in precipitation

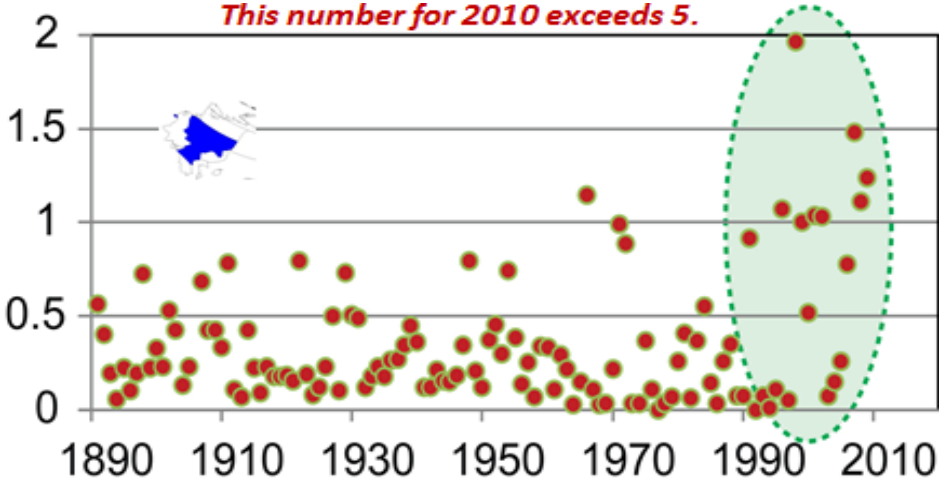
All the above lead to summer dryness and promote extremely dry episodes



Changes in the surface water cycle over Northern Eurasia in the 20th century; areas with more humid conditions (blue), with more dry conditions (red), with more agricultural droughts (circled), and with more prolonged dry episodes (rectangles).

Annual and winter number of days with thaw over European Russia south of 60°N

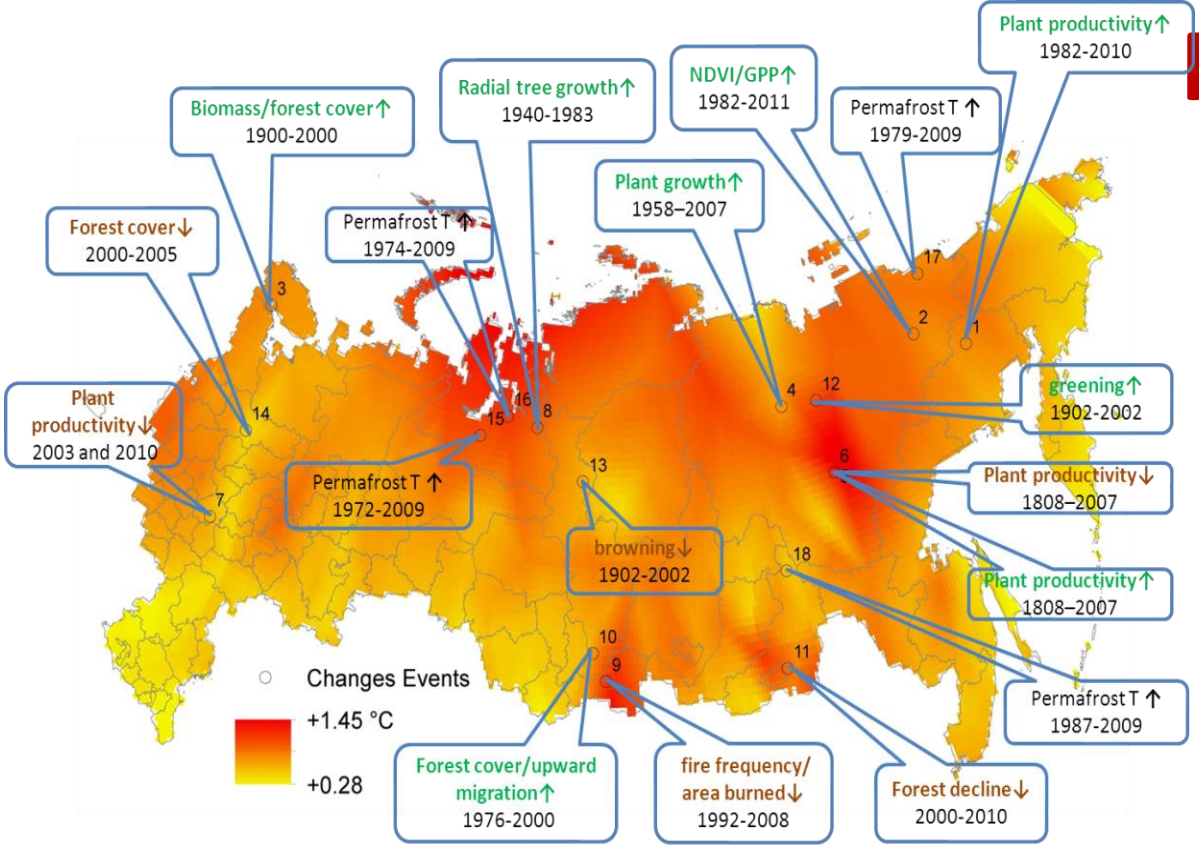




Number of "hot" nights, T_{min}>23.9°C over European Russia south of 60°N

Research Focus:

Biospheric changes



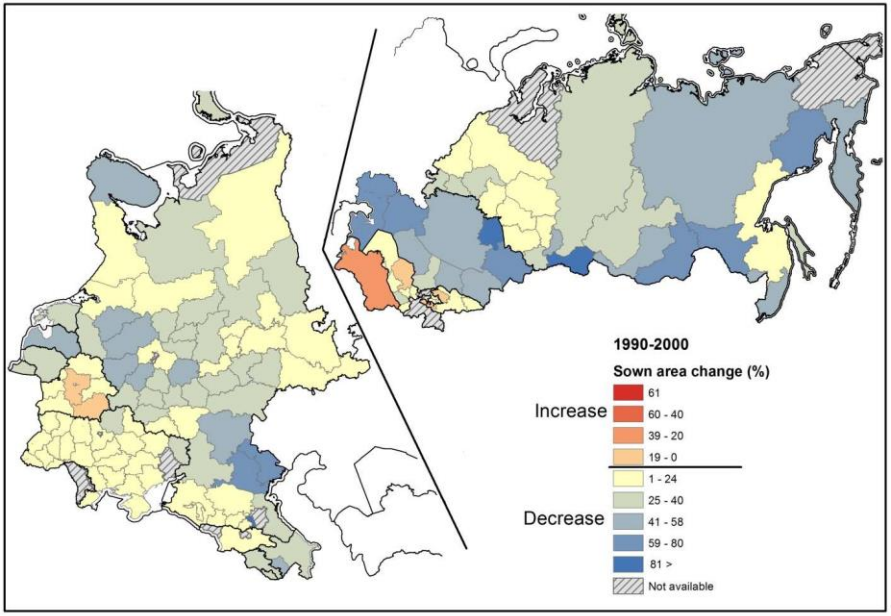
Synthesis of observed climate change impacts on Russian forests. The green (brown) font indicates positive (negative) impacts on vegetation while black font indicates the trend of changes (Schaphoff 2015).

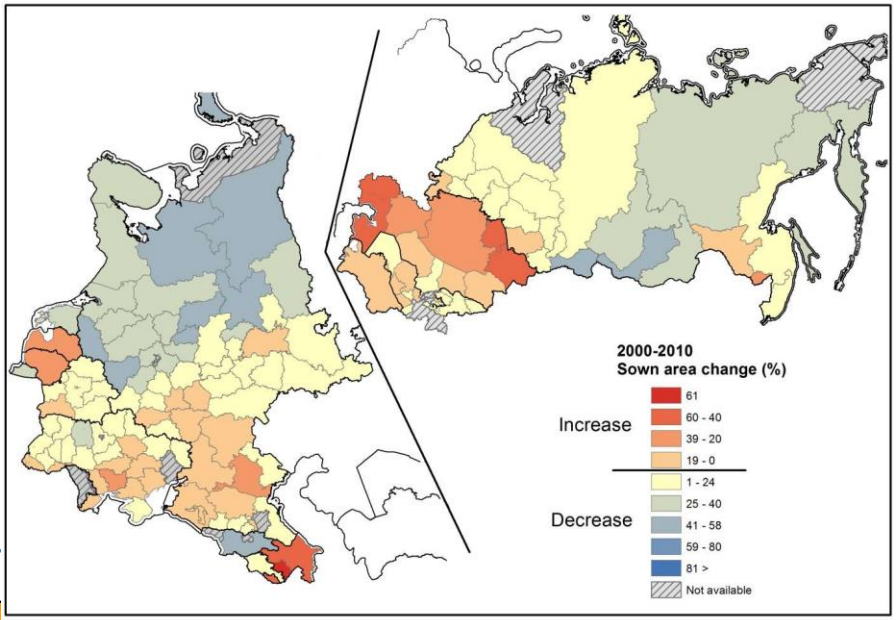
Future studies focus should be concentrated on

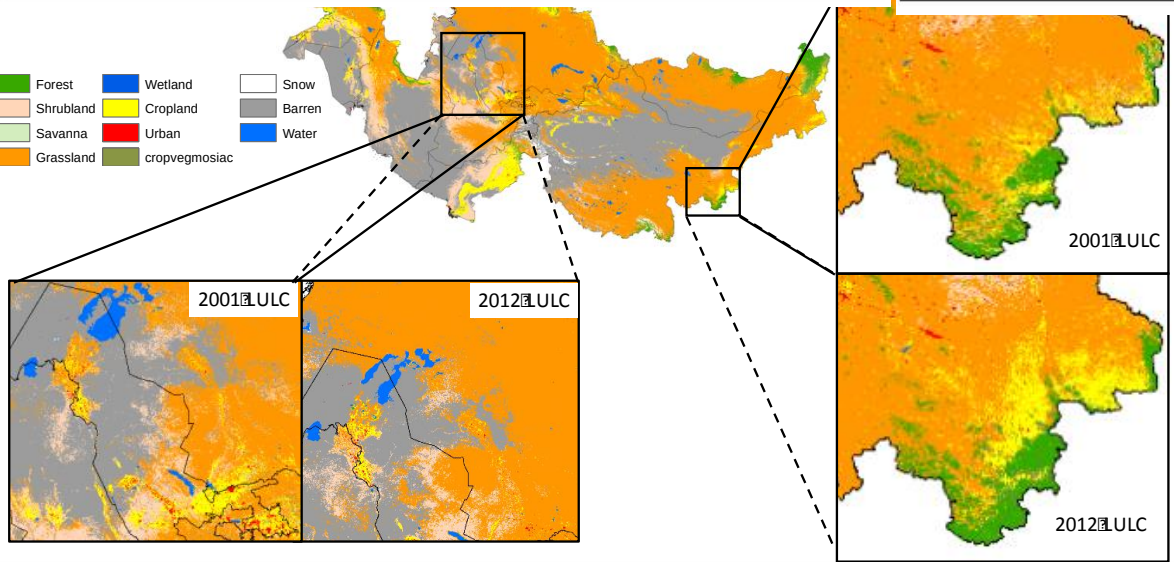
- ***Development of an integrated observing system on environment, land, landscapes and ecosystems;***
- ***Development of new classes of ecosystem process-based models on structure, growth, productivity and resilience of vegetation ecosystems as part of both integrated observing systems and scientific background of sustainable ecosystem management;***
- ***Developing integrated modelling clusters that would include ecological, social and economic components as the input to Earth system models***
- ***Developing strategies and policy recommendations for sustainable ecosystem management, adaptation to, and mitigation of, expected climate change.***

Research Focus: Pressure on agriculture and pastoral production

Land abandonment: Changes in sown areas across the former Soviet Union (left) from 1990 to 2000 and (right) from 2000 to 2010; areas of abandoned sown areas from 1990 to 2010 are: 40 Mha in Russia; 5.4 Mha in Ukraine; and 13 Mha in Kazakhstan (Prishchepov et al. 2016).







Agro-land losses: LC/LU change in the Asian dryland belt from 2001 to 2012 (Qi et al. 2012, 2016).

Research Focus: Changes in infrastructure

Future studies within this focus should be concentrated on:

In High latitudes:

- Integrative analysis of the cumulative effects of infrastructure on social and natural systems and implications of climate and socio-economic changes on ecosystem services, residents, and industry;
- Developing adequate, economically-viable adaptation and mitigation strategies for northern communities and areas of intensive industrial development.

In the temperate zone of East Europe:

- *In-depth research of underlying and proximate land-use change drivers and socio-ecological interactions that cause land-cover change;*
- *Assessment of trade-offs between land-use and regional ecosystem services revealing optimal strategies for resource and climate-smart agriculture and land-use; and*
- *Studies of carbon management, CO_2 emissions, and short-lived climate pollutants.*

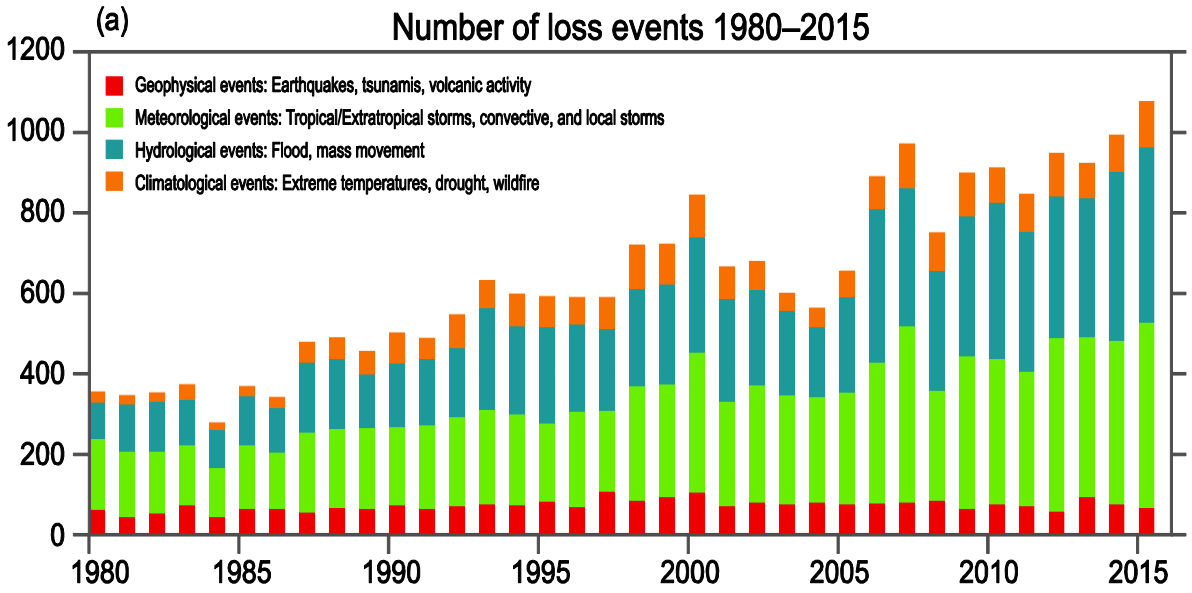
In the Taiga and Far East zones

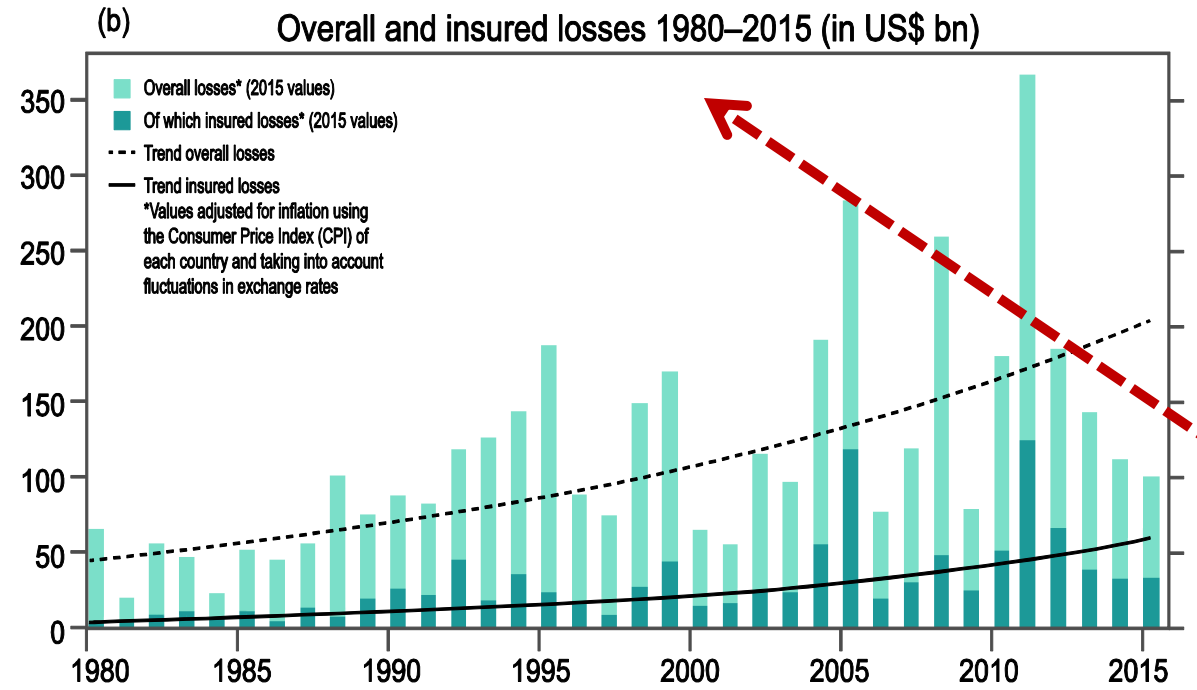
- *integrated modeling of forest growth, fire, logging, infrastructure and other human land-use decisions, along with climate, providing the ability to build different scenarios of the future;*
- *Planning for sustainable future of regional communities involving legitimate economic uses of bio- and geologic resources which also preserve carbon sinks and biodiversity.*

In Central Asia, Mongolia and Northern China on answering the following questions:

- *How the infrastructure changes have facilitated regional food security from both production and consumption perspectives,*
- *If and how the major infrastructure changes reduced or escalated socioeconomic disparity at different spatiotemporal scales within and across the states in the region, and*
- *What are the critical infrastructures that would enable regional rural communities to improve their livelihoods.*

Research Focus: Societal feedbacks in response to environmental changes

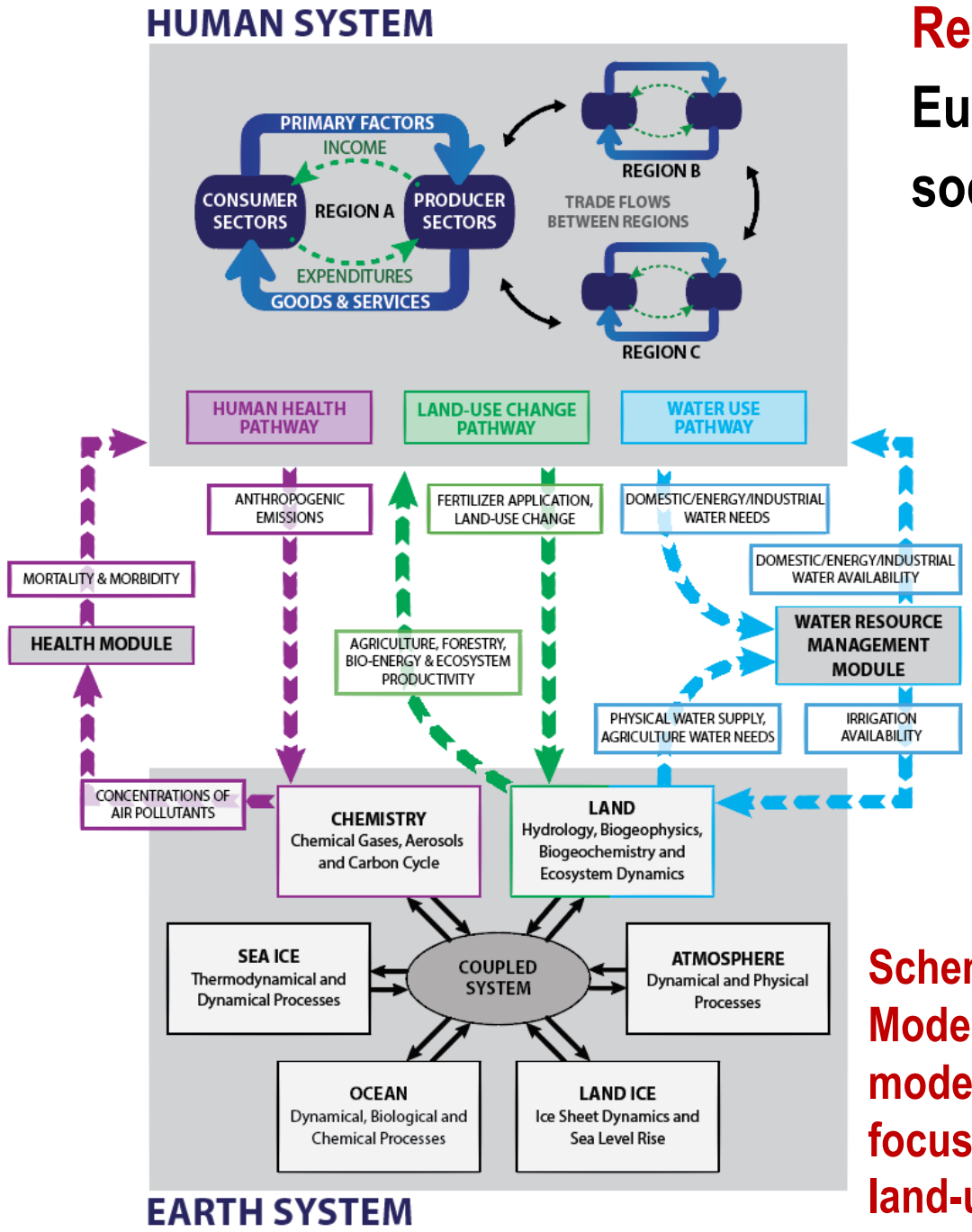




Planning in order to be prepared for risks related to the *increasing* possibility of changes and to reduce the adverse impact of disasters and increase resilience of the communities at risk is needed. This planning should be based upon numerical experiments with models that realistically describe processes of environmental changes in all their complexity and interactions. *Future studies within this focus should be concentrated on development of such models with direct social feedbacks.*

The frequency and damage of the major natural and environmental disasters. Source: Munich Re-insurance

Research Focus: Role of Northern Eurasia in the global Earth and socioeconomic systems



Future studies within this focus should be concentrated on exploitation of a suite of regional process-oriented models, the Earth System models, and Integrated Assessment Models under different environmental and socioeconomic change scenarios with tracking the changes beyond the Northern Eurasia domain, i.e., teleconnections

Schematic of an Integrated Assessment Model (IAM) that couples a human activity model and an Earth system model with a focus on three feedback pathways: health, land-use change, and water resources.

Transition from NEESPI to “**N**orthern **E**urasia’s **Fu**ture” **I**nitiative (**NEFI**)

Future Earth: New global platform for sustainability research launched in June 2014

- ***Future Earth* – research for global sustainability, will provide a cutting-edge platform to coordinate scientific research which is designed and produced in partnership with governments, business and, more broadly, society.**

Goal: **Interdisciplinary solution-oriented approach that will allow effective policy-making in environment management and control**

MAIRS => Future Asia; BALTEX => Baltic Future;
NEESPI =>“**N**orthern **E**urasia’s **Fu**ture” **I**nitiative (**NEFI**)

Major NEESPI Science question remains intact:

- **How do Northern Eurasia's terrestrial ecosystems dynamics interact with and alter the biosphere, atmosphere, and hydrosphere of the Earth?**

But it is the time to expand this academic curiosity **question "how?"** to another, more practical:

- **What will the changes in this ecosystems dynamics and interactions mean for the societal well-being, activities, health, and strategic planning?**

NEFI Challenge

How to provide in Northern Eurasia a sustainable societal development (economy well-being, activities, health, and strategic planning) in changing climate, ecosystems, and… societies?