Northern Eurasia Earth Science Partnership Initiative (*NEESPI*) Science Plan Overview

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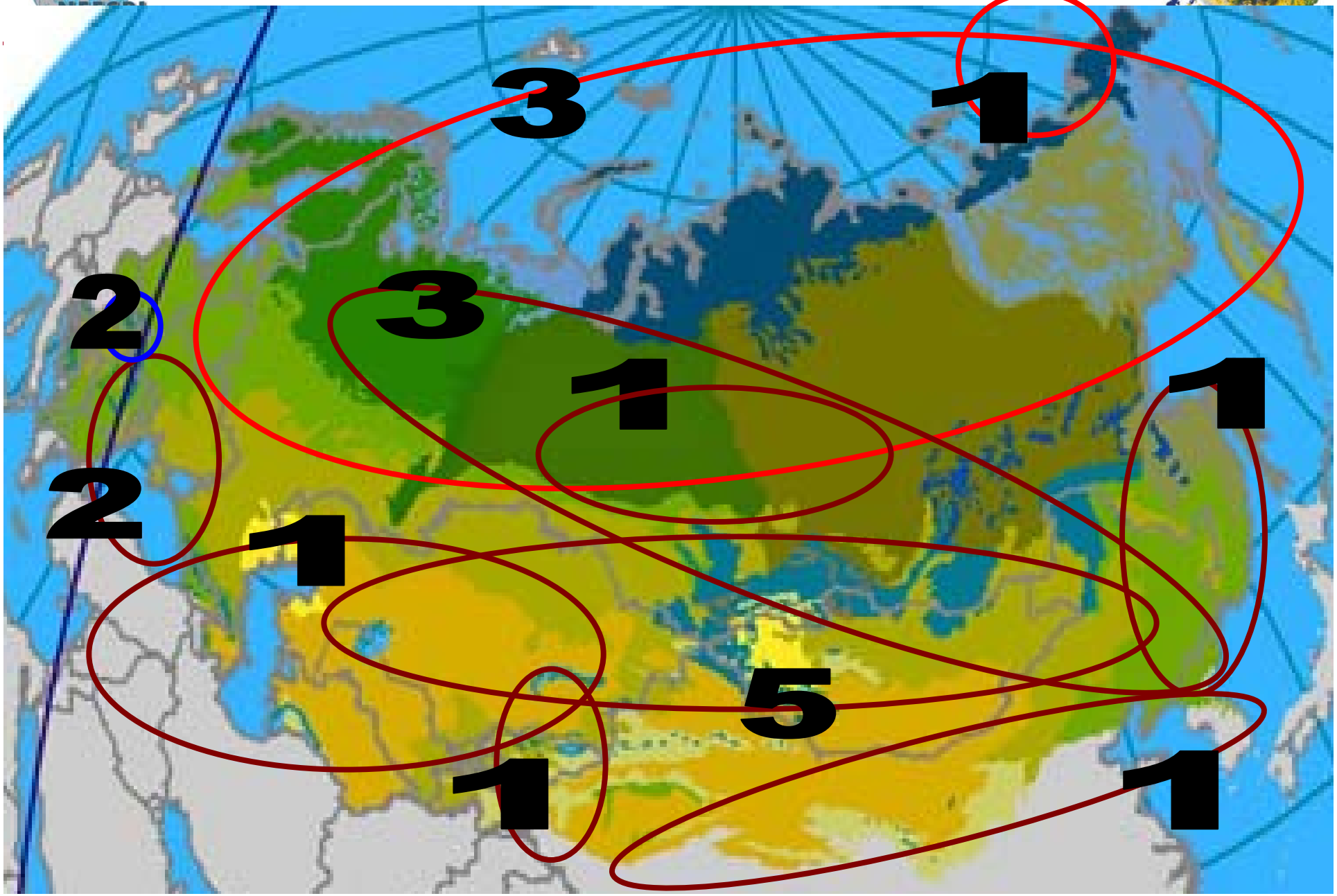
Global, Interdisciplinary, Active

- **Global** - Priorities were assigned to projects that addresses regional changes that affect (or may affect) Global Earth System
- **Interdisciplinary** -Strong interactions within the system terrestrial ecosystem -hydrosphere-cryosphere - atmosphere – human society in the region require interdisciplinary studies
- **Active** - Preparation of the NEESPI Science plan (2003-2004) occurred simultaneous with pilot projects initiation and proposals' writing (some of them have been already funded)

Currently active NEESPI projects count and area



The overarching NEESPI science question:

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

This question can be reformulated in a pragmatic way as:

- **How do we develop our predictive capability of terrestrial ecosystems dynamics over Northern Eurasia for the 21st century to support global projections as well as informed decision making and numerous practical applications in the region?**

Link to COPES

NEESPI Science Plan Structure

[available at http://neespi.org]

1. INTRODUCTION
2. SCIENTIFIC QUESTIONS AND MOTIVATION
3. MAJOR SCIENTIFIC TOPICS
   - 3.1. Terrestrial ecosystem dynamics
   - 3.2. Biogeochemical cycles
   - 3.3. Surface energy and water cycles
   - 3.4. Land use interactions: societal-ecosystem linkages
   - 3.5. Ecosystems and climate interactions
   - 3.6. Topics of special interest
     - 3.6.1. Cold land region processes
     - 3.6.2. Coastal zone processes
     - 3.6.3. Atmospheric aerosols and pollution
4. REMOTE SENSING
5. MODELING
6. DATA AND INFORMATION TECHNOLOGY
7. EDUCATION
8. RESEARCH STRATEGY

Scientific Background Appendix

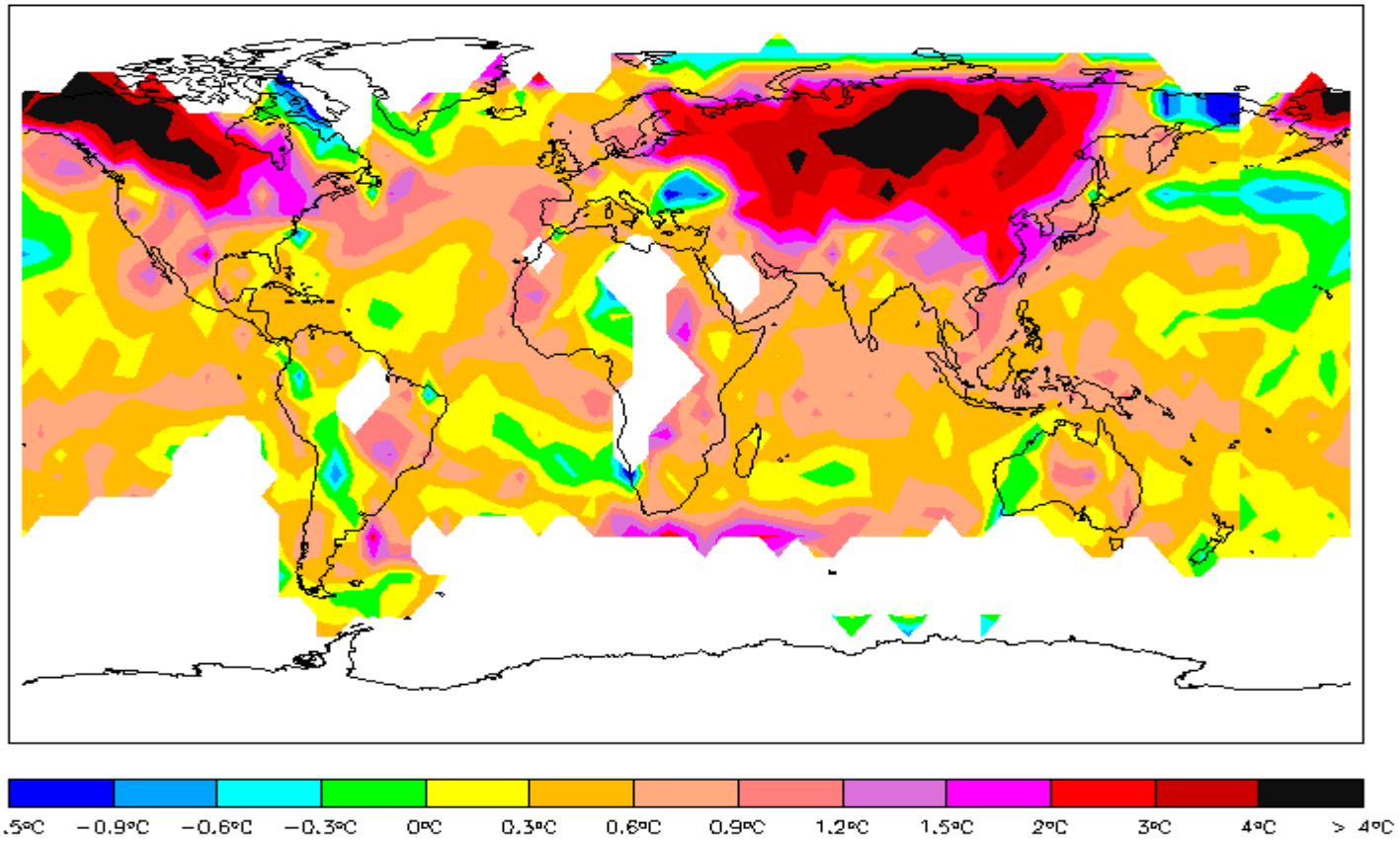
TOOLS

Rationale for the Science Plan structure

Strong climatic and environmental changes….

Current …

Mean Winter Temperature Change 1965 to 2004 over the globe

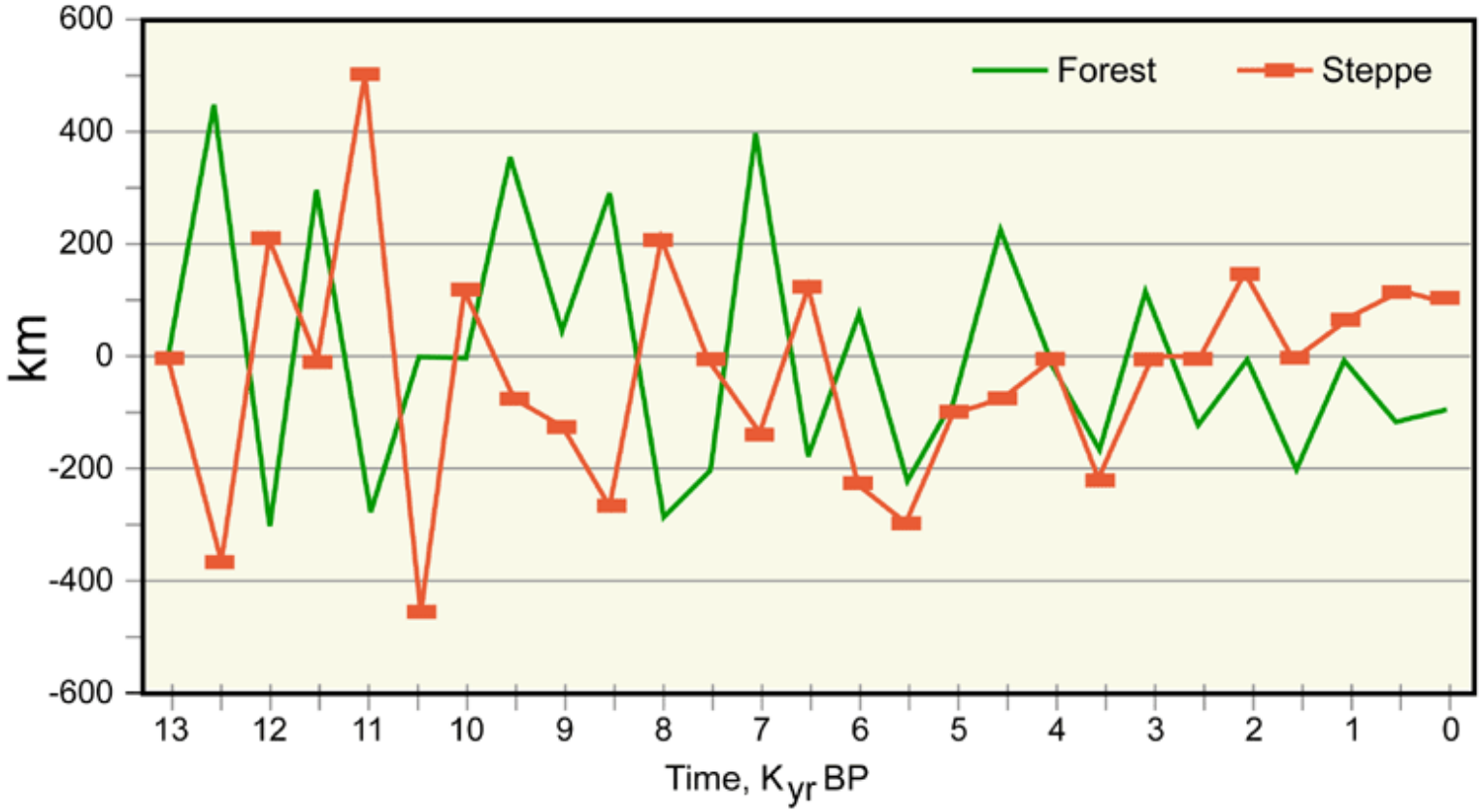


- Data source: (Jones and Moberg 2003). Processed by the U.S. NOAA NCDC Global Climate at the Glance Mapping System.

Just one “local” example:

20 years ago these oil tanks were 60 m away from the coast of Pechora Sea (Ogorogov, 2003)

… in the past...

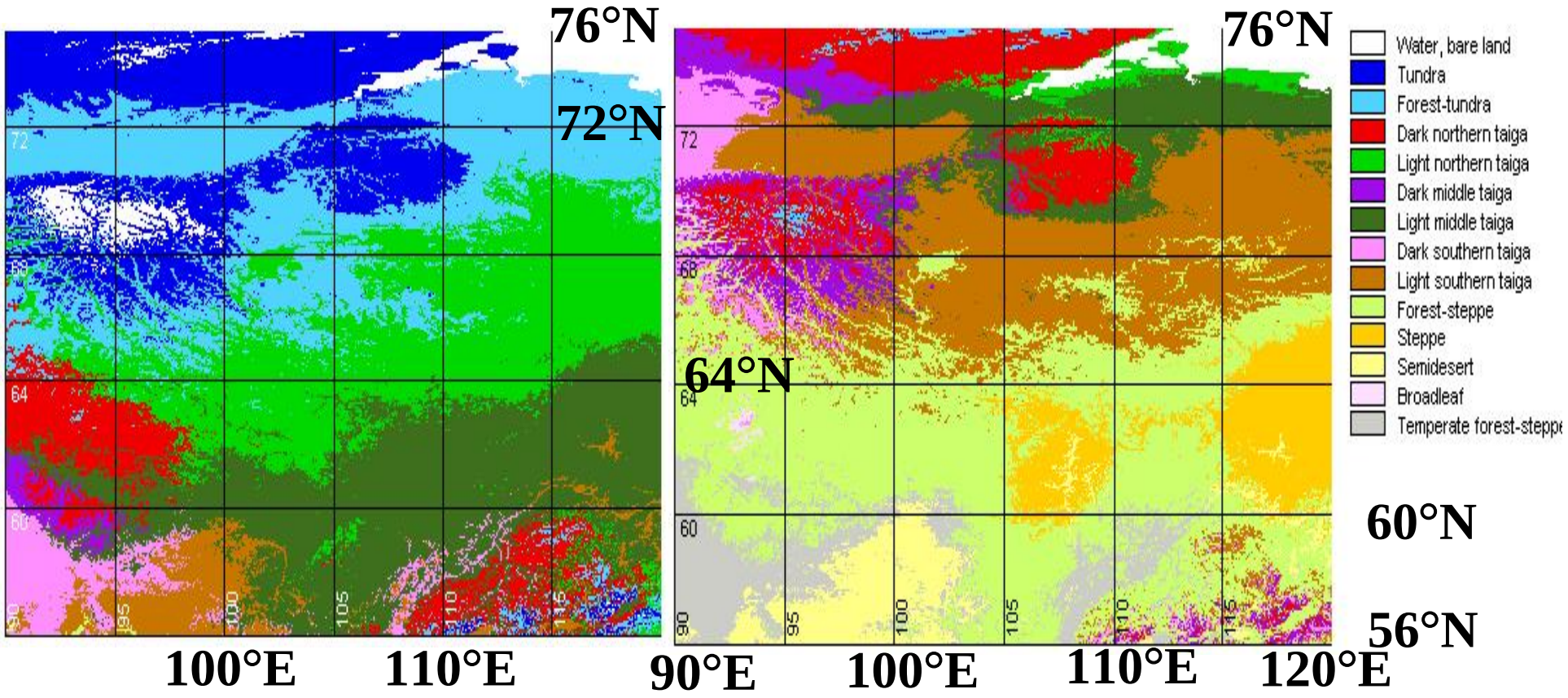


Changes of the northern boundaries of forest and steppe zones along the 39°E (past 13K years)

(Kozharinov and Puzachenko 2005)

… and projected.

Ecosystems' changes projected for the future



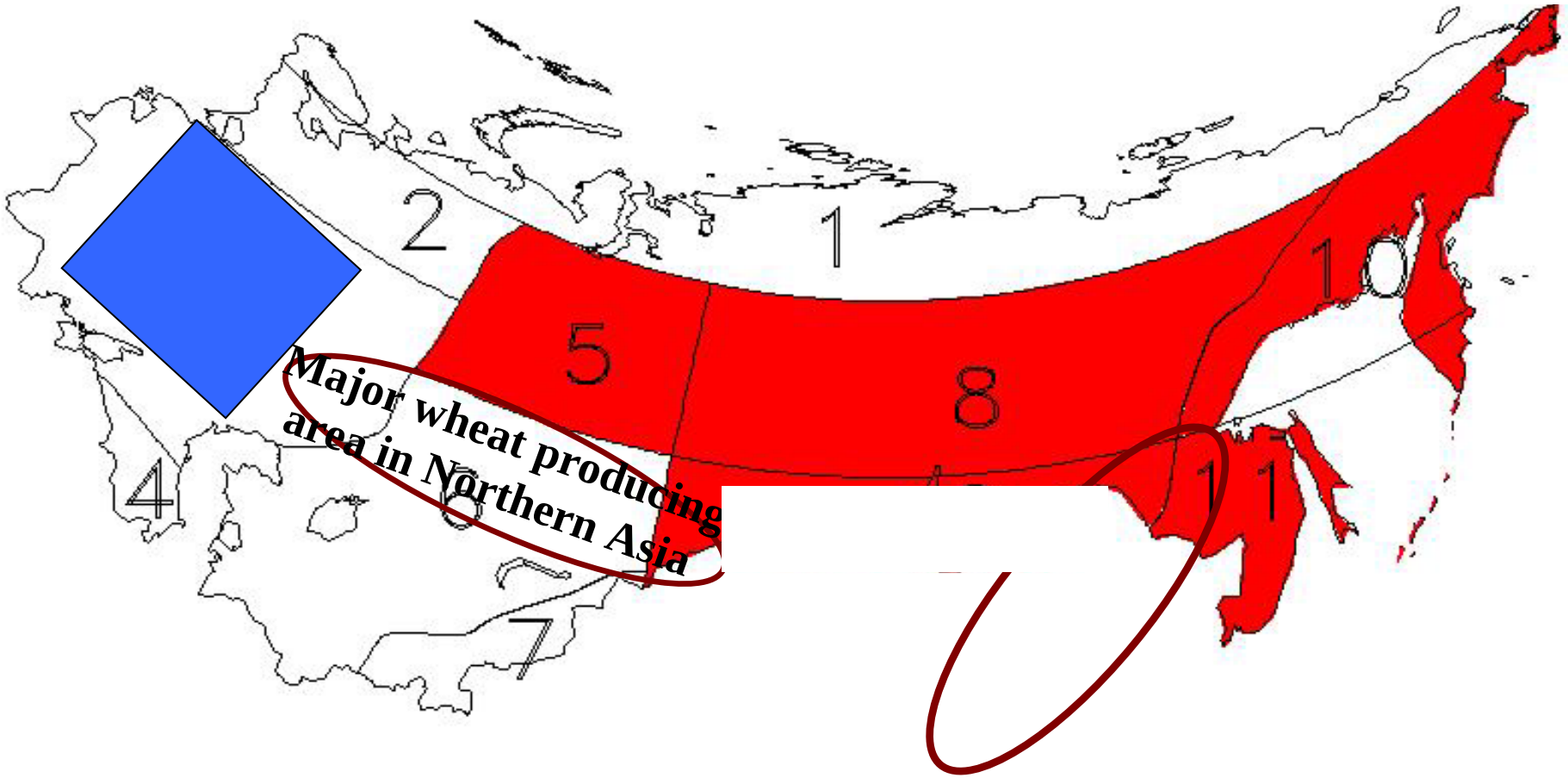
Present

In year 2090

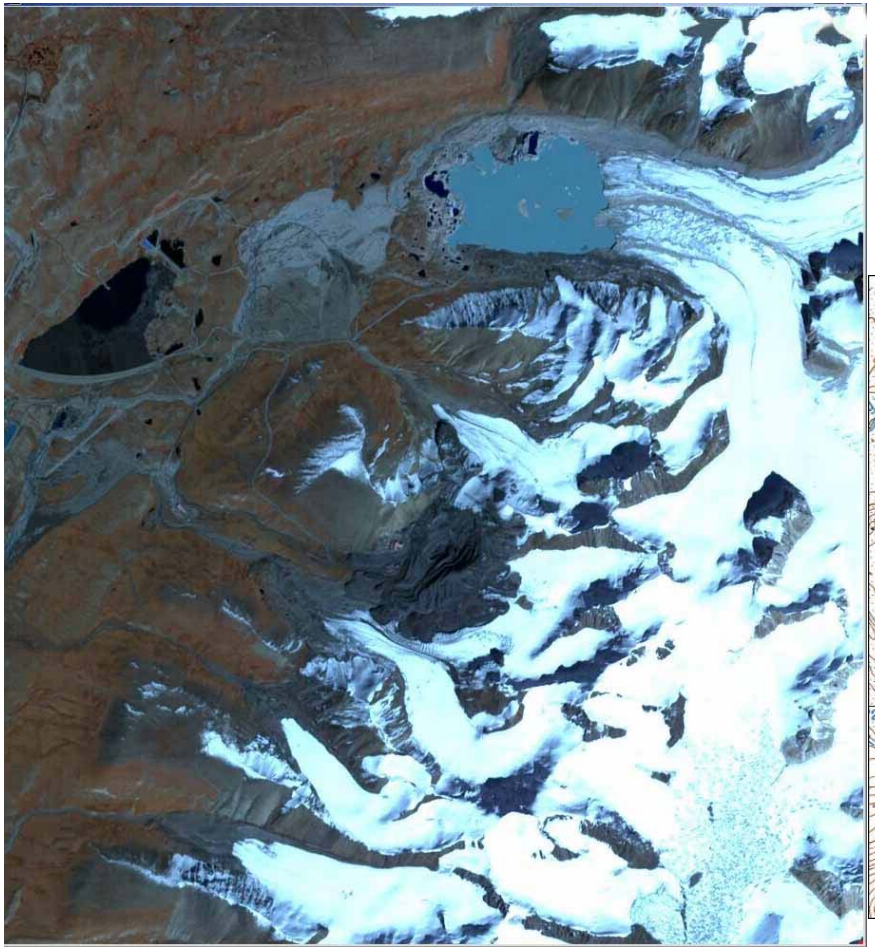
Major ecosystems distribution in central and eastern Siberia

(Tchebakova et al. 2003)

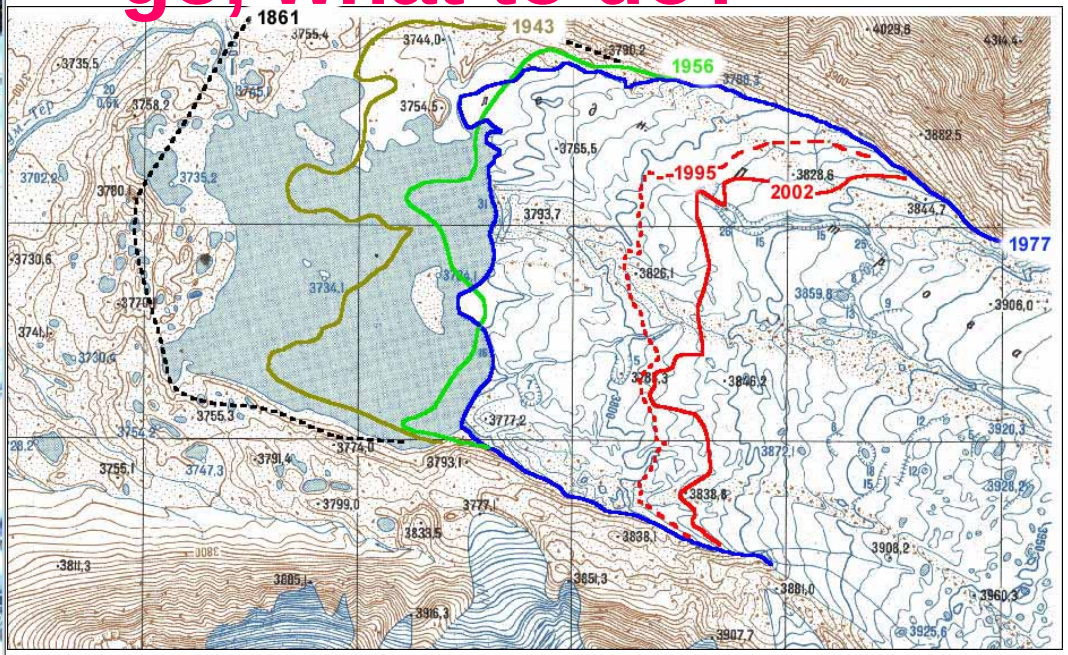
Regions in Northern Eurasia where potential forest fire danger has increased in the 20th century (**red**), the regions where agricultural droughts have increased **(brown ovals),** and the regions with improved humidity conditions (**blue**) [Mescherskaya et al. 1997 updated; Zhai et al. 2004; Groisman et al. 2005; Robock et al. 2005; Dai et al. 2004; Shiklomanov and Georgievsky 2003]



Changes are affecting water supply ...



When the millenium-old water storage will go, what to do?



Example. Central Asia ***.Example of a central Tien Shan glacier recession. Petrova Glacier in the Akshiyrak area, ASTER image, September 2002 (A), and instrumental topographic data (B) (Aizen and Kuzmechonok, 2003)***

Land cover...

Two possible scenarios after the permafrost thaw:

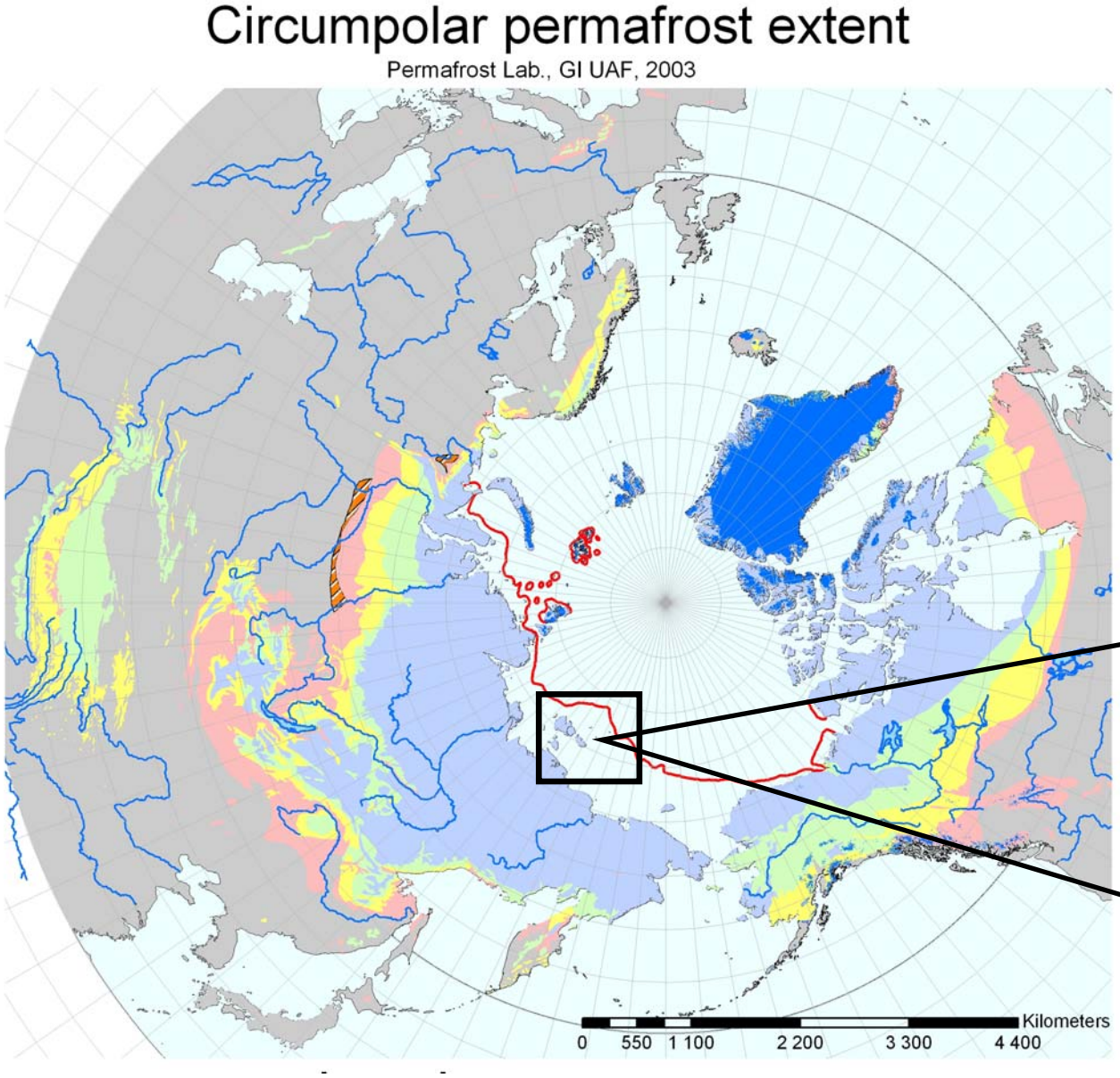
Wetlands

Steppe

… The carbon cycle over land..

In the area of “wet thermokarst” formation, new and significant sources of CH_4 production will be developing. There will be a considerable difference in greenhouse production from degrading permafrost depending on a different type of substrate and soil carbon quantity and quality.

… and in the Arctic coastal zone



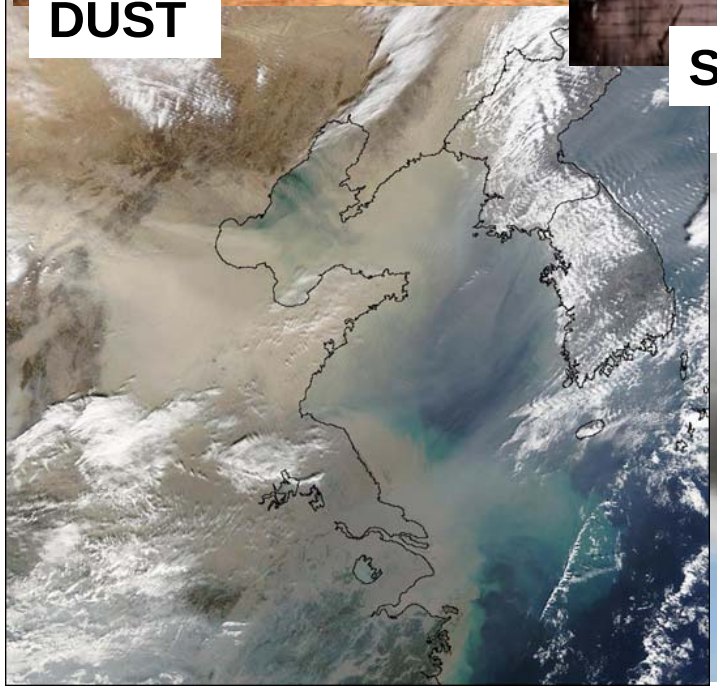
Coastal erosion and sub-sea permafrost degradation is a new and potentially very important issue for the global change.

Diverse sources of natural and anthropogenic aerosols affect environment and human society in the NEESPI region especially hard

DUST

SULFATES

SMOKE

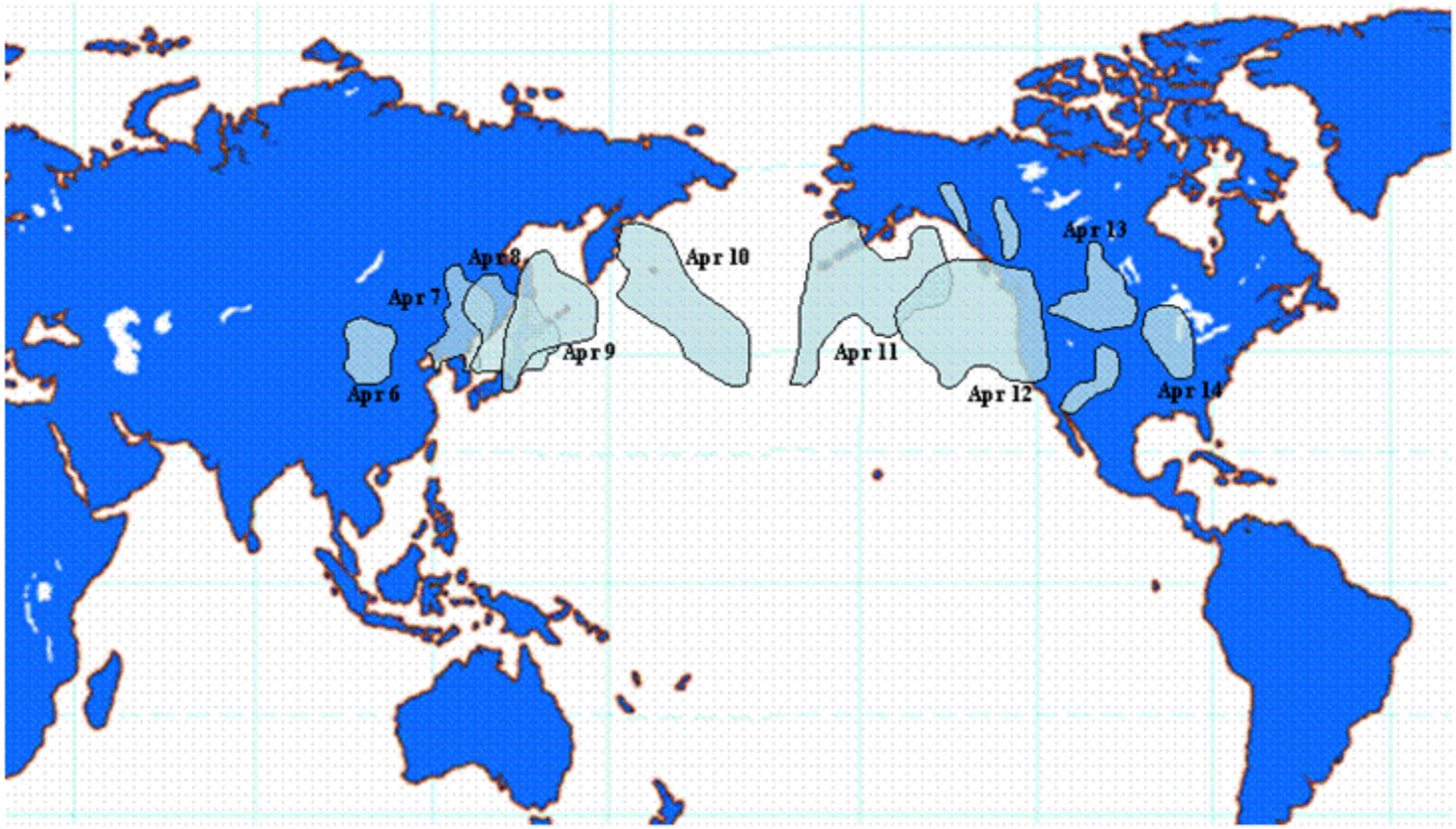


… represent challenges to China

Increasing frequency of dust storms and increasing rate of soil erosion.

Air pollution. Fine aerosol particles are responsible for causing the greatest harm to human health.

… but, the aeolian mineral dust transfer may have the global scale affecting North America as well



- Long-range transport of the dust storm originated over the Gobi desert on April 6th, 2001 (Darmenova and Sokolik, 2002)

Rationale for the study

Strong interactions in the system **terrestrial ecosystem - atmosphere hydrosphere - cryosphere - human society** and feedbacks to global energy, water, and carbon cycles

Radiation balance of forested (RB_f) versus nearby forest-free (RB_0) sites

$RB_f = a\ RB_0 + b$ (Rauner 1972)

Conifer forest: $a = 1.10$; $b = 20\ W\ m^{-2}$

Deciduous forest: $a = 1.05$; $b = 15\ W\ m^{-2}$

=> Surface Radiation Budget is strongly affected by "natural" land cover changes:

1962

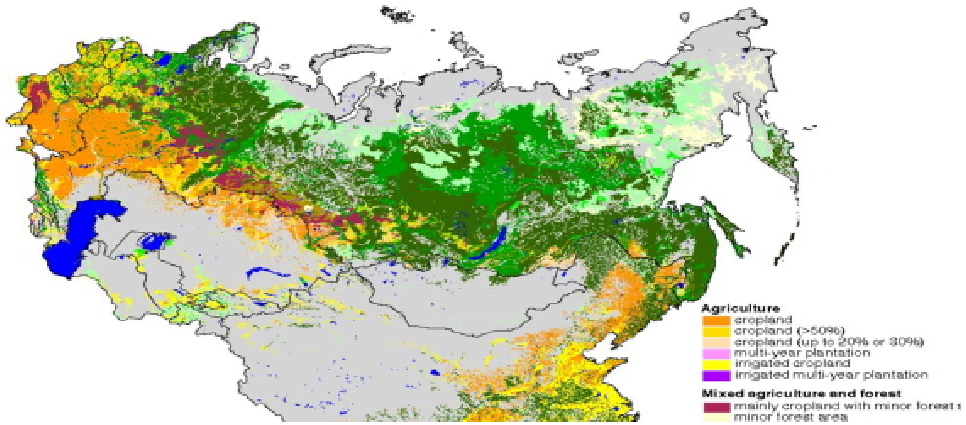
1997

… as well as by the changes caused by human activity:

Example 1:

More than 90% of steppe and forest-steppe zones in Northern Eurasia is currently cropland (orange areas in the map)

[Rozenzweig et al. 2003]



Example 2:

Land use dynamics in the past 60 years in the Volga River Basin show that 13 Mln Ha of agricultural land (or ~20%) have been replaced by forest (10 Mln) and reservoirs (3 Mln)

[Golubev, Speranskaya & Tsitsenko 2003]

… up to the extremes cases that lead to ecological disasters

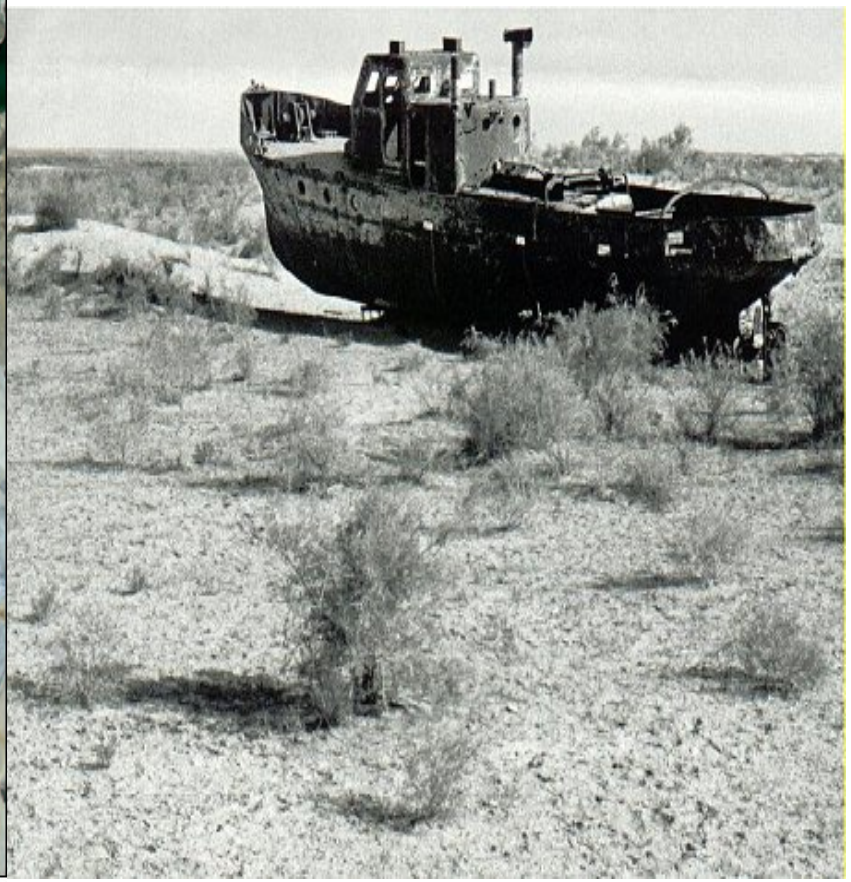
Most of the Aral Sea will disappear in the next ten years

July - September, 1989

1989

August 12, 2003

2003



Major concern:

Ecosystems and climate interactions in the region are very strong.

But, various biogeochemical and biogeophysical feedbacks are poorly understood and are difficult to project.

Example: Classical biogeochemical feedback

- In a warmer climate, there will be an intensification of bioproductivity, B+ΔB, and thus a sequestration of some fraction of the anthropogenic CO_2 will occur.
- For example, boreal forest located in the regions of greatest warming *and* a general surface heat deficit is a primary candidate for this ***negative*** **feedback.**
  But, what if ...

But, what if…

… **the area of the boreal forests changes?**

… the rate of release of methane and CO_2 from soil increase?

The above may generate a potential runaway scenario of a strong positive biogeochemical feedback.

- Plus, there are several other "if"…

"Uncertainty" is the answer…

Specific human dimension

These were "managed" societies and now *social shocks superimposed with environmental changes reduce the resilience of the societies of the region*

- Political system changed
- Land use rules changed
- Economics changed
- Infrastructure of social services unsupported

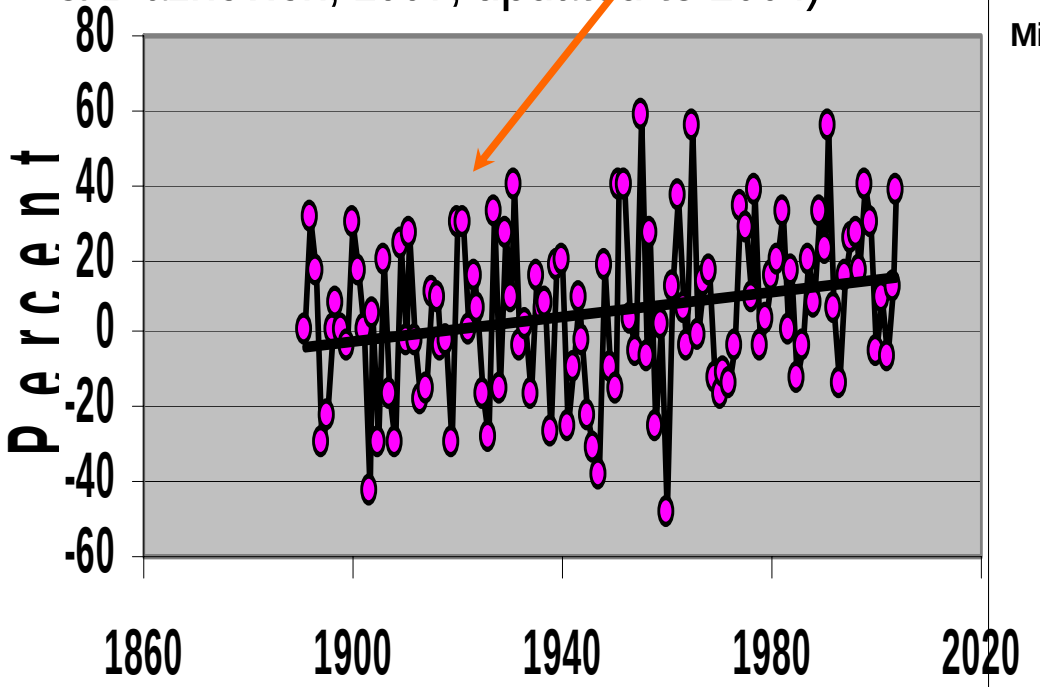
Plus

- "Hot spot" of warming
- Biogeochemical feedbacks changing in uncertain ways

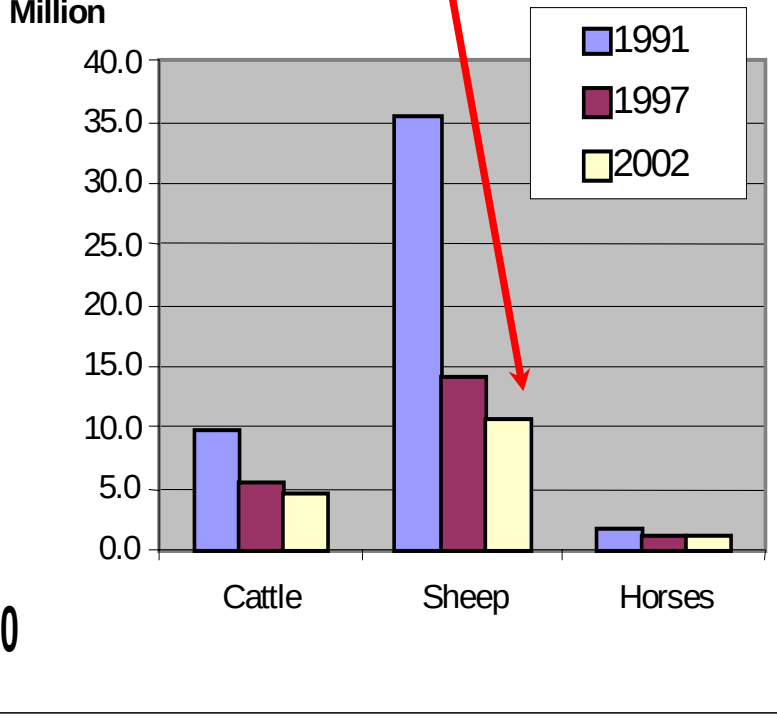
Example: Kazakhstan.

Satellite data show greening, meteodata show drying, and socio-economic data show a decline.

Regional drought index (Mescherskaya & Blazhevich, 1997, updated to 2004)



Change in livestock inventory



Thus, it looks like we have to study everything in the region:

Human activity changes

Climate system changes

Greenhouse gases changes

Ecosystems' changes

and

their interactions

=> A synergetic approach to projections of the future changes is a core of the NEESPI

One of the critical science questions:

- **How do we account for the synergy of feedbacks of major processes within the regional terrestrial ecosystems, climate, cryosphere, and hydrosphere of Northern Eurasia and their interactions with society?**

IGBP [GCP, GLP, iLEAPS], IHDP, DIVERSITAS

WCRP [GEWEX, CLiC, GWSP]

Major NEESPI foci

- **Focus on transient zones that are most vulnerable in the future changes**
  - **Coastal zone**
  - **Tundra-forest**
  - **Forest-steppe**
  - **Steppe-desert**
  - **Mountains**
- **Focus on feedbacks that make the projection of the future changes uncertain**
  - **Biogeochemical feedbacks**
  - **Biogeophysical feedbacks**
  - **Human activity**

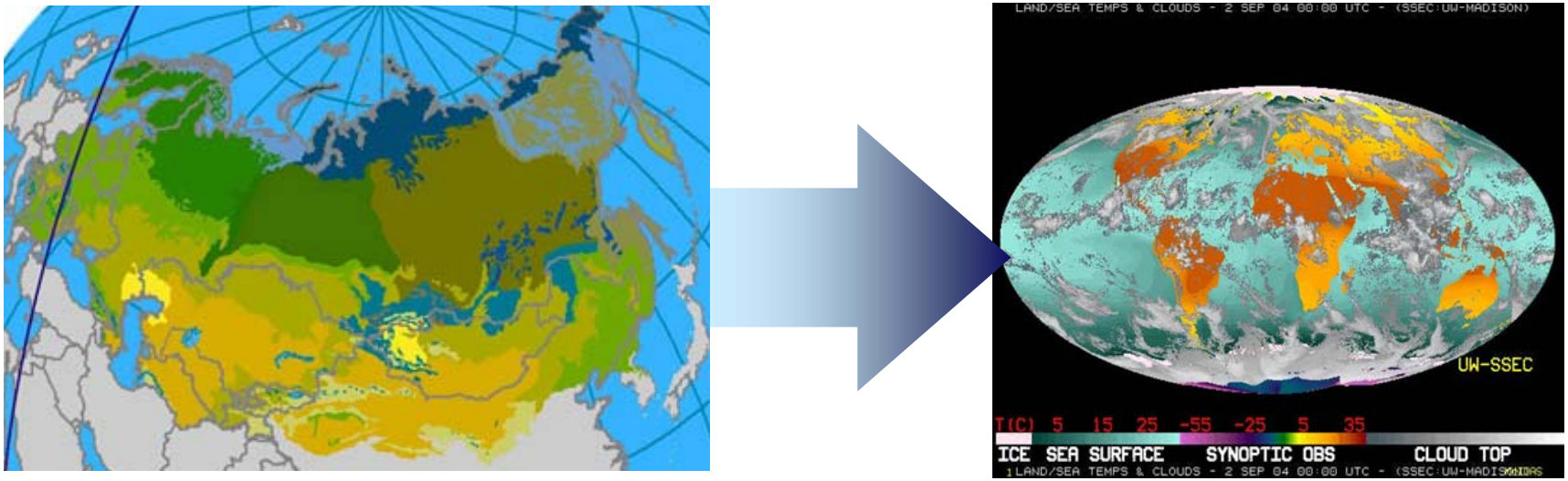
NEESPI Deliverables:

to have in ~10 years

- **A suite of process –oriented models for each major terrestrial process in all its interactions**
- **A suite of global and regional models that seamlessly incorporate all regionally specific feedbacks associated with terrestrial processes**
- **An integrated observational knowledge data base for environmental studies**
- **A system in place that can serve the emergency needs of the society**

GEOSS Vision in the NEESPI Interpretation

- Enable a healthy public, economy, and planet through an integrated, comprehensive, and sustained Earth observation system



From a Regional View to a Global Analysis and Projections