

Changes in Northern Eurasia as a precursor of global warming may describe how this particular system has reacted to warming. We have an area that undergone intense warming for 40 years with the mean annual temperature during the past 15 years being 1K higher than all other periods in the instrumental record, so we can study what could have been predicted - a priori predictions.

Part I. What do we know about environmental change in Northern Eurasia?

Climate change:

- There is overwhelming evidence of a significant air and soil temperature rise over the last 40 years:
 - In some cases, precipitation increased, but because of a strong temperature increase, the indices (of drought, fire weather, etc) indicate drier conditions. At the same time, there are wetter conditions in the Western part of the domain, and drier conditions in warm season east of Ural Mountains.

Cryospheric change

- There is a widespread evidence of recession of mountain glaciers with acceleration since 1990ies.
- Frozen ground and permafrost observations show increase in thawing indices and warming of permafrost. This may promote increase in methane and CO₂ emission from permafrost

Runoff change:

- There are increases of river runoff in the major rivers draining into Arctic Ocean and in the Caspian Sea Basin, and decreases of river runoff in Northern China, Central Asia, and Mongolia enhanced by land use and water withdrawals

Seasonality change:

- The observed earlier spring and the later autumn onsets are confirmed by RS and ground station observations:(early river ice breakup, snow cover extent change)
- Despite these changes, there are apparent increases in maximum seasonal snow pack which have been noted but not well documented
- The same seasonal changes are supported by phenological observations
- In Mongolia, seasonal timing of greenup is spatially heterogeneous

Vegetation change:

- Tree line is moving into arctic and alpine tundra
- Dwarf willows enlarging into shrub form plants as part of conversion to taller vegetation in tundra
- There is an increase in frequency in uncontrolled fires in the boreal forest. Note that the Soviet era fires were probably underreported.
- There is anecdotal evidence of illegal forest logging in Far East Russia

Environmental changes related to socio-economic changes:

Changes in early 1990 due to collapse of the Soviet Union:

Russia:

- There is a decrease in forest logging (by 60%), large agriculture farming (decrease in cultivated land use), fire control, insect and pest control, harvests.
- At the same time, it led to increase in pastoral lands and of carbon uptake due to fires
- Endangered infrastructure built on permafrost that is thawing

Central Asia:

- There is an observed shift toward drier land, a decrease in cattle number, and partial recovery of land from pre-1990 overgrazing

China and Mongolia – changes since 1970

- An increase in desertification
- An increase in reforestation efforts in China

Part II. Data and process knowledge needs for the NEESPI region:

Data:

- Evapotranspiration and soil moisture data for different land cover types
- Validation data to support current and the near future remote sensing data.
- Forest biomass structure

- Large scale albedo changes due to changes in snow cover, arid lands, and forest type.
- Permafrost-related data such as: methane and CO₂ emissions, and aerobic or anaerobic decomposition rates.
- Wetlands dynamics
- Vegetation changes
- Climatology in complex topographic areas, e.g., precipitation

Process knowledge:

- Paludification: Effect of bog amount change on dynamics of permafrost thawing and vegetation – needs to be quantified, as well as susceptibility of raised bogs to fire
- The impact at the regional scale of the observed local indications of deforestation, creating wetlands, gas emission, and fires
- How vegetation reacts to an atmospheric CO₂ increase (interaction of increased CO₂ with stomata of different species)
- Sensitivity of grass-forest or tundra - steppe metastable biomes (unique to NE) to environmental change
- Southern transitional zones and processes that control changes in these zones (forest – steppe and steppe-desert) are underrepresented in the ongoing NEESPI research.

Part III. Regional changes affecting the globe

- Carbon storage change
- Temperature gradients change
- Surface cover change -> Radiation budget change
- Fresh Water budget of the Arctic Ocean
- Atmospheric aerosol emission

Part IV. Global changes affecting the NE region

- The NE region is highly sensitive to small changes in global circulation as demonstrated by temperature, humidity, cryospheric, and vegetation changes.. In particular, the NE, being generally a dry region, is very sensitive to changes in westerly circulation.

Recommendations for research priorities:

Strategically important direction of research should focus on:

- Cold region studies:
 - Better understanding of permafrost processes and permafrost change effect on regional and global carbon cycle
 - Interaction of hydrological and biological system responsible for emission and composition greenhouse gases
- Hydrological and land cover change studies in semiarid areas with a large social impact
- Establishing a baseline model - create a regional reanalysis model (see modeling group report)
- Different model scenarios coupled with higher resolution regional models accounting for feedback (see modeling group report)

Short term and easily achievable objectives:

- Wetlands mapping and monitoring
- Linking surface radiation budget and land cover characteristics
- Near-real time in-situ data sharing amongst scientific communities within the region
- Integration of the NEESPI pilot projects deliverables
- Inventory of untapped datasets over NE from old SU, European and Chinese archives