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## Abstract

The current state of natural landscapes of Northern Eurasia is defined by climate change and severe and non-satisfactory regulated anthropogenic pressure. Based on a full carbon account for terrestrial vegetation ecosystems of Russia, we analyze the relative impacts of major drivers on the magnitude and uncertainty of the Net Ecosystem Carbon Balance (NECB) under current and expected climates and environment. The “manageable” part of the full carbon account (disturbance and consumption of plant products) is on average estimated to be 15-20% of annual net primary production. The expected increase of climate aridity may generate dramatic increases in disturbances (wild fire, insect & diseases outbreaks) and intensification of processes of “green desertification”. The paradigm of sustainable forest management (SFM) is a cornerstone of integrated landscape management in boreal regions and a basic prerequisite for proper management of the terrestrial carbon cycle. The transition to SFM in Northern Eurasia will require development of expected adaptation to, and mitigation of, negative impacts of climate change, as well as introduction of policies for global change.

## Drivers

The current state and trajectories of future development of natural landscapes in high latitudes of Northern Eurasia are defined by:

1. Current unsatisfactory social and economic situation in boreal Northern Eurasia;
2. The dramatic magnitude of on-going and expected climatic change (warming up to 10-12°C under global warming at 4°C, increasing aridity in continental regions), and weather variability;
3. Increasing anthropogenic pressure, particularly in regions of intensive oil and gas exploration and extraction;
4. Large areas of sparsely populated and practically unmanaged land;
5. Vulnerability of northern ecosystems which historically developed under cold climates and where buffering capacity is not well known;
6. Risk of catastrophic natural disturbances (fire, insect outbreaks) where frequency and severity have accelerated during recent decades;
7. High probability of irreversible changes of vegetation cover;
8. Insufficient governance of natural renewable resources (e.g., forests) and industrial development of new territories (oil and gas extraction and exploration, metallurgy etc.).

## Terrestrial Ecosystems Full Carbon Account for Russia (FCA)

FCA presents a quantitative basis of carbon management. We applied the methodology of the FCA developed by the IIASA Forestry Program (Shvidenko et al. 2010). The information basis of the accounting is presented by an Integrated Land Information System which comprises a Hybrid Land Cover (Fig. 1) and corresponding attributive databases (Schepaschenko et al. 2010).

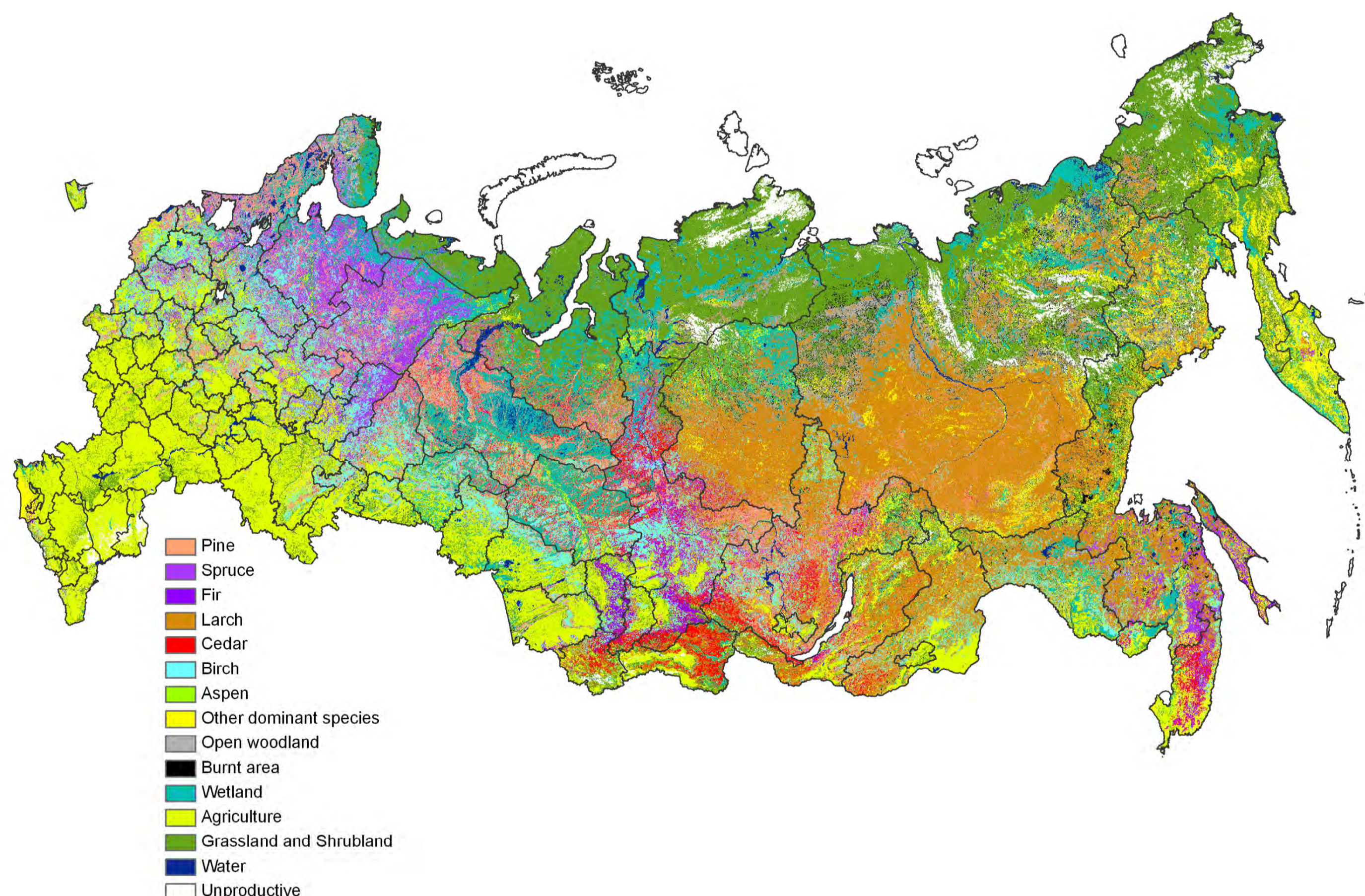


Fig. 1: Hybrid Land Cover of Russia

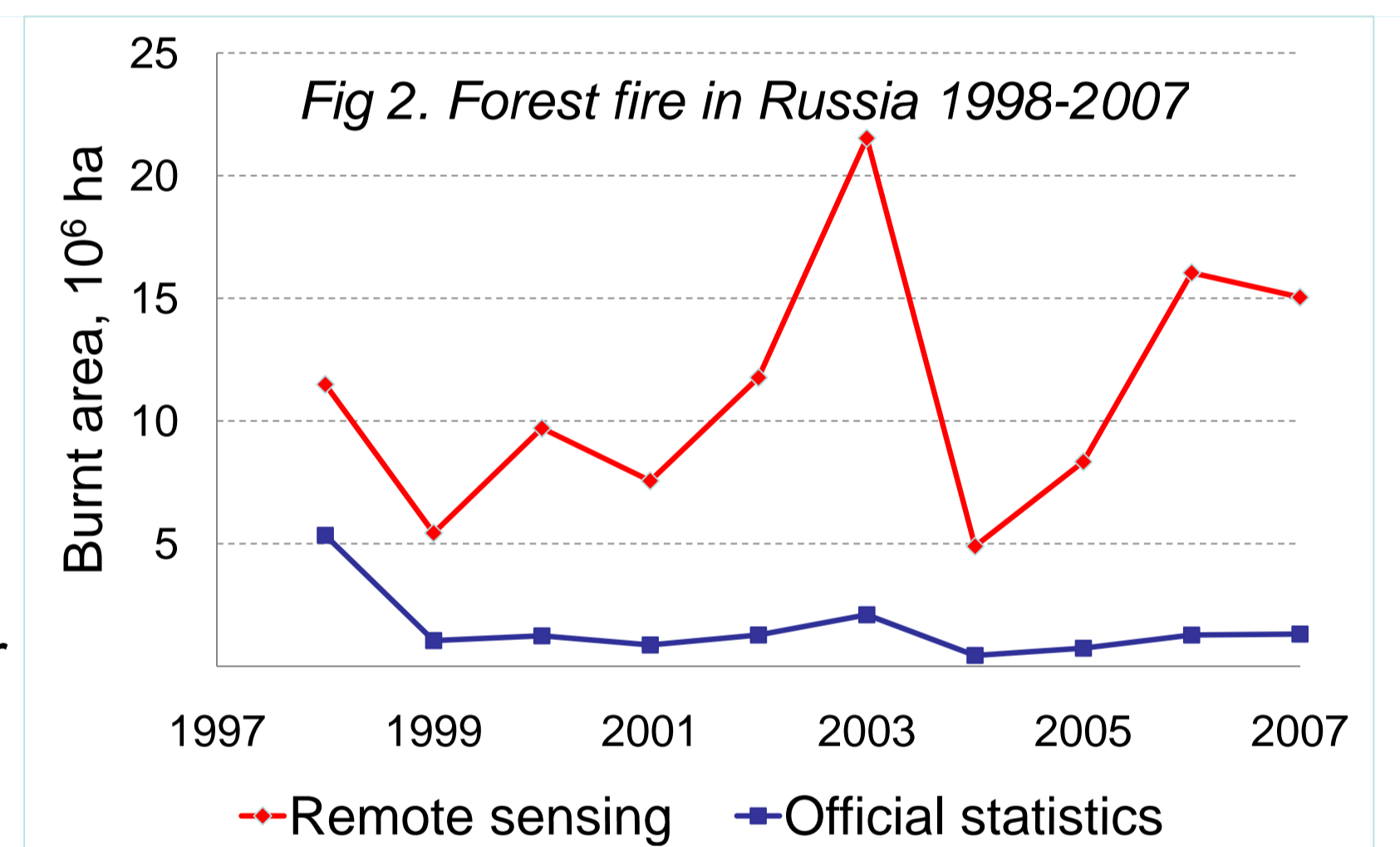
The Net Ecosystem Carbon Balance for Russia is presented in the Table (average fluxes for 2003-2008, Tg C year<sup>-1</sup>, positive values mean sink)

| Carbon balance components                                  | Tg C year <sup>-1</sup> |
|--|-------------------------|
| Forest   | 563                     |
| Open woodland  | 28                      |
| Shrubs   | 22                      |
| Natural grassland  | 58                      |
| Arable land (including other cultivated agricultural land) | 32                      |
| Peatland (undisturbed)                                     | 47                      |
| Peatland (degraded and peat use)                           | -36                     |
| Wood products  | -48                     |
| Food products (import-export)                              | -18                     |
| Flux to hydro- and lithosphere                             | -81                     |
| <b>NECB (NBP)</b>  | <b>567</b>              |

## Carbon management

Of the total NPP of ~5.1 Pg C yr<sup>-1</sup>, the “manageable” part consists of 15-20%. Dynamic trends and interannual variability of NECB are mostly dependent on weather conditions during growth seasons of individual years, regimes of natural disturbances, and anthropogenic impacts on ecosystems. In the long term, thawing of permafrost and change of hydrological regimes of vast territories may result in a catastrophic decline of the forested area and wide distribution of “green desertification”.

The risks for terrestrial ecosystems, agriculture and forestry includes: (1) negative processes linked to the destruction of permafrost; (2) loss of soil fertility; (3) impoverishment of soil biota, decline in productivity of lands; (4) lack of water resources in arid regions; (5) damage of agricultural lands, particularly in river valleys; (6) anomalous outbreaks and spatial distribution of traditional and new insects and microorganisms; (7) alteration of the forest fire regime; (8) loss of biodiversity; (9) “green desertification”, and (10) impacts of air pollution, soil and water contamination.



Transition to integrated land management and SFM are an obligatory prerequisite of a proper carbon management. Preparation of boreal landscape structure against the increasing threat of catastrophic fire is an urgent problem today. However, transition to SFM is hindered by economic stagnation of vast territories and unsatisfactory demographic processes. A number of socio-economic and land use - land cover scenarios for such development indicate the existence of possible methods to do so if appropriate national policies will be developed and implemented.

Introduction of proper carbon management includes:

- development of a concept of sustainable development of regions in high latitudes;
- development of integrated observation systems;
- reconsideration of existing and introduction of a new, relevant system of specially protected territories;
- transition to a new paradigm of SFM – from a pure resource to a multi-service use of forests with a clear emphasis on environmental and protective services;
- development of a new strategy, legislative and institutional backgrounds of forest fire protection;
- new ways of thinking in the interaction between humanity and nature in northern regions;
- the development of a legislative and normative base of adaptation and mitigation at the federal and regional levels.

## References

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- Shvidenko A., Schepaschenko D., Maksyutov S. 2010. Impact of terrestrial ecosystems of Russia on global carbon cycle in 2003-2008: an attempt of synthesis. *Proc. of ENVIROMIS-2010 Conference*. Tomsk, Russia.