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Current state and prospects of carbon management in high latitudes of Northern Eurasia

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The current state and trajectories of future development of natural landscapes in high latitudes of Northern Eurasia are defined *inter alia* 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^{o}C under global warming at 4^{o}C); (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 buffering capacity of which is not well known; (6) risk of catastrophic natural disturbances (fire, insect outbreaks) whose frequency and severity have accelerated during recent decades; and (7) high probability of irreversible changes of vegetation cover. These specifics are overlapped with insufficient governance of natural renewable resources (e.g., forests) and destructed practice of industrial development of new territories (oil and gas extraction and exploration, metallurgy etc.).

Based on a full carbon account for terrestrial vegetation ecosystems of Northern Eurasia, we analyze the relative impacts of major drivers on magnitude and uncertainty of the Net Ecosystem Carbon Balance (NECB) under current and expected climate and environment. 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 a short term, disturbances and human impacts cause a theoretically "manageable" part of the full carbon account, which on average is estimated to be of about 20% of annual net primary production. In a 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 paradigm of sustainable forest management (SFM) is a cornerstone of integrated landscape management in boreal regions and a basic prerequisite of proper management of the terrestrial carbon cycle. Basic drivers which generate major threats for terrestrial ecosystems and particularly for forests are increasing aridity of climate over major part of Asian Russia (the trend already clearly observed during the last 50 years), intra-seasonal variability of weather and irreversible changes of the hydrological regime. Development of an efficient system of forest protection is a crucial prerequisite. Current fire protection requires principal improvement of all its components (monitoring; technical and financial capacity; education of population; etc). Preparation of boreal landscape structure against the increasing threat of catastrophic fire is an urgent today's problem. However, transition to SFM is hindered by economic stagnation of vast territories (outside of areas of intensively exploited natural resources) and unsatisfactory demographic processes. Introduction of ecologically friendly methods of industrial development and integrated land management on a landscape basis is one of the very few ways to introduce proper carbon management in the region. 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.