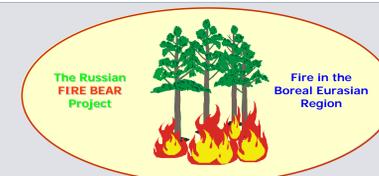


The influence of changing forestry practices on the effects of wildfire and on interactions between fire and changing climate in central Siberia



Proposal Summary

The Russian boreal zone is a region of global significance in terms of climate change impacts and carbon storage, but it is also a tremendous, largely untapped, reservoir of forest products. Currently, wildfires are the dominant disturbance regime in the Russian boreal forests, burning 10 to 15, (and up to 20) million ha per year (e.g. Soja *et al.* 2004). Wildfires are projected to increase in both frequency and severity as climate changes, and recent data from Siberia suggest that average burned areas may have been increasing over the past 10 years (Sukhinin, unpublished data). Both legal and illegal logging are increasing rapidly in many forest areas of Siberia (Vandergerg and Newell 2003). These logged areas appear highly susceptible to fire due to a combination of high fuel loads and accessibility for human-caused ignition, and there may be differences in fuels and in the effects of fire on the ecosystem and the environment between legal and illegal logging activities. Recent data collected by our research group show that fires occurring on logged areas are typically of higher intensity and severity than those in unlogged forests, but the specific effects of fire and logging vary widely among forest types and as a result of weather patterns during and prior to the fire (Buryak, 2007). Such fires may often occur close to communities, where they can threaten homes and businesses. Changing patterns of land use, primarily due to timber harvesting, increase landscape complexity and can be expected to increase the emissions and ecosystem damage from wildfires, inhibit recovery of natural ecosystems, and exacerbate impacts of wildland fire on changing climate and on air quality.

Research Goal

The overall goal of this project is to assess the relative effects of wildfire, under variable climate conditions, on logged and unlogged sites in central Siberia as a means for incorporating fire/climate/land management interactions into projections of effects of changing climate on regional fire and vegetation patterns.

Research Approach

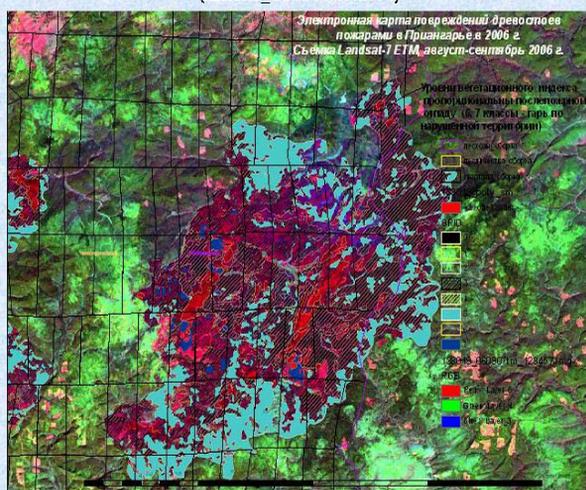
- Conduct field campaigns to obtain data on fuel consumption, fire characteristics, emissions, and fire effects for wildfires on both logged and unlogged sites, and compare resulting carbon stocks with those on unburned sites.
- Evaluate the behavior and effects of fire under different management scenarios and fire weather conditions to determine relationships between climate variability, forestry practices, and fire impacts.
- Further develop relationships between ground-based sampling, weather data, and satellite analysis of active fires and burn scars at Landsat and MODIS scales to enable landscape-level and broad regional projection of tree mortality, fuel consumption, emissions, vegetation recovery, and other ecosystem fire effects on logged and unlogged sites.
- Estimate the spatial and temporal variability of CO₂, CO, CH₄ and aerosol particle emissions from fires as a result of changes of climate and forestry practices.
- Use vegetation climate models already developed for central Siberia to project potential interactions between changing climate, logging, and fire.

Anticipated Impacts

Most research on the effects of fire and fire/climate interactions on carbon cycle, fire emissions, and feedbacks between climate change and fire regimes, has focused on relatively undisturbed forests. However, as the areas impacted by forest harvesting in Siberia increase, it is clear that any accurate regional assessment of these interactions must include effects related to logged areas. The results of this research will provide a basis for improved projections of impacts of climate change and logging activities on burned area, fire severity, fire emissions, and carbon cycle.

Sample results from previous work:

Mortality distribution on the scar of Angara region, fires in July 2006. (Landsat_ETM 07.09.2006)



For unlogged sites in the Angara Region we have developed regression relationships between post-fire tree mortality on field plots and remote sensing data, using dNBR (differenced Normalized Burn Ratio), NDVI and other indices. Through this approach we can map mortality over large landscapes. We will extend these relationships to logged sites and to other aspects of burn severity.

(Anatoly Sukhinin)

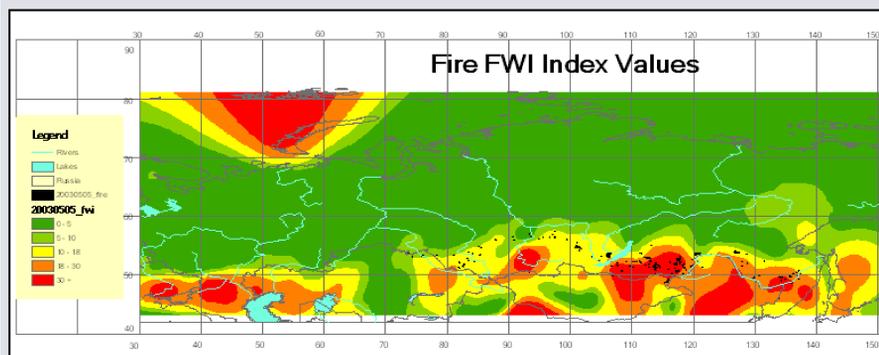
Recent accomplishments:

After a project planning meeting in Canada in late spring 2009, two Russian teams went to the field last summer to test methods and begin data collection on vegetation and fuel characteristics and fuel consumption following fires. They worked in three major areas of central Siberia: the Angara region, Chitah, and the Shushenskoye region, primarily in Scots pine and larch-dominated forest types. These teams obtained data from the four types of sites shown on the right. In Chitah, we are also sampling illegal as well as legal logging sites, which differ in logging methods, as well as sites that have been logged after fire. Thus far, we have sampled over a dozen sites with different characteristics.

Fire	Logging	Unlogged	Logged
Unburned		X	X
Burned		X	X

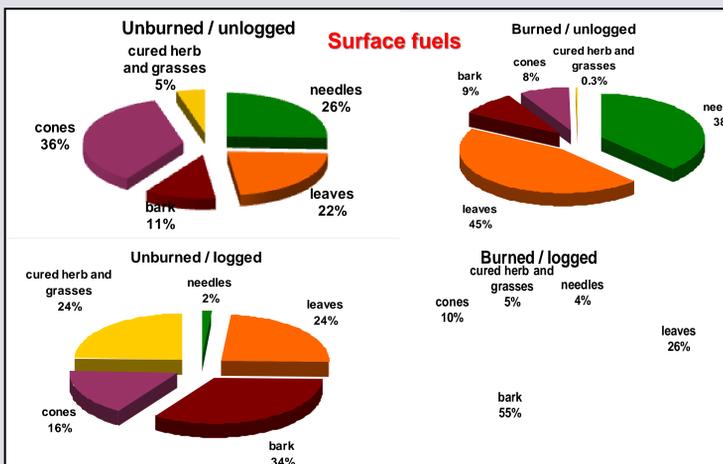


Examples of study sites in the Angara Region. Dominant tree species here was Scots pine with intermixed larch and poplar.

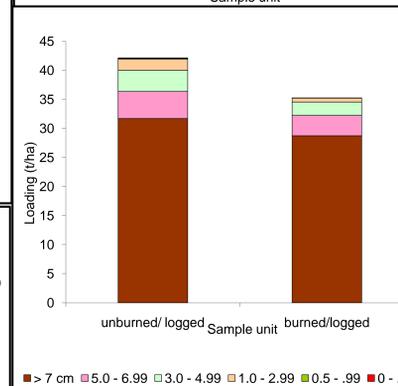
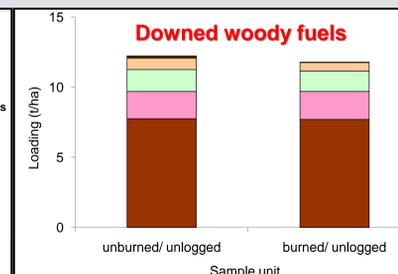


Fire Weather Index is a component of the Canadian Fire Behaviour System that correlates well with fire behavior and emissions. We have already computed and mapped Daily FWI values across Siberia for a large number of years. In this example from 5 May 2003, fires are shown by black polygons. High FWI is associated with areas of high fire activity. We will relate fire weather, fuel, and vegetation models with data on fuel consumption and emissions for logged and unlogged sites to estimate regional impacts of fire on carbon, GHG emission and aerosols.

(Doug McRae)



Results: The types of surface fuel available to burn (above) and the total fuel loading (right) varied greatly between logged and unlogged sites. On unburned unlogged sites, for example, there were more needles and cones, while on unburned logged sites there was more bark and herbaceous vegetation. About 4% (less than 0.5 t/ha) of downed woody fuel was consumed by fire on the unlogged site, and about 16% (8 t/ha) was consumed on the logged site. Thus emissions from combustion of downed woody fuel would have been about 16 times as great on the logged site as on the unlogged site. Legend indicates size classes of downed woody fuels (which would include logging slash on logged sites).



Preliminary Conclusions

The examples shown here are for the Angara region only. Results were similar on sites in the Chita and Shushenskoye regions. Based on the sites studied thus far, above-ground carbon stocks are higher on unlogged than on logged sites. However, both live and dead surface fuel loads are much higher on logged sites, as might be expected where logging slash is typically left onsite. As a result fuel consumption and emissions are much higher on logged sites. The magnitude of these differences is such that quantifying them is clearly important for determining carbon stocks and fire emissions for forests in Siberia.

We will sample additional sites over the next two years to get a broad representation of the ranges in fuels, carbon, fuel consumption, and emissions on logged and unlogged sites in central Siberia.