

Objectives

The SibFORD project aims at the development of methods and tools to estimate carbon emissions induced by forest disturbances using Earth observation (EO) techniques in combination with in-situ data and contemporary models, and to improve the understanding of human impacts on the carbon balance in boreal ecosystems through analysis of multi-annual integrated land surface-model / remote sensing datasets. The Project is being carried out within the Central Siberia region, which regularly experiences disturbances by fire and logging. A spatially explicit assessment of the carbon emissions caused by disturbances requires a number of studies and developments focusing on improving current methods of estimating relevant forest cover characteristics and disturbance parameters from remote sensing techniques, the adaptation of existing models for assimilation of EO data derived parameters, development of relevant databases and GIS tools. The project studies involve use of multi-resolution satellite data (e.g. SPOT-Vegetation, Terra-MODIS, Landsat-ETM), as well as available or new products (e.g. ESA Globcover and EC JRC GLC 2000 land cover maps, SIBERIA project forest biomass map) to characterise forest cover and disturbances and their impact on the carbon balance.

The SibFORD project will result in (i) advanced numerical integration methods to use multi-sensor EO data describing forest characteristics and disturbances with land surface models, (ii) a harmonised and up-to-date forest database and a multi-annual disturbances database for Central Siberia, and (iii) new automated GIS tools for estimating disturbance-induced carbon emissions and the analysis of human impacts that can be used by regional foresters and scientists. The developed tools and data will be made available to public organisations, NGO's and the international scientific community. The satellite data analysis methods and GIS tools are being generated with the perspective utilisation in the years to follow, especially for Kyoto protocol implementation phases and the post-Kyoto process. Close links to EC's and ESA's GMES initiative and to international programmes such as GOCF-GOLD, NEESPI and IGBP have been established through the project team members.

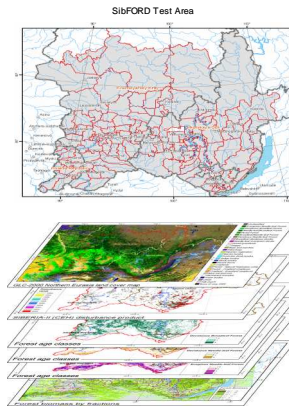
Methodology & Data

Forest Cover Characteristics

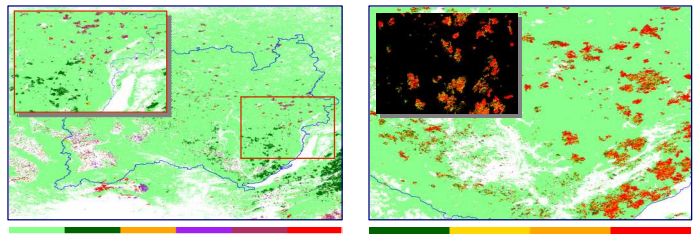
GIS-based forest database including information on the major environment components was developed for solving SibFORD Project tasks involved in obtaining an integrated estimate of the current and initial forest parameters in the Central Siberia test site (88° - 112° E, 50° - 62° N).

Besides general topographic base information the forest database of the SibFORD project includes the following new data products:

- Forest age classes map and fire disturbance database derived from aerial photo analysis
- Forest age classes raster map were produced on the base of combined analysis of the forest inventory species age data and GLC2000 forest classes and SIBERIA-II (CEH) Disturbance map. Three layers of forest age classes were created for the ever green needle-leaf, deciduous broadleaf and deciduous needle-leaf forests.
- Forest biomass assessment per fractions is based on State Forest Account Database (per Forestry), GLC2000 Forest Classes (6 classes) and Forest Age Classes (4 classes)



Burnt Area and Fire Severity Assessment

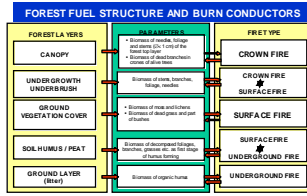


A burnt area mapping method involved Terra-MODIS daily time-series data analysis to detect inter-annual vegetation changes combined with MODIS hot-spot data to distinguish fire related changes from other types of disturbances has been developed and applied to generate a burnt area database for the period 2003-2007.

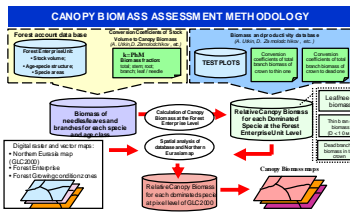
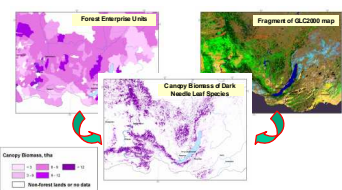
Fire severity assessment method is based on spectral mixture analysis of MODIS weekly time-series data in order to estimate fire induced trees mortality and is applied to generate an appropriate database for the period 2003-2007.

Forest Fuel Loads

Main fire conductors are tree parts burned during fire propagation. It consists of leaf or needle, small stem and branch of tree and undergrowth, litter and ground vegetation. There are conversion coefficients defining quantity relationships between tree stock volume and upper described tree parts for each species and age group. The methodology of canopy biomass assessment has been developed based on the complex analysis of Russian forest account database and forests derived from Northern Eurasia map (GLC2000).

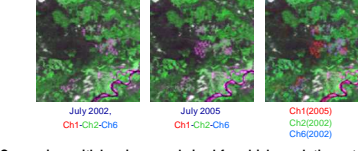


Example of Canopy (Dark Needle Leaf species) Biomass (t/ha) Assessment

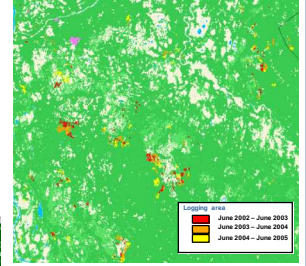
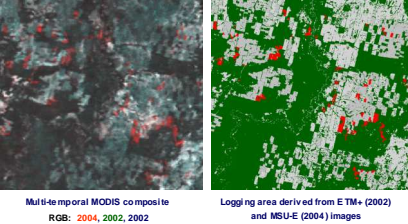


Logging

Detection of clear-cuts using MODIS



Comparison with logging area derived from high-resolution satellite data

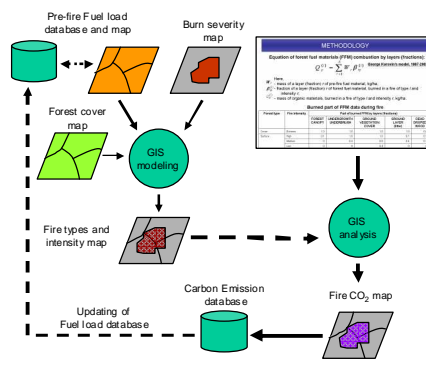


One of the main objectives of the SibFORD project is to examine the feasibility of MODIS 250-m resolution data to detect human induced changes in forest ecosystems with focus at logging activities and to develop the prototype of an automatic method and satellite data processing chain to ensure the possibility to perform clear-cuts detection on regular basis at large geographical scale. The clear-cuts mapping is performed using time-series of cloud-free monthly mosaics for the consecutive years of the period 2002 - 2005.

Carbon Emissions

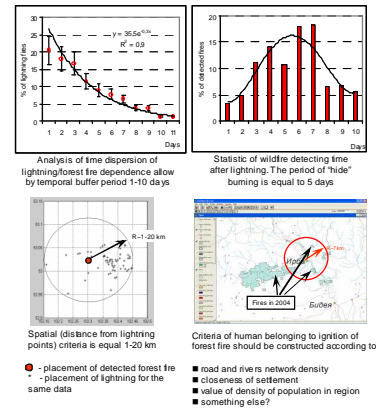
A fire carbon emission model requires input parameters describing fire type and intensity, based on spatial structure of burnt severity and pre-fire forest fuel loads. Fire type (crown and ground) and its intensity (high, medium, low) is estimated through combined analysis of data on burn severity and forest type maps. Spatial structure of forest fuel and dominated forest species map is used to attribute burnt area in terms of the fire type. The data on burnt area affected by crown and ground fire is combined with burnt severity map to estimate fire intensity.

The development of forest fuel loads combustion methodology is based on the pre-fire fuel loads and burn severity maps derived from satellite data of course and medium resolution (Spot-Vegetation, Modis-Terra).



Human Impact

Estimation of the human impact to the forest disturbances degree and amount of carbon emission requires in the first place attributing the fire events according to the ignition source, i.e. fires induced by humans or natural fires by lightning. Such attributing will be performed through GIS analysis of the burnt area mapping results combined with additional data, such as available for the project partners databases on lightning detection and large fire records from Forest Fire Service of Russian Forest Agency, as well as some other available GIS layers on roads network, settlements, population density and some other spatially explicit information indicating possible human influence on fire origin. As a result of the analysis the carbon emission database on the cell level will be attributed by rate indicating how the total amount emitted carbon shares between human and natural factors of forest disturbances.



Partner

IRI
1) Boreal Ecosystems Monitoring Laboratory
Space Research Institute (IKI)
Russian Academy of Sciences
Moscow / Russian Federation

LEF
2) Center for Forest Ecology and Productivity
Russian Academy of Sciences (CFEP)
Moscow / Russian Federation

SIF
3) Sukachev Institute of Forest (SIF)
Siberian Branch of Russian Academy of Sciences
Krasnoyarsk / Russian Federation

University of Leicester
4) Department of Geography
University of Leicester
Leicester / UK

GAFAG
5) GAF AG
Munich / Germany

Institute for Geography
6) Department for Earth Observation
Institute for Geography
Friedrich-Schiller-University
Jena / Germany