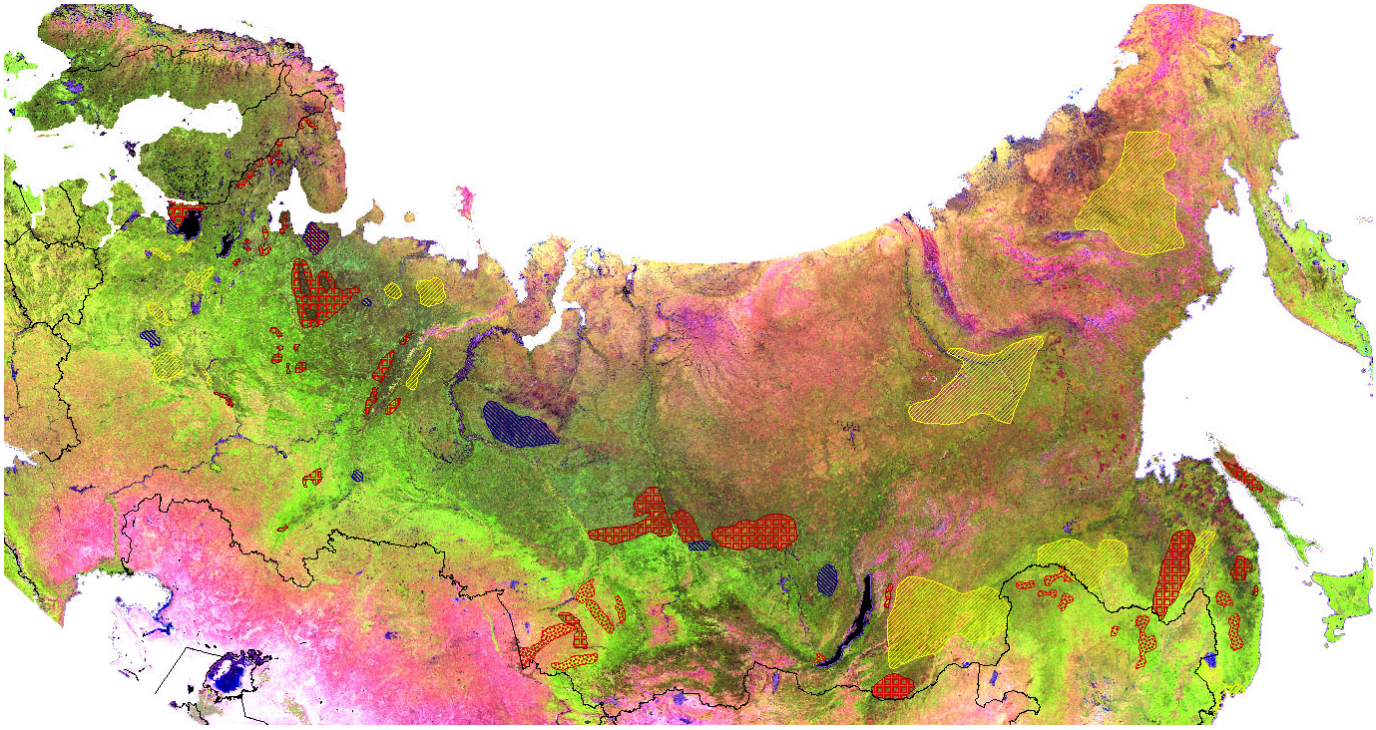
# IDENTIFICATION OF "HOT SPOT AREAS" OF FOREST COVER CHANGES IN BOREAL EURASIA



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**GLOBAL FOREST WATCH**

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2005

EUR 21684 EN

# 4. TESTING AUTOMATIC APPROACHES OF HOT SPOT DETECTION OVER RUSSIA

In these studies, "hot spot areas" were defined as areas of intensive forest cover change over a limited area and time. These changes can be causes by individual disturbance processes or a combination of them, including logging, forest fires, forest mortality due to pests and pollutions, forest conversion for agricultural activities, urbanization, mining operations and other disturbances.

This chapter describes the results of three exploratory approaches tested for an automated determination of such 'hot spot areas' or 'regions' in Russia:

- The first approach is based on Russian official forest inventory data at the regional (oblast) level;
- The second approach uses topographic and forest maps to spatially disaggregate regional level statistics by forest composition and accessibility.
- The third approach uses satellite imagery at 30 to 250 m resolution to delineate "hot spots" located in the vicinity of Intact Forest Landscapes

## *4.1. Use of Russian state forest account data to determine "hot spot regions"*

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### 4.1.1. Introduction: data and method

This study used the Russian official inventory data of the forest sector. These data are part of the State Forest Fund Accounts (SFFA) produced by the Federal Forest Agency of the Russian Federation (FFA, 1999, 2004). The SFFA is compiled as a reference public book once every five years and updates all governmental information related to the forest fund.

In this study, SFFA data from the reference books for the years 1998 (FFA, 1999) and 2003 (FFA, 2004) have been used. These data are available for the 87 regions of the Russian Federation (Oblast, Krai, autonomous Okrug, or Republic in Russian terms) grouped into 7 federal districts covering the whole Russian Federation. As considered in the SFFA database the Russian forest fund includes the following land categories:

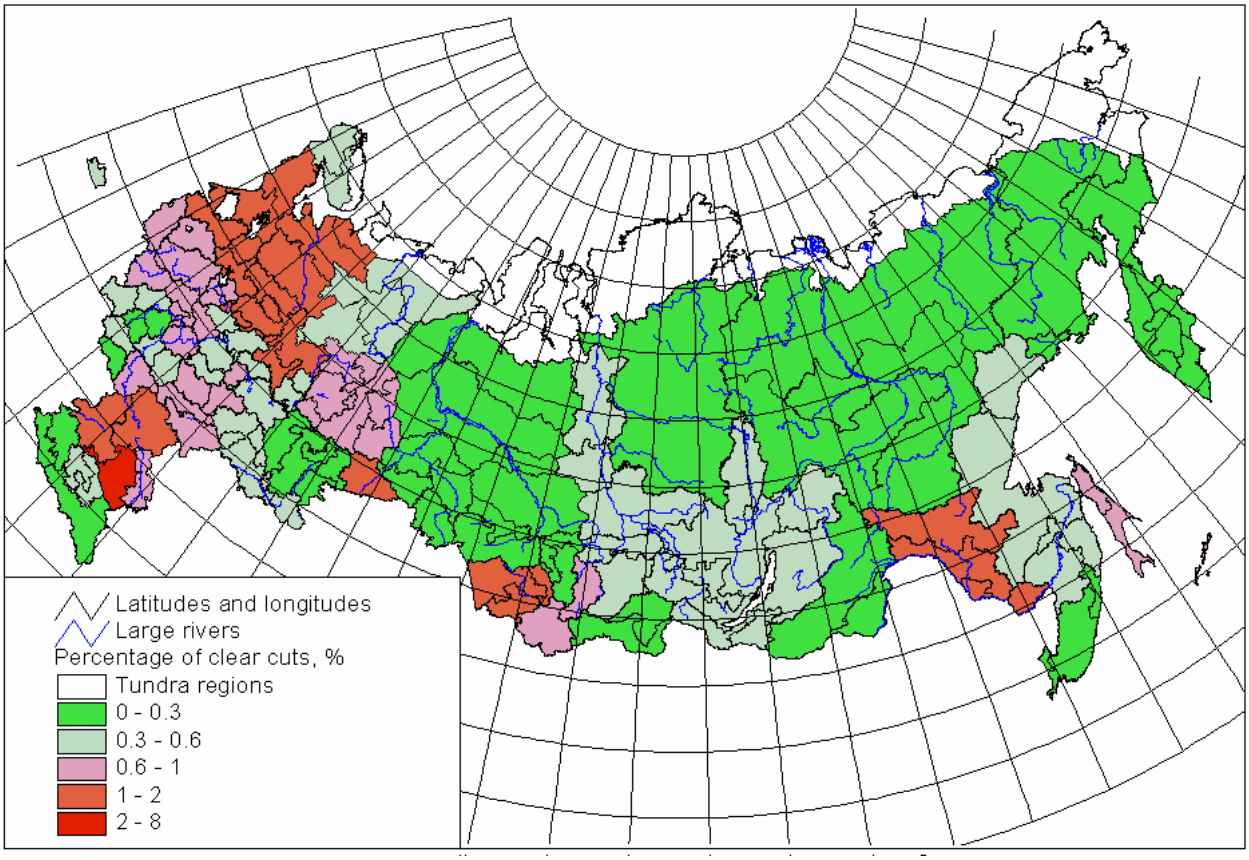
a) "forested land": land covered by any forest stand, with stand area and growing stock description;
b) "non-forested land": land stated for reforestation (clear-cuttings, fire-sites, dead stands and sparse forests), with area description;
c) "non-forest land": land not used for forest production (clearings, roads, farm lands, etc.), as well as tree-less areas located within the borders of the forest fund area (wetlands, rocky detritus, sands, surface water, etc.), also described by area.

The categories "forested land" and "non-forested land" are combined into a category "forest land", which is areas capable of forest growth and not used for other purposes than forest production.

### 4.1.2. Influence of disturbance factors

From these forest accounts, it is possible to calculate the proportion of the area of clear cuts, burned areas or dead stand areas to the total area of "forest land" in each region. These proportions can be considered a measure of the influence of a given disturbance factor. Figure 12 shows that the percentage of clear-cuts is the greatest in some north-western regions (Karelia Republic, Leningradskaya oblast, Vologodskaya oblast, Arkhangelskaya oblast, Kostromskaya oblast, Novgorodskaya oblast) and southern regions (Volgogradskaya oblast, Rostovskaya oblast, Kalmykia Republic) of European Russia and in a few regions of southern Siberia (Altaiskiy krai, Amurskaya oblast). All these regions are characterised by a high density population with developed infrastructure, and some of them are located close to borders with countries importing timber, such as Finland and China. These characteristics seem to explain accurately the results.

*Figure 12: Percentage of clear-cut area to total forest area by region for year 2003 over Russia*




Note: An annual clear cut rate of more than 1 percent over large areas is by definition not sustainable if the minimum rotation period is 100 years, even if all logged areas are either replanted or naturally regenerated.

The same analysis was performed with the percentage of burned areas. The regions with the highest levels of burned areas are located in northern-eastern part of Siberia (Chukotskiy okrug, Magadanskaya oblast, Yakutia Republic, Khabarovskiy krai). This is mainly due to the fact that these regions are largely inaccessible and are not under active fire protection. In European Russia, the highest percentage of burned areas is found in Rostovskaya and Volgogradskaya oblast, characterized by hot and dry summers which lead to higher frequency of forest fires.

The percentage of dead stands is the highest in Kalmykia Republic, Taymyrskiy okrug, Sahalinskaya oblast, Chelyabinskaya oblast and other regions, but there are no general geographical or economical trends in their spatial distribution. Chemical pollution is a probable reason for stand mortality in Taymyrskiy okrug and Chelyabinskaya oblast, while unfavorable weather conditions and grazing are the main factors in Kalmykia Republic and insect pests is the main driver in Sahalinskaya oblast.

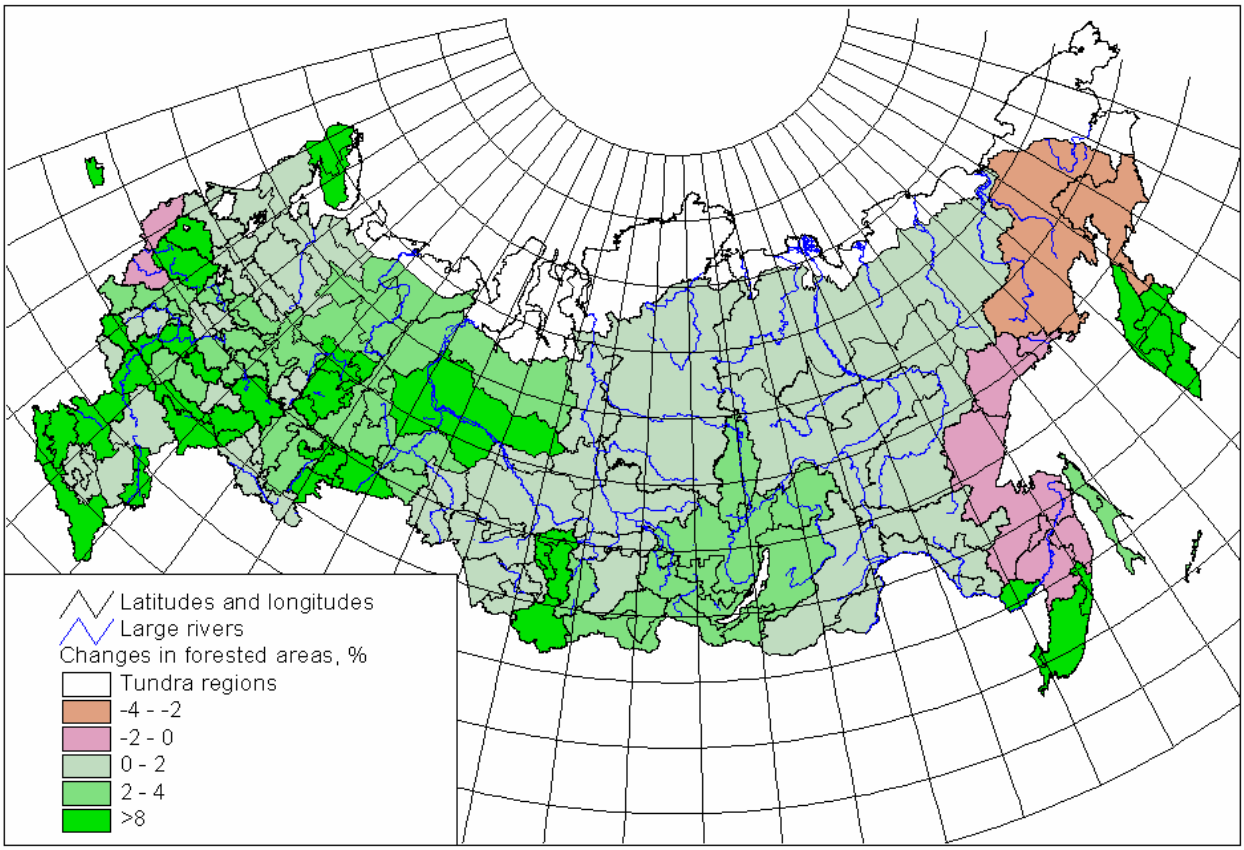
Such analysis can reflect not only the level of disturbances, but also the rate of reforestation of non-forested land. For example, Siberian regions have a high percentage of burned area due to both frequent fires and low rates of regeneration (in some places the time for regeneration can take 40-50 years).

### 4.1.3. Dynamic analysis for the determination of "hot spot regions"

The previous approach is static in the sense that the analysis is made for a given point in time. However, the time-series of SFFA gives an opportunity to perform a "dynamic" comparison of area changes. We compared SFFA data through time with respect to total forested area, clear-cuts and

burned areas. The results displayed in next figure show that the highest rates of decrease in forested area occur in several regions in western (Pskovskaya oblast, Smolenskaya oblast) and eastern (Chukotskiy okrug, Koryakskiy okrug, Magadanskaya oblast, Khabarovskiy krai) parts of the Russian Federation. The rate of decrease in forested area is not high (1 to 4% over 5 years) and can be explained by logging in the western regions and forest fires in the eastern ones. These regions represent only 12% of Russia's forested lands. In the other 88% of forested land, of the trend is for forested area to increase. This increase is explained by the general decrease in agriculture and logging during the last 15 years due to economical and social reforms. Such relative changes in the total forested area can tentatively be used as an indicator for determining "hot spot regions".

***Figure 13: Relative changes of total forested area by regions of Russia between 1998 and 2003***




The same dynamic analysis was performed with clear-cuts and burned areas. The largest rate of increase in clear-cut areas from 1998 to 2003 was found mainly in the European Russia regions (Kalmykia Republic, Novgorodskaya oblast, Smolenskaya oblast, Orlovskaya oblast, Volgogradskaya oblast, Moscowskaya oblast, Yaroslavskaya oblast, Leningrdaskaya oblast). These are the most populated regions of Russia with well developed timber industry and trade. The rate of increase in clear-cuts areas in these regions over the five-year period is rather high (from 50% to 200%). There are no Siberian regions with high-level increase of clear-cut area.

The same conclusion is found for changes in burned areas after performing the dynamical analysis. Burned areas increased in many European regions (Vologodskaya oblast, Yaroslavskaya oblast, Ryazanskaya oblast, Moscowskaya oblast, Smolenskaya oblast, Komi Republic, Astrahanskaya oblast, Volgogradskaya oblast) at more than 200%. This result might be explained by climate change, with in particular warmer and dryer summers increasing the forest fire danger. Burned area also increased in some Siberian regions (Koryakskiy okrug, Khabarovskiy krai, Magadanskaya oblast, Chuktoskiy okrug).

The indicators described above (percentage of clear-cuts, burned areas, dead stands, relative changes) characterize different aspects of the forest cover change processes. A possible combination of all indicators can be obtained by first ranking regions using each indicator individually and then summing

up the obtained ranks. All regions of the Russian Federation were ranked by ascending percentage of clear-cuts, burned areas, dead stands, relative changes of clear-cut and burned areas and descending relative changes of total forested area. Then sums of ranks were calculated for all regions. A high sum suggests that the region can be considered as a "hot spot region". The ten "hottest" regions are shown in next table. These regions are mostly located in European Russia close to industrial centers (Moscowskaya oblast, Leningradskaya oblast, Volgogradskaya oblast, Yaroslavskaya oblast, Smolenskaya oblast), in southern regions unfavorable for forestry (Rostovskaya oblast, Kalmykia Republic) or in regions with traditionally unsustainable levels of forest harvesting (Vologodskaya oblast, Komi-Permyatskiy okrug). Only one region from Siberia is listed, Khabarovskiy krai, close to China.

***Table 5: The ten "hottest" regions of the Russian Federation***

| Region | Rank (from 1to 87) | | | | | | Sum of ranks |
|---|---|---|---|---|---|---|---|
| | relative area of clear cuts | relative burnt areas | relative area dead stands | change of forested area | change of clear cuts | change of burnt areas | |
| Volgogradskaya oblast | 85 | 80 | 69 | 74 | 83 | 79 | 470 |
| Smolenskaya oblast | 57 | 58 | 77 | 80 | 85 | 83 | 440 |
| Leningradskaya oblast | 79 | 53 | 58 | 78 | 80 | 62 | 410 |
| Rostovskaya oblast | 84 | 81 | 73 | 27 | 71 | 60 | 396 |
| Moscowskaya oblast | 74 | 35 | 63 | 51 | 82 | 84 | 389 |
| Yaroslavskaya oblast | 67 | 55 | 62 | 37 | 81 | 86 | 388 |
| Khabarovskiy krai | 41 | 84 | 81 | 83 | 30 | 66 | 385 |
| Vologodskaya oblast | 78 | 50 | 42 | 75 | 53 | 87 | 385 |
| Komi-Permyatskiy okrug | 69 | 66 | 39 | 76 | 50 | 75 | 375 |
| Republic Kalmykia | 87 | 9 | 87 | 61 | 87 | 42 | 373 |

However the proposed approach contains two main limitations:

(i) First, the Russian regions are not homogeneous either in size or content. The largest regions are all located in Russian Asia but it is impossible to find intra-regional trends using the data provided in the SFFA reference books as these data are aggregated to the regional scale. It is very probable that the largest regions (e.g. Yakutia Republic or Krasnoyarskiy krai) are spatially heterogeneous for forest cover change patterns. A possible remedy would be to use the original SFFA database instead of the reference books because this database provides forest inventory data at a more local scale (for about 2,000 local forest management units called "leskhoz"). Copies of this database can be obtained (against a fee) from the Federal Forest Agency, the producer of the database.

(ii) The limitation is due to the duration of the data collection process by the Federal Forest Agency. Information in the SFFA database is updated for a given local forest management unit when a new forest inventory is carried out. The inventories conducted over the last five years provided an update only of 35% of the area covered by the database, and inventories of the last six to ten years another 36%. For the remaining part (29%), data are more than 10 years old. As a result, the present SFFA information combines data received at different time periods. Consequently our analysis does not reflect the exact status of forest resources for the year 2003 neither the exact changes for the period 1998-2003. In particular, some of the recent changes in the forest cover are not yet recorded in the SFFA database.

The main advantage of this approach lies in the use of official Russian statistical data. Policy-makers at the regional level can be convinced that good land-use planning and protective measures are needed, as the results of these actions can be easily monitored from official data. This advantage, to our opinion, is great enough to compensate for the described limitations.