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IRIS

Irkutsk Regional Information System for Environmental Protection
Integrating and strengthening the European Research Area

Instrument Specific Support Action

Thematic Priority Environmental Protection

Deliverable D.1.3 Quarterly Report (Year I, Quarter III)

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Dissemination Level		
PU	Public	PU
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

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Section 1 – Project objectives and major achievements during the reporting period

Project objectives

The Irkutsk Regional Information System for Environmental Protection – 'IRIS' assesses the current status and dynamics of the Irkutsk region's forestry environment, influenced by man-made changes and anthropogenic impact arising from pollution sources and other negative anthropogenic drivers located in the region and in adjacent areas. It will investigate the responsiveness and vulnerability of forestry environment within the region under different scenarios of industrial development and nature-preserving measures.

The output of the project is the adaptation of the existing GIS layers, completion and transfer into operative testing and exploitation a simplified version of the Regional Information System that serve as a prototype for other regions of Northern Eurasia. The project also includes the preparation of the detailed prospective studies and explorations aiming at the development of the efficient simulation and management tool for practical use by regional governance and nature-protection service(s). The tool will help to manage the risks associated with man-made changes and anthropogenic stress affecting the forest ecosystem of the region under investigation, as well as other regions of Northern Eurasia.

The major goals of IRIS are to *efficiently share Earth Observation (EO) data and domain-specific environmental and economic information within earth science community and regional governance and to identify environmental impacts that are both economic and socially responsible.* Thus, for integrated environmental management methodical designs are necessary which refer to the complexity of the natural resource to be managed and the difficulty to predict the factors or driving forces influencing them.

Following the principle of interoperability IRIS is planned to become part of a distributed network of similar systems where not only data is being distributed and shared, but also applications are being offered and used throughout the network. IRIS is thus using standards published by the World Wide Web Consortium (W3C®), the Open Geospatial Consortium (OGC™) or the International Organization for Standardization (ISO). On the long-term, decision makers and earth science communities will highly profit with applications, where domain-specific knowledge and information has been rigorously categorized.

Major achievements during the reporting period

IRIS builds on former Framework Programme 4 and 5 projects, extends their networks to Russia and adopts some of their findings to the specific needs of the involved governmental agency. That implements for the first time that the scientific results from former EC-funded scientific co-operations are being collected and transformed to tools for regional management by the administration. Thus, the first project phase dealt with questions like:

What is available from finished and on-going projects?

IRIS is a follow-on activity to the SIBERIA-II project. The products which have been generated include regional maps of land cover, fire induced disturbances, phenology, snow depth, snow melt date, onset and duration of freeze and thaw, LAI and others. Most of these products are available for several years and cover the entire Irkutsk region.

The GIS database already developed for the Irkutsk region by the Institute for Applied Systems Analysis **(**IIASA) together with a number of Russian institutions includes a number of layers (landscape, soil, vegetation, forests, utilities), which will effectively used for the goals of the regional information system on environmental protection and anthropogenically-driven risk assessment. However, in order to serve as a basis of IRIS, the GIS require an adaptation to recent technological standards. The information and methodological basis of the project intends to be developed in the form of a regional information system. The GIS being already developed by some Russian and international groups includes a number of levels highly relevant to the objectives of this study. The project supplements this GIS by other layers adapt the system and transfer it into operative testing and exploitation. A wide dissemination of a system is planned by preparation of an Internet oriented version.

What is the natural and anthropogenic impact on the local environment?

The Irkutsk region is politically important since its development represents the economic and sustainable growth in the vast rural territories of Siberia. The many years of human impact culminated in heavy industrial development during Soviet times – causing electricity demands which are supplied by world's largest hydro-power plant system along the Angara River. Large areas are under intensive anthropogenic press, which intends to be substantially increased. Atmospheric pollution by large industrial zones, contamination by untreated waste water effluents and higher run-off loads of nutrients caused by intensified land use and timber logging are pointed out as today's most apparent man-made environmental risks for Irkutsk region. Another development is that over the last decade China's exports of wood products have been fast growing and hence their imports of timber. The high value forests of the Irkutsk region are affected by this development and since then information provision for forest protection with respect to natural and human-induced disturbances is needed. Due to common forest fire events as well as intensive human activities such as clear cutting and cultivation the Irkutsk region is characterized by intensive large area changes of forests.

Satellite-based EO is crucial

Satellite-based Earth Observation (EO) platforms are the primary data source from which the above mentioned environmental impacts can be assessed. Without a priori information about such patterns, observations made by remote sensing sensors supply an independent and unbiased framework to analyse the landscape at multiple scales. IRIS' strategy follows an approach that considers spatial, spectral and temporal resolution demands by combining a variety of EO products because satellite images are one of the basic sources of information for study of the forest state and land cover monitoring. The multi-band and multi-temporal images from the EO platforms SPOT-Vegetation, TERRA/MODIS, Monitor-E/, Aura/OMI or ENVISAT/ASAR data deliver a wealth of environmental information. Therefore, such remote sensing information is often used for environmental studies, risk management and so on. Moreover, the results of these studies serve as a base, core or additional information for creating a specific and multipurpose GIS.

Considering recent technological developments

It is a methodical challenge to derive sound parameter sets from EO data and to implement spatial tools in large regions and, at least across administrative boundaries. In this context IRIS will profit from recent technological developments, like universal connectivity (internet), new advanced sensors (ALOS-PALSAR), comprehensive analysis environments (GIS, Spatial Data Infrastructures), standards for data, metadata and web services (like OGC), or communication platforms for computer-supported cooperative work (Wikis). One of essential components of IRIS is the implementation of an Open Source GIS system. Open Source technology is a growing field that encourages the free sharing of software, codes and services. The goal of the Open Geospatial Consortium (OGC) is to promote standard open software interfaces. These interfaces will enable geoprocessing so that different geospatial systems are able to communicate with each other.

Using web service technology

Such as pointed out above, the goal of the Open Geospatial Consortium (OGC) is to promote standard open software interfaces. These interfaces will enable geoprocessing so that different geospatial systems are able to communicate with each other. Consequently, IRIS' spatial data base will be implemented as 3-tier architecture with database server (PostgreSQL), application server (Geoserver or Mapbender Client Suite) and internet browser. PostgreSQL with the PostGIS extension follows the Simple Features for SQL specification from the Open Geospatial Consortium. The application server acts as an OpenGIS-compliant web services layer on top of existing data sources. For a later stage, it is in discussion that the Mapbender Client Suite as a framework for managing spatial data services will be implemented as IRIS Online-GIS. Moreover, Mapbender provides interfaces for user and group administration and management functionality for maps displayed and data served by OGC Open Web Services. Thus, the main technical goal of IRIS is to bring GIS functionalities into web browsers by using recent developments of web map services (WMS), web feature services (WFS) or web coverage services (WCS).

Summarizing, it is a methodical challenge to derive sound parameter sets from Earth Observation data and to implement spatial tools in large regions and, at least across administrative boundaries. In this context IRIS will profit from recent technological developments, like (1) universal connectivity (internet, web), (2) comprehensive analysis environments (GIS, spatial databases), (3) standards for data, metadata and services (like OGC), or (4) communication platforms for computer-supported cooperative work.

Where did we go from here during the reporting period? *There is a*
- need for more structure and documentation of what is available,
- need for strategies to make data and information synergistically available (GIS-compatible),
- need to build up both, spatial high-resolution information and baseline information from time series,
- need for the involvement of IRIS users in the development process.

Subsequently and according to the workplan, additional information/data are collected and investigated for the domains
(1) remote sensing data,
(2) information on man-made changes and stress sources and
(3) the development of strategies for efficient communication among IRIS developers and IRIS users.

Section 2 – Workpackage progress of the period

The quarterly report refers to the third quarter of year 1, months 7-9 (Tab.1). Active Work Packages (WP) for this period are WP 2000 and WP 3000. WP 4000 is in preparation. WP 1000 is reported in Section 3.

Table 1: Reported work packages.

Work Package	**Year 1**				**Year 2**			
	I	**II**	**III**	**IV**	**I**	**II**	**III**	**IV**
WP 1000								
WP 2000								
WP 3000								
WP 4000								
WP 5000								
WP 6000								
Months	from 1 till 3	from 4 till 6	from 7 till 9	from 10 till 12	from 13 till 15	from 16 till 18	from 19 till 21	from 22 till 24

WP 2000 follows the break-down structure as defined in the IRIS work programme. The first nine months of IRIS are being used to firstly collect additional in-situ and remote sensing data and metadata for Irkutsk region. Tasks concern the collection of satellite remote sensing data (archived and newly obtained) for forest monitoring (WP 2100), collection of in-situ data (WP 2200), thematic processing of the collected remote sensing data and their adjustment for inclusion in Regional GIS (WP 2300).

In parallel with WP 2000, implementation of **WP 3000** was also performed. During the first three months of IRIS the current man-made changes and pollution sources in the Irkutsk region are assessed (WP 3100).

The hypotheses on major potential pollution sources will be also formed and carefully checked (WP 3200). Output of WP 3000 is an input for WP 4000 (start month 10).

The results of previous two work packages serve as an input for **WP 4000** focused on update of existing GIS for Irkutsk region. Currently, the GIS being developed for the Irkutsk region by IIASA together with a number of Russian institutions includes a number of layers (landscape, soil, vegetation, forests), which will be effectively used for the goals of the regional information system on environmental protection and anthropogenically-driven risk assessment. However, in order to serve as a basis of IRIS, the GIS requires to be supplemented and adapted to friendly user interface. This prototype of the IRIS-GIS will allow an assessment of state and functioning of the regional forests, to identify areas of rapid changes, which require operative monitoring, and to estimate environmental risk in different aspects. From another side, an expert system for assessing the impacts of negative anthropogenic drivers on forests (WP 4100/3) will serve as a basis for preparing of programs of new advance studies and research initiatives.

Please note: The following chapter (“Work Packages 2000”) of this report serves at the same time as Deliverable ⇒ D.2.4 Technical report on Work Package 2000. New ⇒Deliverables are highlighted and colored in **dark green.** Deliverables are also available from ftp server at **angara.geogr.uni-jena.de** (SFTP using SSH2).

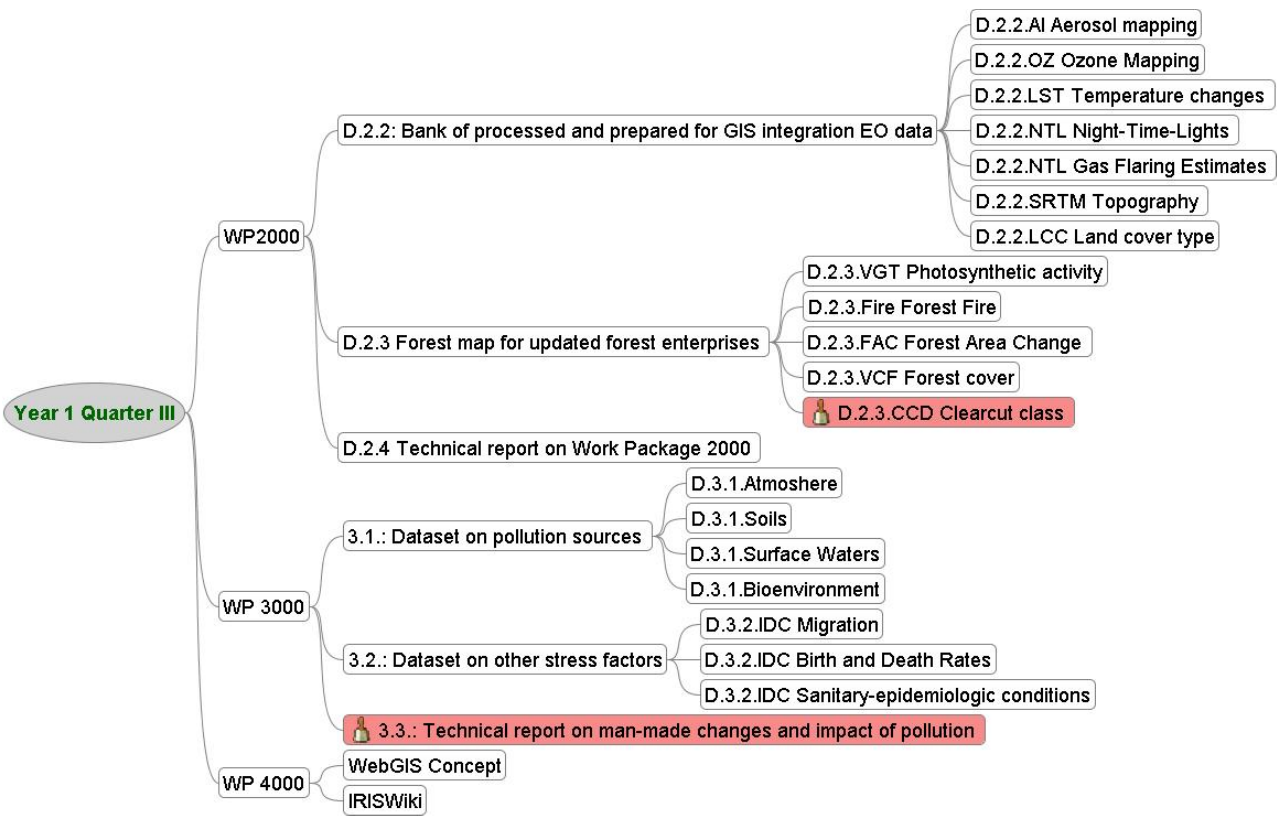

Figure 1: Graphical representation of reported deliverables. Red coloured packages are not described and delivered with this report.

Work Package 2000

Objectives

- **To collect additional available remote sensing data for the region under study to update existing GIS (e.g. historical and Russian acquisitions).**
- **To collect additional available in-situ data for the region under study to update existing GIS.**

Through close links of IRIS with other large projects of the coordinator, a very extensive set of diverse satellite data can be used. WP 2100 searched for other available additional sources (e.g. other time series, historical and Russian acquisitions). Thus, WP 2100 collected additional remote sensing information from different satellites and sensors for the last 20 years time period for the region under study.

WP 2200 dealt with the collection of additional information from forest sector for the region under study and here corresponding attributes for newly inventoried forest enterprises and for transformed territories based on Remote Sensing data for the integration in the regional forest database.

WP 2300 dealt with pre-processing and analysis of newly obtained remote sensing data such as SAR processing or trend analyses.

Progress towards objectives

Additional multi-scale EO data/ products

For Deliverables D.2.1, D.2.2, D.2.3, D.2.4 and D.3.2 data of different EO sensors in different spectral, spatial and temporal dimensions are collected. Long-term and temporal high-resolution EO data such as the TOMS/OMI Aerosol Indices, MODIS temperature or fire data, DMSP Nighttime Lights or SPOT-VGT NDVI were transformed into monthly, seasonally or yearly composites. Recent acquisitions in different spectral domains like Monitor-E or Envisat-ASAR data were acquired to derive reliable and up-to-date information on forest extent and changes. High-resolution imagery such as from Quickbird (Google ™) can be used to describe anthropogenic-driven impacts and developments as well as to validate area-wide EO products. It is a methodical challenge to make these data sets compatible and synergistically available.

EO platforms are the primary data source for area-wide, daily, weekly or yearly time-series analyses to better understand the inter-annual variations of the environmental processes and turnovers. To ensure a continuous, area-wide approach we have chosen spatially low but temporally high resolution atmospheric data from the “Total Ozone Mapping Spectrometer” (TOMS) and the “Ozone Monitoring Instrument” (OMI). Both sensors provide temporal high resolution global information about the total ozone content as well as aerosol distribution of the atmosphere. TOMS/OMI data represent the primary long-term, continuous record of satellite-based observations available for use in monitoring global and regional trends in total ozone and aerosols over the past 25 years.

Spatially medium resolution EO land products such as time series from Terra/Aqua MODIS or SPOT-VGT serve as baseline information for higher resolution images at a more or less particular point in time. So far, IRIS uses the monthly Land Surface Temperature (LST) product (MOD11C3; 5km per pixel) and SPOT-VGT NDVI (1km) for trend analyses. Different MODIS Land products have been obtained and processed (see table 2). MODIS is designed to provide a comprehensive series of global land and atmosphere observations in the visible and infrared regions of the spectrum. Four daily MODerate-resolution Imaging Spectroradiometer (MODIS) observations are available to contribute to global monitoring, the Terra instrument acquires 10:30 am and 10:30 pm, the Aqua instrument 2:30 pm and 2:30 am. The MODIS products used in here are gridded (500 m, 1km, 5km) composites over a daily, 8-day, monthly or yearly interval. The product uncertainties are well defined. Products thus are ready for use in scientific publications. Native MODIS data files have been released in the Sinusoidal projection. The tile coordinate system has horizontal and vertical tile numbers. Tiles are 10 degrees by 10 degrees at the equator. Irkutsk region coverage was obtained by merging four tiles (see figure 2). From January 1, 2007 onward data are being processed as version 005 products. Historical acquisitions of MODIS data (version 004) are being reprocessed.

Up-to-date and spatially high resolution C-band SAR data from ENVISAT-ASAR (25-50 meters) are used for reliable and up-to-date information on forest extent and changes in areas with high dynamics. Until today the data were acquired both at no costs from internet databases and external project agreements or at low cost reproduction fees. Expenses were therefore be minimised. The Geographic LatLong projection with the WGS84 Datum/Spheroid and the Albers Equal Area Conic projection with the WGS84 Datum/Spheroid are the standard for all spatial data used in IRIS.

The Albers Equal Area Conic projection parameters are:
Central meridian: 99.0 (99 00 0.00 East longitude)
Latitude of projection origin: 50.0 (50 00 0.00 North latitude)
First standard parallel: 56.0 (56 00 0.00 North latitude)
Second standard parallel: 73.0 (73 00 0.00 North latitude)
False easting: 1,000,000.0 (one million meters)
False northing: 0.0

Data are provided in either raster or vector formats. Data provided in raster format are in the ENVI image format with a separate header file (.hdr) or as GeoTIFF. Data provided in vector format are ESRI's Shape file format (.shp).

Trend analyses using linear regression

Climate and human impact are influencing factors on Irkutsk region's ecosystem fluxes. Thus, to detect significant positive and negative trends in both the SPOT-VGT NDVI mosaics (1998 – 2005, Huettig et al. 2006) and the MODIS LST products (2000 – 2006), a temporal trend analysis using the ordinary least squares (OLS) regression technique on the basis of a linear regression model ($Y = a + bX + å$) as presented by Fuller (1998) and Zhou et al. (2001) was applied on the dataset. Every pixel value is plotted over time and the linear model fit is calculated by minimizing the sum of the vertical deviations (least squares) from each data point to the line. By applying the linear regression model on satellite time series data it will be possible to detect linear changes of the pixel values over time. These changes can be detected either with positive or negative slope values. The slope value thus gives information about the annual increase or decrease of pixel value, here temperature or NDVI. Another parameter taken into account is the coefficient of determination (R^2), which describes how strong the linear relationship is between LST or NDVI change and time. To avoid interpretation errors the trends are analyzed on a confidence level of 95% using standard t-test. The SPOT-VGT NDVI and the MOD11C3 LST datasets were regressed over six respective seven years for the same time interval (seasonal). The standard t-test is useful to detect step changes within satellite data (De Beurs et al., 2005).

Hüttich, C., Herold, M., Schmullius, C., Egorov, V. Ego & BARTALEV, S. A. (2006). SPOT-VGT NDVI and NDWI Trends 1998-2005 as indicators of recent land cover change processes in Northern Eurasia. Presented at: 2nd Workshop of the EARSeL Special Interest Group on Land Use and Land Cover, 28-30 September 2006.

Fuller, D.O. (1998). Trends in NDVI time series and there relation to rangeland and crop production in Senegal, 1987-1993. *Int. J. of Remote Sensing*, **19**, 10, 2013-2018.

Zhou, L. M., Tucker, C. J., Kaufmann, R. K., Slayback, D., Shabanov, N. V., & Myneni, R. B. (2001). Variations in northern vegetation activity inferred from satellite data of vegetation index during 1981 to 1999. *J. of Geophys. Res.*, **106**, 16, 20,069-20,083.

SAR data processing

According to the cross- and along-track components of radar images, a strong dependence of radar backscatter to mountain slopes is given. Thus, for forest mapping, radiometric and geometric corrections are necessary. Prerequisite is the availability of precise elevation data. For forestry, the use of low incidence angles enhances the sensitivity to biomass, whereas the use of high incidence angles enhances the discrimination of forest types through interaction with forest structure. The use of cross polarisation improves the discrimination between volume scattering (vegetation) and surface scattering (soil), in this case the forest/non-forest discrimination and the retrieval of low biomass values (forest regeneration, re-growth). In case of forest area/type applications ENVISAT-ASAR AP mode with VV/VH polarisation for swaths IS4-6 can be recommended.

Forest area maps for the Irkutsk region are generated using cross-polarized ENVISAT-ASAR precision images acquired at large incidence angles (swath 7). For quality control and product verification archived Landsat TM5 and Landsat ETM 7 as well as ground reference data are used. The acceptability threshold of the thematic mapping accuracy is 90% for forest areas and 85% for forest area changes, respectively.

Deliverables

⇒ D.2.1.: Database of additionally collected remote sensing data for the region under study
⇒ **D.2.2: Bank of processed and prepared for GIS integration remote sensing data for the region under study**
⇒ **D.2.3 Forest map for updated forest enterprises and corresponding attributes of Database**
⇒ **D.2.4 Technical report on Work Package 2000 (Section 2 chapter "WorkPackages 2000" of this report)**

⇒ **D.2.2.NTL** area-wide DMSP persistent lighting including gas flaring estimates (1992 – 2003) to point on increasing/ decreasing human activities;

⇒ **D.2.2.AI** area-wide TOMS/OMI-Aerosol Index (AI) (1980 – 2007) mapping to distinguish between human-induced or natural and local or regional sources of aerosol particles and the impact on the Irkutsk region;

⇒ **D.2.2.OZ** area-wide OMI-Ozone (2004 – 2007) mapping to distinguish between human-induced or natural and local or regional sources of total ozone;

⇒ **D.2.2.LST** area-wide MODIS/Terra Land Surface Temperature data (MOD11C3) to detect and to link significant temperature variations with the rate of growth of vegetation, to determine risk potentials for infrastructures such as slope failures in permafrost regions and to map temperatures as major stress factor on human health;

⇒ **D.2.2.LCC** area-wide MODIS/Terra Land Cover Classification product (MOD12C1) containing multiple classification schemes and percentage of each pixel covered by a given Land Cover type to map land cover properties during 12 months of input data (one year);

⇒ **D.2.2.SRTM** area-wide digital height data and 1st order derivates (slope, aspect) from GTOPO30 and SRTM-Water bodies as well as file listing of area-wide SRTM-3 data to include into image processing and terrain analyses

⇒ **D.2.3.VCF** area-wide MODIS Vegetation Continuous Fields product contains proportional estimates for vegetative cover types: woody vegetation, herbaceous vegetation, and bare ground;

⇒ **D.2.3.Fire** area-wide MODIS/Terra Forest Fire data (2000 – 2005) to link fire distribution with climate and human impact;

⇒ **D.2.3.FAC** ENVISAT-ASAR SAR imagery (2006) for selected areas to map clear cutting, burnt areas and re-forestation for an up-to-date forest area change map to point on the human impact on forests;

⇒ **D.2.3.CCD** Meteor-3M, Monitor-E and Resurs-DK data (2002 and 2006) to get reliable and up-to-date information on clear cutting for selected areas (not yet delivered);

⇒ **D.2.3.VGT** area-wide SPOT-VGT seasonal NDVI mosaics (1998 – 2005) to point on photosynthetic trends under the influence of climate and human impact;

Detailed description

Aerosol mapping

In studies of the anthropogenic impact on the environment, an important aspect is the spatial and temporal variability of gaseous pollutants and aerosols in the atmosphere. Aerosols occur either naturally, generated from dust storms (Fig. 2, 3), volcanoes or forest fires (Fig. 4) or human-induced, such as by burning of fossils (Fig. 5) or land cover alteration. Details about the amounts and properties are required to estimate their effect not only on public health but also on cloud properties and surface temperature. Numerical simulations allow to reduce the volume of costly and time consuming experimental studies as well as to assess the contribution of local and remote emission sources to the secondary pollution of the regional forestry and soil conditions. It is important here to conduct a risk assessment and determine the potential anthropogenic "signal" among a great variety of photochemical air pollutants and aerosol particles. Pointing pollutant sources is thus an important task of the project to better understand its impact on public health, climate and forests. IRIS uses data from Nimbus-7, Earth Probe and Aura satellites. Their instruments (TOMS, OMI) were designed to measure the distribution of ozone or aerosols globally.

The "Total Ozone Mapping Spectrometer" (TOMS on Nimbus-7 and Earth Probe) and the "Ozone Monitoring Instrument" (OMI on Aura) provide high resolution global information about the total ozone content as well as aerosol distribution of the atmosphere. TOMS data represent the primary long-term, continuous record of satellite-based observations available for use in monitoring global and regional trends in total ozone and aerosols over the past 25 years. Three data sets are processed within IRIS:

Deliverable⇒	**D.2.2.AIN7: Monthly Aerosol Index**
Instrument/Product:	TOMS (on Nimbus-7)
Time coverage:	January 1980 – December 1992
Map coverage:	global, gridded 1.0° x 1.25° products
Source:	ftp://toms.gsfc.nasa.gov/pub/nimbus7/data/aerosol/
Credits:	NASA Goddard Space Flight Center
IRIS-Processing:	monthly means were calculated from daily data
Comment:	global-coverage ENVI-IDL-file for querying (IDL-Code is available at FSU)

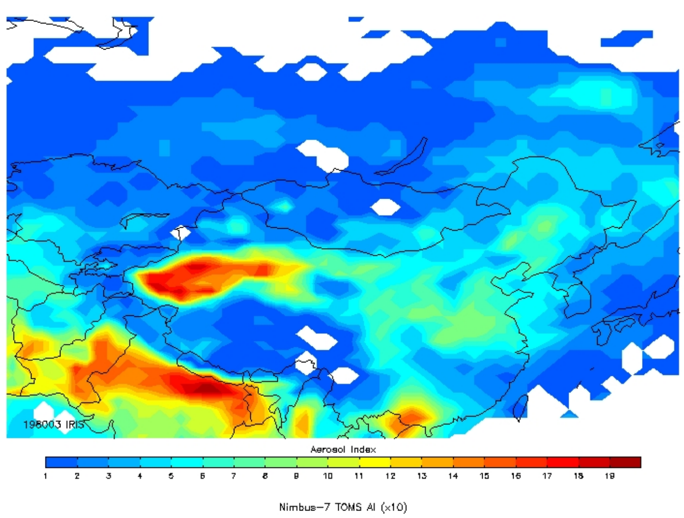

Figure 2: Monthly averaged AI over Asia on April 1980. Main sources of aerosols with proximity to the Irkutsk region are Taklamakan and Gobi deserts and Manchuria.

Deliverable⇒	**D.2.2.AIEP: Monthly Aerosol Index**
Instrument/Product:	TOMS (on Earth Probe)
Time coverage:	January 1997 – December 2004
Map coverage:	global, gridded 1.0° x 1.25° products
Source:	ftp://toms.gsfc.nasa.gov/pub/eptoms/data/aerosol/
Credits:	NASA Goddard Space Flight Center
IRIS-Processing:	monthly means were calculated from daily data
Comment:	global-coverage ENVI-IDL-file for querying (IDL-Code is available at FSU)

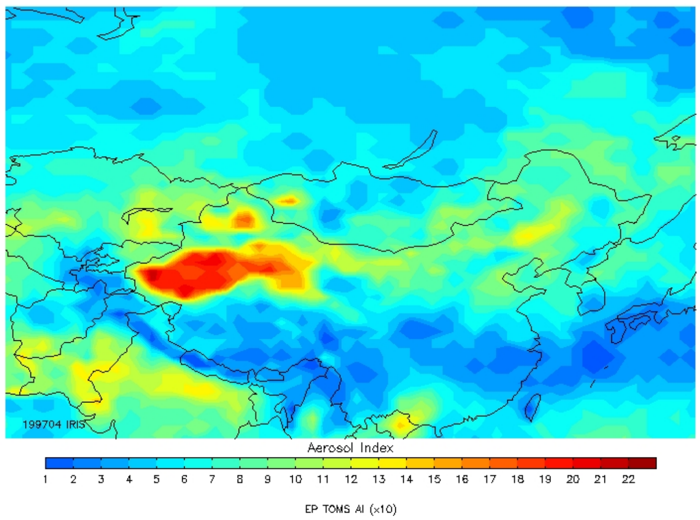

Figure 3: Monthly averaged AI over Asia April 1997. Main source of aerosols with proximity to the Irkutsk region are Taklamakan and Gobi deserts and Manchuria.

Deliverable⇒	**D.2.2.AIAura: Monthly Aerosol Index**
Instrument/Product:	OMI TOMS-like (on Aura)
Time coverage:	September 2004 – April 2007
Map coverage:	global, gridded 0.25° x 0.25° products
IRIS-Processing:	monthly means from daily global Level 3 data
Source:	ftp://toms.gsfc.nasa.gov/pub/omi/data/Level3e/aerosol/
Credits:	NASA Goddard Space Flight Center
Comment:	GeoTiff Layerstack for Irkutsk region; ready for IRIS-DB integration

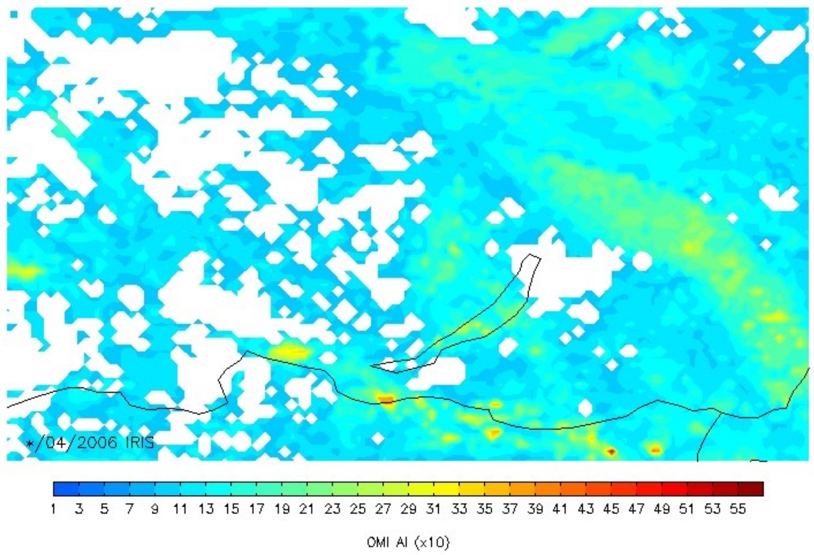

Figure 4: Monthly averaged AI over Irkutsk region for April 2006. With better spatial resolution of OMI (compared to TOMS), isolated high AI values along the Russian-Mongolian border can be observed, which results from smoke from forest fires. The smoke plume to the East is generated by the phenomenon described below.

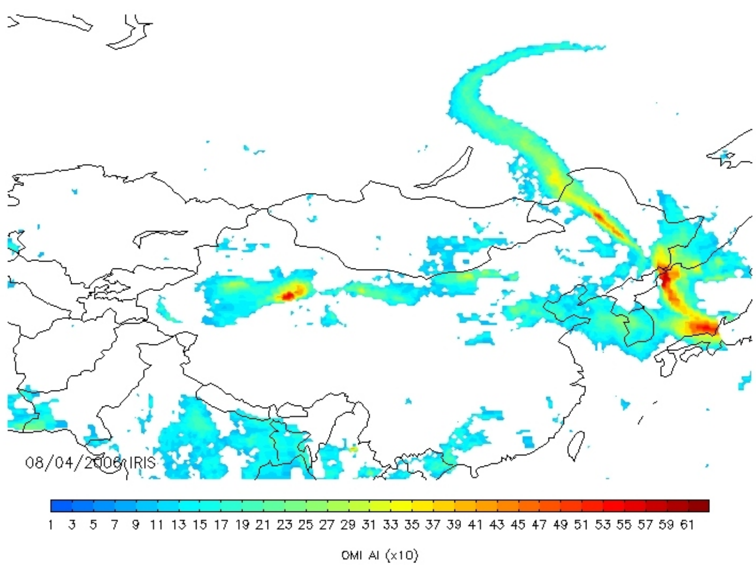

Figure 5: Another effect can be shown for the daily AI over Asia on 08th of April 2006. The days before, a major dust storm crossed China from West to East with sand from Taklamakan and Gobi deserts. The sand also picked up heavy metals and carcinogens as the clouds passed industrial areas. The pollutants are transported by prevailing winds to Korea, Japan and in a longsome plume to Eastern and Central Siberia.

Ozone mapping

Since decreasing concentrations of chlorofluorocarbons the growing of the stratospheric Antarctic ozone hole has slowed, so far. But on the other hand human activities have increased surface-level ozone. Tropospheric ozone is now a major component of air pollution affecting public health and vegetation. There are large uncertainties in the understanding of the ozone production and the relative importance of human-induced and natural sources. Troposheric ozone can arise from both local and regional sources since it crosses large distances. The OMI instrument on Aura is able to measure stratospheric and tropospheric ozone in one column (Fig. 6). To get the tropospheric ozone residual, the stratospheric column ozone needs to subtract. Stratospheric ozone on its part can be determined by Auras Microwave Limb Sounding (MLS) instrument. At this time only OMI data have been processed but it is foreseen to include MLS data to calculate the tropospheric ozone residual.

Deliverable⇒	**D.2.2.OZAura: Monthly Total Column Ozone**
Instrument/Product:	OMI TOMS-like (on Aura)
Time coverage:	September 2004 – April 2007 (32 months)
Map coverage:	global, gridded 0.25° x 0.25° products
IRIS-Processing:	monthly means from daily global Level 3 data
Source:	ftp://toms.gsfc.nasa.gov/pub/omi/data/Level3e/ozone/
Credits:	NASA Goddard Space Flight Center
Comment:	GeoTiff Layerstack for Irkutsk region; ready for IRIS-DB integration

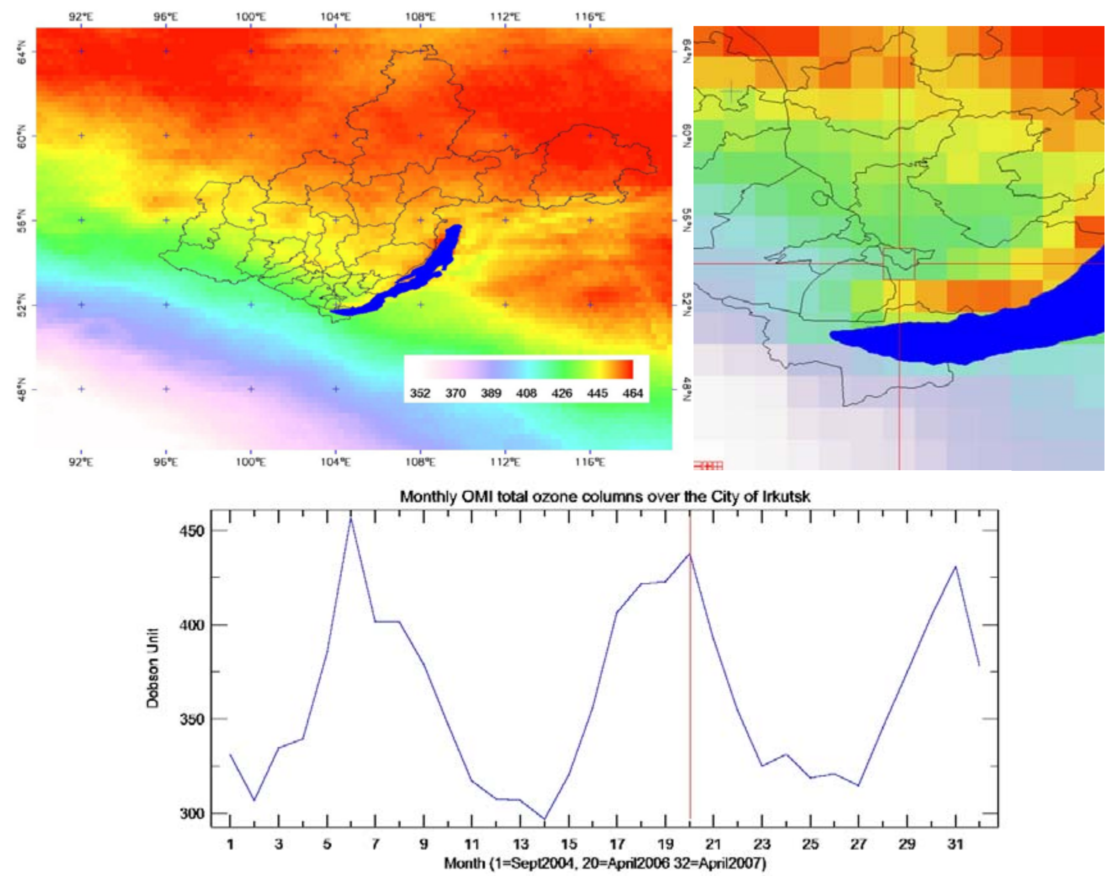

Figure 6: OMI Aura averaged monthly total ozone column (Dobson Units) for April 2006 (top left) and spectral profile for September 2004 till April 2007 (below) for the pixel covering the City of Irkutsk (top right). Because OMI measures the total ozone column, the gradient in the top left image can be explained by different thickness of the atmosphere for high- and lowland situations.

Land surface temperature changes

Canopy temperature is among the main determinants of the rate of growth of vegetation. Increasing temperatures are a major stress factor on the composition of vegetative ecotypes and plant (forest) physiology and force the outbreak of insect calamities and forest fires. Moreover, permafrost is influenced with rising risk potentials for infrastructures (slope failures). Time series analyses of 7-year record satellite observation of monthly Terra-MODIS Land Surface Temperature Climate Modelling Grid data (MOD11C3) for the Irkutsk region were carried out and trends in daytime Land Surface Temperatures were assessed. MOD11C3 is simply composited and averaged from the global 8-day CMG product (MOD11C2) over a period of 32 days. MOD11C2 again is composited and averaged from the global daily CMG product (MOD11C1) over a period of 8 days. Science quality status is 'validated' but product accuracy has been estimated using only a small number of independent measurements. MOD11C3 time coverage is 2000-2006 on a monthly and seasonal base with a ground resolution of 5.6 km. A spring trend has been calculated for March, April and May. The summer season consists of the averaged months June, July and August and so on (fall: September, October, November; winter: December, January and February).
Trends are analyzed on a confidence level of 95% using standard t-test and show the increase/decrease of LST per year. The patterns in Figure 7 give information about the annual increase/decrease of pixel values, originally Kelvin. Another parameter taken into account is the coefficient of determination (R^2), which describes how strong the linear relationship is between LST change and time.

The multi-scale data set hasn't full explored yet. Moreover, for a better understanding of recent trends Surface Temperature analysis data (GISTEMP) from the NASA Goddard Institute for Space Studies (GISS) will be incorporated. GISTEMP gives information about the surface temperature change in a global monthly resolution from 1880 to 2005.

Deliverable⇒	**D.2.2.LSTSM: Seasonal LST data (7 years by 4 seasons)**
Deliverable⇒	**D.2.2.LSTOLS: Seasonal LST trends (at a confidence level of 95%)**
Instrument/Product:	MODIS/Terra Land Surface Temperature/Emissivity Monthly L3 Global 0.05Deg
Time coverage:	March 2000 – February 2007 (84 consecutive months or 28 seasons)
Map coverage:	global, gridded 0.05° x 0.05° products (5-6 km)
IRIS-Processing:	OLS regression for monthly and seasonal (from monthly) means
Source:	NASA, EOS Data Gateway http://edcimswww.cr.usgs.gov/pub/imswelcome/
Credits:	EDC DAAC
Comment:	Grid, GeoTiff Layerstack for Irkutsk region; ready for IRIS-DB integration
Comment:	Vector data for Irkutsk region; ready for IRIS-DB integration

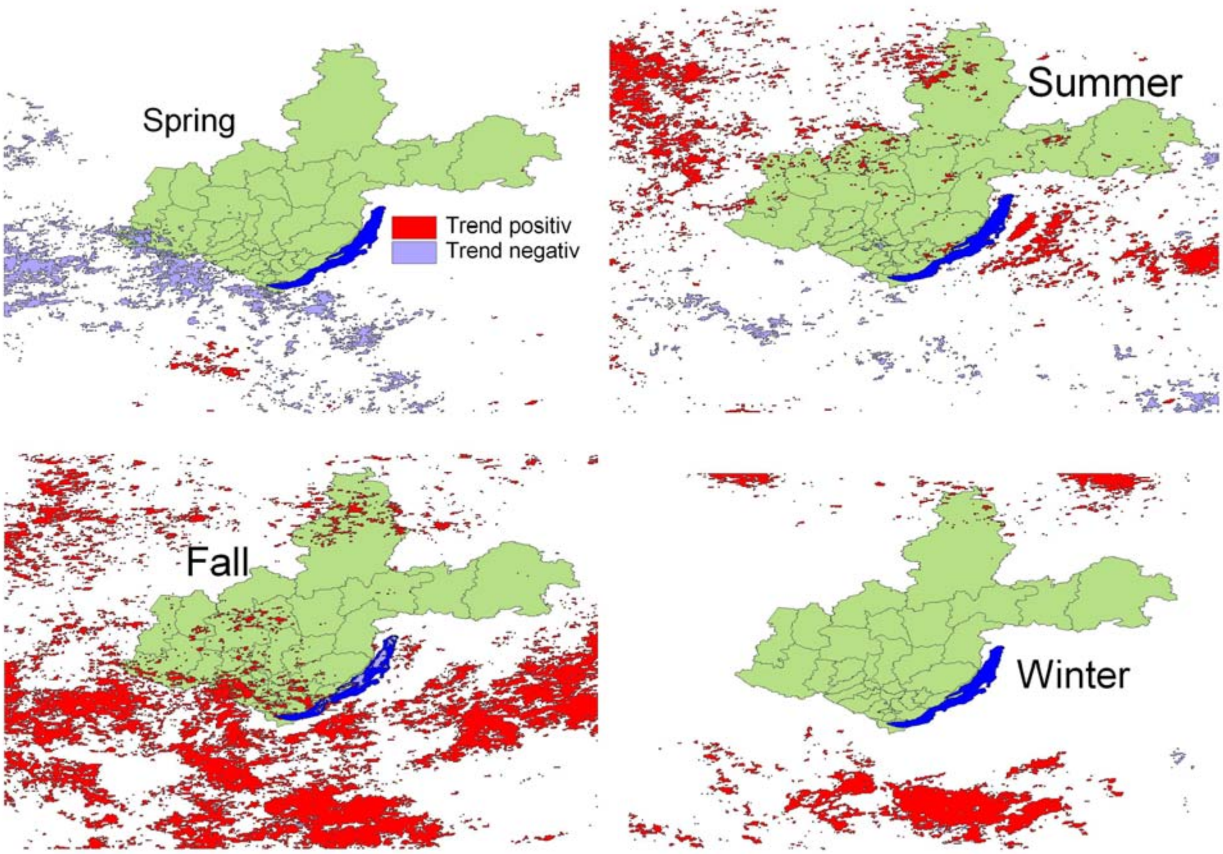

Figure 7: Seasonal land surface temperature trends derived from 84 consecutive month time-series of the MOD11C3 product for the Irkutsk region. Trends are analyzed on a confidence level of 95% using standard t-test and show the increase/decrease of LST per year.

Land cover types

The MODIS MOD12C1 product contains multiple classification schemes and percentage of each pixel covered by a given Land Cover type to map land cover properties. The classification schemes are multitemporal classes describing land cover properties as observed during the year. The primary land cover scheme (Fig. 8) developed by the International Geosphere-Biosphere Programme (IGBP), include 11 natural vegetation classes and 3 developed land classes.

Deliverable⇒	**D.2.2.LCC: Land Cover Types Yearly (2001)**
Instrument/Product:	MODIS/Terra Land Cover Types Yearly L3 Global 0.05Deg CMG
Time coverage:	2001
Map coverage:	area-wide, gridded product (5.6 km)
Source:	NASA, EOS Data Gateway http://edcimswww.cr.usgs.gov/pub/imswelcome/
Credits:	EDC DAAC
Comment:	Grid, GeoTiff Layerstack for Irkutsk region; ready for IRIS-DB integration

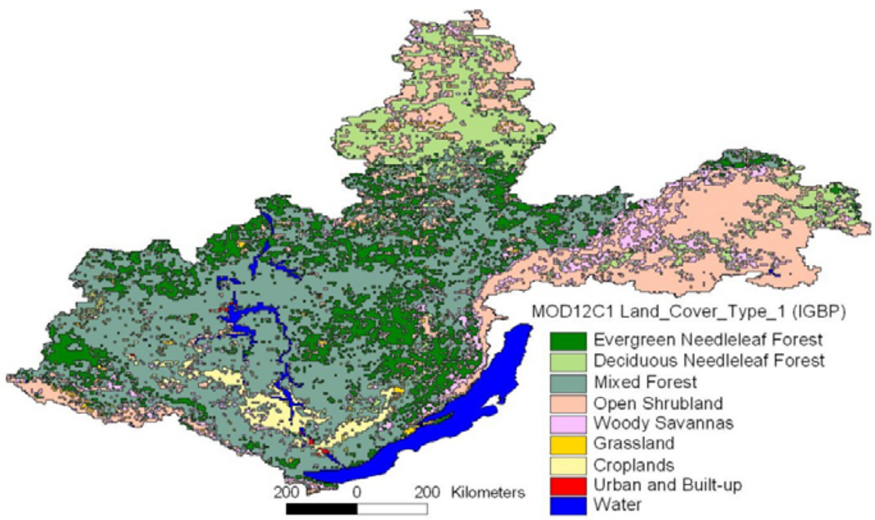

Figure 8: MOD12C1 IGBP Land Cover classification scheme for Irkutsk Province.

Vegetation Continuous Fields

MODIS Vegetation Continuous Fields product (Fig. 9) contains proportional estimates for vegetative cover types: woody vegetation, herbaceous vegetation, and bare ground and shows how much of a land cover exists.

Deliverable⇒	**D.2.3.VCF: Vegetation Continuous Fields Yearly (2001)**
Instrument/Product:	MODIS Vegetation Continuous Fields
Time coverage:	2001
Map coverage:	area-wide, gridded product (500 m)
Source:	EOS Data Gateway http://edcimswww.cr.usgs.gov/pub/imswelcome/
Credits:	Global Land Cover Facility (GLCF)
Comment:	Grid, GeoTiff Layerstack for Irkutsk region; ready for IRIS-DB integration
Citation:	Hansen, M., R. DeFries, J.R. Townshend, M. Carroll, C. Dimiceli, and R. Sohlberg (2003), Vegetation Continuous Fields MOD44B, 2001 Percent Tree Cover, Collection 3, University of Maryland, College Park, Maryland, 2001.

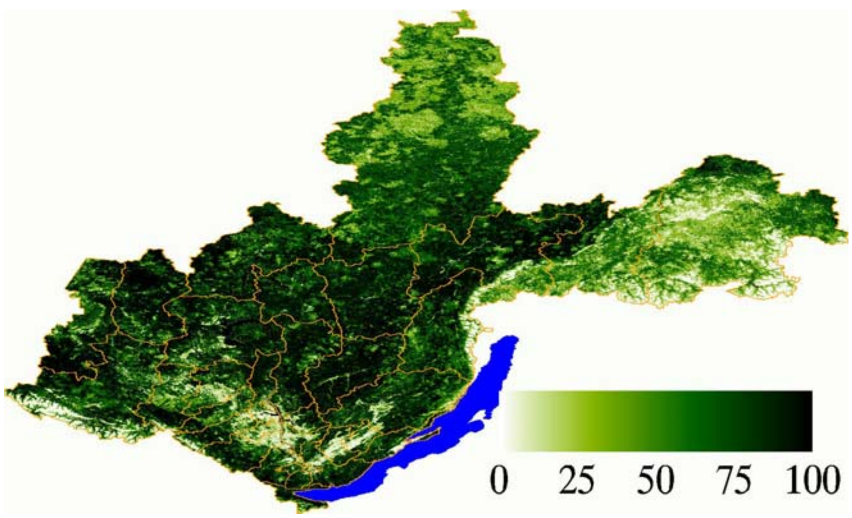

Figure 9: MODIS Vegetation Continuous Fields Percent Tree Cover (0-100%) for the Irkutsk region.

Forest Fire

Fire locations are detected using daily 4- and 11-micrometer brightness temperatures (data: courtesy of S. Bartalev). For the Irkutsk region (Fig. 10), forest fire distribution for the years 2000 - 2005 is displayed. Irkutskij, Ol'khonskij, Kachugskij and Zhigalovskij districts were most affected by forest fires.

Deliverable⇒	**D.2.3.Fire: Yearly Fire data (6 years)**
Instrument/Product:	MODIS/Terra Thermal Anomalies/Fire Yearly
Time coverage:	2000 –2005
Map coverage:	area-wide, gridded product (1 km)
Source:	NASA, EOS Data Gateway
Credits:	EDC DAAC
Comment:	Vector, Shape-file for Irkutsk region; ready for IRIS-DB integration

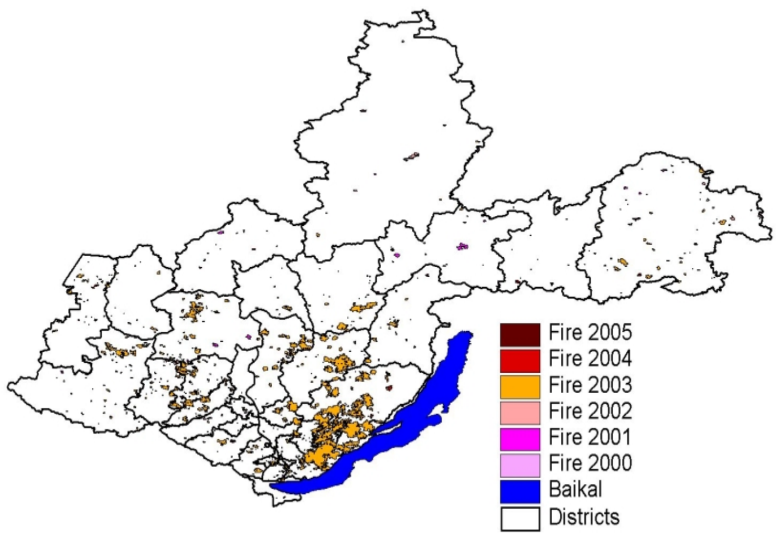

Figure 10: Forest Fire distribution 2000-2005.

Changes in photosynthetic activity

The data source of this time series analysis is based on S-10 standard products from the SPOT-4 Vegetation sensor. The Vegetation sensor was especially designed for vegetation mapping and monitoring and was launched in 1998 onboard the French SPOT-4 satellite. The data used in this study is provided by the TerraNorte Information System by the Russian Academy of Science's Space Research Institute. Time series analyses of 6-year record satellite observation of seasonal SPOT-VGT mosaics for Northern Eurasia were carried out and trends in vegetation photosynthetic activity were assessed. SPOT-VGT time coverage is 1998-2005 for summer and fall, 1999-2005 for spring season with a ground resolution of 1km. Mosaics were derived for spring (March-May), summer (June-August) and fall (September-November). Trends are the increase/decrease of NDVI per year (HÜTTICH et al., 2006). Tundra or disturbed areas show an increase or "greening" of vegetation. Districts most affected (Fig. 11) are Katangskij, Nizhneudinskij and Ust'-Ilimskij. In contrast, and after excluding impacts like clearcuts, fires or insect calamities, there are areas with decreasing photosynthetic activity, also called "browning" of vegetation. Most notably affected areas are in Ust'-Kutskij, Kirenskij and Bodajbinskij district. Together with the LST data, this multi-scale data set hasn't full explored yet.

Deliverable⇒	**D.2.3.VGT: SPOT-VGT seasonal NDVI mosaics**
Instrument/Product:	SPOT-VGT
Time coverage:	1998 –2005
Map coverage:	area-wide, gridded product (1 km)
Source:	SPOT Image
Credits:	Space Research Institute, Russian Academy of Science
Comment:	Vector, Shape-file for Irkutsk region; ready for IRIS-DB integration

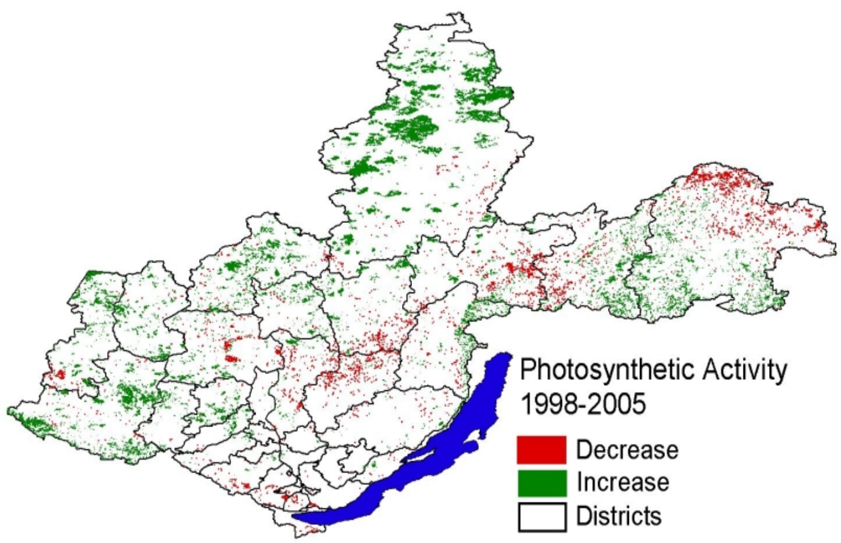

Figure 11: Positive and negative trends of summer NDVI 1998-2005 (Trends at 95% confidence level).

Forest Area Change Map 2000-2006

Forest/Non-forest area maps can be generated using high-resolution, cross-polarized Envisat ASAR (C-Band-SAR) precision images acquired at large incidence angles (swath 7). Main processing steps include image preprocessing (Sigma Nought calculation, orthorectification, topographic normalization, dB-values calculation, segmentation, image classification and accuracy assessment. Figure 7 shows coverage of Envisat ASAR/AP images for 2006 for the Irkutsk region. For future SAR acquisitions it is of special interest that the participant FSU is Principal Investigator for ALOS PALSAR (L-Band-SAR) and therefore entitled to receive data for the Irkutsk region.

13 cross-polarised C-Band ENVISAT ASAR APP IS7 scenes have been acquired. The precision images represent land surface with a pixel spacing of 12.5 m x 12.5 m, which were resampled to 25 m; for 100 km in along-track and 56 km across-track (swath width). Incidence angles varied between 42.5-45.5 degrees. Polarisation combination is HV and HH.

Figure 12 show the Ortho-Image Mosaic ENVISAT ASAR APP IS7 from 22.01.2006 to 14.03.2006 in the Service Area of Irkutsk 2006. The numbers inside of each scene correspond to the ID in Table 2 to identify the acquired scenes with start and stop date, scene center, orbit, track and frame as well as polarisation. The classification result is used for forest area map, burnt area & clear cut map, basis for forest area change map and ARD map.

Deliverable⇒	**D.2.3.FAC: Forest Area Change Map 2000-2006**
Instrument/Product:	ENVISAR ASAR APP IS7 (Alternating Polarisation Mode Precision Images)
Time coverage:	22nd January 2006 – 14th March 2006
Map coverage:	12.5 m x 12.5 m, resampled to 25 m; 100 km in along-track, 56 km across-track
Source:	EOLI
Credits:	ESA
Comment:	Shape-file for selected areas; ready for IRIS-DB integration

Table 2: Data source specifications for ASAR APP IS7

ID	Start	Stop	Scene center	Orbit	Track	Frame	Swath	Polarisation
1	22.01.2006 03:38	22.01.2006 03:38	57.47 97.95	20370	276	2457	I7	HV HH
2	08.02.2006 03:04	08.02.2006 03:04	56.59 106.32	20613	18	2475	I7	HV HH
3	08.02.2006 03:05	08.02.2006 03:05	52.16 105.14	20613	18	2565	I7	HV HH
4	11.02.2006 03:09	11.02.2006 03:09	57.47 105.13	20656	61	2457	I7	HV HH
5	11.02.2006 03:09	11.02.2006 03:10	56.59 104.88	20656	61	2475	I7	HV HH
6	11.02.2006 03:10	11.02.2006 03:10	55.7 104.63	20656	61	2493	I7	HV HH
7	14.02.2006 03:15	14.02.2006 03:15	56.59 103.45	20699	104	2475	I7	HV HH
8	14.02.2006 03:15	14.02.2006 03:16	55.7 103.2	20699	104	2493	I7	HV HH
9	27.02.2006 03:07	27.02.2006 03:07	56.59 105.6	20885	290	2475	I7	HV HH
10	27.02.2006 03:07	27.02.2006 03:07	55.7 105.35	20885	290	2493	I7	HV HH
11	02.03.2006 03:12	02.03.2006 03:13	56.59 104.16	20928	333	2475	I7	HV HH
12	05.03.2006 03:18	05.03.2006 03:19	55.7 102.48	20971	376	2493	I7	HV HH
13	14.03.2006 03:35	14.03.2006 03:35	57.16 98.59	21100	4	2457	I7	HV HH

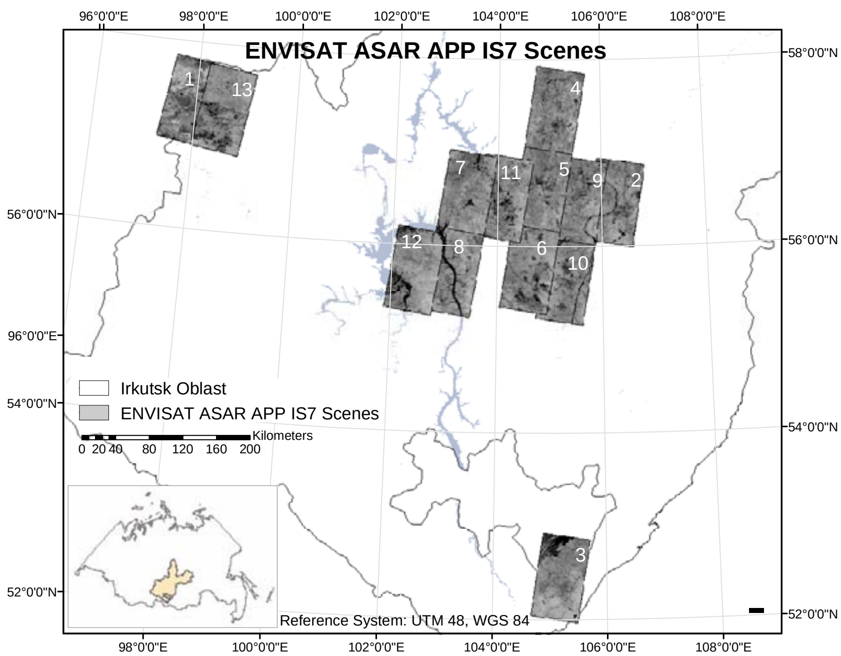

Figure 12: Ortho-Image Mosaic ENVISAT ASAR APP IS7 22.01.2006 – 14.03.2006, Irkutsk Region.

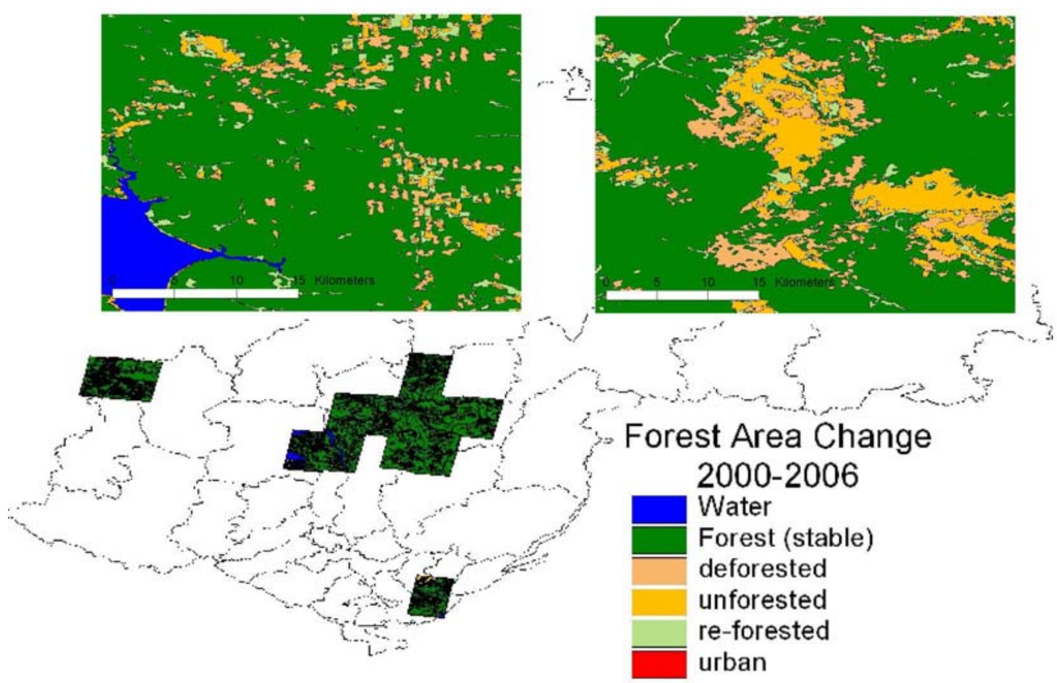

Figure 13: Forest Area Change Map 2000-2006. Top left: clearcut pattern, top right: burnt areas.

Figure 13 shows the Forest Area Change Map 2000-2006 which is based on the Landsat ETM 7 Mosaic classification 2000-2002 and the ENVISAT ASAR APP IS7 classification. It has to be mentioned that most of the change areas from 'Unforested Area' to 'Re-Forest' (light green) depend on the better detectability of roads, pipelines and smaller clear cuts in Landsat ETM 7 scenes. Especially the detection of roads and pipelines in ASAR scenes depend on the view direction of the sensor and the extension of the object and are therefore not always observable in the SAR data. In some cases, old clear cuts visible in Landsat ETM 7 scenes feature already enough biomass or young forest stands in ASAR APP IS7 scenes that the backscatter signal reaches higher dB values than bare soil or fresh clear cuts and are therefore classified as 'Forest' in the SAR data.

Remote sensing data search was also carried out for acquisitions from Resurs, Okean, Meteor and Monitor satellites. Additional images were obtained from Roskosmos archives. Unsupervised classification was carried out and forest/non-forest mask has been derived for two fragments (165 km^2 and 10 km^2) from the following data sets:

- Meteor-3M (MSU-E) image, 10.07.2002
- Monitor-E (RDSA) image 20.07.2006,
- Monitor-E (RDSA) image 30.07.2006,
- Resurs-DK (pan) image 10.09.2006.

A delay for the deliverable results from bureaucracy tasks (export control commission). The partner hopes to adjust all documents in two weeks.

Deliverable⇒	**D.2.3.CCD: Clear Cut Delineation**
Instrument/Product:	Meteor-3M, Monitor-E, Resurs-DK
Time coverage:	10.07.2002; 20.07.2006; 30.07.2006; 10.09.2006
Map coverage:	Zima and Bratsk districts
Source:	NTsOMZ
Comment:	not yet delivered

Night-Time-Lights and Gas Flaring Estimates

Version 2 DMSP (Defense Meteorological Satellites Program)- Night-Time-Lights Time Series from 1992 to 2003 contains the lights from cities, towns, and other sites with persistent lighting, including gas flares. Data can be used for the estimation of increasing/decreasing human activities in the Irkutsk region (Fig. 14, top). Global Gas Flaring Estimates (Fig. 14) based on DMSP observations are available from 1992 through 2005. Gas flaring is a practice for the disposal of natural gas in mineral oil producing areas where there is no infrastructure to make use of the gas.

The Night-Time-Lights files are cloud-free composites made using all the available archived DMSP smooth resolution data for calendar years. In cases where two satellites were collecting data - two composites were produced. The products are 30 arc second grids, spanning -180 to 180 degrees longitude and -65 to 65 degrees latitude. Gas Flaring Estimates are polygon vectors in shape format.

Deliverable⇒	**D.2.2.NTL: DMSP persistent lighting including gas flaring estimates**
Instrument/Product:	DMSP
Time coverage:	1992 – 2003
Map coverage:	area-wide, gridded product (0.0083° x 0.0083°)
Source:	NOAA's National Geophysical Data Center http://www.ngdc.noaa.gov/dmsp/tar_zip.html http://www.ngdc.noaa.gov/dmsp/interest/flares.php?roi=Russia_not_KM
Credits:	US Air Force Weather Agency
Comment:	Vector, Shape-file for Irkutsk region; ready for IRIS-DB integration

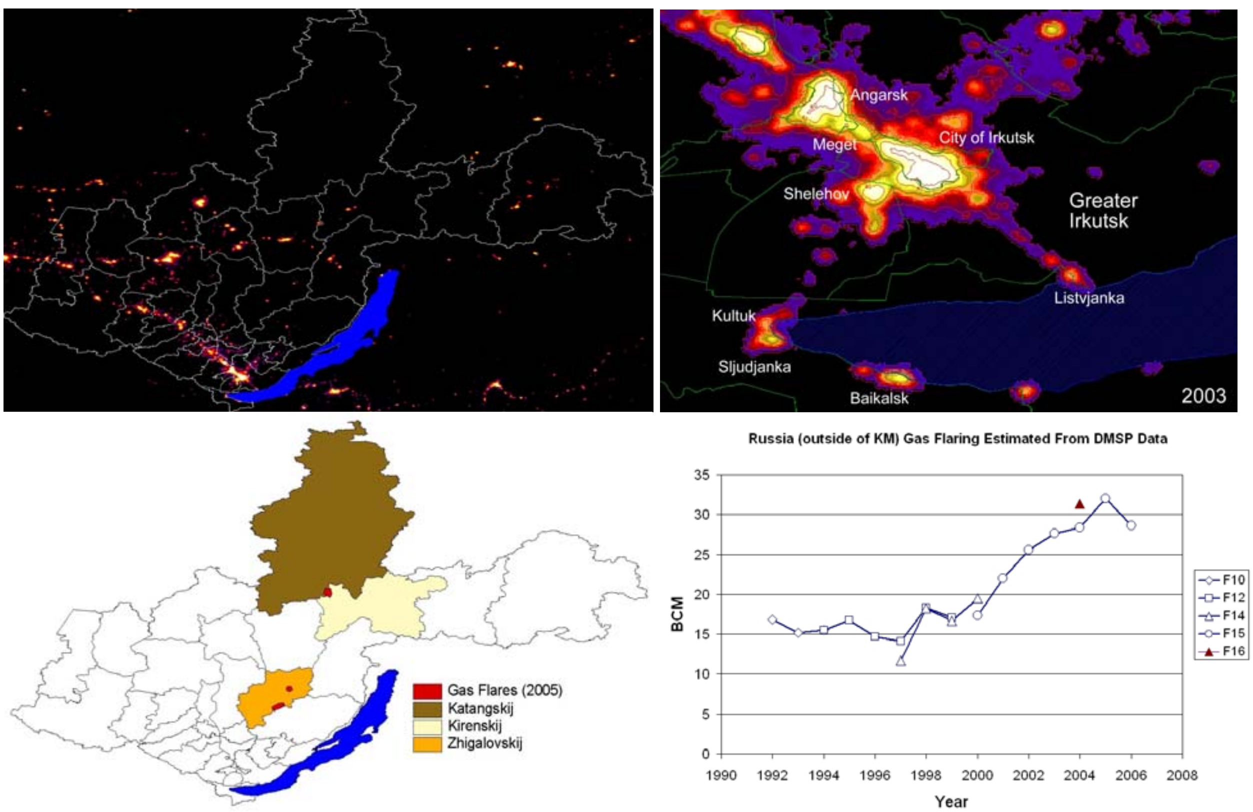

Figure 14: Stable lights 2003 for Irkutsk region (top left) and for the Greater Irkutsk (top right) as well as three Gas Flares detected for districts Kirenskij and Zhigalovskij (Kovykta Gas Condensate Deposit). Down right: Increase of Gas Flares over Russia (Source: http://www.ngdc.noaa.gov)

SRTM3 Topography and Water bodies

SRTM data are distributed in two levels: SRTM3 sampled at three arc-seconds. Three arc-second data (~90 meters) are generated by three by three averaging of the one arc-second SRTM1 samples (~30 meters). Data are divided into one by one degree latitude and longitude tiles in geographic projection. SRTM3 files contain 1201 lines and 1201 samples. The SRTM Water Body data are a by-product of the data. Ocean, lake and river shorelines were identified and delineated. First order derivates such as slope and aspect have been calculated. The product inhere is the GTOPO30 model (Fig.15). The original SRTM3 data tiles for Irkutsk region are listed and are available on IRIS' FTP-site. Data comprise 93 files (623 MB zipped). The analysis of SRTM elevation and slope data gives further evidence for a strong influence of terrain relief to the trends.

Deliverable⇒	**D.2.2.SRTM: Digital Terrain Elevation data and derivates, Water Bodies**
Instrument/Product:	SRTM C-Band SAR
Time coverage:	2000
Map coverage:	area-wide, gridded product (0.0083° x 0.0083°)
Source:	NASA ftp://e0srp01u.ecs.nasa.gov/srtm/version2/
Credits:	NASA
Comment:	Grid and Vector for Irkutsk region; ready for IRIS-DB integration

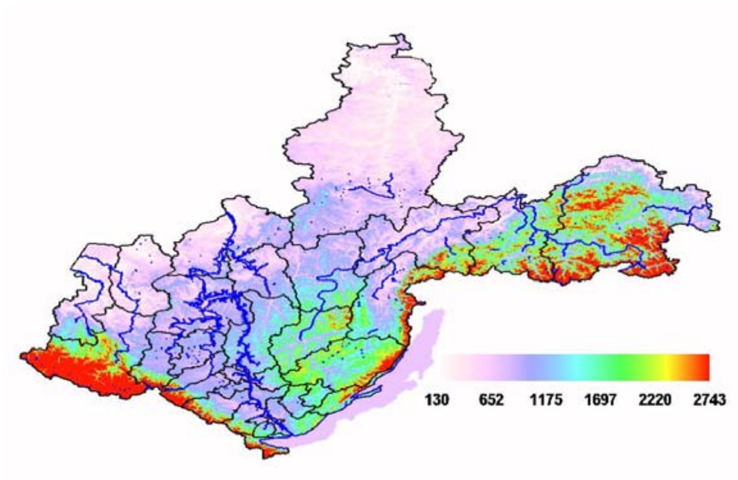

Figure 15: GTOPO30 Digital height model (meters) and water body data for Irkutsk Region.

Work Package 3000

Objectives

- **To assess the current and historical man-made changes and negative impacts arising from pollution sources and other anthropogenic drivers located in the Irkutsk region and in adjacent areas.**
- **To gather information on actual and potential sources of pollution in the region under study and in the proximity of its border**

WP 3100 comprises an assessment of current man-made changes and stress sources in the Irkutsk region. It includes the collection of data on current major pollution sources and other negative anthropogenic drivers in the region under study and in the proximity of its border from literature, maps and other open public sources, as well as from expert judgements of leading regional ecologists and economists. One task comprises the processing of satellite remote sensing data to reveal the man-made changes as well as zones affected by negative impacts (see ⇒D.2.2AI, ⇒D.2.2.OZ and ⇒D.2.2.LST). The assessment of impact of catastrophic disturbances (in particular, fire) on environmental and human health has already been carried out in ⇒D.2.3.Fire. Unification of collected information to be put in as additional layers of the developing GIS has also been performed.

Progress towards objectives

In parallel with the previous workpackage, implementation of **Workpackage 3000** has been performed. During the first nine months of IRIS the current man-made changes and pollution sources in the Irkutsk region were assessed (WP 3100). The hypotheses on major potential pollution sources has also formed and carefully checked (WP 3200). The Technical report on man-made changes and impact of pollution (present and potential) on forest (⇒ D.3.3) has not been submitted yet by the responsible partner. **A delay for the deliverable results from bureaucracy tasks (reorganisation of the institute). The partner hopes to adjust all documents in two weeks.** The deliverable will contain the following reports:

(1) The history of the industrial development of the Irkutsk province;
(2) The history of the impact on the environment, specifics of the Irkutsk Province, as of the economic region;
(3) The recreational territories of Irkutsk province;
(4) The analysis of the comfort level of life of the population in the territories of Irkutsk province.

Deliverables

⇒ **Deliverable 3.1.: Dataset on pollution sources in the region under study**
- ⇒ D.3.1.POLLUTION-tables.rar
- ⇒ D.3.1.ENV-IMPACT-maps.rar
- ⇒ D.3.1.ENV-IMPACT-maps.pdf

⇒ **Deliverable 3.2.: Dataset on other stress factors in the region under study**

⇒ Deliverable 3.3.: Technical report on man-made changes and impact of pollution (present and potential) on forest.

Sanitary-epidemiologic conditions

⇒ **D.3.2.IDC:** Sanitary-epidemiologic conditions in cities of the province and impacts of ecological factors on health of the population in 2002 and 2003.

Territory and group of territories
Disease
Group of the Population
The reason (source)

- impact of chlorine, chlorine byproducts, tetraethyl lead (production)
- severe climatic conditions, unsatisfactory quality of the potable water, significant presence in the bowels of the rare elements, including gold, which create the increased radiation background
- closeness of the industrial enterprises, deficiency of the quality of the potable water, aggravation of problems of social character due to the agricultural economy
- negative development of conditions of life in the Northern areas
- anthropogenous load, which results is significant deterioration of ecological state due to the harmful emissions in the atmosphere and polluted drains into the water reservoirs, and soils' saturation with toxic substances, which fall down with atmospheric sediments and thawed snow
- the aluminium and chemical industries, thermal power stations
- the consumption of drugs intravenously, a sexual way, a vertical way
- influence of cultural and natural factors, high fluoric load. Ways of its entry: respiratory, food stuffs and water.

Indicator of the disease per 100 thousand of the population
Scale of the distribution, number of people
Changes in comparison with 2001/2002
Units

Birth and Death Rates, Migration

⇒ **D.3.2.IDC:** Indicators of the Birth and Death Rates in Irkutsk Province's Territories for 2001-2005 (Number of born and dead per 1000 persons and territory)

⇒ **D.3.2.IDC:** Indicators of the dynamics of the natural migration of the population of Irkutsk province and of the Russian Federation since 2000 till 2004.

⇒ **D.3.2.IDC:** Indicators of the infantile death rate in Irkutsk province's territories since 2001 till 2005.

⇒ **D.3.2.IDC:** Indicators of diseases of the population of Irkutsk province for years 2003-2005 (per 100 thousand people)

⇒ **D.3.2.IDC:** Comparison of diseases indicators of all the population of Irkutsk province and of the Russian Federation for year 2004.

⇒ **D.3.2.IDC:** Groups of the municipal Entities by the level of poverty based on the complex index of the territory's development

Table 3: Groups of the municipal Entities by the level of poverty based on the complex index of the territory's development

Good standing municipalities and districts (group I)	Relatively good standing municipalities and districts (group II)	Relatively bad standing municipalities and districts (group III)	Bad standing municipalities and districts (group IV)
 Angarsk[1)] **Bratsk** **Shelekhov** [1)] **Sayansk**	**Irkutsk** **Taishet** **Tulun** **Usolye-Sibirskoye** **Ust'-Ilimsk** **Ust'-Kut** (23)[1)] **Cheremkhovo** Ziminsky district (7) Kazachinsko-Lensky district (9) Nizhneilimsky district (15) Sludyansky district (18) Taishetsky district (19)	**Bodaibo** (4)[1)] **Zima** **Nigneudinsk** Bratsky district (3) Balagansky district (2) Zhigalovsky district (5) Tulunsky district (20) Kirensky district (12) Kuitunsky district (13) Mamsko-Chuisky district (14) Nizhneudinsky district (16) Ust'-Ilimsky district (22) Cheremkhovsky district (25) Chunsky district (26) Zalarinsky district (6) Irkutsky district (8) Usolsky district (21)	Katangsky district (10) Olkhonsky district (17) Ust'-Udinsky district (24) Kachugsky district (11)

[1)] The municipal entity includes an administrative district and cognominal area centers

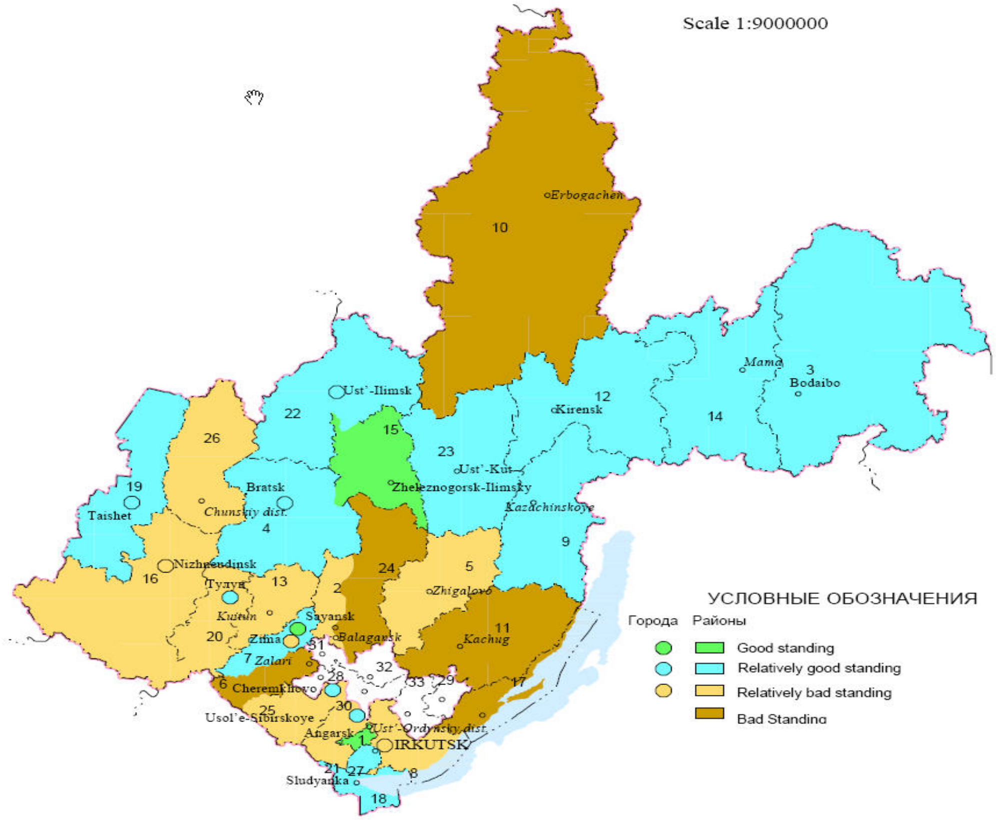

Figure 16: Groups of the municipal entities by the level of poverty based on the complex index of the territory's development.

Work Package 4000

Objectives

- **To assemble available open data sources for IRIS GIS**
- **To develop easy-to-use IRIS GIS interface for use by policy makers, scientists and the public**

Progress towards objectives

⇒ Further development of the thematically and technically concepts of the Information System

Requirements analysis

Requirements analysis is an important part of the GIS system design process, whereby GIS engineers identify the needs or requirements of the users/clients. Once user requirements have been identified, the system designer is then in a position to design a solution. Through close links we will employ Irkutsk's administration and the Irkutsk Science Center to establish the exact requirements of the users, so that a system that meets the needs is produced. Summarized, requirements analysis is the task of communicating with users to determine what their exact requirements concerning the IRIS-GIS are. Thus, the involvement of the IRIS user community is the most challenging objective and remains an ongoing.

Contributions to standards

One of essential components of IRIS will be an Open Source GIS system. Open Source technology is a growing field that encourages the free sharing of software, codes and services. The goal of the Open Geospatial Consortium (OGC) is to promote standard open software interfaces called OpenGIS. These interfaces will enable geoprocessing so that different geospatial systems are able to communicate with each other. The use of common languages such as XML or GML enables easy integration between systems. OpenGIS supports the easy retrieval of geospatial information in a distributed environment, regardless of physical location of the data. These distributed datasets can then be combined and rendered for display.

WebGIS technology

The IRIS Service will be implemented as 3-tier architecture (Fig. 17) with (1) database server or simple file server, (2) application server and (3) internet browser. In our case, (1) PostgreSQL, the SQL compliant, open source object-relational database management system with the PostGIS extension and (2) Geoserver or Mapbender Client Suite as Mapserver. PostGIS follows the Simple Features for SQL specification from the Open Geospatial Consortium.

The Geoserver can act as a thin, portable, OpenGIS-compliant web services layer on top of existing data sources (even simple file directories). Geoserver supports open protocols from the OGC to produce KML/KMZ, GML, Shapefiles and more (http://docs.codehaus.org/display/GEOS/Home). In the first stage, Geoserver will act as IRIS Open Web Service to make IRIS results (metadata and vector layers) available for Internet browsers.

The second and final stage brings GIS functionalities on the Web. It is in discussion that the Mapbender Client Suite as a framework for managing spatial data services will be implemented as IRIS Online-GIS. Mapbender provides interfaces not only for displaying and navigating but also for querying OGC Open Web

Services. Moreover, Mapbender provides interfaces for user and group administration and management functionality for maps displayed and data served by OGC Open Web Services.

Mapbender software seems to be optimal for the realization of the IRIS Online-GIS, because it covers the following topics (http://www.mapbender.org):

- Web-GIS Client (OGC WMS, WFS, Catalog Service Client)
- Geo-CMS (Content Management System)
- Web-based Digitizing/Editing Functionality (OGC WSF-T Client)
- Security Management (Authentification, Authorization)
- Accounting Management (Logging)
- Spatial Web Services Orchestrating

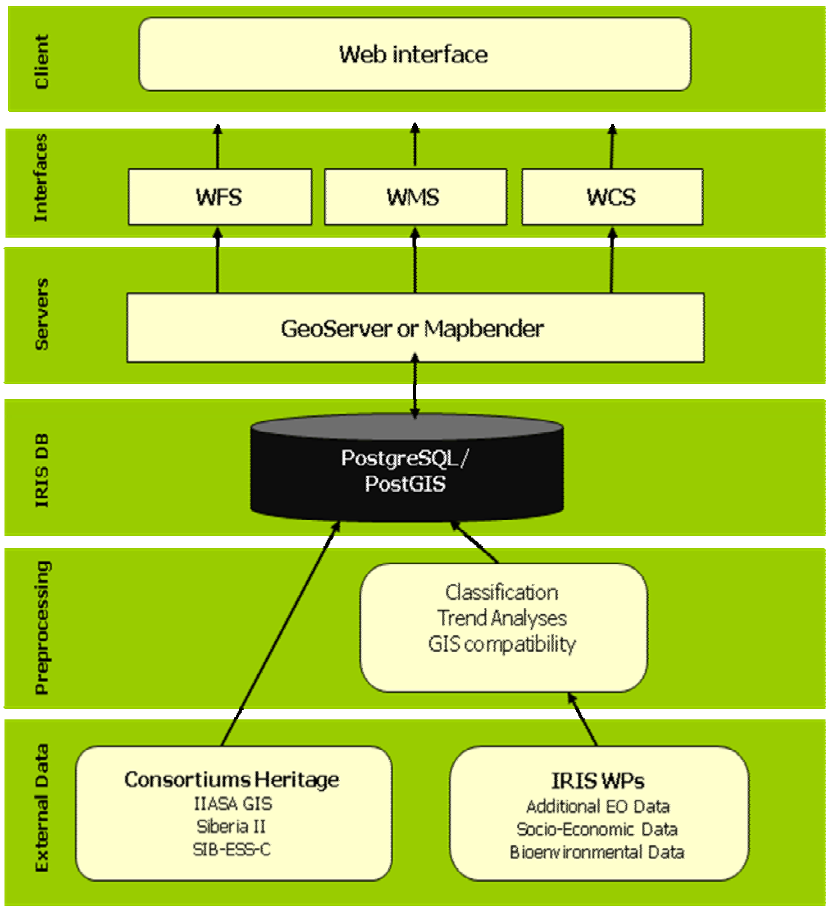

Figure 17: Concept of bringing data and GIS functionalities to the web.

Computer supported cooperative work

The Communication Platform, that is online serves as the basis for computer supported cooperative work. – 'The more people who use the platform, the more valuable it becomes.' - We implemented MediaWiki, a free and open source software that is used to organize and facilitate collaborative work. Due to the strong emphasis on multilinguality in the Wikimedia projects, internationalization has received significant attention by developers. The user interface has been fully or partially translated into more than 70 languages (http://www.mediawiki.org).

Section 3 – Consortium management and coordination

Consortium management tasks

After reorganization, partner NTsOMZ is now the department of Scientific and Technological Center for Earth Space Monitoring" (NTTs KMZ), branch of the Federal State Unitary Enterprise "Russian Institute of Space Device Engineering" (FSUE "RISDE").
Administrative coordination included the task of preliminary payment. Due to reorganisation Partner No. 5, the Irkutsk Science Center is not able to open its own bank account. To ensure that the money will be transferred to the eligible partner, the coordinator is in close contact with the Financial Project Manager at the EC to find a feasible way.

Comments regarding contributions

As defined in the work plan, each partner has well defined responsibilities within the project. Deliverables have to be submitted in time. To monitor the progress of the work packages and to check it regularly against the work plan, the coordinator is using modern communication technology for the communication between the different partners. Teleconferences at regular intervals using voice-over-IP technologies are held with Russian partners in Irkutsk, Moscow and St. Petersburg. Nevertheless a delay for the deliverables results from bureaucracy tasks (reorganisation of the institute, export control commission).

Co-ordination activities in the period

In order to disseminate the results of the study carried out in the framework of the project, the following actions are foreseen:

(1) strengthen communication between partners by teleconferences and the 3rd IRIS meeting, organized for the 25-26th of May at NIERSC, St.Petersburg;

(2) developing an IRIS dissemination database on science and economy, on national as well as international level.

The dissemination of IRIS activities will be strengthened with the upcoming IRIS web services. A first step towards the Online-Service, the communication platform (called IrisWiki) helps partners to quickly find and view information and applications relevant to their roles and responsibilities (English and Russian language). With this platform, partners can make more information available to partners and the public on a "pull" basis. IrisWiki serves as a powerful tool for communication within the project, for developer issues and even more important, for the collection of user requirements. The IrisWiki is documenting GIS-developments, specifications and discussions of standards in an ongoing process. IRISWiki is hosted at: http://www.iris.uni-jena.de/iriswiki/index.php .

Project Meetings

- Kick-off meeting July 7-8 2006, organized by FSU and the ORESP team of the ISC
- 2nd IRIS meeting is planned to be held in May 2007 at NIERSC, St. Petersburg, Russia or at Vienna, Austria.
- 3rd IRIS meeting is organized for the 25-26th of May at NIERSC, St.Petersburg, Russia

Section 4 – Other issues

Working Notes

(http://www.iris.uni-jena.de/sites/download.html)

- Integration of GoogleEarth high-res imagery
- Atmospheric Data and Information Services
- GE Quickbird coverage vs Forest Inventory and VCF
- Evaluation of DMSP Night-Time-Lights and Gas Flaring Estimates
- Evaluation of the MOD11C3 CMG (Land Surface Temperature) product

Presentations and Conference Proceedings

(http://www.iris.uni-jena.de/sites/download.html)

2nd Mongolian International Conference on Land cover/Land use *study* & ***GOFC-GOLD*** Workshop
Frotscher, K. & C.C. Schmullius (2006): Projects and Initiatives addressing Environmental Impact Studies in Northern Mongolia and the Lake Baikal Region. 2nd International Conference on Land cover/Land use study using Remote Sensing and Geographic Information System, Ulaanbaatar, Mongolia, 8-9 June 2006.

ENVIROMIS 2006
Frotscher, K. & C. Thiel (2006): Forest Monitoring in the Framework of a Regional Information System for Environmental Protection. ENVIROMIS Conference, Tomsk, Russia, 1-8 July 2006.

SIB-ESS-C Symposium, 18th-20th September 2006, University of Leicester, UK, Environmental change in Siberia - Insights from Earth Observation and modelling.

SibFORD Kick-Off, 09-10 February 2007, Potsdam, Germany

ENVISAT Symposium 2007, 23-27 April, Montreux, Switzerland:
Frotscher, K, Thiel, C. & C.C Schmullius (2007):
The Irkutsk Regional Information System for Environmental Protection (IRIS). ENVISAT SYMPOSIUM, Montreux, Switzerland 23-27 April 2007.

Planned:

IPY GeoNorth 2007
Frotscher, K., Lipnyagova, R.R., Dumov, V., & Schmullius, C.C (2007):
The Irkutsk Regional Information System for Environmental Protection (IRIS). IPY GeoNorth 2007 First International Circumpolar Conference on Geospatial Sciences and Applications Yellowknife, Northwest Territories, Canada 19-24 August 2007. (Abstract has been accepted.)