

# Report from the Regional GOFC-GOLD/NERIN Workshop

## **NELDA Project:**

### **Validation of Land Cover Maps and Future Expansion of Test Site Network**

*(Проект NELDA: Валидация карт растительного покрова и расширение сети тестовых участков)*

**July 8, 2006, Tomsk, Russia**

at the International Conference on Environmental Observations, Modeling and Information Systems ENVIROMIS-2006, 1-8 July 2006 ( <http://www.scert.ru/en/conferences/enviromis2006/>)

*Prepared by Olga N. Krankina, Oregon State University*

*on behalf of workshop participants*

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## Executive Summary

The Regional GOFC-GOLD/NERIN Workshop “NELDA Project: Validation of Land Cover Maps and Future Expansion of Test Site Network” was held on July 8, 2006 in Tomsk, Russia as part of the International Conference on Environmental Observations, Modeling and Information Systems ENVIROMIS-2006 (1-8 July 2006, <http://www.scert.ru/en/conferences/enviromis2006/> ). Northern Eurasia Land Dynamics Analysis (NELDA) project is designed to develop tools, methods, data, and collaborations needed to better characterize land-cover dynamics across the Northern Eurasia region. The project seeks to balance the priorities of continental and global scale mapping with local monitoring needs, and to capitalize on completed studies by team members.

The workshop brought together 44 participants from different regions of Russia, and also from Germany, USA, Uzbekistan, Ukraine, and Kyrgyzstan. The representatives of research teams participating in NELDA, scientists interested in joining the network of validation sites, representatives of research programs, and students with interest in collaborative work on remote sensing of land cover were among the participants. The workshop agenda included an overview of GOFC-GOLD Northern Eurasia Regional Information Network (NERIN, <http://www.fao.org/gtos/gofc-gold/net-NERIN.html>), presentations on validation of coarse resolution land cover products at NELDA test sites, discussion of plans for expanding the network of validation sites, and assessment of specific needs for monitoring land-cover change in West Siberia region and at other sites. The full set of presentations is available for review and download at <http://nerin.scert.ru/docs/NELDA-Workshop-2006/>. The general discussion focused on the draft of the LCCS-compatible legend for land cover classification at NELDA sites and on NELDA’s place within GOFC-GOLD framework and in the constellation of international programs for monitoring land cover change and other related processes.

The presentations and discussions at the workshop showed that:

- Significant progress was made in expanding the use of remotely sensed data in Northern Eurasia and NERIN workshops were effective in facilitating this progress. Further development of NERIN requires maintaining and expanding the ongoing network projects and development of new projects.
- Several additional teams are interested in joining the NELDA network of test sites; some can build on significant prior research investment.
- Future NERIN workshops should focus on methods available for land-cover change detection, validation of land cover and land-cover change products, and development of interdisciplinary research that builds on improved monitoring of land cover.
- Successful future development of land-cover mapping and use of remotely sensed data in the region depends on coordination among the various agencies and programs.

Based on these conclusions a set of follow-up activities was initiated including the development of funding proposals to support additional test sites, meetings to create a framework for improved international coordination of remote sensing and integrated research in the region, planning the next NERIN workshop “Methods for Detection and Validation of Landcover Change” at the Open All-Russia Conference on Remote Sensing Nov. 13-17, 2006 hosted by the Space Research Institute of the Russian Academy of Sciences in Moscow ([http://www.iki.rssi.ru/d33\\_2006.htm](http://www.iki.rssi.ru/d33_2006.htm) )

The workshop in Tomsk was hosted by SCERT (<http://www.scert.ru/en/> ) with travel support for participants provided by START.

## BACKGROUND

Global Observation of Forest and Land Cover Dynamics (GOF-C-GOLD <http://www.fao.org/gtos/gofc-gold/index.html>) is a coordinated international effort working to provide ongoing space-based and *in-situ* observations of forests and other vegetation cover for the sustainable management of terrestrial resources and to obtain an accurate, reliable, quantitative understanding of the terrestrial carbon budget. Regional networks are an integral part of GOF-C-GOLD; they promote sharing resources and expertise and perform an essential crosscutting role in the implementation of GOF-C-GOLD's thematic components – Land Cover and Fire. The regional networks provide a forum for users and researchers operating in (or with an interest in) a common geographic area, and represent a link between national agencies, regional user groups, and the global user/producer community.

Given the importance of Northern Eurasia for global ecosystem and climate processes, improved characterization of land cover and land-cover change in the region is a scientific priority. This region is the largest landmass in the extratropics, the largest terrestrial reservoir of organic carbon, an area of active land use changes and socio-economic transformations, and a major source of uncertainty in many global-scale estimates. GOF-C-GOLD convened a series of workshops in Northern Eurasia with the overall objective to improve the observations of forest cover and land dynamics (see workshop summaries at <http://www.fao.org/gtos/gofc-gold/series.html>). These workshops underscored the need for improved validation of data products with ground measurements and the importance of educating and engaging the user community, particularly in Russia and other countries of the Former Soviet Union. To address this need the Northern Eurasia Regional Information Network (NERIN, <http://www.fao.org/gtos/gofc-gold/net-NERIN.html>, <http://nerin.scert.ru/>) was initiated. Recent activities included the inventory of available datasets using a web-based METADATA form (<http://wwwdata.forestry.oregonstate.edu/MDEDIT/index.aspx> in English and <http://nerin.scert.ru/MDEDIT/index.aspx> in Russian; 180 datasets as of March 2006) and assessment of available data at the recent workshop (“Observations of Land Cover and Needs of Research Projects in Northern Eurasia”, June 18-19, 2005, St. Petersburg, Russia). Currently NERIN network is positioned to move beyond the information exchange and assessment of data availability towards developing a system for continuous land-cover monitoring that would meet the needs of users in the region and the global change science community. Active network projects are needed as a basis for building an operational land-cover monitoring system. The on-going fire-validation project works on comparing and validating the moderate resolution active fire and burned area products with high resolution remotely sensed and *in-situ* data.

The new activity for GOF-C-GOLD Land Cover Theme is the Northern Eurasia Land Dynamics Analysis (NELDA) project. NELDA is designed to develop tools, methods, data, and collaborations needed to better characterize land-cover dynamics across the Northern Eurasia region. Building on recent and ongoing projects, NELDA links together several research teams to establish a set of test sites for land cover analysis in the region (Figure 1), use these sites to validate global and regional land cover and land-cover change products, develop new methods for continental mapping of vegetation disturbance, assess the continental-scale patterns of vegetation recovery following different types of disturbance, evaluate the utility of available products to meet the regional and local needs, and define the requirements for new land cover products. The project seeks to balance the priorities of continental and global scale mapping with local monitoring needs, and to capitalize on completed studies by team members. Ultimately, the project results will inform the development of operational land cover monitoring across the region. The team includes scientists from 6 different

research centers in Northern Eurasia and 5 organizations in the U.S. (Oregon State University; Goddard Space Flight Center; Boston University; University of Maryland, USDA Forest Service). While funding constraints limited the number of test sites and the scope of work proposed for Phase I (Figure 1), at the recent NERIN Workshop (June 18-19, St. Petersburg, Russia) several additional teams active in the Northern Eurasia region expressed interest in NELDA activities.

The workshop in Tomsk was planned to bring together representatives of research teams participating in NELDA, those interested in joining the network of validation sites, and local science and application community with interest in remote sensing of land cover. The agenda (Appendix 1) was designed to introduce the participants to GOFCC-GOLD, NEESPI program, NERIN network, NELDA project, and plans for individual test sites, to assess of specific needs for monitoring land-cover change in West Siberia region and at other validation sites, and to explore potential for additional collaborations in the region. The workshop was open to all interested participants of ENVIROMIS-2006 conference (<http://www.scert.ru/en/conferences/enviromis2006/>) organized by Dr. E. P. Gordov of SCERT (the Siberian Center for Environmental Research and training / Institute for Monitoring of Climatic and Ecological Systems of the Siberian Branch of the Russian Academy of Sciences, Tomsk, Russia [gordov@scert.ru](mailto:gordov@scert.ru)). The conference organizers provided logistical support, workshop venue, equipment for presentations, 2 coffee breaks, and copies of workshop agenda and presentation abstracts. The workshop was attended by 43 participants (Appendix 2) from different regions of Russia, and also from Germany, USA, Uzbekistan, Ukraine, and Kyrgyzstan. Travel support for 6 workshop participants was provided by START (<http://www.start.org/index.html>).

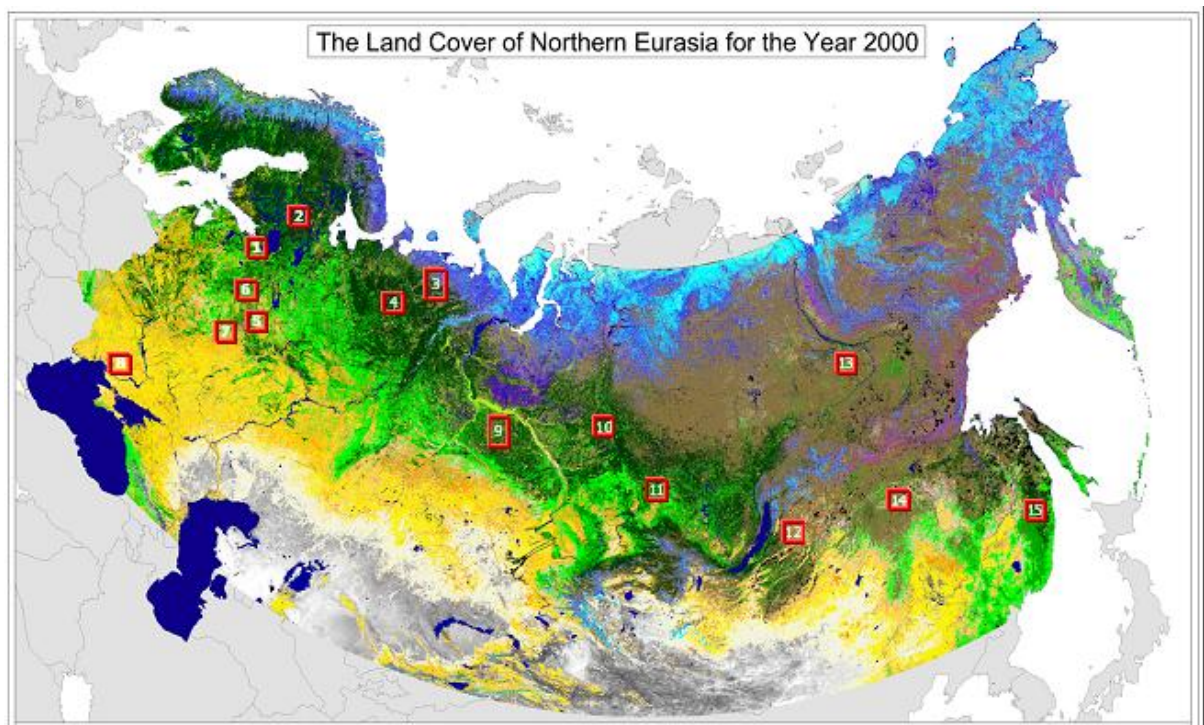


Figure 1. Location of NELDA test sites (Map was created at EC JRC as part of GLC 2000 project, Bartalev et al. 2003).

## OVERVIEW OF PRESENTATIONS AND DISCUSSIONS

The workshop focused on achieving three primary goals:

- 1) review the progress at the currently included NELDA test sites;
- 2) evaluate new potential sites for expansion of NELDA activities;
- 3) discuss the first draft of the LCCS-compatible legend for land cover classification at NELDA sites and MODIS-based land cover classification for Northern Eurasia.

Additionally, NELDA's place within GOFD-GOLD framework and in the constellation of international programs for monitoring land cover change and other related processes was discussed.

The **presentations of the current project participants** have shown a considerable variety in land-cover types and change processes at NELDA sites. All presented sites have identified their location and sources of ground data, evaluated the processes driving land cover change in these areas, started acquiring high resolution data for long-term land cover monitoring, and researched the opportunities for substituting Landsat 7/ETM+ data with high resolution data of similar quality from other sensors for further land cover change assessment. The major possible sources of post May 2003 high resolution data were identified as: 1) the mid-decadal data collection from Landsat 5 and Landsat 7 (NASA HQ and USGS) which should become available ~ 2007-2008; 2) IRS and SPOT-VEGETATION imagery collected by SCANEX; 3) ASTER imagery available to PIs of NASA funded projects.

The major types of land-cover change to be examined at NELDA sites include timber harvest, fire, insect outbreaks, successional change in species composition, and forest and shrub regrowth on agricultural lands and on disturbed forest lands. Several processes slowing down the re-establishment of pre-disturbance conditions at the selected test sites. Marsh formation and frequent spring grass fires are found to support the establishment of birch-dominated early successional forests and thus delay the formation of dark coniferous primary forests in Siberia. Additionally, wildland fire activity within forests previously damaged by pest infestation has shown that around 30% of forests damaged by pest infestation can be expected to be severely burned. The time frame for vegetation regrowth unaffected by other processes (fire, marsh development, replanting) is approximately defined as: 1) establishment of birch dominated stands 5-7 years after the disturbance; 2) coniferous stands ~130 years after the disturbance. This general trend remains very similar within large areas in Siberia with certain variations along north-south stretch.

Several potential **new test sites** were presented. These sites cover some of the land cover and change types previously not included in the network of test-sites. Additionally, the inclusion of these test sites would allow for expanding the network of participating institutions and increase the use of remotely sensed data in the region. The first presented test site is found in the northern part of Western Siberia. Its inclusion would allow for monitoring the rapid change of processes involved in permafrost-related development of peatlands and associated processes of lake formation and drainage and formation of bulges with lichen cover. The second proposed site is found in desert conditions and will allow for long-term monitoring of desertification of lands around the Aral sea. The third proposed site is found in the Volga region where the primary impact on vegetation is caused by logging, both legal and illegal; there is also vegetation degradation due to excessive recreational use, as well as fires and impact of insects and diseases on forests.

First draft of **LCCS-compatible legend** has been developed by the Boston University team. Although the legend has classes which could be generally used for global mapping, this legend is developed specifically for creating the new MODIS-based land cover map for Northern Eurasia and its validation at test sites. The legend was discussed and generally found reasonable with considerable additions and modifications suggested. The participants were unanimous in emphasizing the need for peatland/wetland land cover type(s) within this classification. For example, depending on the definition peatland will occupy 60% or more of the West Siberia test site. However, the number of necessary peatland classes has not been decided upon at the workshop. The majority of participants have agreed that at least 3 classes of peatlands should be distinguished and mapped. Olga Krankina (and Mike Wolter) has been tasked by the GOFCC/GOLD community to develop suggestions for including wetlands/peatlands in LCCS compatible land cover legend and changes to NELDA legend should follow. It was noted that the shrub classification is too detailed for Northern Eurasia and will be difficult to support with ground data. It was suggested that all shrubs should be clustered into one category - "shrubs", possibly with deciduous/evergreen distinction but for virtually all shrubs in the region are deciduous. It was also suggested that the agricultural category should be subdivided into "croplands" and "pasture" and that "pasture" should then be grouped with "grasslands". The extent of grassland use for pastures is often difficult to ascertain. The question of hay lot designation as pastures or as grasslands was asked. The presented land cover legend also fails to account for forest disturbances leading to considerable forest mortality. Therefore a "dead forest" class should be added to the legend to map forests with >50% dead trees (due to fire, pest outbreaks, etc.). There was considerable confusion regarding the ability of mapping soil moisture. However, since this is a supplementary parameter it is not required for all test sites.

The discussion of the mapping process at medium to coarse resolution showed the need for additional review of MODIS classification approach within the NELDA team. A variety of classification approaches were developed or used by NELDA participants. The participants are encouraged to share their approaches with each other and to select any approaches they are comfortable with as long as they provide acceptable accuracy.

Climate modeling community raised an issue of the necessity of dynamic land cover mapping at coarse scale (climate modeling grid). They noted the lack of such data necessary for vegetation and climate modeling. Although important, this issue is outside the scope of the NELDA project at this time. However, in addition to the static land cover map, yearly maps of land cover change are planned within the project as well.

Several participants have raised a question of data availability in vector formats. The production of land cover maps is planned to be done in raster format. However, it might be useful to consider that in the future for this and other product distribution purposes.

NELDA efforts should be coordinated with other international projects working within the same geographic area. Various projects have established test sites in Siberia (e.g. Siberia II has a number of sites in Yakutia) which can be used for independent validation of the MODIS land cover change map if the NELDA sites are used for the algorithm development. Additionally, there is a need for a broader scale programmatic coordination between NELDA activities, NEESPI, European programs and multiple other activities. In particular, the program will benefit from official collaboration with SIRS program (a new initiative for an integrated study in Siberia) and particularly VALERI

([http://lpvs.gsfc.nasa.gov/lai\\_intercomp.php](http://lpvs.gsfc.nasa.gov/lai_intercomp.php)). A meeting for discuss this collaboration could be tentatively set up for the ESSP meeting in Beijing (November 2006). One of the potential ways to organize the work of these programs is to make SIRS a regional part of NEESPI program, there is also a possibility to invite SIRS participants to NELDA workshops and visa versa.

Finally, NELDA should aim at closer collaboration with other studies and directions within Earth System Science community by bringing in a comprehensive view of land cover change and its contribution to hydrological processes, carbon cycle, climatic changes, etc. Although there are existing projects which evaluate these issues, NELDA has a great potential to broaden the scope and improve the understanding of the extent of land cover change in Northern Eurasia and the impact of land-cover distribution and change on a range of ecosystem processes. In terms of future organization of research, ENVIROMIS 2006 & previous workshops showed the urgent need for an overarching, international organization endorsed at the top level to lead an integrated set of studies about Northern Eurasia and especially Siberia which undergoes severe environmental, anthropogenic and climate change.

## CONCLUSIONS AND FOLLOW-UP

Shortly after the workshop a full set of presentations was posted at <http://nerin.scert.ru/docs/NELDA-Workshop-2006/> . The presentations and discussions at the workshop showed that:

1. Over the last few years the significant progress was made in expanding the use of remotely sensed data in Northern Eurasia. NERIN workshops were effective in facilitating information exchange and formation of the community of users. Further development of NERIN will require maintaining and expanding the ongoing network projects (fire monitoring and NELDA) and development of new projects (for example, using improved land cover mapping in hydrological and climate change modeling).
2. There is interest in the region in validation work and in collaborating with NELDA project. Several additional teams could join the network of test sites but additional funding will be needed to engage these groups. For some of them the additional funding could be modest as there is significant prior research investment that can be leveraged.
3. In collaboration with other studies and directions within Earth System Science, NELDA has a great potential to improve the understanding of the impact of land-cover distribution and change on a range of ecosystem processes, including water and energy exchange.
4. Future NERIN workshops should focus on discussion of methods available for land-cover change detection, validation of land cover and land-cover change products, and development of interdisciplinary research that builds on improved monitoring of land cover.
5. Successful future development of land-cover mapping and use of remotely sensed data in the region depends on coordination among the various agencies and programs. Past coordination efforts have achieved great improvements in information exchange among agencies, programs, and projects but greater coordination of research, development, and funding priorities remains a challenge and there is a critical need for an overarching, international organization endorsed at the top level to lead an integrated set of studies about Northern Eurasia.

Based on these conclusions a set of follow-up activities was initiated including:

1. A proposal for funding for one additional NELDA test site was developed and submitted to CRDF (E. Kurbanov and Olga N. Krankina, Principal Investigators). An additional proposal

is under development for possible submission to Asia-Pacific Network in 2007 (E. Gordov, PI; Olga N. Krankina, Tsolmon Renchin, and Galina Stulina, Co-Investigators). A proposal for test-sites in the tundra zone of West Siberia is planned based of prior research by Sergey Kirpotin and Yuri Polischuk.

2. A meeting to discuss international cooperation to lead an integrated set of studies about Northern Eurasia is tentatively set up for the ESSP meeting in Beijing (November 8-12, 2006).
3. The next NERIN workshop “Methods for Detection and Validation of Landcover Change” is planned for November 15-16 as part of Open All-Russia Conference on Remote Sensing Nov. 13-17, 2006 in Moscow at the Space Research Institute of the Russian Academy of Sciences (IKI; [http://www.iki.rssi.ru/d33\\_2006.htm](http://www.iki.rssi.ru/d33_2006.htm) )
4. The next meeting for current participants of NELDA team is planned for February-March 2007, in Corvallis, OR
5. Preliminary planning is underway for LCCS workshop in Tashkent (spring 2007).

## **ACKNOWLEDGEMENTS**

SCERT (the Siberian Center for Environmental Research and training / Institute for Monitoring of Climatic and Ecological Systems of the Siberian Branch of the Russian Academy of Sciences, Tomsk, Russia) provided logistical support, workshop venue, equipment for presentations, 2 coffee breaks, and copies of workshop materials. Travel support for 6 workshop participants was provided by START. We thank Tatiana Loboda of UMD for taking detailed notes during the workshop; these notes serve as a basis for workshop report. We also thank Alexander Titov of SCERT for compiling workshop presentation and promptly posting them on NERIN site.

# ATTACHMENT 1

## WORKSHOP AGENDA

### 9:00 – 10:30 **Session 1: Overview**

Welcome, NERIN and NELDA overview, and workshop plans - O. Krankina (30 min)

NERIN fire component and the challenge of mapping fire scars – T. Loboda (20 min)

Land cover monitoring needs in West Siberia – E. Gordov, V. Krutikov and Yu.Polishchuk (20 min)

Questions to speakers and discussion (20 min)

10:30 – 11:00 Coffee Break

### 11:00 – 12:30 **Session 2. Dynamics of Land-Cover and NELDA Test Sites (Phase 1)**

1. Alexander Maslov – Principal land cover changes in Central Russia boreal forests and NELDA validation site network (20 min)

2. Anatoly Dyukarev - Characteristics of the West Siberia NELDA site (20 min)

3. Elena Fedotova/ Slava Kharuk – NELDA’s “Insects” and “Wildfire” sites in Central Siberia and Russian Far East (20 min)

4. Questions to speakers and discussion (30-40 min)

Lunch

### 14:00 – 16:00 **Session 3. Planning for NELDA II - new test sites, land cover attributes, and processes to monitor**

1. Garik Gutman – LCLUC Program/NEESPI: the Update (20 min)

2. Gerard Begni – On potential themes and mechanisms for future cooperation with POSTEL and SIRS projects (a personal position paper) (20 min)

3. Proposed additional sites

a. Eldar Kurbanov -- Monitoring of forest land use change in Povolgie of Russia using Landsat data (20 min)

b. Galina Stulina – Studies of land-cover change in Fergana Valley and Aral Sea Region (20 min)

c. Sergey Kirpotin - Natural dynamics of sub-arctic landscapes in the West Siberian Plain as indicator of global changes of climate

4. Additional suggestions from the audience and discussion (20-30 min)

16:00 – 16:30 Coffee break

### 16:30- 18:00 **Session 4. NELDA study plan: approaches, methods, and legends (open meeting of NELDA team)**

1. O. Krankina Overview of study plan and draft legend (15 min)

2. Pologova N. “Types of forest-bog complexes and their reflection by satellite images” (20 min)

3. Kozin E. - “Processing of satellite imagery on the basis of the object- oriented approach” (20 min)

4. General Discussion and Wrap-up - O. Krankina

## ATTACHMENT 2

### List of NELDA Workshop Participants

1.	Balybina, A.S.	V.B. Sochava Institute of Geography SB RAS, Irkutsk, Russia, E-mail: nadya@irigs.irk.ru
2.	Begni, Gerard	MEDIAS, France, gerard.begni@medias.cnes.fr
3.	Bilichenko, Irina	V.B. Sochava Institute of Geography SB RAS, Irkutsk, Russia, bilichenko@irigs.irk.ru
4.	Dyukarev, Anatoly	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, dyukarev_a@mail.ru
5.	Eliseev, Aleksey	A.M.Obukhov Institute of Atmospheric Physics RAS, Moscow, Russia, eliseev@ifaran.ru
6.	Erokhin, Dmitry	Institute of Biophysics SB RAS, Krasnoyarsk, Russia, the_greatest_idea@rambler.ru
7.	Fedotova, Elena	V.N. Sukachev Institute of Forest, Krasnoyarsk, Russia, E-mail: kharuk@ksc.krasn.ru
8.	Frotscher, Karsten	Friedrich-Schiller-University, Jena, Germany, karsten.frotscher@uni-jena.de
9.	Gerlach, Roman	Friedrich-Schiller-University, Jena, Germany, roman.gerlach@uni-jena.de
10.	Golovatskaya, Evgueniya	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, golovatskaya@imces.ru
11.	Gordov, Evgeny	Siberian Center for Environmental Research and Training and Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, gordov@scert.ru
12.	Gutman, Garik	NASA HQ, Washington, USA, E-mail: ggutman@nasa.gov
13.	Irodova, Victoria	Institute of Petroleum Chemistry SB RAS, Tomsk, Russia
14.	Khutornoy, Oleg	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, khutor@imces.ru
15.	Kinard, Jim	The Ohio State University, USA; kinard.1@osu.edu
16.	Kirpotin, Sergey	Tomsk State University, Tomsk, Russia; E-mail: kirp@ums.tsu.ru
17.	Kopysov, Sergey	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, Kompasov@mail.ru
18.	Kozin, Evgeny	Institute of Petroleum Chemistry SB RAS, Tomsk, Russia, esk@ipc.tsc.ru
19.	Krankina, Olga	Oregon State University, USA, E-mail: olga.krankina@oregonstate.edu
20.	Krupchatnikov, Vladimir	Institute of Computational Mathematics and Mathematical Geophysics SB RAS, Novosibirsk, Russia E-mail: vkrup@ommfao1.sccc.ru
21.	Krutikov, Vladimir	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, krutikov@imces.ru
22.	Kurbanov, Eldar	Mari State Technical University, Yoshkar-Ola, Russia, eldar@marstu.mari.ru
23.	Loboda, Tatiana	University of Maryland, USA

		E-mail: <a href="mailto:tloboda@hermes.geog.umd.edu">tloboda@hermes.geog.umd.edu</a>
24.	Lubsanova, Tatyana	Institute of General and Experimental Biology SB RAS, Ulan-Ude, Russia, <a href="mailto:rae@biol.bsc.buryatia.ru">rae@biol.bsc.buryatia.ru</a>
25.	Malinovskikh, Aleksey	Altay State Agrarian University, Barnaul, Russia, <a href="mailto:aleksei1976@rambler.ru">aleksei1976@rambler.ru</a>
26.	Maslov, Alexander	Institute of Forest Science RAS, Uspenskoe, Moscow region, 143030 Russia; <sup>2</sup> ScanEx Research and Development Center, Lva Tolstogo 22/5, Moscow, 119021 Russia. E-mail: <a href="mailto:am-pyrola@mail.ru">am-pyrola@mail.ru</a>
27.	Murkina, Ekaterina	Russian Research Institute for Hydrometeorological Information – World Data Center (RIHMI-WDC), Obninsk, Russia, <a href="mailto:anna_x@meteo.ru">anna_x@meteo.ru</a>
28.	Nikolaeva, Svetlana	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia
29.	Nochvay, Vladimir	National University “Kyiv-Mogyla Academy”, Ukraine, <a href="mailto:fhvortex@yahoo.com">fhvortex@yahoo.com</a>
30.	Okladnikov, Igor	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, Siberian Center for Environmental Research and Training, Tomsk, Russia, E-mail: <a href="mailto:oig@scert.ru">oig@scert.ru</a>
31.	Onuchin, A.A.	Institute of Forest SB RAS, Krasnoyarsk, Russia, E-mail: <a href="mailto:onuchin@ksc.krasn.ru">onuchin@ksc.krasn.ru</a>
32.	Petrova, Elena	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, <a href="mailto:petrova@imces.ru">petrova@imces.ru</a>
33.	Polishchuk, Yury	Ugra State University, Khanty-Mansyisk, Russia, <a href="mailto:yupol@uriit.ru">yupol@uriit.ru</a>
34.	Pologova, Nina	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, <a href="mailto:pologova@imces.ru">pologova@imces.ru</a>
35.	Preis, Yulia	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia
36.	Protasov, Konstantin	Institute of Atmospheric Optics SB RAS, Tomsk, Russia, <a href="mailto:prot@iao.ru">prot@iao.ru</a>
37.	Sofronova, Tatyana	Institute of Forest SB RAS, Krasnoyarsk, Russia, <a href="mailto:volokit@ksc.krasn.ru">volokit@ksc.krasn.ru</a>
38.	Spitsyna, Tatyana	Siberian State Technological University, Krasnoyarsk, Russia, <a href="mailto:t-spitsina@mail.ru">t-spitsina@mail.ru</a>
39.	Stulina, Galina	SANIIRI- Central Asian Scientific Research Institute of Irrigation and Scientific-Information Center of Interstate Coordination Water Commission of Central Asia (SIC ICWC). Tashkent, Uzbekistan, E-mail: <a href="mailto:stg@hotmail.ru">stg@hotmail.ru</a> ; <a href="mailto:galina_stulina@mail.ru">galina_stulina@mail.ru</a>
40.	Timoshok, Elena	Institute of Monitoring of Climatic and Ecological Systems SB RAS, Tomsk, Russia, <a href="mailto:timoshokee@mail.ru">timoshokee@mail.ru</a>
41.	Titov, Alexander	Institute of Monitoring of Climatic and Ecological Systems SB RAS and Siberian Center for Environmental Research and Training, Tomsk, Russia, <a href="mailto:titov@scert.ru">titov@scert.ru</a>
42.	Torgoev, Almaz	Institution of Physics and Rock Mechanics, Bishkek, Kyrgyzstan, <a href="mailto:torgoeval@yahoo.com">torgoeval@yahoo.com</a>

43.	Williams, Roger	The Ohio State University, USA; williams.1577@osu.edu
44.	Zhukoff, Eugene	All-Russian Research Institute of Silviculture and Mechanization of Forestry, Pushkino, Russia, zhukoff1965@mail.ru

## ATTACHMENT 3

### ABSTRACTS

#### NELDA Project Overview

Olga N. Krankina  
Oregon State University

Given the importance of Northern Eurasia for global ecosystem and climate processes, improved characterization of land cover and land-cover change in the region is a scientific priority. While multiple moderate and coarse-resolution land-cover products have been developed, their validation remains a challenge, particularly for boreal and temperate Northern Eurasia where validation sites are sparse, several land-cover types are unique, and processes of ecosystem disturbance and land-cover change are widespread, including fire, timber harvest, insect outbreaks, agricultural conversion and abandonment, melting permafrost, and forest regrowth. Coarse-resolution sensors such as MODIS can track many forms of vegetation change, and the MODIS record is now long enough to support monitoring of ecosystem disturbance and recovery.

The project will (1) Characterize land cover and its change across boreal and temperate Northern Eurasia and (2) Develop methods, data, and collaborations needed to monitor future changes. Our specific objectives are:

- A. **Establish a network of test sites across Northern Eurasia** for characterizing land-cover, land-cover change, and disturbance using moderate resolution imagery (Landsat, SPOT, IRS). The test sites will provide data for validation of coarse-resolution land-cover products and a sample of major vegetation change and disturbance processes within each region. Current land-cover distribution and recent (30 year) change will be mapped from time series of Landsat-resolution imagery. Test site information will be incorporated into CEOS LPV (<http://lpvs.gsfc.nasa.gov/>) and additional research teams will be encouraged to join the network of test sites thus creating a basis for long-term monitoring of land cover change.
- B. **Cross-compare and validate coarse-resolution land cover products using the test sites.** Test sites will provide data to quantify the accuracies of existing and newly developed products. On a qualitative level, we will assess and compare the performance of land-cover products in different parts of the region and for different land-cover classes, use local expertise to interpret and evaluate mapping errors, and identify specific needs and possibilities for improved mapping. We will initially concentrate on MODIS suite and GLC2000, then include a broader set of digital products, e.g. global AVHRR 1km and 8km-resolution land cover products, NASA MODIS vegetation continuous fields (VCF) products, the atlas of frontier forests by World Forest Watch, Central Siberia Forest Cover Map using ERS and JERS-1 radar satellite data, and Geoland – a MERIS-based 2005 map.
- C. **Develop methods for continental mapping of vegetation disturbance** using coarse resolution imagery from MODIS. We will rely on samples of vegetation change and disturbance processes created in part “A” to develop and test methods; then integrate MODIS datasets (e.g., active fires, burned areas, NDVI time series, Vegetation Continuous Fields tree cover changes, internal land cover products) with Landsat-based disturbance and change data from the test sites, to produce a zero-order vegetation disturbance/change map for the period 2000-2006.. This map will then be integrated with a new map of land cover for the region (Objective D).
- D. **Produce a new, updated land cover map for Northern Eurasia** based on MODIS data. This map will provide the best available characterization of land cover for this region for circa 2005 at 500-m spatial resolution based on improved training site data base, high quality spectral-temporal information from MODIS, and integration of information from the GLC-2000 map into the classification process. This map will include disturbance-related land-cover types and a confidence layer, which provides a measure of the classification quality for each pixel.

## **PRINCIPAL LAND COVER CHANGES IN CENTRAL RUSSIA BOREAL FORESTS AND NELDA VALIDATION SITE NETWORK**

**Alexander Maslov**<sup>1,2</sup>

<sup>1</sup> Institute of Forest Science RAS, Uspenskoe, Moscow region, 143030 Russia; <sup>2</sup> ScanEx Research and Development Center, Lva Tolstogo 22/5, Moscow, 119021 Russia. E-mail: am-pyrola@mail.ru

Principal land cover changes in Central Russia boreal forests were studied since 1980 on permanent sample plots and ground test areas. Since 2005, these areas and plots serve as ground truth areas for NELDA validation site network. The most important land cover changes and disturbances in Central Russia (Moscow, Tver and Kaluga regions) are: urban growth; drastic bark-beetle outbreak in Norway spruce forests; logging of old-growth natural forests; reforestation processes (with change to deciduous stands); post fire dynamics (after severe droughts in 1972, 2002); reforestation of abandoned fields. For retrospective analysis we use ScanEx R&D Center archive of images (mainly Landsat), for recent analysis – images from ScanEx Moscow center for RS data acquisition. IRS-1C and IRS-1D satellite images (PAN, LISS with spatial resolution 23 and 6 m) as well as SPOT 2, 4 images (since 2006) were found to be the most useful for detection of land cover type change and disturbance. The ground data include: digital forest maps and forest inventory information, species composition and stand structure data from permanent sample plots, vegetation surveys of forests and clearcuts. Cross-comparison and validation of fine-, middle- and coarse-resolution land cover products are planned for year 2006.

## **Monitoring of forest land use change in Povolgie of Russia using Landsat data**

Eldar Kurbanov, Oleg Vorobyov, Natalya Vlasova, Aleksandr Gubayev  
Mari State Technical University, 424000 Yoshkar-Ola, pl. Lenina, 3  
Department of forest inventory and measurements  
Тел. (8362) 686873 Факс (8362) 410872 eldar@marstu.mari.ru  
<http://www.marstu.mari.ru:8101/depart/csfm>

Russian forests have undergone significant changes in the last century. Recent tendencies in forest management and illegal cuttings continue to change the forest landscape. State forest inventory data are often not enough to describe the scale and overall picture of such land use changes. The aim of this study is to improve characterisation and monitoring of forest land use changes in Povolgie of Russia by the use of ETM+ data (Landsat 7) between 2000 and 2005. In the estimation, we are using 8 ETM+ image channels. The 60 ground forest plot data of the Mari State technical University forest inventory and measurements department also have been used in this study. Only those field plots of the Povolgie area, which were located within a single stand and measured in 2000 or later, were included. The sample plots of clear-cut and burnt areas were also located and excluded in the case of temporal discrepancy between the field measurements and the images.

The analyses and interpretation results on forest land use changes from Landsat images in combination with the ground data over the Povolgie region will be presented on the ENVIROMIS -2006

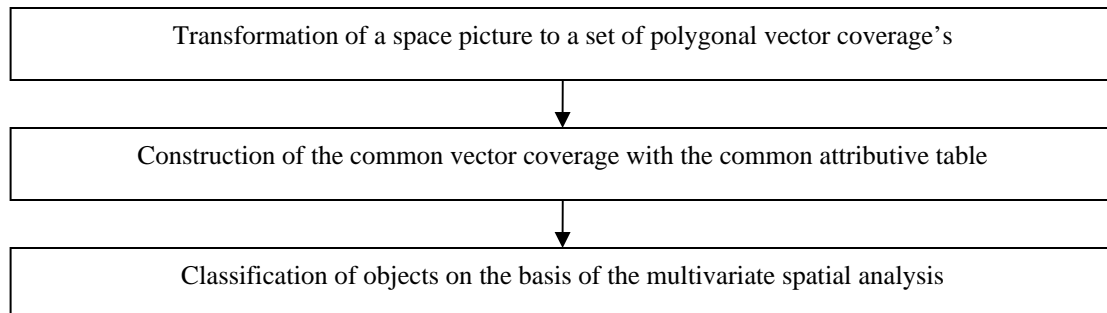
## **PROCESSING OF SATELLITE IMAGERY ON THE BASIS OF THE OBJECT-ORIENTED APPROACH**

**Kozin E.S.**

Institute of Petroleum Chemistry of SB RAS, Tomsk, Russia; e-mail: [esk@ipc.tsc.ru](mailto:esk@ipc.tsc.ru)

The technology of processing of space pictures based on application of the object-oriented approach is considered. The traditional technology of processing of space pictures is based on examination of a space picture as raster image. In the object-oriented approach each pixel of a space picture is considered as separate object. In figure the general algorithm of realization of the offered approach is submitted. At the first

stage the source space picture transformed to a set of vector coverage's GIS, and each spectral band transformed to a separate vector coverage. On the basis of the data on parameters of an orbit and parameters of radiometric calibration the geographical binding is executed and signal intensity for each pixel of a space picture is calculated. At the second stage with the help of standard queries GIS the common coverage for all coverage's of a space picture is constructed. Each object of this common coverage represents result of operation of intersection of all coverage's of a space picture, and the attributive table contains values of signal intensity for each band of a space picture. At the third stage on the basis of the attributive table of the common coverage and the multivariate analysis the classification and recognition executed, therefore the thematic digital map of a landscape is constructed.



The offered approach allows to use in processing all spectral bands of a space picture as against the traditional approach which capability are limited RGB to a palette.