

Report from the Regional GOFC-GOLD Workshop
OBSERVATIONS OF LAND COVER
and Needs of Research Projects in Northern Eurasia

*Pre-symposium workshop at the 31st International Symposium on Remote Sensing of
Environment “GLOBAL MONITORING FOR SUSTAINABILITY AND SECURITY”*

(<http://www.niersc.spb.ru/isrse/>)

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Global Observation of Forest and Land Cover Dynamics (GOFC-GOLD) is a coordinated international effort to ensure a continuous program of space-based and in situ forest and other land cover observations to better understand global change, to support international assessments and environmental treaties and to contribute to natural resources management.

GOFC-GOLD encourages countries to increase their ability to measure and track forest and land cover dynamics by promoting and supporting participation on implementation teams and in regional networks. Through these forums, data users and providers share information to improve understanding of user requirements and product quality.

GOFC-GOLD is a Panel of the Global Terrestrial Observing System (GTOS), sponsored by FAO, UNESCO, WMO, ICSU and UNEP. The GOFC-GOLD Secretariat is hosted by Canada and supported by the Canadian Space Agency and Natural Resources Canada. Other contributing agencies include NASA, ESA, START and JRC. Further information can be obtained at <http://www.fao.org/gtos/gofc-gold>

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Executive Summary

The Regional GOF-C-GOLD Workshop “Observations of Land Cover and Needs of Research Projects in Northern Eurasia” was held June 18-19, 2005 in St. Petersburg, Russia as a pre-symposium workshop at the 31st International Symposium on Remote Sensing of Environment “Global Monitoring for Sustainability and Security”. Due to the sheer size of Northern Eurasia region, remotely sensed satellite data are critically important for better understanding of interactions of ecosystems, atmosphere, and human dynamics in Northern Eurasia. The potential of the remotely sensed data has not been fully used to date, in large part because of the difficulty in locating and accessing *in-situ* data sets and integrating them with remotely sensed data. The workshop brought together 84 participants representing 16 different countries and made an important step in the development of the GOF-C-GOLD regional network in Northern Eurasia (NERIN, <http://www.fao.org/gtos/gofc-gold/net-NERIN.html>).

The oral and poster presentations at the workshop (informed participants of regional data sets and observational networks generated by new and recent projects that were funded by NASA, European Community, Russia, Kazakhstan, Mongolia, and Japan. A special session examined availability and limitations of social science data for Earth Science research in Northern Eurasia. Included in the workshop was also a capacity-building session focusing on FAO Land Cover Classification System (LCCS-2). Two panel discussions evaluated the availability of observational data in Northern Eurasia for studies of land cover at regional and at global scale. Workshop participants acknowledged that over the last few years **significant progress** was made in meeting the data needs of research projects in Northern Eurasia; in particular:

- Availability and use of remotely sensed data in studies of land cover increased dramatically. It is important however for NERIN community to continue advocating for maintaining the availability of data, both remotely sensed and *in-situ*.
- Data sharing and collaborative research gained greater acceptance and growing support in the NERIN community.
- The importance of product validation, harmonization, and cross-comparison is widely recognized, but the effort in this direction is clearly insufficient
- There is a growing understanding of the need for “common language” in classifications of both land cover and land-cover change; UN Land cover classification system (LCCS) is a fundamental basis of harmonized land cover mapping.
- The method development for extracting thematic land-cover information from the remotely sensed data is approaching the level that allows initiating the transition from research projects to a system of operational monitoring of land cover that would meet an array of societal needs, including support for international conventions.
- The important role humans play in land-cover dynamics is widely recognized, however quantitative understanding of this role remains a challenge. Availability and quality of social science data is a cause for concern and methods for combining the remotely sensed and social science data need to be developed further so that robust projection of future changes in land cover can be made.

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 to build the basis for operational land-cover monitoring. 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 planned parallel 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 will link together the interested research teams, establish a set of test sites for land cover analysis in the region, 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. Ultimately, the project results will inform the development of operational land cover monitoring across the region.

The following considerations for planning the future development of NERIN emerged from the workshop:

1. ***Planning for long term*** is critically important because the task of monitoring land-cover change is long-term by definition; the transformation of research projects into services for users and integration of research into services – is another long-term task.
2. Acceptance and use of data products for the region is the ultimate measure of network success and a major obstacle is the lack of ***statistically valid independent validation of land-cover products***. Developing a “living” database of accuracy assessment sites can help address this persistent problem.
3. Improved ***understanding of coupled human dynamics and environmental change*** is essential for meeting the needs of decision support structures and communities. Network should facilitate the development an effective dialogue among scientists and interdisciplinary studies across physical and social science domains.
4. Better ***understanding of user needs*** is necessary for prioritizing network activities and framing future research.
5. Critical ***near-term funding priorities*** include support for network projects, synthesis of results and coordination among ongoing projects, organization of workshops, and training/capacity building.

In summary, the workshop provided a thorough review of available observations of land cover in Northern Eurasia, identified several important issues that need to be addressed for improved understanding and characterization of land-cover and its change, and discussed NELDA project that would serve as a next important next step in the development of NERIN.

1. Background

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/GOLD (<http://www.fao.org/gtos/gofc-gold/index.html>) convened a series of workshops in Northern Eurasia with the overall objective to improve the observations of forest cover and land dynamics: August 2000 in Novosibirsk, June 2001 in St. Petersburg, August 2002 in Krasnoyarsk, and February 2005 in St. Petersburg (see workshop summaries at <http://www.fao.org/gtos/gofc-gold/>). 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 formation of Northern Eurasia Regional Information Network (NERIN) was initiated. NERIN is a network of people, institutions, and projects with a common goal to promote and coordinate the production and provision of Earth System observations for a wide range of user communities in Northern Eurasia. The network includes two closely linked thematic components *Land Cover* and *Fire*. Olga N. Krankina (<http://www.cof.orst.edu/cof/fs/faculty/krankina.htm>) acts as a network coordinator dealing mainly with land cover while Ivan Csiszar (UMD) coordinates the fire-related work.

NERIN is part of GOF-GOLD (Global Observation of Forest and Land Cover Dynamics), which 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-GOLD; they are crucial for sharing resources and expertise and perform an essential crosscutting role in the implementation of GOF-GOLD's thematic components. 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 and user groups and the global user/producer community. GOF-GOLD leadership supported the idea of organizing a regional information network in Northern Eurasia.

The previous GOF-GOLD workshop for the region "Observational Data in Support of NEESPI" was held in St. Petersburg, Feb. 23-26, 2004. The development and implementation of Northern Eurasia Earth Science Partnership Initiative (NEESPI <http://www.neespi.org/>) shaped the thematic foci of that workshop. The workshop showed that many years of research and operational data collection in Northern Eurasia produced a large body of knowledge and data that can be available to support new research. The presentations at the workshop provided a thorough overview of data availability primarily in the boreal part of Northern Eurasia. The workshop and the data inventory effort (<http://wwwdata.forestry.oregonstate.edu/MDEDIT/index.aspx>) improved the understanding of available data resources. The workshop recommended to strengthen the network by maintaining active network projects and to establish multilateral/multinational support for network activities. The next workshop was planned for August 2004 in Rostov-on-Don. It was to address the observational data needs for non-boreal regions of Northern Eurasia including Ukraine, Georgia, Uzbekistan, Kyrgyzstan, Georgia, Turkmenistan, Azerbaijan, Tajikistan, Kyrgyzstan, Tajikistan, Turkmenistan, Azerbaijan, Armenia, Uzbekistan, Kazakhstan, Mongolia, China, and Japan. That workshop had to be postponed indefinitely due to insufficient financial

support from international organizations. The latest workshop in St. Petersburg covered the entire Northern Eurasia region including boreal and non-boreal biomes. The preparations for the workshop began in fall 2004.

2. Workshop Objectives and Preparation

The workshop “**Observations of Land Cover and Needs of Research Projects in Northern Eurasia**” was planned for June 18 - 19, 2005 as a pre-symposium workshop at the 31st International Symposium on Remote Sensing of Environment (ISRSE) “Global Monitoring for Sustainability and Security” (<http://www.niersc.spb.ru/isrse/>). The goal of the workshop was to assess availability of observational data to meet research needs, to encourage information exchange and collaborations among research teams active in the region, and to initiate strategic planning for land cover mapping, monitoring, analysis, and modeling across Northern Eurasia. The workshop agenda (Attachment 1) included the introduction of new and recent projects in the region that were funded by NASA, EU, Russia, Kazakhstan, Mongolia, and Japan and an overview of FAO Land Cover Classification System (LCCS-2). Session co-chairs defined the content of their sessions, selected speakers, and worked with them on presentation format and content. The workshop aimed to review the observational data that were not covered at the Feb. 2004 workshop in St. Petersburg expanding the scope of NERIN geographically (beyond the boreal forest) and thematically (socio-economic data). The workshop agenda also included two panel discussions on observational data needs and the role of NERIN in regional and global studies of land cover.

The list of attendees (Attachment 2) was developed to include representatives from research teams and institutions actively engaged in collecting operational and scientific observational data on land cover. The workshop was open to all interested participants of the ISRSE, who were encouraged to provide their contact information to be included in the list of participants. The final list of participants included representatives from Russia, USA, Italy, Germany, France, Canada, Portugal, Azerbaijdjan, Norway, Austria, Japan, Italy, Estonia, Mongolia, Kazakhstan, Portugal, and Ukraine. Participants from China were invited and expressed interest but could not attend due to visa difficulties.

3. Overview of Presentations and Discussions

Oral and poster presentations at the workshop were planned to provide an overview of observational collections supported by different countries. Abstracts of oral and poster presentations were distributed at the workshop (Attachment 3). In his introductory talk *Michael Brady* described GOFC-GOLD as:

- An ambitious, multifaceted international strategy to bring the Earth’s land surface under continuous observation
- A panel of the Global Terrestrial Observing System (GTOS), one of three Observing Systems supported by the International Global Observing Strategy (IGOS) Partners
- A vision to share data, information and knowledge, leading to informed action and decision support
- A network of participants implementing coordinated research, demonstration and operational projects using earth observation and other data effectively for global monitoring of terrestrial resources, global assessments, and the study of global change
- An international organization of Space Agencies and end-users working together
- A long-term process of building an improved match between Observations, Data Products and User Needs.

Regional Networks within GOFC-GOLD function as a:

- Forum for data producers and users to interact and assess regional priorities and requirements, current data availability, and existing data collection systems
- Forum for scientists and resource managers to improve communication and the transfer of methods, technology and applications experience
- Mechanism for involving regional scientists and users in new product accuracy assessment (validation) and for harmonizing national products in a regional context
- Implementing regional response to the needs of the International Conventions in the framework of GOFC-GOLD, GTOS/GCOS

Session 1 focused on datasets generated with support from NASA LCLUC program. Program manager *Garik Gutman* in his overview pointed out that NASA contributes to GOFC-GOLD by supporting regional network activities, science projects, and development of datasets. A number of recently completed and ongoing pilot projects focus on biomass burning, landcover dynamics, biodiversity in Eastern Europe, and support for Reindeer Mapper. Recently funded were 9 projects under Carbon Cycle/LCLUC Processes and 7 projects under Water Cycle/LCLUC Processes for a total of about \$3.5 M. Additional projects may be supported based on the results of new competition. *Olga Krankina* showed that research projects in the boreal zone assembled large collections of observational data focused mostly on forests. The research teams gained thorough understanding of data availability and limitations; exchange of information among teams improved significantly in recent years but a more regular and systematic exchange would be important. The level of data documentation and archival varies among projects; investigators need incentives to document and make their data available. Heavy reliance on Landsat by many scientists creates continuity problems. *Ivan Csiszar* with contribution by Nancy Maynard (NASA), Guoqing Sun (UMd), Susan Conard (USFS) and collaborators presented data sets from 5 fire-related projects and a summary of the recent GOFC/GOLD Regional Fire Workshop (Moscow, 17 November 2004, part of Russian Terrestrial Remote Sensing Symposium). Data availability and networks in the non-boreal NEESPI region was covered by *Anatoly Gitelson* based on one completed and 3 newly funded projects. *Jianguo Qi* with contributions from Chinese collaborators presented China regional network and the results of the International Conference on Land Cover and Land Use Change Processes in North East Asia Region (Feb. 3-5, 2005, Harbin, China). The talk showed that remotely sensed and *in-situ* data are increasingly becoming available to research communities in China, there is a strong long-term local commitment to study LCLUC; significant research activities are in progress and focus is moving from data to information and knowledge for operational use.

Poster session A included a total of 19 posters representing many of the projects mentioned in oral Sessions 1, 3, and 4.

Session 2: Regional Social Science Data. *Robert Walker* (with Dmitrii Logofet, and Vladimir Korotkov) examined availability and limitations of social science data for Earth Science Research in Russia, including census data and transportation network. *Volker Radeloff* described his projects that examine post-USSR land cover change in Eastern Europe including widespread agricultural abandonment followed by conversion to shrublands and forest. Socio-economic trends differ markedly among neighboring countries with similar ecological conditions allowing to test hypotheses on the relative importance of environmental versus socioeconomic factors as controls and forcings of land cover distribution and land cover change. The project will use a range of socio-economic variables, including GDP, land ownership, population, housing, and households, urban markets, and employment. *V. Razuvaev* used long-term meteorological data record and reports on damage from natural hazards to examine the impact of changes in climate extremes on

forestry and agriculture. The limitations of available socio-economic data on the damage caused by hazardous weather require the development of new methods of analysis. **Nancy Maynard and Boris Yurchak** presented the data and information exchange system for “Reindeer Mapper” project. The system combines satellite data and GIS with indigenous traditional knowledge and local data to generate maps/reports/analysis for information sharing and policy making. **Anatoly Shvidenko** pointed out that socioeconomic data for Northern Eurasia is often biased, obsolete and incomplete; methodology for examination of complex social, ecological, and economic interactions is poorly developed; and the effects of global change are inadequately represented in socioeconomic projections. Integrated Land Information System was developed at IIASA and includes layers with socioeconomic data (GDP, population, labor resources, production of major goods, dynamics of major economic indicators, living standard of population including income, consumption, education, medicine, etc.). **Dennis Ojima** stressed the new emphasis on integrated analysis of land dynamics in the science framework of the Global Land Project (GLP). The keys to meeting the challenges to GLP include greater appreciation of the coupled socio-environmental system, analysis of decision making, valuation of ecosystem services, scaling across physical and scientific dimensions of observational systems and methods, case studies, experiments, and model analyses; vulnerability analysis of multiple stressors from and on the coupled system; and incorporation of historical aspects and timescales of social and environmental changes.

Session 3 examined observational data collected by projects that were funded by European agencies. **Martin Herold** indicated that in Siberia II project the availability of remotely sensed data was good while *in-situ* data for validation were lacking. The project generated information on landcover and change, spatial-temporal wetland dynamics, above-ground biomass & long-term change. Siberia II land cover product relied on local expert knowledge, Landsat TM analysis, some classes from GLC2000, 1000 training polygons from forest inventory, and LCCS-based legend (GLC2000). The overall agreement with four other land cover products was 66.6% while for tree cover the agreement was very high (99%). Improved coordination and cooperation in development, sharing, and integration of land cover information, both *in-situ* and satellite is important. **Frederic Achard** explained activities at JRC that address some of the issues for Eurasia, including land resources assessment (continental & regional boreal land cover mapping, estimation of forest biomass from radar mosaics), forest cover monitoring (disturbances by fires: burnt area assessments and quantitative estimation of forest cover change with optical fine or medium resolution imagery and multi-temporal radar mosaics), and forest carbon flux assessment. Collaborators participating in product development include S. Bartalev (IKI, Moscow), D. Ershov (IKI, Moscow), E. Lapshina (Tomsk), V. Usoltsev (Ekaterinburg). **Heather Reese** presented the experience with mapping the forest and mountain vegetation cover of Sweden. The project relies on easy access to nationwide satellite images including Landsat, Spot, MERIS, MODIS, interested users who fund the work, an automated production line, and availability of national field inventory data. **Stein Rune Karlsen** described a set of projects at NORUT that developed vegetation maps of northern Fennoscandia and neighboring parts of NW Russia using MODIS and Landsat TM/ETM+ data. The products include MODIS-based vegetation map of Fennoscandia and monitoring change in lichen cover for the effects of grazing and pollution. Investigation of MODIS mapping potential suggests that certain important vegetation types cannot be mapped with acceptable accuracy by MODIS, including clear-cuts, lichen heaths, mountain meadows, and other vegetation types that tend to occur in small patches. **Galina Churkina** presented the effort to reduce uncertainties in the European carbon balance by improving the accuracy of land cover classification. Different available global land cover data sets result in significantly different

estimates of C stocks. C-cycle modeling has specific requirements to land-cover classification that are not fully met by many common classification systems. Improved data on land-cover change over the last century is important for reducing the uncertainty in C balance.

Session 4 included presentations on several active projects in the Northern Eurasia region that are funded by Japan and Mongolia. *Rikie Suzuki* presented his daily NDVI data set from 1982 to 2000 over Eurasia continent. The dataset was constructed based on PAL data for the analysis of vegetation phenology; the onset of phenological events (green-up, maximum, senescence) across Northern Eurasia was visualized. Next, daily climate data (temperature and precipitation) will be compiled to investigate the link between climate and phenology. *Takeshi Ohta* gave an overview of Japanese projects in support of hydro-meteorological field experiment in Northern Eurasia within WECNoF/CREST/JST and IORG programs. Data from before 2003 for Tiksi, Yakutsk, and Tynda sites is available on CD-ROM; data obtained before 2002 is posted on GAME-AAN web page <http://www.suiri.tsukuba.ac.jp/Project/aan/aan.html>, and the two follow on projects will provide data beginning in 2005 according to their data policy. To improve the modeling of water, energy, and carbon dioxide balance it is important to obtain the physical and ecophysiological parameters of forests from remotely sensed data. *Renchin Tsolmon* demonstrated a method for estimating biomass and fractional forest cover from satellite imagery and showed the results of her analysis over a range of scales, from plot to entire boreal forest. She expressed interest in contributing to a regional network project.

As part of **Day 1 Wrap-up** O. Krankina gave a brief overview of NERIN status and plans for the network project NELDA (Northern Eurasia Land Dynamics Analysis). The project is designed to characterize land cover and its change across boreal and temperate Northern Eurasia and to develop data, methods, and collaborations needed to monitor future changes. The first set of test sites was previously selected and workshop participants were invited to propose their research sites as additional NELDA sites. Proposed future network priorities include developing network projects, engaging additional participants, harmonizing activities between fire and land cover components. Critical funding priorities include network projects, synthesis and coordination work among ongoing projects, organization of workshops, and training/capacity building. *Anatoly Gitelson* presented the results of his inventory of observational datasets available for the Central Asia region. The inventory covered Aral-Caspian closed basin and included the information on the status and availability of observations at hydrometeorological stations in Kazakhstan, Kyrgyzstan, Uzbekistan, Tajikistan, and Turkmenistan.

Session 5 focused on projects supported by funding sources within the CIS countries. *G.N. Korovin* explained the development of information support for the national system of accounting for the forest C sinks and sources; this is an essential condition for including forests in Kyoto Protocol mechanisms. Remote sensing methods are expected to play a role in improving the estimates of large-scale changes in forest cover. *V. I. Gorny* proposed the use of thermal inertia approach for monitoring of biome migration with climate change using remotely sensed data. *A. Georgiadi* gave an overview of data needs and availability for studying hydrological consequences of global climate warming within large river basins of Northern Eurasia, including basin-level, national, continental and global data sets. He proposed that hydrological data theme should be included in NERIN. *Sergey Bartalev* demonstrated the availability of different types of land-cover data within the Terra Norte information system that was developed at the Space Research Institute in Moscow. *Lev Spivak* presented the space monitoring system of the Republic of Kazakhstan, including satellite systems, ground infrastructure, national archive of remotely sensed data, and the

development of applications such as agricultural monitoring, disaster management, fire and air pollution monitoring, and other environmental monitoring tasks. **Rudolf Treyfeld** described the status and future prospects of using remote sensing methods in Russian forest inventory. While the experience with using satellite imagery for forest inventory in Russia goes back to 1970'ies, there is not enough experience with extracting information from currently available high-resolution data. Research is needed to determine the effectiveness of using satellite imagery in place of aerial photos. **D.G. Zamolodchikov** gave an overview of the various types of information that can be extracted from forest inventory data and examined strengths and limitations of these data types as a basis for scientific analysis of spatial patterns of biomass production and decomposition in forest ecosystems. Several research-based datasets are also available (Bazilevich, Utkin, Usol'tsev, and others). To derive new data products based on satellite data, the accurate ground data can be developed by combining information from the forest inventory with research databases; this would allow translating forest inventory attributes into values of interest for ecological research (biomass, NPP, NEP, etc.).

Poster Session B covered projects funded by CIS.

Panel Discussion 1 focused on regional studies, their data needs and the role of NERIN in addressing those needs. **Acad. Alexander Isaev** sees that NERIN heads in the right direction with its effort to gather information about data available from various sources. The issue of data availability is important to address in the context of traditions and legal framework of different countries within the region. There has been great progress in providing free access to data via the web (as presentation by Bartalev showed). However it is important that data availability is discussed as part of developing specific projects and that funding is made available. The initiative of Olga Krankina to develop a regional project should be supported. It is also important to include information on the source data in presentations of research results, while only a few presentations from the workshop revealed sufficient information on the data sets that were used. **Jean-Paul Malingreau** is impressed with the quality of presentations and the range of topics at the workshop. Improving data availability should be part of the network plan. Though carbon accounting is an important science question, it is not the only one to be addressed (e.g. biodiversity). There is a need to maintain long-term observations, "Keep watching" is a long-term task. Transformation of projects into services for users and integration of research into services – is another long-term task. For example, GMES attempts to establish long term services of forest monitoring, food production, etc. Further, data reliability and accuracy information is needed and it is also very important that projects with similar objectives or products collaborate. **Anatoly Shvidenko** emphasized the importance of having a common language. Collection of Metadata should be extended to capture the full range of datasets. There are already quite a number of data sets available and it is problematic to have multiple separate databases dealing with the same information (e.g. three phytomass databases). There is a need to coordinate these data bases. It may be useful to make source datasets available, not only final products/datasets. **Sergey Bartalev** noted that we already entered a new age of data availability. Five years ago, it would have been hard to believe what we have currently available on remote sensing data, but the prospects for data continuity are uncertain. For example there is no clear evidence for continuation of MODIS and Landsat mission. There are several regional land cover maps that can be expanded to a broader region and improved maps are needed. There is a relationship between land cover and many biophysical parameters (fpar, lai, chlorophyll content) and it is important to have land cover products useful for mapping those parameters. **Rikie Suzuki** addressed issues on the linkage

between *in-situ* and RS data by referring to LAI and phenology data. LAI is an important parameter for climate change and vegetation models and more accurate data on LAI is needed. There is a lack of ground truth data for phenology and also, we need cropping calendar as remote sensing can not distinguish between cropland and natural grassland.

Comments from the audience:

1. (Leonid Vedeshin). We need to include datasets that reflect the effects of anthropogenic emission on human health (example: recent fires in Moscow region). A large database is available and we need these data for predicting health of the population of northern region. This topic needs to be included in future plan for NERIN work.
2. (Natalia Vandysheva) Improved mapping is needed for agricultural land. The workshop mainly discussed forests, but there is a good potential for using the RS in monitoring of agricultural lands, especially in Central Russia where shrublands develop on abandoned agricultural lands. Improved availability of high-resolution data (Quickbird/Ikonos) is important.
3. (Gerard Begni) MEDIAS-France has set up the MEDIAS network focused on environment and climate change for some ten years. This network has been extended to Northern Eurasia during the three previous years - partly with the support of CNES, the French Space Agency. There are obvious synergies between NERIN and this regional part of the MEDIAS network. MEDIAS-France is quite eager to co-operate with NERIN and regional institutions to develop these synergies.
3. Ukraine: there is a need to expand flux tower network to cover Ukraine.

Session 6 was dedicated to harmonization of land cover products and LCCS capacity building workshop. **John Latham** described the relevancy of harmonized land cover for addressing the unprecedented ecosystem change. Current national/international land mapping initiatives reflect different interests, requirements, and methodologies; current maps exist as independent datasets with limited compatibility and validation, and there are no updates or they are irregular. The potential for using these maps for change assessment is limited. Harmonization is a “Bottom up process”: from an existing divergence to a state of comparability/compatibility; union of similarities in existing definitions; does not necessarily eliminate all inconsistencies. UN Land cover classification system (LCCS) is a fundamental basis of harmonized land cover; it combines high level of flexibility with an absolute level of standardization of definitions between different users. The workshop on LCCS for NIS/CIS states is planned for early 2006. **Martin Herold** further detailed the strategies for harmonization of land cover observations with LCCS. The system relies on a combination of common land cover diagnostic attributes (life form, leaf type, leaf longevity etc.) to define land categories. The system includes mixed units to represent different types of mixing (spatial, thematic, temporal, and layering). **Curtis Woodcock** presented a brief report on CEOS Cal/Val efforts related to land cover (input from Jeff Morissette), an overview of the “Best Practices” recommendations for Accuracy Assessment of Global Land Cover Products, and an outline GOF/GOLD Land Cover Implementation Team strategy for validation of global land cover datasets (input from Martin Herold). Validation is the process of assessing by independent means the quality of the data products derived from the system outputs; validation activities should consider user accuracy needs and feedback to algorithm improvements. Accuracy assessment is an expensive, yet essential component of the land cover mapping process. Maps without associated accuracy data remain untested hypotheses. Statistically valid estimates of map accuracy and their publication are essential to validation of land cover products and their ultimate acceptance and use. It is important to assess the overall accuracy of the map as well as per-class accuracies; having the variance of these estimates is also essential. Confusion matrices,

user's and producer's accuracies, as well as the data used to derive them, should be published with the accuracy assessment. GOF/GOLD land cover validation initiative proposes to validate multiple land cover products using a "living database of accuracy sites". The initiative is based on CEOS "best practices", LCCS-based harmonization efforts, and GOF/GOLD regional networks. Initial focus is on existing global products (MODIS land cover and GLC 2000), but all others would be welcome to join the effort (such as GLOBCOVER and any other new global or regional products). **Frederic Achard** outlined experiences and harmonization needs for GLC-2000 land cover classification, which was developed to map the main land cover classes at the global level uniformly and consistently so that they are comparable across regions and countries and as far as possible compatible with IGBP classes. Project implementation was based on participatory approach (about 30 teams involved). GLC-2000 validation relies on two-stage stratified clustered sampling with stratification by land-cover composition and fragmentation; 253 Landsat scenes were used with detailed mapping by regional experts in 5 boxes per Landsat scene. The overall accuracy is 67.1%; user's accuracy is >85% for forests, 50% for shrublands, and 75% for croplands. **Michael Brady** presented the experience with land cover mapping within the Canadian activity "Earth Observation for Sustainable Development of Forests" (EOSD). This is an operational land cover mapping program that is being developed for public access with land cover classification based on Landsat-7 ETM+ data. Harmonization of map legends in the boreal zone needs to be developed within future initiatives in the circumboreal region; this includes large-scale projects such as NELDA – EOSD; Boreal Model Forest Network; and others. A prospective new initiative is Circumboreal Network of Model Forests, which will draw together the skills, resources, and ingenuity of boreal forest specialists in order to accelerate innovation in the best management of the boreal forest. Mechanisms and capacities are in place through the International Model Forest Network that links policy-makers and SFM practitioners in Canada, Scandinavia and Russia, eventually reaching to the USA, China and Japan.

Panel Discussion 2 focused on global studies, their data needs, and the role of NERIN in addressing those needs. **Curtis Woodcock** indicated the exceptional value and suitability of currently operating satellites for studies of land cover, the workshop participants need to consider the future, – how do we improve 5 years from now? Methodology for extracting thematic information is developing and users would like more, but we have to understand the requirements. Do we need more unique sensors?, organized collection of ground data, pooling of ground-based data?, improved methodologies (doubtful)?, synergy of sensors?, creatively combine temporal and spatial scales? **Dennis Ojima** pointed out that suggestions for future improvements should include understanding of coupled human land dynamics and environmental change. This is essential for projecting future changes in agriculture, desertification, socio-economic changes and feedbacks to environment and climate. The studies of land cover (including NELDA) should formulate a framework for understanding and management of human policy and dynamics and the feedbacks from environment to decision-making structure. Scientists across physical and social domains are developing an effective dialog. **John Latham** emphasized the need for map legend harmonization, standardization, and improved validation with *in-situ* measurements. Transition to operational monitoring of land cover as part of land management and decision support system is a major challenge for the scientists. Common language is needed for Land Cover Dynamics as well as land cover classification. Further, it is necessary to develop products that better meet the needs of decision support structures and communities (i.e. woody stock). In planning its future NERIN should take a closer look at the needs of development projects and how NERIN interacts with developing communities. **Vladimir Kattsov** stressed the needs for global vs. regional maps to

validate climate models, fill gaps in observations and project future climate change. The IPCC Third Assessment Report was probably too positive about global models, the Fourth Assessment Report will indicate that while global Climate Models improved, they poorly represent vegetation change and C dynamics. These are urgent issues in global modeling that will not be resolved in the next few years. *Frederic Achard* would like to see scaling up from regional studies to global scale. Data availability is very good at medium resolution (250- 300m), higher resolution global data exist but availability is limited; we can use high-resolution data to validate medium-resolution products. We are getting used to data access, so it is important to express continued needs – SPOT program has no future plans. Continued regional and global harmonization and data sharing are essential.

Comments from the audience:

1. Tectonic processing such as outgassing are often not considered.
2. New data on deforestation is available.
3. Agree with Dennis Ojima – physical and ecological scientists typically agree on terminology, such as the definition of a carbon unit, but social data definition are more challenging, the definitions may differ between societies. Before successful modeling, there is a need to develop consensus among social scientists.
4. Land Cover Classifications are difficult to use in biogeochemical models. In talking about the language we can develop an approach that would not classify each pixels into one of discrete classes but provide a probability of cover types with error co-variance matrix. This approach would contribute to studies of C dynamics immensely.
5. Acad. Isaev advocates for the harmonization of tasks. We need all resolutions, not just particular ones, because resolution must correspond to specific tasks and to the problems to be addressed, researched, and solved. The future research effort should target specific tasks that address the needs of the societies.

4. Conclusions and Follow-up Activities

To summarize the discussions at the workshop *Olga Krankina* noted great improvement in data availability in recent years and the growing culture of data sharing in NERIN community. The presentations and discussions at the workshop showed the widely recognition of the importance of product validation, harmonization, and cross-comparison, but the effort in this direction is clearly insufficient. There is a growing understanding of the need “common language” for mapping both land cover and land-cover change. The method development for extracting thematic land-cover information from the remotely sensed data is approaching the level that allows to initiate the transition from research projects to a system of operational monitoring of land cover that would meet an array of societal needs, including support for international conventions. The important role humans play in land-cover dynamics is also widely recognized, however quantitative understanding of this role remains a challenge. Availability and quality of social science data is a cause for concern and methods for combining the remotely sensed and social science data need to be developed further so that robust projection of future changes in land cover can be made.

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 to build the basis for operational land-cover monitoring. 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. Planning for parallel activity for GOC-GOLD Land Cover Theme was discussed at the workshop. The proposed 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. Building on recent and ongoing projects, NELDA will link together the interested research teams, establish a set of test sites for land cover analysis in the region, 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. Ultimately, the project results will inform the development of operational land cover monitoring across the region.

The following considerations for planning the future development of NERIN emerged from the workshop:

1. **Planning for long term** is critically important because the task of monitoring land-cover change is long-term by definition; the transformation of research projects into services for users and integration of research into services – is another long-term task.
2. Acceptance and use of data products for the region is the ultimate measure of network success and a major obstacle is the lack of **statistically valid independent validation of land-cover products**. Developing a “living” database of accuracy assessment sites can help address this persistent problem.
3. Improved **understanding of coupled human dynamics and environmental change** is essential for meeting the needs of decision support structures and communities. Network should facilitate the development an effective dialogue among scientists and interdisciplinary studies across physical and social science domains.
4. Better **understanding of user needs** is necessary for prioritizing network activities and framing future research.
5. Critical **near-term funding priorities** include support for network projects, synthesis and coordination work among ongoing projects, organization of workshops, and training/capacity building.

Follow-up activities

1. Immediately following the workshop an informal planning meeting was help to identify additional interested participants of NELDA project and prospective new test sites. This work continues via e-mail. Scientists and teams interested in participating in NELDA are invited to contact Olga.Krankina@oregonstate.edu
2. Copies of all available presentations are posted at <ftp://ftp.fsl.orst.edu/pub/krankina> (in “NERIN 2005 workshop at 31 ISRSE” directory). In Russia the presentations are posted at <http://enviromis.scert.ru/en/resources/petersburg-2005/> . The presentations will remain posted on these sites through the end of 2005.
3. An idea for a symposium “Towards Global Synthesis: Forest Dynamics in Brazil and Russia” was proposed by Bob Walker.
4. Updating of METADATA is in progress.

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