This synopsis is for the Land-Cover and Land-Use Change (LCLUC) solicitation of the NASA Research Announcement (NRA) ROSES-2005 NN-H-05-Z-DA-001-N. The NASA LCLUC solicitation was in collaboration with the United States Department of Agriculture (USDA) Cooperative State Research, Education and Extension Service (CSREES). This NRA offered opportunities for research to develop and use NASA remote sensing technologies to improve understanding of human interaction with the environment, and thus provide a scientific foundation for understanding the sustainability, vulnerability and resilience of land-cover and land-use systems. NASA LCLUC and USDA CSREES research contributes toward the goals of the U.S. Climate Change Science Program (CCSP) by providing critical scientific information about LCLUC-climate interactions and the consequences of LCLUC on environmental goods and services, the carbon and water cycles and the management of natural resources. The CCSP Land-Use and Land-Cover Change (LULCC) research addresses the following science questions:

1) What tools and methods are needed to better characterize historic and current land-use and land-cover attributes and dynamics?

2) What are the primary drivers of land-use and land-cover change, and what are the environmental, social, economic, and human health consequences of current and potential land-use and land-cover change over the next 5 to 50 years?

3) How do climate variability and change affect land use and land cover, and what are the potential feedbacks of changes in land use and land cover to climate?

The NRA solicited research proposals in three topical areas: 1) Detection and Monitoring of LULCC processes, 2) LULCC Drivers and Environmental Impacts, and 3) LULCC and Climate Change/Variability Interactions. More details are available at: http://nspires.nasaprs.com

NASA received 173 Step-1 pre-proposals, 87 were encouraged to be submitted as full proposals. NASA/LCLUC and USDA/CSREES selected 14 proposals for funding out of 83 submitted Step-2 full proposals.
Urbanization is altering the global landscape at an unprecedented rate. This form of land cover/land-use change (LCLUC) can significantly reduce infiltration and runoff response times, and alter heat and water vapor fluxes, which can further change surface-forced regional circulation patterns and modulate precipitation volume and intensity. Our central objective is to develop an integrated modeling tool, incorporating spatial data from multiple sensors, to study the interactions between LCLUC, weather, and surface hydrometeorology, with a specific focus on the impacts of urbanization within the Upper Great Lakes region.

The project will evolve on three fronts, including multisensor analysis, model development and integrative analysis and modeling. Datasets from multiple spaceborne sensors will be utilized to explore the role of resolution and spatial heterogeneity on observed and predicted hydrometeorology. Spatial patterns of future LCLUC will be predicted using the Land Transformation Model (LTM), enhanced to incorporate dynamic landcover, economics and policy using Bayesian Belief Networks (LTM-BBN), into its land use change predictions. Different land use scenarios predicted by the LTM-BBN will be represented through the Unified Noah Land Surface Model (LSM) with an enhanced urban canopy model, embedded in the Weather Research and Forecasting (WRF) model. The coupled WRF-Noah LSM model will be used to investigate the connections between land-use, hydrometeorology and the atmosphere, through analysis of water and energy balances over several urbanized watersheds within the Upper Great Lakes region. This analysis will focus on how changing spatial extents of urban and forested areas affect episodic, hydrometeorological events both for current land use as well as projected land use changes.

Developing tools that will lead to an increased understanding of the causal relationships and assessing the impacts of urbanization at regional scales is a critical challenge and central to the science questions underlying NASA's LCLUC Program. The proposed project is directly responsive to the LCLUC and CSREES missions linking LCLUC with climate variability and its effect on the natural environment, with an emphasis on regions undergoing significant urban expansion. In particular, the proposed research addresses a major U.S. Climate Change Science Program question: "How do climate variability and change affect land use and land cover, and what are the potential feedbacks of change in land use and land cover to climate?" The proposed research bridges all three topical areas of the current solicitation, but most directly addresses the goals of the monitoring topical area through development of a suite of tools to better characterize future and current land-use and land-cover attributes and their dynamic contribution to atmospheric and land surface processes.
French, Nancy  Altarum
Using Remote Sensing-Based Measures to Assess NRCS Impacts in Michigan-
Step 2

Agricultural landscapes represent a large proportion of the United States, amounting to 938 million acres of U.S. land (nearly half of all land) for the 48 contiguous states according to the 2002 Census of Agriculture; of this acreage, about 400 million acres are cropland (roughly 20 percent of all land), with the Census and the National Resources Inventory (NRI) offering slightly higher and lower estimates, respectively. These landscapes are dynamic in nature, and this presents a unique challenge for assessment through remote sensing. Nonetheless, many remote sensing-based techniques have been developed, and are being developed, to address land management needs for these agricultural landscapes. These techniques are being applied for mapping and monitoring both agricultural land and the landscapes surrounding agricultural land. Furthermore, these efforts have been supported by NASA to further the development of advanced agricultural remote sensing techniques, and the proposed project seeks to build upon these past efforts linking NASA and the United States Department of Agriculture (USDA).

Specifically, this project, proposed by Altarum Institute and the University of Michigan, will use satellite imagery and NASA-derived data products to assess the impacts of farming programs administered and managed by the USDA's Natural Resources Conservation Service (NRCS). The study area will consist of agricultural lands in Michigan, predominantly in its Lower Peninsula. Furthermore, this project will contribute significantly to efforts to understand the ecological impacts of agriculture and sustainable agricultural practices and will build on an existing cooperative agreement between Altarum Institute and the Michigan office of USDA NRCS.

The main goal of the proposed activity is to develop and employ remote sensing-based analyses to make county-level assessments of inputs to the environmental quality index (EQI) currently under development by Altarum for use by MI-NRCS program managers. Some of the methods and products we propose are established, while others will require some level of development to bring the processes out of the research realm to provide real-world solutions for NRCS. The latter activities will be further scrutinized within the proposed project to ensure that the effort needed to produce results has significant real-world value or to provide a critique of its eventual utility for NRCS program assessment. Long-established remote sensing systems will be used to provide information on the retrospective study (e.g., Landsat and SPOT). Newer established sensors (e.g., MODIS and ASTER) and experimental sensors (e.g., Hyperion) will be used to provide information not available from the more traditional sensor systems.
The proposed work has two primary objectives:

(1) Employ remote sensing-based techniques to provide inputs to the NRCS Program Implementation Measures component of Altarum's NRCS evaluation framework and to develop independent (non-NRCS-based) measures and indicators of ecological health to serve as inputs to the Environmental Quality Measures component of the framework.

(2) Conduct land-cover and land-use change analyses based on remotely sensed data to assess the ecological consequences of changes in land outside the NRCS program activities that may be confounding influences in the evaluation of conservation outcomes.

**Gitelson, Anatoly**  
University of Nebraska-Lincoln  
*Land Cover Land Use Change Effects on Surface Water Quality: Integrated MODIS and SeaWiFS Assessment of the Dnieper and Don River Basins and their Reservoirs*

Remote assessment of surface water quality changes in two major river basins in Ukraine and Russia related to the land use land cover change following the collapse of the Soviet Union using MODIS data with advanced algorithms to retrieve trophic status of turbid productive waters.

**Hansen, Andrew**  
Montana State University  
*Vulnerability of US National Parks to Land Use and Climate Change and Variability 2*

The US National Park Service (NPS) faces the challenge of maintaining ecosystem function and biodiversity within National Parks in the face of climate and land use change. New satellite and other technologies have increasingly allowed reconstruction for past decades of climate and land use at fine spatial scales and consequences for ecosystem processes such as NPP and fire risk. These reconstructions reveal high levels of spatial heterogeneity across the US in directions and magnitude of change in climate, NPP, fire risk, and stream flows. This study will harness these new data sets to better inform the NPS about threats to National Parks. The goal of this study is to assess park vulnerability to current and near-term future climate and land use based on detailed reconstructions and analyses of change and ecological response over the past 50-100 years. Specific objectives are:

1. Quantify change from 1900 to present in land use and climate (mean and variability), ecosystem response and biodiversity (representation of native species guilds, exotic species, species richness).

2. Evaluate statistical patterns of association between land use and climate, ecosystem function, and biodiversity during this time period as a means of
validating vulnerability indices.

3. Evaluate the vulnerability of parks to current and near-term future land use and climate based on past change and ecosystem and biodiversity response.

4. Derive guidelines for mitigating the primary vulnerabilities of each park. The study will include the 70 National Parks in the US that are relatively large in area (>35000 ha). The study will define and include the larger ecosystem surrounding each park. Potential drivers (climate and land use), ecosystem response NPP, stream flow, fire risk, habitat area, and biodiversity response (representation of native species guilds, exotic species, species richness) will be quantified across the 70 national parks during the 1900s using NASA and other imagery, data, and models. Statistical patterns of association will used to evaluate the plausibility of cause and effect relationships between the potential drivers and response variables. The vulnerability of each of the parks to current and near-term future climate and land use change will be assessed based on the RAPPAM methodology. The results will be used to suggest to the NPS which parks are high priority for mitigation, and the primary issues that threaten the parks, and mitigation strategies.

Hansen, Matthew  South Dakota State University

*Establishing a Global Forest Monitoring Capability Using Multi-Resolution and Multi-Temporal Remotely Sensed Data Sets*

Definitive information on the rates and patterns of global forest cover change has been limited due to the difficulties in establishing forest cover change map accuracy and the uncertainty of the estimates of overall rates of change. Furthermore, previous efforts have not been able to provide information on the biogeographical variations of the mechanics and characteristics of forest cover change. A CEOS calibration/validation panel determined that while global land cover maps have proven useful for a wide range of applications, the absence of robust characterization of the uncertainties of the maps have retarded their utility. The CEOS panel also concluded that the problem was particularly challenging for change maps and recommended research that would provide accuracy assessments and statistical characterization of global land cover change datasets.

Our proposed research extends previous NASA-sponsored research on global forest cover dynamics and land cover change estimation to establish a robust, operational forest monitoring and assessment system that:

1) Quantifies rates and describes patterns of global forest cover change by biome and ecoregion.

2) Identifies and quantifies sources of uncertainty of forest cover change maps and areal estimates of change
3) Determines impacts of forest cover change on select ecosystem services.

Our strategy combines the strengths of global forest change mapping to produce a spatially explicit depiction of change at moderate resolution and statistical sampling to provide precise areal estimates of change in forest cover based on more accurate, higher resolution data. In addition, our monitoring strategy generates the data necessary for a statistically rigorous validation of the global forest change maps, thus successfully integrating accuracy assessment within a forest monitoring framework. The research will focus on four primary tasks:

1. Use existing MODIS and AVHRR percent tree cover maps to map areas of likely tree cover change from 1990 to 2005.

2. Implement a remote-sensing based, probability sampling framework that combines the global forest cover maps and high resolution forest characterizations derived from Landsat images to: (a) estimate biome change and the uncertainty of each biome estimate, and (b) determine the overall and individual biome accuracy of the global MODIS and AVHRR tree cover change maps.

3. Evaluate the strengths, weaknesses, and biases of the remote sensing inputs, and how these vary geographically for accurately characterizing forest change, including the ability to quantify deforestation versus afforestation, and natural versus anthropogenic change.

4. Assess the impact on ecosystem services, including a prioritization of ecoregions within each biome that are most threatened by forest cover change.

Kling, Catherine  Iowa State University

*Interactive Drivers of Land-Use/Land-Cover Change in Agricultural Areas: Climate and Land-Manager Choices*

coming decades: land manager choices in response to conservation policy and climate change. Our environmental economics team has developed a tightly integrated modeling system that predicts changes in agricultural land use from changing policy variables, economic drivers, and physical characteristics of the land. These models are being used, in part, to assess the consequences of possible changes in U.S. farm policy as enumerated in discussions related to the 2007 farm bill. Our climate science team currently plays a central role in the North American Regional Climate Change Assessment Program which is developing climate change scenarios at the regional scale by use of regional climate models for use in impacts assessments. We propose to study how the combined drivers of climate change and conservation policies affect land managers land use and cover decisions and, importantly, we tie those decisions directly to changes in environmental outcomes. Specifically, we will focus on how the use of
conservation tillage, land retirement, and fertilizer may change as climate changes and in response to a variety of possible conservation policies. Our environmental measures include both in-stream water quality measures and field-level measures of carbon sequestration, soil and wind erosion, and nutrient loading. Changes in these environmental measures trigger public policy changes which produce feedbacks to the ecosystems being managed (cropping choices, etc) and hence feedbacks to the climate system through biophysical factors such as plant type, evapotranspiration, and albedo. To assess the magnitude of these drivers, watershed models that fully capture the complex interactions between land use, conservation practices, land characteristics, and hydrology will be completely coupled with economic models that can predict the costs of adopting land use changes under various policy regimes. Finally, all of these interactions depend upon the climate conditions in the region and therefore are likely to be altered under different global climate scenarios and by regional feedbacks to the climate system. Indeed, preliminary analysis by our group suggests that climate change may have substantial consequences on major hydrological systems of the region. And another study by our group revealed a regional "warming hole" that has developed and likely will continue, in part due to feedbacks from soil-atmosphere interactions mediated by agricultural crops. Thus, a key element that must be incorporated in a fully coupled system is a global climate model, complete with feedbacks to land cover, agroecosystem responses, economic consequences and human behavior. This project will to address major questions raised in the US Climate Change Science Program (CCSP) Strategic Plan (CCSP, 2005), namely: CCSP Q1 What are the primary drivers of land-use and land-cover change? CCSP Q2 What will land-use and land-cover patterns and characteristics be 5 to 50 years into the future? CCSP Q3 How do climate variability and change affect land use and land cover, and what are the potential feedbacks of changes in land use and land cover to climate? CCSP Q4 What are the environmental, social, economic, and human health consequences of current and potential land-use and land-cover change over the next 5 to 50 years?

Krankina, Olga  Oregon State University  

**NELDA: Monitoring and Validating the Distribution and Change in Land Cover Across Northern Eurasia**

The proposed Northern Eurasia Land Dynamics Analysis (NELDA) project seeks to harness NASA remote sensing technology and local knowledge of land-cover conditions in order to validate and improve land cover / land-cover change products for Northern Eurasia. 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 NELDA project will establish a network of test sites for analyzing land cover, land-cover change, and disturbance captured with time series of Landsat-resolution imagery. Analyses at test sites will rely on recent or ongoing projects and strong regional collaborators with local experience in land cover mapping and change monitoring. The test sites will provide data for validation of existing coarse-resolution land-cover products and samples of important vegetation change and disturbance processes. We will use these samples to develop and test methods for continental mapping of vegetation disturbance that integrate MODIS datasets (e.g., active fires, burned areas, NDVI time series, changes in Vegetation Continuous Fields, phenology products) to produce a vegetation disturbance/change map for the period of 2000-2006. Finally, we will produce a new, updated land cover map for Northern Eurasia based on MODIS data for circa 2005 at 500-m spatial resolution. By improving the training data-base, exploiting the high quality spectral-temporal information from MODIS, and integrating information from the GLC-2000 map directly into the classification process, we will produce the "best possible" map of land cover for the Northern Eurasia region. This new map will include a confidence layer, which provides a measure of the classification quality for each pixel, and a disturbance layer, which shows if a pixel was disturbed since year 2000.

The project will develop tools, methods, data, and collaborations needed to better characterize land-cover dynamics across the Northern Eurasia region and help consolidate a regional network of test sites and researchers dedicated to monitoring land-cover change.

Munroe, Darla  Ohio State University

*A Comprehensive Statistical Analysis System to Associate Local Land-Cover/Land-Use Change and Regional Aerosol Composition and Concentration*

Aerosols, particularly carbonaceous aerosols, will likely play an increasingly important role in the earth’s energy balance and in global climate change. Much of these carbonaceous aerosols are generated by anthropogenic activities, including slash-and-burn agriculture, as well as fossil fuel combustion. The proposed research seeks to add to scientific understanding of the relationship between biomass burning and carbonaceous aerosols by estimating the spatial and temporal dependence structure of regional carbonaceous aerosol concentrations, given atmospheric circulation processes and observed fire occurrences. We examine these trends using a Bayesian hierarchical statistical framework coupled with a numerical weather simulator in a manner that explicitly accounts for the uncertainty associated with these processes. While it is difficult to separate the contribution of biomass burning to regional carbonaceous aerosols due to the chemical and physical processes occurring within the atmosphere, our analytical
technique allows us to estimate the contribution of biomass burning to regional carbonaceous aerosols via the local fire/regional aerosol space-time associations. Finally, we embed the statistical model into an integrated system that will allow the user to forecast aerosol distributions under various environmental policy scenarios. This integrated system will seamlessly retrieve and examine data on aerosols and fires from MODIS and MISR, and visualize the results. In developing our system, we will focus on fire/aerosol relation in mainland Southeast Asia from the end of 2000 to the present. Mainland Southeast Asia is currently experiencing much varied land-use/cover change (including urbanization), though forest clearing for agricultural and forestry activities remains a dominant pattern; our tool is designed to deal with these complex processes and multiple sources of carbonaceous aerosols, yet emphasizes the estimation of the fire-aerosol relationship. We expect to add to the scientific understanding on the processes and changes at work in the study region, but our tool will ultimately have broad applicability to other regions and applications. Thus, the project contributes to NASA strategic objectives to understand and protect the earth, to study the earth from space, and to use NASA's space-based technology to study the interactions between land and atmosphere.

Small, Christopher  Columbia University  

Development and Sensitivity Analysis of High Resolution Land Surface Parameters from Satellite Data and their Use in a Mesoscale Model – LDEO

ABSTRACT

Current Numerical Weather Prediction (NWP) and climate models generally use Land Surface Models (LSMs) that are based on low resolution thematic land cover classifications (e.g., USGS 1 km land cover). At global scales, these low resolution LSM inputs are adequate but at regional scales (100 to 1000 km) the limitations of the LSMS can have a significant impact on the accuracy of the model predictions. Specifically, current LSMS suffer from a) limited spatial and spectral resolution of the optical sensors used to generate the land cover classification, b) saturation of the Normalized Difference Vegetation Index (NDVI) at moderate levels of vegetation cover and c) inaccurate physical parameterization of some thematic land cover classes. This is particularly true in urban and suburban environments where land surface heterogeneity is not accurately represented in low resolution thematic classifications. In order to understand the effect of anthropogenic land cover modification on regional climate in urban and suburban areas, it is necessary to represent this land cover accurately in the LSMS that drive the climate models. We propose to use Spectral Mixture Analysis to estimate areal fractions of biophysical land surface types (e.g. vegetation, rock and soil substrate, water) from moderate resolution satellite imagery (e.g. Landsat) and derive land surface physical properties for input to the LSMS that drive mesoscale regional climate models. The procedure we propose to use has been shown to yield accurate fraction estimates in a variety of urban, suburban and rural environments worldwide. In order to determine the effect of these more detailed land cover inputs we will quantify the difference between
traditional low resolution thematic land cover and aggregated moderate resolution land surface properties, specifically vegetation fraction and albedo. We will test the sensitivity of the regional climate model to each input at different spatial scales in both temperate (New York) and arid (Phoenix) settings. We will also quantify the effect of fine scale (< 1 km) vegetation in each setting by comparing model runs with and without fine scale vegetation.

Soja, Amber  Langley Research Center

Wildfire, Ecosystems, and Climate: Examining the Relationships Between Weather, Extreme Fire Events and Fire-Induced Land-Cover Change in the Changing Climate of Siberia.

This proposed research seeks to utilize 20 years of existing NASA-derived satellite and meteorological datasets and Siberian ground-based extreme fire events datasets to statistically analyze the coincidence in severe fires and the meteorological and synoptic-scale weather characteristics that generate the conditions necessary to sustain extreme fire events. After establishing these relationships, we intend to expand the scope of existing bioclimatic models to predict fire regimes under climate change scenarios for 2030, 2060 and 2090 and to simulate phytomass change and change in the extent and distribution of the dominant vegetation.

Our focus is on Northern Eurasia because this is a region that is currently experiencing rapid warming and is expected to be strongly influenced by future climate change. Siberia is particularly unique because: (1) this region has the potential to interact with and feed back to both the regional and global climate systems due to its continental extent; and (2) the dominant force of Land Cover Change in Siberia is fire disturbance. This project delivers on near- and long-term Climate Change Science Program Land-Use / Land-Cover Change milestones by analyzing existing data to define historic and contemporary rates and the extent of regional Land Cover Change brought about by a major driving force of that change, fire disturbance. Also, the primary weather and climate variables that drive and sustain large fire events will be statistically quantified. Then, fire danger mapping and bioclimatic models will be used to project the largest driving force of change and the resulting change in future Land Cover.

Overall, the goal is to explore the degree to which current and future climate variability affects wildfire-induced Land Cover Change and to highlight the significance of the interaction between the biosphere and the climate system in support of the inclusion of biospheric models in future Atmosphere Ocean General Circulation Models.
Climate of Northern Eurasia has been undergoing major changes over the past century. Growing evidence suggests that land-use/land cover changes and increasing amounts of anthropogenic aerosols might be among the key drivers of observed climate change. Among main aerosol types, wind-blown mineral dust would be most affected by human-induced land-cover and land-use changes (LCLUC). Desiccation of the Aral Sea, conversion of the steppe in Kazakhstan to the agriculture fields in 1950s, severe desertification of northeast China resulting in the formation of new deserts are just a few examples of land-use changes that led to increased dust loadings over and downwind of the NEESPI study domain. Furthermore, by altering local mesoscale circulation and precipitation, land use processes could change the dust emission from natural arid and semi-arid regions. In turn, dust lifted in the atmosphere can affect the land processes by altering the surface radiation budget and photosynthetically active radiation, providing additional radiative heating of the boundary layer and by causing direct and indirect (via clouds) radiative forcing at the top-of-the-atmosphere. The degradation of visibility and health problems caused by dust make it an important air quality issue. The recent IPCC (2001) report pointed out that both LCLUC (via surface albedo) and atmospheric dust are important forcing drivers, yet they were considered as two independent factors. Given the intimate coupling between the land processes and wind-blown atmospheric dust and their importance in the climate system, an improved understanding of how land-use/land-cover changes affect Asian dust and associated feedbacks is urgently needed to make assessments of climate change more realistic. This proposal is a collaborative effort of the researchers having the multi-year experience in the atmospheric dust, LCLUC, and climate fields aimed to address this complex problem focusing on the NEESPI study domain. The main goal of this study is to investigate how and to what extent land-use/land-cover changes and varying dust loadings and their interactions have been affecting climate of drylands in the NEESPI study domain over the past 50 years. Our strategy is to integrate the diverse satellite and ground-based data on land-use/land-cover, Asian dust, and climatic variables that will enable us to perform spatio-temporal statistical analysis as well as to guide the modeling efforts. The specific objectives are as follows: Objective 1. Reconstruct land-use/land cover changes and dust storm events in Central and East Asia over the past 50 years by merging available data from satellite, weather and monitoring stations, and historical records. Objective 2. Investigate the spatio-temporal structure relating the dynamics of LCLUC, dust events, and climatic variables (surface temperature, winds, precipitation, humidity, cloud coverage, drought indices) by conducting statistical analysis at a range of spatial and temporal scales using a combination of the statistical methods. Objective 3. Based on the analyses described above, assess the individual and coupled effects of land-use and Asian dust changes on regional climate via their impacts on energy- and water-budgets.
Determine the formulation of these effects for further quantifications through climate modeling. Such formulations will be both as simple prescriptions for forcing scenarios and as including the coupled dynamics of the land-dust system. Our proposed research directly targets the NASA LCLUC program solicitation that requests the proposals in support of the Northern Eurasia Earth Science Partnership Initiative (NEESPI). This proposal in particular addresses the mineral dust, the key component of atmospheric aerosol in Northern Eurasia, which is involved in important interactions with LCLUC and climate change via a complex and still poorly understood series of direct impacts and feedbacks. We seek to gain a better understanding of those interactions that are central to answering the key NEESPI science questions highlighted by the LCLUC program solicitation. Furthermore, our proposal contributes to the overall goals of NASA and its vision on "...To understand and protect our home planet."

**Turner, Billie**  
Clark University  
*Landscape Vulnerability-Resilience in the Southern Yucatan Peninsular Region [SYPR]*

Consistent with the expansion of international and national programs dedicated to land change science, this proposal examines the synthesis question of vulnerability-resilience of the land system in the southern Yucatán of Mexico. Building from its long-standing land-change science focus, the Southern Yucatán Peninsular Region project (1997-pr) proposes to use Landsat TM/ETM+, ASTER, MODIS, and AVHRR data, combined with modest fieldwork, to address part of the following overarching question: Is the land system of the southern Yucatán becoming less resilient, experiencing a reduction of its capacity to deliver ecosystem services, and increasing its vulnerability to combined biophysical and socioeconomic hazards? This question is salient because the southern Yucatán houses the Calakmul Biosphere Reserve and constitutes a critical ecotone for MesoAmerican Biological Corridor, but yet has incurred substantial development and deforestation over the past 35 years. The proposed project addresses three "outcomes-to-be-avoided" that diminish the capacity of the forest ecosystem to maintain crop productivity, diversity of forest types and species diversity, and resistance to catastrophic fire events; through seven hypotheses ultimately linking to the land changes underway. Three hypotheses consider if the region and landscape display increasing extent and intensity in deciduousness in forests, surface temperature, and incidental burning. Two address reduced soil fertility and long-term productivity due to these changes and those in the cultivation. And, an additional two examine the consequences of the first five on regional and landscape biotic diversity and species behavior. The finding will form one part of larger and longer term effort to create a coupled human-environment model of vulnerability-resilience for the region.
Vorosmarty, Charles  
*University of New Hampshire*

*Role of Land Cover and Land Use Change in Hydrology of Eurasian Pan-Arctic*

harmonized data archive and analysis tool, which will be used to improve our current understanding of interrelationships between climate, hydrology, and land cover/land use changes over the Northern Eurasian (NEESPI) domain. The work is organized around three major Goals, with three distinct time horizons (1935-present, contemporary satellite era, future to 2050):

**GOAL 1 SYNOPTIC-SCALE ANALYSIS:** To combine existing data and modeling resources within an integrated framework for diagnostic studies over historic and contemporary time frames to identify the individual and combined impacts of climate, LCLUC, and other factors and to rank these in importance.

**GOAL 2 CONTEMPORARY HIGH RESOLUTION ANALYSIS:** To identify "hot spots" of rapid hydrologic change and to assess the fidelity of the synoptic-scale results.

**GOAL 3 FUTURE TRENDS:** From the computed contemporary benchmark, stage scenario analysis of future water system change as a result of climate, land use/land cover, water engineering and other key drivers across the northern NEESPI domain.

**GOAL 4 PROVISIONAL DESIGN OF INTEGRATED MONITORING SYSTEM TO DETECT AREAS OF RAPID HYDROLOGICAL CHANGE.** To employ consolidated environmental data sets based on modern remote sensing, ground-based monitoring, and modeling to determine the required space and time resolutions and other design criteria to detect and monitor hot spot areas across the northern NEESPI domain. The workplan is built around several well-established models, data sets, and remote sensing capabilities of the proposing group, and will be applied in the context of a set of systematic numerical experiments. These information resources are "project-ready" and will be applied in the full regional context of the northern NEESPI domain. An integrated analysis system for this domain, NEESPI-RIMS, will be developed and represent an extension of the current pan-Arctic Regional Integrated Monitoring System.

Identifying the separate and conjunctive impacts of factors such as climate change, land use and land cover change, fire, permafrost degradation, the redistribution of lakes and wetlands, and water engineering will be critical to understanding the full dimension of hydrologic change in the region, and in designing environmental monitoring systems to analyze these unfolding changes.

Walker, Skip  
*University of Alaska-Fairbanks*

*Application of Space-Based Technologies to Examine Land-Cover/Land-Use Change Along a Transect on the Yamal Peninsula and Novaya Zemlya, Russia*

The overarching goal of our proposed research is to use remote-sensing technologies to examine how the terrain and anthropogenic factors of reindeer herding and resource development, combined with the climate variations on the Yamal Peninsula, affect the spatial and temporal patterns of vegetation change and how those changes are in turn affecting traditional herding by indigenous people of the region. The Yamal Peninsula in northern Russia has been identified
as a "hot spot" for both Arctic climate change and land-use change. The Yamal has undergone extensive anthropogenic disturbance and transformation of vegetation cover over the past 20 years due to gas and oil development and overgrazing by the Nenets reindeer herds. We propose to establish a transect of eight sites across the Yamal to investigate the combined effects of climate change and anthropogenic influences. We will investigate how vegetation changes in this heavily impacted region on poor sandy soils compares with other areas in the Arctic, especially a similar transect on loess soils with less grazing impact in North America. We will use a combination of ground-based studies, remote-sensing studies, and studies of Nenets land-use activities to help develop vegetation-change models that can be used to predict future states of the tundra. This research is in response to the Northern Eurasia Earth Science Partnership Initiative (NEESPI). It principally addresses the NEESPI science questions regarding the local and hemispheric effects of anthropogenic changes to land use and climate. Furthermore, it will use and contribute to NASA's global-change observations, particularly work exploring the consequences of the dramatic decline in the Arctic sea ice and the greening of terrestrial vegetation that is occurring in the northern latitudes. The project will combine the long-term record available through AVHRR and MODIS sensors with the most recent sensors that provide very detailed spatial and spectral information regarding land-cover/land-use change in the Arctic. The project is also the intersection of three International Polar Year (IPY) initiatives: (1) "Greening of the Arctic" (GOA), (2) "Cold Land Processes in NEESPI" (CLPN) and (3) "CircumArctic Rangifer Monitoring and Assessment" (CARMA).