

PATTERN TO PROCESS: DEVELOPMENT OF A SIGNATURE PROGRAM IN LAND USE AND LAND COVER CHANGE

Interdisciplinary Environmental Research Initiative at Michigan State University

Stuart H. Gage, Entomology
David L. Skole, Geography

INTENT OF THIS PROPOSAL

This proposal is intended to initiate a major new cross-campus environmental research program focused on Land Use and Cover Change. This program is intended to galvanize and coordinate on-going environmental research projects and faculty members at Michigan State University. The overall goal is to create a nationally and internationally recognized *Signature Program*, which brings together existing expertise and provides a basis for catalyzing new activities. We recognize that such a campus-wide initiative is a major undertaking and will require more investment than can be provided by the Strategic Partnership Program alone. Thus, the objective for this proposal is to seek initial resources in the amount of \$590,000 over a 3-year period in key areas in an effort to *enable* the overall development and implementation of such a program through: (1) creation and installation of an Environmental Research Enterprise Zone, and (2) organization of a major international conference on Land Use and Cover Change to be held at Michigan State University in the year 2001.

IMPORTANCE OF LAND USE/COVER CHANGE RESEARCH

Air, water, and land are the three major physical components of the Earth's Biosphere. In the US, environmental problems such as smog in Donora Pennsylvania in 1948, and the Cuyahoga river fire in Cleveland during 1969 mobilized very early initiatives to address the quality of air and water (Diamond and Noonan 1996). The sound use of the land from an environmental perspective is still out of reach. It is widely accepted that land use is an important component of global change (Ojima et al 1991, Meyer and Turner 1992, Vitousek 1994). However, the interdisciplinary nature of the interactions between different ecological, technological, social, and economic drivers of land use remains to be elucidated. For instance, land use/cover is an acknowledged driver that has yet to be included in current global circulation models studying the causes and consequences of climate change. The land use/cover system (Figure 1) is by its nature highly complex (Heilig 1994) and only through a multidisciplinary approach we can improve our current understanding of the system (Dale 1997). Recently, MSU researchers have developed numerical models of land use

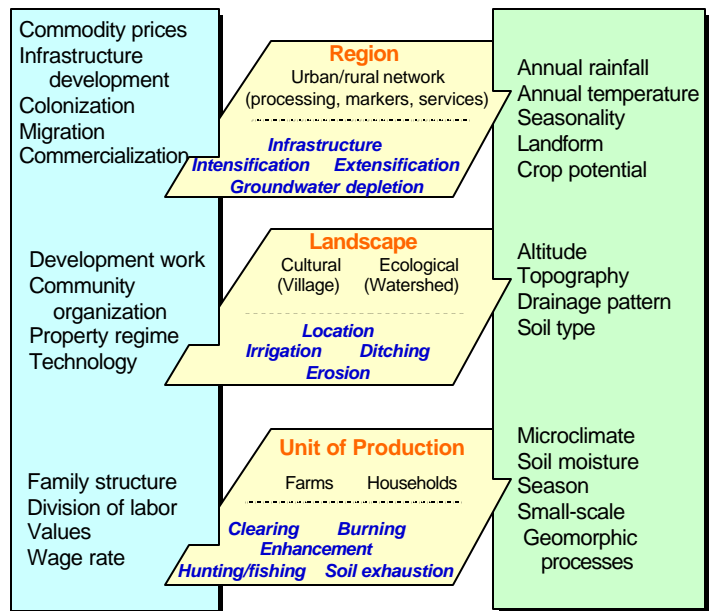
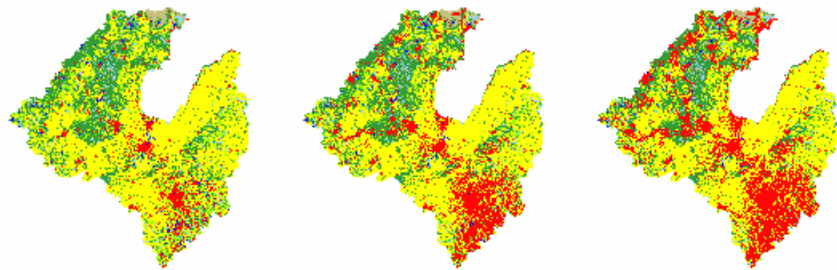


Figure 1. Integration of human (left) and environmental (right) drivers of land use/cover across scales from local to global.

and land cover change for Michigan to characterize the future land transformation (www.ns.msu.edu/lum). This model predicts as shown in the figure below, human population trend (red color) in the Saginaw Bay Watershed based on an integration of policy options, land use trends and human population census. Michigan State University has established a history in land use issues by establishing an outreach series of Land Use Forums (www.msue.msu.edu/luf/) and MSUE has identified some land use resources (www.msue.msu.edu/msue/iac/landland.html).



MSU LEADERSHIP



Michigan State University is well known for its scientific and technological capabilities as one of the nation's premier Land Grant University. From a scientific point of view, MSU is internationally recognized for its research in forestry, agriculture, water resources, human health and other real-world applications. In addition it promotes a truly interdisciplinary approach by the integration of the social and biophysical sciences. From a technological point of view MSU has several facilities which provide: (i) advanced remote sensing and spatial analysis at a large scale, (ii) unique access and know-how for using massive amounts of spatial data (iii) information systems technology to disseminate information.

Thus, MSU has all the necessary components to respond to current issues and demands on environmental research. We propose to capitalize on MSU's existing strengths by creating a nationally and internationally recognized interdisciplinary Signature Program on Land Use and Land Cover Change Research and Outreach that will serve to stimulate excellence in teaching and service. We will accomplish this goal through the following specific objectives.

SPECIFIC OBJECTIVES

- a) ***Establish*** a unique nationally and internationally recognized research program in Land Use and Land Cover Change as a central, contributory element of MSU's environmental research initiative.
- b) ***Create*** an interdisciplinary focus for a campus-wide activity that enhances and expands MSU externally funded research.
- c) ***Develop*** new opportunities for excellence in teaching and service coupled to an active research program.
- d) ***Stimulate*** new modes of entrepreneurial activities through expansion and enhancement of existing excellence in environmental research ("We cannot do the same things better, we must do new things").
- e) ***Incubate*** new technologies for improved campus and public access to information about the state of the local, regional, and global environment.

THEMES AND SCOPE

To galvanize a broad-based, university-wide effort we will build on prior successes, including but not limited to:

- Basic Science and Remote Sensing Initiative (BSRSI) (www.bsrsi.msu.edu/)
- Computational Ecology and Visualization Laboratory (CEVL) (www.cevl.msu.edu)
- Center for Remote Sensing (CRS) (www.crs.msu.edu/)
- Partnership for Ecosystem Research and Management (PERM) (www.fw.msu.edu/perm/).

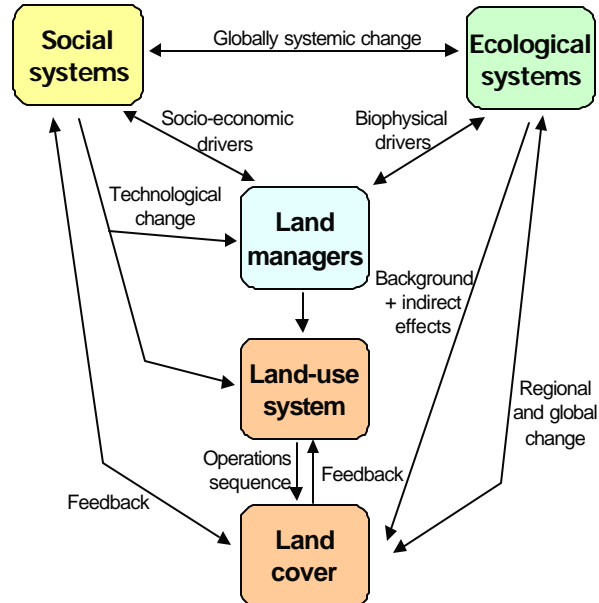
We will twin these recent successes with other nationally and internationally recognized strengths and successes at Michigan State University such as the Kellogg Biological Station - Long Term Ecological Research (www.lternet.edu).

This land use/cover signature program will provide the necessary leverage to obtain external funding to produce large returns per unit of initial investment. We are in the position to evolve from recent notable externally funded initiatives such as NASA Center of Excellence, NASA Earth Science Data Center, Landsat-7 receiving station, and Internet 2.

Our research themes will:

- have an Earth System Science and Global Change framework
- address all dimensions of land use/cover change research
- accomplish multi-scaling (from global to local systems) at different temporal scales
- emphasize relationships between biophysical and socio-economic systems
- address land-water interactions, land-air interactions, and the role of human disturbance and management

Such studies will have policy relevance for the Upper Great Lakes region.



This land use/cover program will foster collaboration and synergism among researchers that will:

- Capture patterns of change using new earth observing satellites (e.g. Landsat 7, EOS), in-situ measurements (e.g. weather and climate, water quality), and socio-demographic data (e.g. digital census databases, surveys, digital atlases).
- Understand the fundamental processes driving change through field-based analyses, surveys, and research efforts, which provide on-the-ground insight.
- Synthesize, assess, and evaluate models and report cards in response to state, regional, national, and international policy needs.
- Disseminate information using computational and visualization technology for managing complex ecological and landscape information from the local to global scales.

STRUCTURAL COMPONENTS OF THE PROGRAM

We envision this program on land use/cover change to be the core of an *MSU Environmental Science Enterprise (ESE)* that will be research-centered, with strong ties to applications and outreach in addition to graduate and undergraduate education. This ESE will:

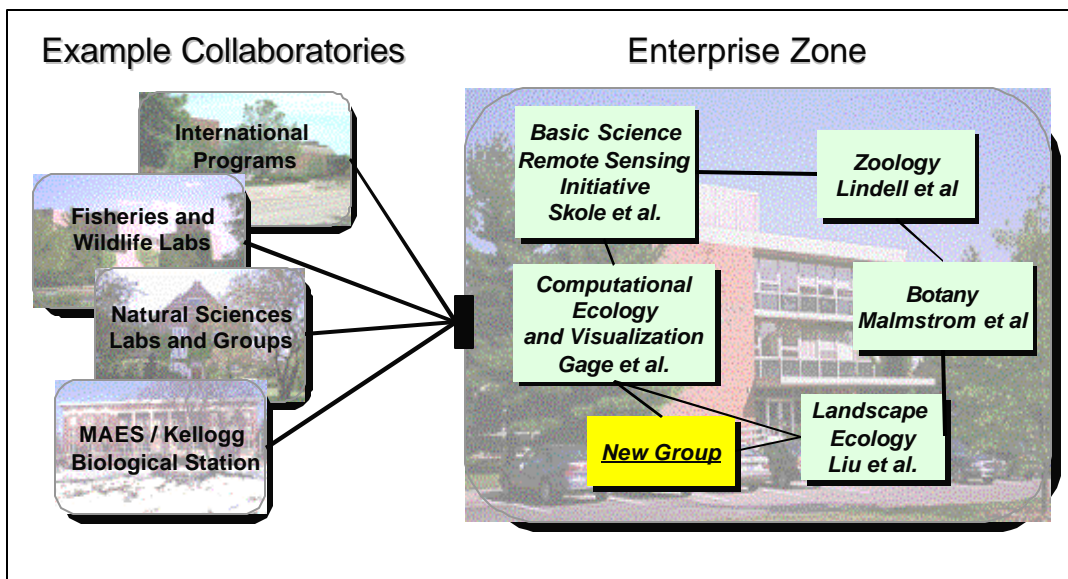
- Promote cross college and cross discipline collaboration
- Support an enterprise which can adjust to changing national and university priorities
- Enhance entrepreneurial initiatives
- Emphasize excellence in research and education.



The use of the term *Enterprise* is intentional; we want to convey the concept of a campus-wide, interdisciplinary and broadly participatory activity that has flexibility for change as research questions and priorities change. It is not a call for the creation of a Center, per se, but rather the establishment of a program of activities. Indeed, some centralization of activities may occur and we do envision the establishment of a central facility for collaborative work. The intention of this central place, or *Enterprise Zone*, is a modular concept, design and implementation, offering groups and PIs from various campus units a place to co-locate for collaborative work.

An Environmental Research Enterprise Zone. This E-Zone will be a dynamic place where research groups can co-locate for collaborative work, but which is flexible to change participants as priorities change. It will provide a physical place in which the faculty and student communities can discuss and interchange ideas related to the Environment.

Research Collaboratory. This will be a “laboratory without walls” in which we will use network technology to tie groups together, either on campus or off campus -- including state agencies and foreign colleagues. MSU is one of the 151 participant universities across the US leading the Internet 2 project aimed to develop a “new networking capabilities and advanced applications to enable researchers and education into the new century” (www.internet2.edu/html/about-i2.html)



OVERALL ACTION PLAN

The overall Signature Program will be developed in two Phases: (1) an **Enabling Phase** and (2) an **Expansion Phase**. The enabling phase will focus on a core of successful and critical groups to jump-start it and will create a place and means for collaboration. The expansion phase will define some early crystallizing activities and will enable entrepreneurial Chairs, Deans, and faculty to extend participation. Note that this proposal seeks resources only to begin the Enabling Phase through a two step process: (1) installation of the Enterprise Zone and its associated Research Collaboratories, and (2) organizing and planning an international conference for the year 2001. Here we present the details as an Action Plan. In the next section we describe the requested resources from the Strategic Partnership Program

Enabling Phase (Year 1)

Research

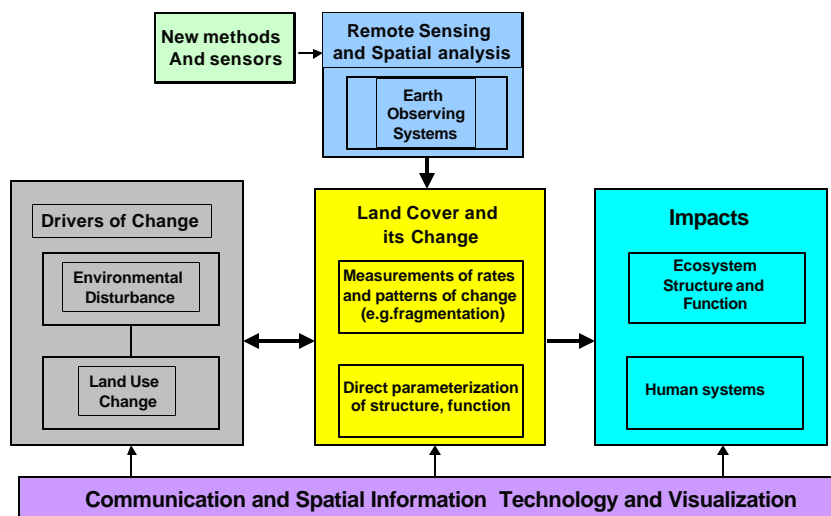
To initiate the process a core set of collaboratories will be formed by existing groups and programs whose philosophy, organization or facilities can contribute significantly to the Environmental Science Enterprise. Proposed groups and programs include:

Initial Suite of Core Groups	Initial Suite of Core Programs
<ul style="list-style-type: none"> • The Basic Science and Remote Sensing Initiative (Skole, Qi) • The Computational Ecology and Visualization Laboratory (Gage) • The Basic Science and Remote Sensing Initiative affiliates (ZOL:Lindell, BOT: Malstrom) • The Center Remote Sensing (Groop, Lusch) • The Landscape Ecology/PERM (Liu) 	<ul style="list-style-type: none"> • Michigan Agricultural Experiment Station programs • International Study Programs • Ecology and Evolutionary Biology Program • Social Science Environmental group • Other groups TBD

These groups/programs cover important technological aspects of the land use/cover program including remote sensing, spatial analysis, and information and visualization. In addition, these core groups/programs have ongoing projects to jump-start the enterprise zone and the collaboratories.

An office for the land use/cover signature program will be established which will host a Research Associate and two Graduate Assistants. The main responsibilities of these personnel will be to:

- Assist in the development of the physical infrastructure of the E-Zone
- Implementing a public relations strategy to promote the E-Zone concept including web page development, in-house publication, etc.



- Identify and facilitate linkages with MSU faculty
- Coordinate and develop the Global lu/lc Symposium to be held at MSU in 2001
- Develop infrastructure to provide computational and data resources to faculty in the E-Zone

The Enterprise Zone will be housed in *Manly Miles* and will include the following tenants: BSRSI, RESAC, CRS, CEVL outpost, Zoology outpost, Botany outpost, Landscape Ecology outpost. This step will require some renovation, furniture, equipment, network lines, administrative and technical support. Equipment for videoconferencing will facilitate the communication between the Enterprise zone and the collaboratories.

Also it will be necessary to formalize the initial collaboratories, including the KBS RS/GIS Lab, Las Alturas station, Landscape Ecology Lab, CEVL, other TBD. This part of the process will require cost matching to departments and units and the necessary installation of network lines.

This phase require some critical programmatic and institutional recasting. The MSU administration will need to “reinvent” existing initiatives as programs of the new enterprise with some resource reprogramming -- e.g. MAES appointments.

Some initial identified initiatives during this phase are:

- Human Dimensions Research: institutions, agency
- Public Policy and Integrated Assessment
- Agriculture as a Biological System
- Climatology and Climate Change: GCMs/ Meso Scale analyses
- Long range transport of organisms in the atmosphere

Education and Outreach

This signature program will have strong ties to education. During this phase, we will have discussions with Departmental Chairs to determine the best strategy for student involvement in this program that will permit students to be exposed to relevant issues in science and technology with relation to land use/cover change. Initially we propose an array of internships and mentoring programs to begin undergraduate student involvement. Several environmental educational programs are shown below:

- Bailey Scholars (canr.msu.edu/bailey/Home/index1.htm)
- Lyman Briggs School (msu.edu/~lbs/)
- Rise Program
- Earth System Science Education (creator.ns.msu.edu/esse/)
- University Committee for a Sustainable Campus (ecofoot.msu.edu/)
- GLOBE (globe.fsl.noaa.gov/)
- General Environmental Science and Education (lib.msu.edu/link/uncats.htm)

Expansion Phase (Years 2 and 3)

Research

The E-Zone program should be announced by the University Administration to call for additional interests. We will use strategic solicitations to bring entrepreneurial departments into the E-Zone as new starts. They will include Initiatives which are incubated in departments (Departmentally driven scenario), at the College level, from the Administration, or from within the enterprise for a

two year period. Successful initiatives will move fully into the Enterprise as they flourish on their own.

A memorandum of understanding (MOU) will commit members of the Enterprise zone to:

- Share ideas
- Share data
- Publish internal documentation (Intranet journal)
- Seminar participation
- Contribute to student training

We will implement an Initiative Roundtable within the University to generate new ideas and build cross-campus collaborations/partners. The output will provide ideas for programmatic priorities and opportunities. Round tables eventually will become a regular part of the E-Zone itself through a “systems synergy” facility (video conferencing, remote whiteboards, training center, computer visualization, etc).

We will develop a mechanism to provide opportunities for inbound sabbatical professorships to work on synthesis of ongoing initiatives and development of new ones.

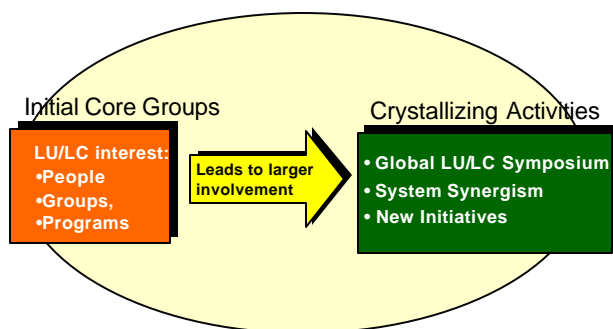
We will expand existing initiatives in which MSU is involved. They include:

- Extending the research and outreach under the NSF LTER at KBS to region-wide scale through remote sensing. Development of an LTER Great Lakes Initiative.
- Developing an LTER-like analog in the tropics in Costa Rica for research and teaching.
- Coordinating a network of existing Michigan and regional projects, such as the North Central Regional Agroecosystem Assessment (USDA funded), and the Grand Traverse Bay Land Transformation Initiatives (Great Lakes Protection program).
- Regionalization of Extension: developing multi-state alliances with other Land Grant Universities (UWisc, UMin) and state and federal agencies as a NASA supported Regional Earth Science Applications Center for resource management using remote sensing.
- Expanding the NSF funded GLOBE and NASA funded ESSE projects to develop a new high technology based curriculum in global change and environment
- Development of a remote sensing receiving station through NASA and NSF

Toward campus-wide involvement

Critical in the crystallization process of the E-Zone to gain wide participation will be the implementation of activities including:

- A major conference for the end of the year 2001, in which we will invite distinguish speakers from different parts of the world. Output from this conference will provide ideas for programmatic priorities and opportunities.
- Build a public relations strategy with government, academic, and industry aimed to increase the visibility of the MSU's Environmental Research Initiative.
- Infuse the principles of a learning organization, so members can expand personal capacities, improve own worldviews, build a shared vision, allow for collaborative learning, and develop systems thinking.



MSU units with faculty that can potentially participate in this initiative include Kellogg Biological Station / Long Term Ecological Research, Center for Integrated Plant Systems, MAES, International Programs, Geology/CNS, Zoology, Sociology, Agricultural Economics, Resource Development, Anthropology, Fisheries/Aquatic, Engineering, Communication and Arts.

Management Structure

- MSU Stakeholders: VPRGS, MAES, Environmental Deans
- A steering committee comprise of “internal” and “external” stakeholders
 - VPRGS office, MAES
 - Enterprise Program Directors
 - Chairs, Deans, faculty
- Independent external consultative/review group
 - Distinguished professors, CEOs, agency people, etc

Education and Outreach

Student participation will be expanded from undergraduate to graduate level involvement. Graduate students will be encouraged to participate through assistantships (masters) and enrichment programs (PhD). We propose the creation of Associate degrees in environmental science with emphasis in land use/cover technology to be offered to individuals outside the university.

Resource Request from Strategic Partnership

Personnel

An office for the land use/cover signature program will be established which initially will house a Research Associate and two Graduate Assistants

Resources \$270,000 (over 3 years)

E-Zone Collaboratories

There will be six (6) E-Zone posts that will house the MSU E-Zone participants. Each post will be equipped with SGI NT high visualization computers with high-speed networks to large information servers which house LULCC information. The E-Zone will be managed by Gage and Skole who will report to directors of MSU laboratories currently participating in the E-Zone. The initial members of the E-Zone will include laboratories in Entomology, Zoology, Botany, Geography, Fisheries and Wildlife and Basic Science and Remote Sensing Initiative. The number of the E-Zone participants may grow or may remain constant. Member may move into or out form the Z-Zone depending on interests of what they bring to the LULCC program. E-Zone participants will report to an individual identified by the Vice President for Research and Graduate Studies.

The objectives of the E-Zone are:

- To facilitate collaboration between MSU faculty interested in LULCC
- To enable development of new thrusts and initiatives related to LULCC requiring a multi-disciplinary perspective
- To ensure that MSU initiatives in LULCC are orchestrated such that we maximize the benefits related to external resources in LULCC

- To communicate among the research, education and outreach community about emerging issues related to LULCC

Resources: \$110,000 (over 3 years). Retrofit existing space to house representatives from the initial E-Zone participants. Purchase computation resources to facilitate LULCC research and education by E-Zone participants. Install high-speed network lines between MSU the first set of E-Zone participants.

Sabbatical Enterprise Initiative

An objective of the E-Zone is to encourage and facilitate the attraction of world class LULCC expertise. We plan to establish facilities to support two simultaneous experts. We will provide facilities similar to those that support each of the Collaboratories. The people who occupy the Sabbatical Enterprise Initiative will be supported for 3-month, 6-month or one year interval. We intend to attract professionals in LULCC from a combination of academia, industry and government. We will strive to mix local (Michigan), national and international participants. We expect the Sabbatical Enterprise participants to work with the E-Zone collaborators. The System Synergism Facility will provide the interactive interface between collaboratories.

The objectives of the Sabbatical Enterprise is to:

- Attract the best minds in the world to MSU to interact on issues related to LULCC
- Provide access to faculty and students to leaders in LULCC
- Encourage development of new initiatives by individuals attracted to MSU's LULCC program in collaboration with MSU faculty

Resources \$50,000 (over 3 years): We need to be able to support ½ of a sabbatical salary (\$50,000 annual equivalent). The individual(s) will have access to the same resources as the other E-Zone participants (computational infrastructure).

System Synergism Facility

The System Synergism Facility is a collaborative technology room to facilitate local inter-person collaboration or collaboration over long distances using remote communication technology. This facility will house the latest in collaborative technologies including white boards, video conferencing, interactive displays, and high speed computational and visualization technologies. The facility will be networked with high-speed network capacity to enable the transmission of large scales of information remotely.

The SSF will be a keystone element in the E-Zone. The purpose of the facility is to:

- Identify new ideas that may evolve into new funded research and education projects
- Brainstorm on initiatives identified by faculty, university administration and staff
- Connect to remote E-Zone participants within the University
- Connect to remote participant in other universities and other organizations
- Provide a place for E-Zone participants to create interdisciplinary and multi-disciplinary proposals
- Provide a place to demonstrate capacity of LULCC program at MSU to Industry and other entrepreneurial interests

Resources \$90,000 (over 3 years). Outfit System Synergism Facility with communications, video and computational resources; White boards; Video communication; Digital Presentation facilities; Computational resources

International Workshop on LULCC

One of the major activities proposed in this initial Land use/cover change program is the implementation of an international workshop at Michigan State University that will:

- give a national and international diffusion of the land use/cover change program at Michigan state university
- stimulate the participation of different government, private, and educational sectors of Michigan on issues related to land use/cover change
- bring an up-to-date perspective on the current understanding and needs on land use/cover change
- propose new lines of research on land use/cover change at MSU that are suitable for external funding

Developing the framework for this workshop will be the first activity of the enterprise zone (E-Zone). The workshop should provide an opportunity to present a wide array of issues in relation to land use/cover change from an ecological, social, physical, and technological points of view at small and large spatial scales. To begin the process, a campus-wide workshop will be implemented to promote the land use/cover change initiative at MSU and to obtain suggestions and input for the international workshop. We will establish a Web site to maintain a constant communication among interested people and keep them informed on the preparation of the workshop. This web site will also be used to post the results of the workshop

The workshop will be directed to key people within the different sectors (government, private, industrial, and academic) involved in Land use/cover issues.

A person will be hired to coordinate the logistics of the workshop (housing, computational infrastructure, session dynamics, and publication of proceedings)

Resources: \$70,000 Workshop Manager; Workshop logistics

CAPACITY OF INVESTIGATORS

Dr Gage has been a Professor at Michigan State University since 1984 and has extensive experience in quantifying the dynamics of animal populations at regional temporal and spatial scales. His focus on the role of meteorological and physical effects on insect pests of agricultural and forest systems have led to development of large scale monitoring and modeling efforts for risk assessment in forest and agricultural settings. Gage directs the Computational Ecology and Visualization Laboratory [<http://www.cevl.msu.edu>]. His current research involves quantifying visualizing ecological processes associated with agriculture and forest systems at multiple time and spatial scales. He is studying the role of habitat structure as it affects beneficial organisms at the landscape scale. Gage is investigating the spatial dynamics of forest defoliators (gypsy moth) at a statewide and regional scale. He is developing a regional visualization model of agricultural dynamics in the US "Corn Belt".

Gage serves on the USDA North Central Regional Committee on the Movement and Dispersal of Biota and on the Regional Committee on Agricultural Meteorology and has served as Chairperson on each of the committees. He is past Chairperson of the Governing Board of the Alliance for Aerobiology Research and has participated in several Aerobiology Symposia sponsored by the American Meteorological Society. He and co-author Scott Isard are in the final stages of submitting a book manuscript to MSU Press with entitled "Flow of Life in the Atmosphere: An Airscape Approach to the Management of Pest Organisms".

Gage teaches principles of computational ecology and leads a NASA supported project (ESSE) where his team developed two undergraduate courses in Earth System Science. He serves on the University Space Research Association Board on Earth Science. Gage is Co-PI on the NSF Long Term Ecological Research project in Michigan and is Co-PI on a GLOBE grant. Gage is coordinating a regional simulation-modeling workshop at the San Diego Supercomputer Center on behalf of the NSF-LTER Network Office. Recently Gage developed the Computational Ecology and Visualization Laboratory.

Dr. Skole is currently the director of the Basic Science and Remote Sensing Initiative, a research program focused on environmental research using remote sensing systems. Dr. Skole's research interests focus on the role humans play in changing land cover throughout the world. He uses satellite data to measure the patterns of landscape change at regional and global scales, then employs field research to uncover the fundamental processes of change. Dr. Skole is also developing analyses and models of the carbon cycle and biodiversity. Currently he is involved in research projects focused on understanding the interannual variation in deforestation rates, and the social and ecological controls on its variation over time. He is PI of a NASA ESIP center. He is also PI for the NASA Landsat Pathfinder Project, PI on a number of other funded research projects including the Large Scale Amazon Basin Experiment. He is a PI and member of the Landsat 7 Science Team, and is a PI with the Canadian Radarsat program and the Japanese JERS program. Dr. Skole is the PI on the NASA funded Center of Excellence in the Applications of Remote Sensing at MSU. He is also PI and Co-I on several studies of the human dimensions of land use and cover change.

Skole is the Chairman of the IGBP/IHDP Core Project on Land Use and Cover Change, a Steering Committee member for the IGBP Data and Information Systems project, as well as a member of the Standing Committees of the IGBP and IHDP. He has served on several NASA committees and panels for EOS and its data system and other programs. He is currently the High Resolution Design Team Leader for the CEOS project on Global Observations of Forest Cover. He has consulted and been awarded contracts for several private aerospace firms including Raytheon and Hughes, and for the World Bank and NGOs including the World Resources Institute.

References

- Diamond, H.L. and P.F. Noonan. 1996. Land use in America. Island Press, Washington D.C. 351 pp.
- Heilig, G.K. 1994. Neglected dimensions of global land-use change: reflections and data. *Populations and Development Review* 20: 831-859.
- Meyer, W.B. and B.L. Turner II. 1992. Human population growth and global land-use/cover change. *Annu. Rev. Ecol. Syst.* 23:39-61.
- Ojima, D.S., T.G.F. Kittel, T. Rosswall, B.H. Walker. 1991. Critical issues for understanding global change effects on terrestrial ecosystems. *Ecological Applications* 1: 316-325.
- Vitousek, P.M. 1994. Beyond global warming: ecology and global change. *Ecology* 75: 1861-1876.