LAND SYSTEMS
FOCUS AREA

NEESPI LAND USE
RESEARCH BRIEFING
BEIJING
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Dennis Ojima
NREL
Colorado State University
THE GLOBAL LAND PROJECT

RESEARCH THEMES

• Social and Physical Factors Contributing to Land System Change
• Consequences of Land System Changes
• Integrated Analysis of Coping and Adaptation to Global Environmental Change
GLOBAL LAND PROJECT

Earth System

Land Systems

Social Systems
- Population
- Social/Economic structure
- Political/Institutional regimes
- Culture
- Technology

Decision Making

T1.1

T1.2

Land Use & Management

T2.1

Ecosystem Services

T2.2

Ecological Systems
- Biogeochemistry
- Biodiversity
- Water
- Air
- Soil

T2.3

T2.4

T3.1 Critical pathways of change
T3.2 Vulnerability and resilience of Land-Systems
T3.3 Effective governance for sustainability

T1. Dynamics of land-systems
T2. Consequences of land-system change
T3. Integrating analysis and modelling for land sustainability
Keys to meeting Challenges

- Greater appreciation of the coupled socio-environmental system
- Analysis of Land 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
- Incorporation of historical aspects and timescales of social and environmental changes.
DYNAMIC GLOBAL LAND TRANSITIONS

LAND USE [Human control]

LAND COVER [Biophysically controlled]

Social Systems
- Institutions
- Culture
- Technology
- Population
- Economic

Human Decisionmaking
- political/economic choices

Ecological Systems
- Biogeochemistry
- Genetic bank
- Water
- Air

Ecosystem goods & services
- clean air/water
- waste recycling
- food/fibre/fuel
- recreation

Economic Problems
- poverty
- unequal wealth
- war
- globalization

Ecological Problems
- pollution
- diseases
- food/fibre/fuel shortages
- overcrowding
Defining ecosystem services

Provisioning
Goods produced or provided by ecosystems
- food
- fresh water
- fuel wood
- fiber
- biochemicals
- genetic resources

Regulating
Benefits obtained from regulation of ecosystem processes
- climate regulation
- disease regulation
- flood regulation
- detoxification

Cultural
Non-material benefits obtained from ecosystems
- spiritual
- recreational
- aesthetic
- inspirational
- educational
- communal
- symbolic

Supporting
Services necessary for the production of all other ecosystem services.
- Soil formation
- Nutrient cycling
- Primary production

Millenium Ecosystem Assessment 2003
Linking Across Scales of the Coupled System

Natural hierarchy
- Global ecology
  - Regions/Biomes
    - Communities & Ecosystems
      - Populations
        - Individual organisms
  - Invasive plants
    - Invasive diseases

Increased large scale coupling over time

Human hierarchy
- Global economy
  - Regional/national
    - Invasive multinationals
  - Local communities
    - Households
      - Individual people

Decreased local coupling over time

Past

Present

Mike Coughenour
NEESPI Focus Research Center for Land Use Studies

• **Venue:** Natural Resource Ecology Laboratory, Colorado State University, Fort Collins, Colorado, USA
• **Objectives:** conduct, promote, and facilitate research aimed at integrative study of coupled human-environment interactions of land use change in Northern Eurasia
• **Links to International Projects:** GLP, IGBP-IHDP
• **Leaders:** Ojima
• **Current Science foci:**
  - Land use
  - Coupled Human-Environment System
  - Land use change and dust emissions

**Other relevant activities:**
✓ The Focus Research Center will provide study institutes on vulnerability and sustainability issues for the NEESPI region

http://www.nrel.colostate.edu/projects/eln
Regional Eurasian Characteristics of Change: “Social Shocks” & GEC

- Political system changed
- Collectives Disbanded
- Economics: privatization, subsidies not provided, internal and external markets
- Infrastructure of social services unsupported (affecting health, education, welfare, etc)
- “Hot spot” of warming
- Biogeochemical feedbacks changing in uncertain ways
CLIMATE TRENDS OF THE 1990’S

Temperatures of the 1990’s as much as 0.5°C warmer
Precipitation drier by 30% of the 30 year average
1982-2003 Trend in Growing Season NDVI

1982-2003 Trend in NPP (g C m\(^{-2}\) yr\(^{-2}\))

Hicke, Ojima, & Tucker (in review)
LAND USE PRESSURES
Herders and Households in Mongolia

Data provided by T. Chuluun
Livestock dynamics in Mongolia

- camel
- horse
- cattle
- sheep
- goat

Animals, millions

Years


GOAT
Dynamics of arable land in Kazakhstan 1950-2004
Dynamics of the amount of sheep and goat in Kazakhstan 1950 – 2004 (mln. head)
Arable Land Dynamics in Kazakhstan
(1950 to 2004)
Land cover change detection in Northern Kazakhstan

Kostanai oblast is one of the northern Kazakhstan administrative Regions. The territory – 196,000 sq. km (about size of Nebraska). Significant extension of the oblast from north to south causes change of the three natural zones: forest steppe, steppe and northern desert (semidesert).

Most of KO is in the high risk zone of agriculture with unstable climatic conditions: recurrent droughts and extreme winter temperatures. Large scale ploughing of the steppes in Kazakhstan (1954 – 1960) during the development of virgin lands. Many poor lands in the south were involved in this development. During the 1990s to present agricultural land abandonment has been extensive in this oblast.
Band differencing

Experts familiar with the region identify areas of potential change based on standard deviation of the data. Separate band difference images as well as their composite are analyzed. Most of the image in multiband composite turns gray because of the assigned value 128 to the least changed pixels. The rest “changed” pixels have 27 colors as a result of mixing assigned values of 0, 128 and 255 in a composite image.
Mosaics consist of Landsat bands 7 (red), 4 (green), and 2 (blue).
Images available at the Global Land Cover Facility include:
ETM+ September, 2000
TM September 1994
MSS June 1974 and April 1975
DAYCENT MODEL

Plant Production
- NPP Allocation
- Crop Yields

Trace Gas Flux
- CO₂, CH₄
- N₂O, NOₓ

Soil Nutrients
- NO₃, NH₄, P, S

Land Use
- Vegetation Type
- Nutrient, H₂O Inputs
- Tillage/Harvest
- Grazing/Burning
- Irrigation

SOM
- Active
- Slow
- Passive

Soil H₂O Temp

Soil H₂O Temp
CENTURY SIMULATED RESULTS

Northern Kazakhstan - Soil Organic C

- native grassland
- wheat cropping - manure
- wheat cropping - manure and synthetic N

Graph showing changes in soil organic C from 1800 to 2000.
Northern Kazakhstan - GHG\textsubscript{net}

GHG\textsubscript{net} = N_2O_{dir} + N_2O_{ind} + \text{deltaSOC}

CENTURY simulation results
RESEARCH STRATEGY

• Further evolve the Land science community that better integrates the social and physical communities
  – Land and water management data sets
  – Characterization of drivers and agents of changing land use dynamics
  – Identify and quantify ecosystem services
  – Characterize the vulnerabilities associated with provisioning of ecosystem services
RESEARCH STRATEGY

• Develop and apply integrated social-physical analytical framework with regional scientist input
  – Agent-based model linkages to ecosystem models
  – Dynamic vegetation coupled to soil-hydrological-biogeochemical dynamic models (DGVM-2)

• Ground and satellite based observations
  – Detection of land use change
  – Observational network of key drivers (social and physical)
Funded Research Areas

- **Land Cover** (14)
- **Mountain Research** (2)
- **Forest Dynamics** (5)
- **Fire Research** (3)
- **Land-Water Interactions** (4)
- **Societal Impacts** (2)
- **Data Support** (2)
DISTRIBUTION OF RESEARCHERS

Figure 1.a

Number of people

China | France | Germany | Mongolia | Russia | Switerland | USA | Uzbekistan

0 | 4 | 8 | 8 | 12 | 16 | 20 | 20
DISTRIBUTION OF PROJECTS

Figure 1.b

Number of people

- China
- Kazakhstan
- Mongolia
- Russia
- Ukraine
- Uzbekistan
- Regional

China: 8
Kazakhstan: 4
Mongolia: 1
Russia: 4
Ukraine: 3
Uzbekistan: 4
Regional: 20
The Eurasia Land Network

http://www.nrel.colostate.edu/projects/eln/index.htm

Purpose

This site is designed to act as an information source for researchers working on land related projects in Eurasia. The site aims to bring together links to existing networks, projects and researchers in the region or working in the region. The site does not present any new information, rather it brings together links to relevant websites, data sources, details of meetings etc.

The Northern Eurasia Earth System Science Partnership Initiative (NEESPI) is an active, yet evolving program of internationally-supported Earth systems science research. The geographic focus of NEESPI is Northern Eurasia, an area of the globe that is undergoing significant changes with potential consequences for global change. The goal of NEESPI is to develop a comprehensive understanding of Northern Eurasian terrestrial ecosystem dynamics, biogeochemical cycles, surface energy, water cycles and human activities and their interaction with the biosphere, atmosphere, and hydrosphere. Further details of the aims and objectives of NEESPI can be found at www.neespi.org.

NEESPI has several focus research centres. The Natural Resource Ecology Laboratory (NREL) at Colorado State University, USA is a NEESPI Focus Research Center for Land Use Studies. As part of this role NREL have set up The Eurasia Land Network.

It is hoped that this site will enable researchers to identify potential project partners, inform them of forthcoming meetings and funding opportunities.

What's New

- NEW information on the 'Central and North Asian Mountains Network Meeting' now on the meetings page
- New information on relevant past meetings added
- Information on scholarship opportunities added to the funding page

Associations

This site is associated with:

- Northern Eurasia Earth Science Partnership Initiative
- Global Land Project

It will also be associated with a forthcoming 'China arid land' network.... details will be posted soon.
LAND USE/COVER

- Eastern Siberia
- Yamal Peninsula
- Black Sea and River Basins
- Steppe systems: Mongolia, China, Kazakhstan, Uzbekistan
- Croplands
- European Forests
MOUNTAIN AREAS

- Caucasus Mountains
- Central Asian Tien Shan

FOREST SYSTEMS

- Boreal forest
  - Russia
  - Northeast China
FIRE RESEARCH
  - Siberian
LAND WATER INTERACTIONS
  - Pan Artic
  - Lakes
  - Wetlands
SOCIAL IMPACTS
  - Reindeer Study
  - Drivers of Change
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THANK YOU

ELN WEBSITE
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http://www.globallandproject.org/