

# The NASA Land-Cover/Land-Use Change (LCLUC) Program: Linkages to NEESPI Drylands Component

Garik Gutman,  
LCLUC Program Manager  
NASA Headquarters  
Washington, DC

# Outline

- LCLUC Program Introduction
- International linkages
- NASA NEESPI/MAIRS Drylands Studies



# Land-Cover/Land-Use Change Program



- LCLUC is an interdisciplinary scientific theme within NASA's Earth Science program. The ultimate vision of this program is *to develop the capability for periodic global inventories of land use and land cover from space, to develop the scientific understanding and models necessary to simulate the processes taking place, and to evaluate the consequences of observed and predicted changes*
- <http://lcluc.hq.nasa.gov/>

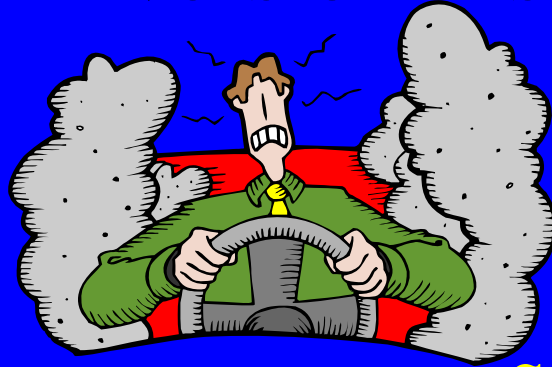


Chris Justice,  
U.Maryland



Garik Gutman  
NASA HQ

# LCLUC: Drivers of Disturbance/Stress



## ■ Natural Drivers

- ◆ Natural hazards (fires, droughts, floods, hurricanes, landslides)
- ◆ Invasive species
- ◆ Climate

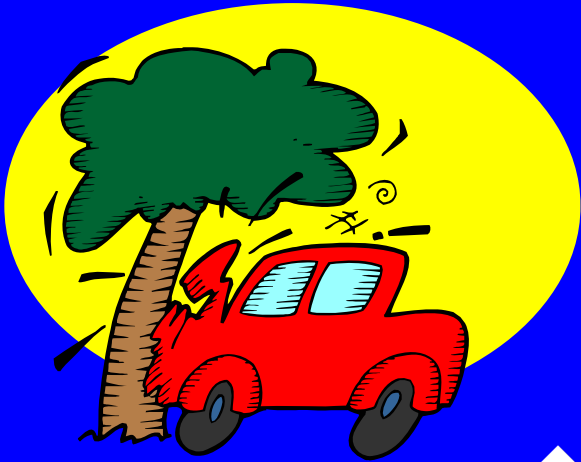
## ◆ Anthropogenic Drivers

- ◆ Agricultural changes
- ◆ Landscape modification, e.g. urbanization
- ◆ Forest clearing, logging & fires
- ◆ Grazing by domestic animals

## ■ Socio-Economic Drivers

- Technological change and macro-economic transformations
- Political economy and institutional change
- Values, attitudes, beliefs, individual and household behavior
- Human population dynamics

# LCLUC Consequences/Impacts



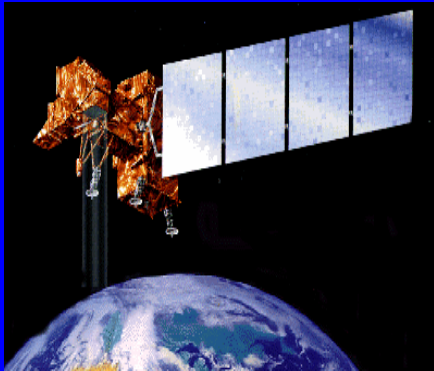
- ◆ Forestry
- ◆ Agriculture
- ◆ Wetlands and coastal zone
- ◆ Water resources and their quality
- ◆ Carbon storage and release
- ◆ Habitat degradation and fragmentation
- ◆ Atmospheric processes

# Tools

- Remote sensing observations (satellite and airborne)
  - Optical
    - Hyper-spatial resolution multispectral (e.g. IKONOS, Orbview)
    - High resolution multispectral (e.g. Landsat, SPOT)
    - Moderate resolution multispectral (e.g. AVHRR, MODIS, MERIS)
    - Lidars
  - Microwave
    - Passive
    - Radars
- In situ observations and intensive field campaigns
- Modeling and integrative data analysis
- Data and information systems

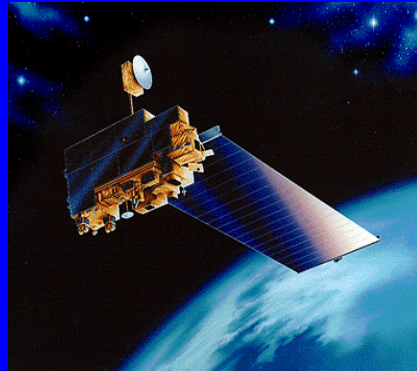
# NASA LCLUC-relevant Missions

## Systematic Missions - Observation of Key Earth System Interactions



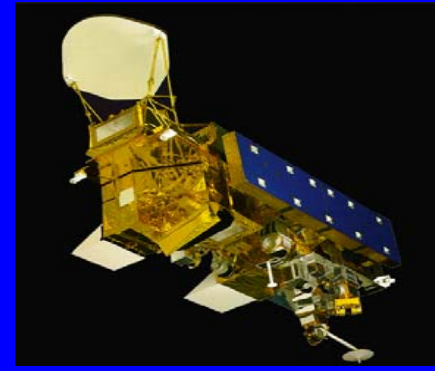
Landsat 7

4/15/99



Terra

12/18/99

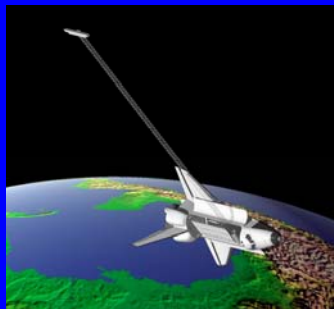


Aqua

5/3/02

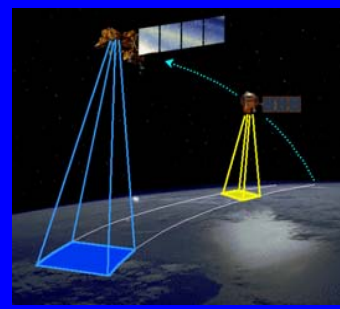
---

## Exploratory Missions - Exploration of Specific Earth System Processes and Parameters and Demonstration of Technologies



SRTM

2/11/00



EO-1

11/21/00



# Non-NASA Missions

- Radars (Radarsat, ALOS)
- Optical: MERIS, SPOT, IRS, etc.
- Defense Meteorological Satellite Project (DMSP)

# Non-NASA Mission: Earth Night Lights Observed by DMSP



# Program Make-up

- Total ~60 projects => more than 200 people
  - LCLUC Monitoring/Modeling
  - LCLUC/Carbon Cycle
  - LCLUC/Water Cycle
  - LCLUC/Climate/Environment/Biodiversity



# LCLUC Book

Gutman-RPIP 6 xpr 05-10-2004 14:15 Pagina 1

PMS 302

REMOTE SENSING AND DIGITAL IMAGE PROCESSING

REMOTE SENSING AND DIGITAL IMAGE PROCESSING

## Land Change Science

Observing, Monitoring and Understanding Trajectories of Change on the Earth's Surface

Edited by

Garik Gutman, Anthony C. Janetos, Christopher O. Justice,  
Emilio F. Moran, John F. Mustard, Ronald R. Rindfuss, David Skole,  
Billy Lee Turner II and Mark A. Cochrane

This volume is a synthesis of the NASA funded work under the Land-Cover and Land-Use Change Program. Hundreds of scientists have worked for the past 8 years to understand one of the most important forces that is changing our planet - human impacts on land cover, that is land use. Its contributions span the natural and the social sciences, and apply state-of-the-art techniques for understanding the Earth's satellite remote sensing, geographic information systems, modeling, and advanced computing. It brings together detailed case studies, regional analyses, and globally scaled mapping efforts. This is the most organized effort made to understand the dominant force that has been responsible for changing the Earth's biosphere.

*Audience*

This publication will be of interest to students, scientists, and policy makers.

*CD-ROM included*

This volume includes a CD-ROM containing full color images of a selection of illustrations which are printed in black-and-white in the book.

Land Change Science

Gutman, Janetos, Justice,  
Moran, Mustard, Rindfuss,  
Skole, Turner II and  
Cochrane (Eds.)

ISBN 1-4020-2561-0



9 781402 025617

KLUWER ACADEMIC PUBLISHERS

RDIP 6



## Land Change Science

Observing, Monitoring and Understanding Trajectories of Change on the Earth's Surface

Edited by

Garik Gutman,  
Anthony C. Janetos,  
Christopher O. Justice,  
Emilio F. Moran,  
John F. Mustard,  
Ronald R. Rindfuss,  
David Skole,  
Billy Lee Turner II and  
Mark A. Cochrane



Kluwer Academic Publishers

CD-ROM INCLUDED

# LCLUC Contribution to GEOSS

- Global Earth Observation System of Systems (GEOSS) officially started in April, 2004 at the second Earth Observation Summit in Japan
- An **infrastructure** connecting international efforts at Earth Observation
  - Will allow scientists to look at measurements of the land, water and air made from the ground, the air or space in conjunction
  - Will bring together existing observation hardware and software, make it compatible and offer data at no cost

# Global Land Monitoring at Moderate Spatial Resolution (30m)

- International cooperation is needed for developing global datasets
  - Land Surface Imaging Constellation
  - Global Land Surveys
- Mid-Decadal Global Land Survey (MDGLS)
  - USGS-NASA joint effort involving L-5 international cooperators
  - Develop a global orthorectified dataset from Landsat observations based on measurements circa 2005 (2004-2007) with 30-m spatial res.
- Decadal Global Land Survey (DGLS)
  - Landsat observations insufficient
  - International effort

# LCLUC International Linkages to Global Programs

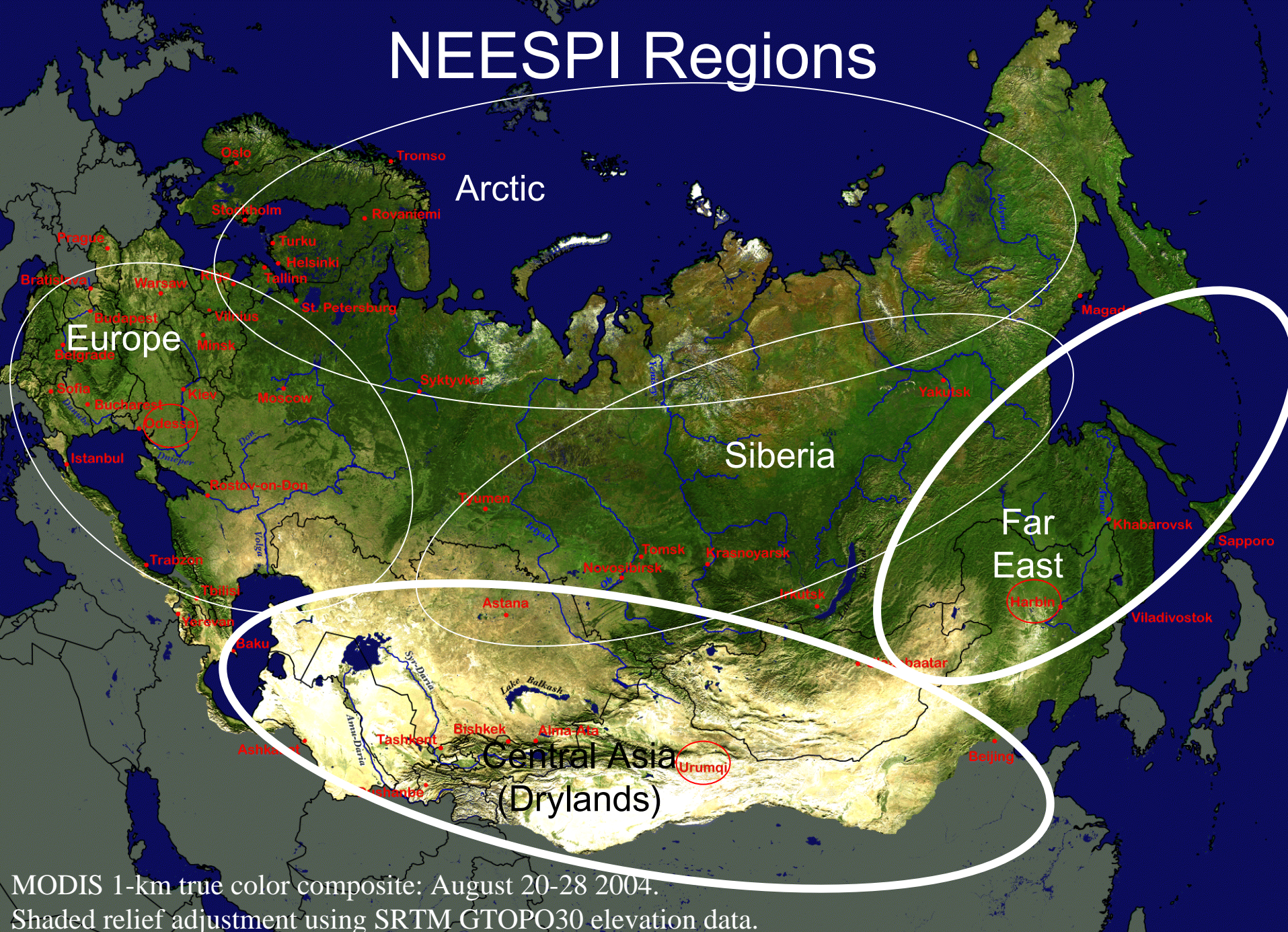
- Well established
  - GTOS/Global Observations of Forest Cover and Land-cover Dynamics (GOFC-GOLD)
- Under development
  - IGBP/iLEAPS
  - IGBP-IHDP/Global Land Project (GLP)

# Support of Regional Initiatives

- LBA: Regional Field Campaign in Amazon
- CARPE: Central African Regional Project on the Environment in Congo Basin (with US AID)
- MAIRS
- NEESPI



# NEESPI Regions



MODIS 1-km true color composite: August 20-28 2004.  
Shaded relief adjustment using SRTM GTOPO30 elevation data.

Produced by Mutlu Ozdogan, NASA GSFC

# Regional NEESPI Meetings

- Far East Regional meeting, Harbin, China: Feb 2005
- Central Asia Regional meeting, Urumqi, China: Sep 2007



# Monsoon Asia Integrated Regional Study (MAIRS)

- the most active human development with a history of more than 5000 years civilization and highest population density of the world
- the most rapid development in last decades and is expected to continue rapid development in the incoming century
- human activities of the monsoon Asia region have and will have significant impacts on the environmental conditions, not only regionally but also globally



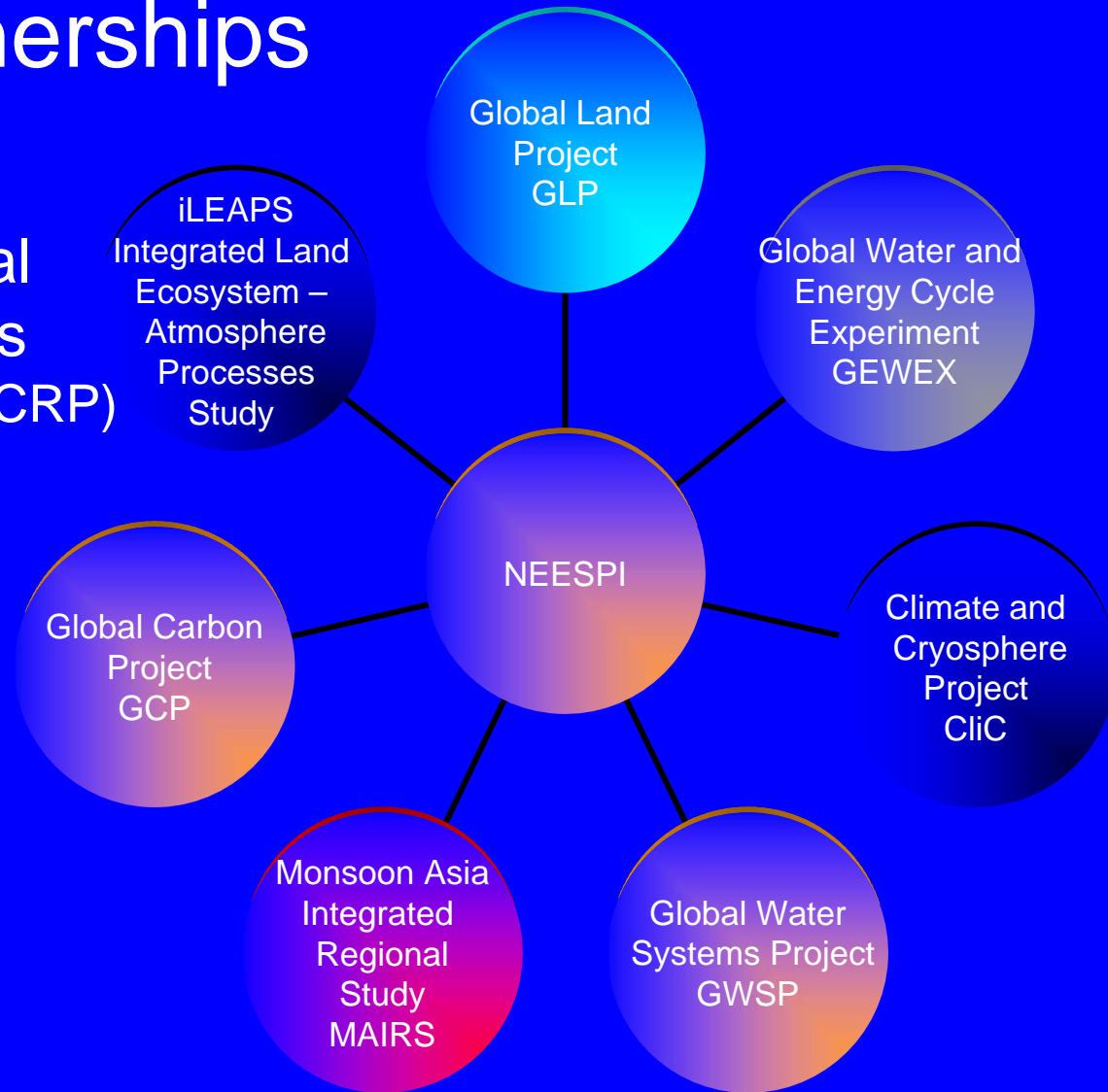
# Northern Eurasia Earth Science Partnership Initiative (NEESPI)

- International, multi-agency program for Earth science research in northern Eurasia focused on ecosystem-climate interactions
- Almost a quarter of the global land, representing most of the existing geo-botanic zones except for tropical; multi-disciplinary program covering basic terrestrial, environmental disciplines
- An important area of the globe with early indications of the global climate change
- Challenges: many countries, many languages, different mentalities, remote locations
- Advantages: plenty of data, talents; existing infrastructure



# Partnerships

Links to Global  
ESSP Projects  
(IGBP, IHDP, WCRP)





NEESPI-MAIRS Overlap

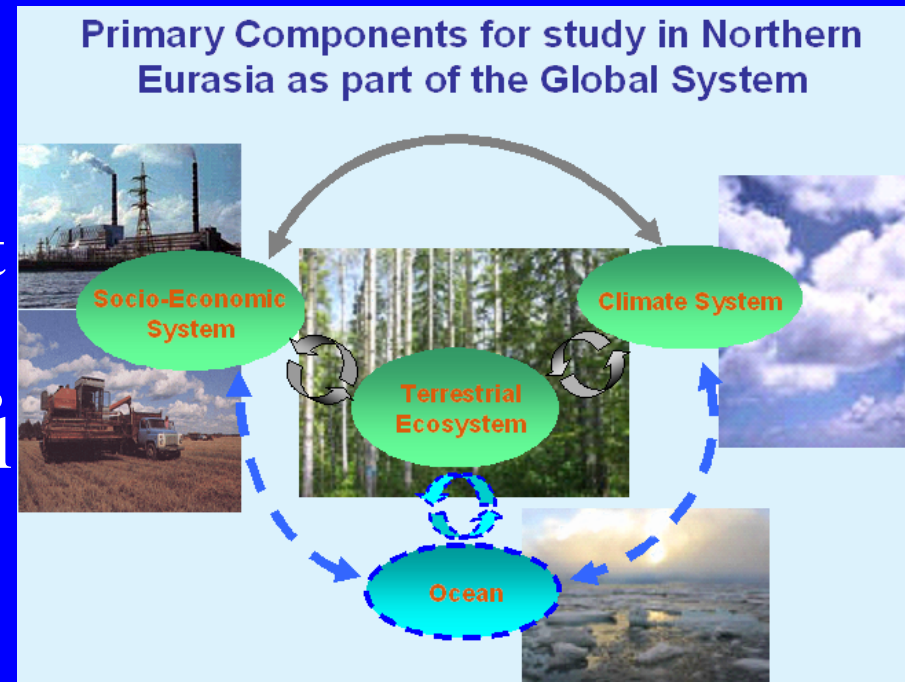


# NEESPI Science Agenda

Focus on climate-ecosystem interactions and societal impacts in boreal and non-boreal zones of Northern Eurasia: Former Soviet Union, Scandinavia, Eastern Europe, Mongolia, China

## Goal:

- To evaluate the role of anthropogenic impacts on the regional ecosystems and climate and how it may affect the global climate
- To evaluate the consequences of global changes for regional environment, the economy and the quality of life in the region

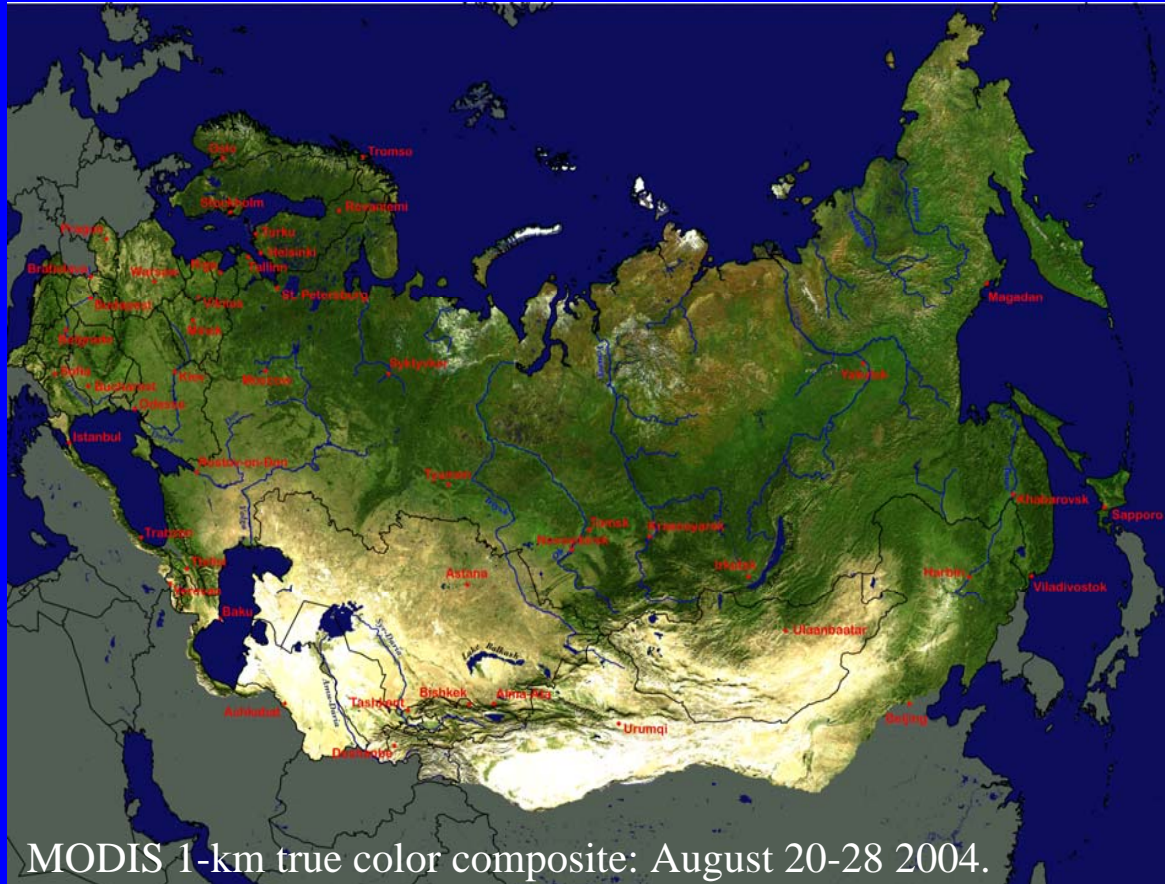


# NEESPI Today

- ~400 investigators from ~200 institutions;  
~100 projects

30 countries

- Russia
- United States
- Canada
- EU
- China
- Japan



MODIS 1-km true color composite: August 20-28 2004.  
Shaded relief adjustment using SRTM GTOPO30 elevation data.  
Produced by Mutlu Ozdogan, NASA GSFC

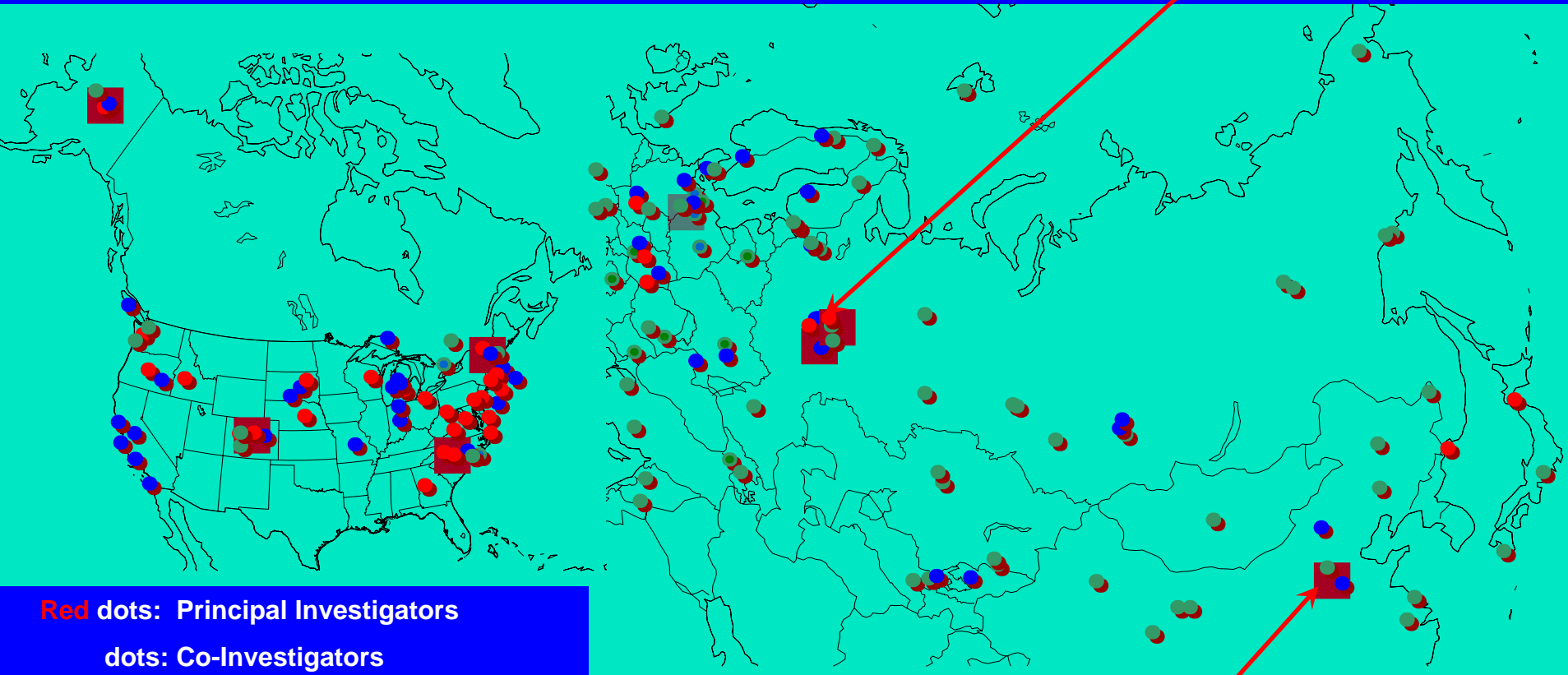




~400 scientists  
~200 institutions  
>100 projects  
30 countries

# NEESPI Participation

18 institutions in Moscow participate in 21 projects



Red dots: Principal Investigators

Blue dots: Co-Investigators

Green dots: Collaborators

Squares: Focus Research Centers and  
Science Data Support Centers

6 institutions in Beijing participate in 5 projects

# NASA Role in NEESPI

- Lead the NEESPI remote sensing component
  - Develop and maintain a regional satellite data base with raw data and products
  - Develop and distribute special remote-sensing based datasets useful for climate modeling
  - Facilitate access to satellite data and products by NEESPI investigators
  - Support regional calibration/validation activities
- Partner to support Focus Research Centers, Science Data Centers, NEESPI logistics
- Support regional network activities
- Support NEESPI projects with a remote sensing component that were peer-reviewed and selected for funding by NASA



# NASA Contributions

- 30+ research projects
- NEESPI Project Scientist
- Meetings
- Data
  - High-resolution Mid-Decadal Global Dataset
  - MODIS, ASTER products
  - EO-1 (ALI, Hyperion)
  - IKONOS from previous acquisitions
  - ACCESS climate dataset

# NASA NEESPI Science

- Carbon Cycle/LCLUC
  - 9 projects (final year)
- New Investigator Program
  - 2 biodiversity projects (final year)
- LCLUC (Hydrology)
  - 7 projects (mid-term)
- LCLUC (Climate, Environmental Impacts)
  - 6 projects (mid-term)
- Terrestrial Hydrology
  - 6 projects (mid-term)
- ACCESS (Data Systems Program)
  - 1 project (mid-term)
- Interdisciplinary Program (Biodiversity)
  - 2 projects (first year)
- IPY – 3 projects (will start soon)
- More starts to be expected early next year



<http://neespi.org>



Total > \$7M per year,  
30+ projects

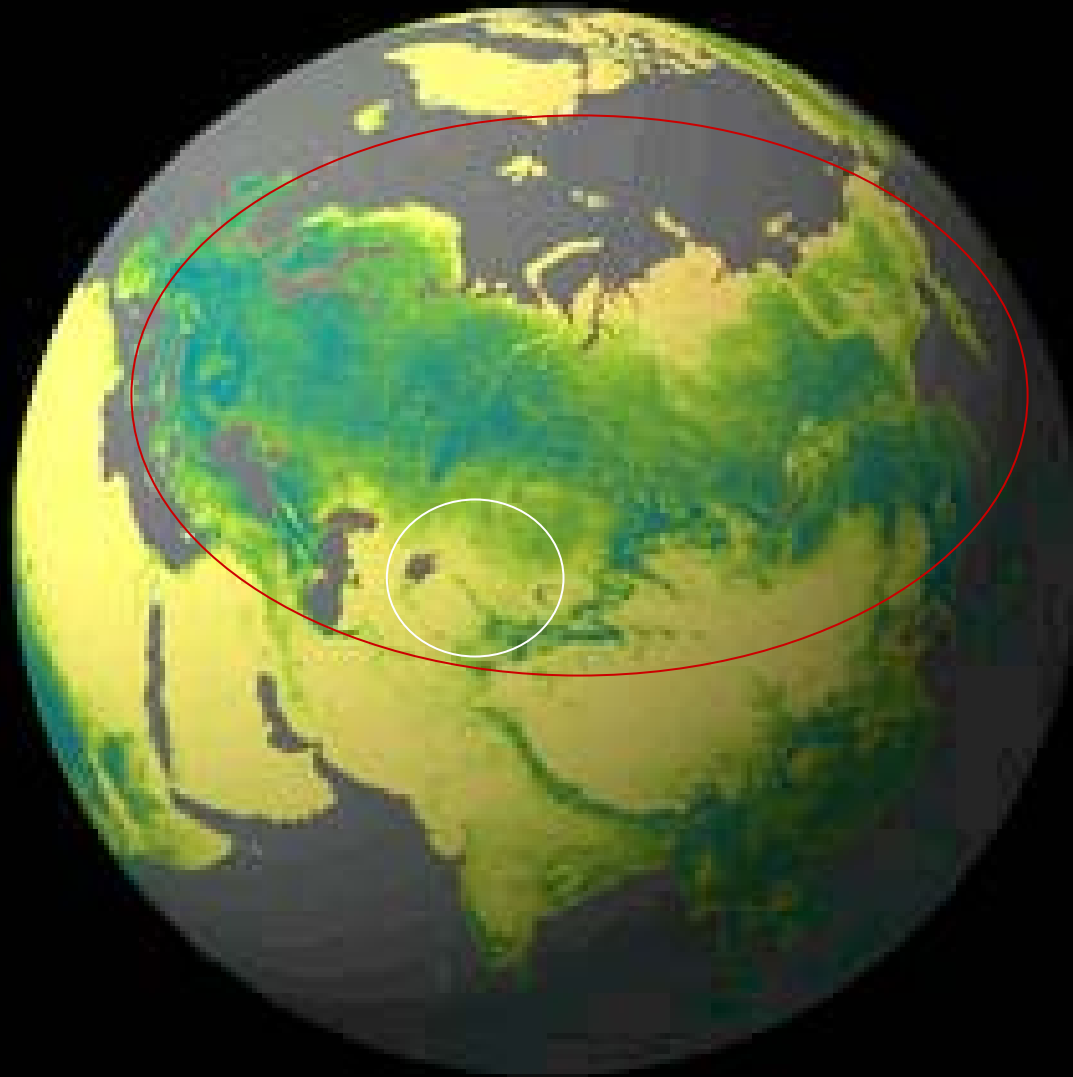
Special issue in Global Planetary Change

<http://www.sciencedirect.com/science/journal/09218181>

# NASA NEESPI/LCLUC Projects

- Glacial Area Changes in Central Asia & LCLUC (PI: Aizen, U. Idaho)
- Role of LCLUC in Water Budget and Water Use Across Central Asia (PI: Vorosmarty, U. New Hampshire)
- Assessing the vulnerability of the Eurasian semi-arid grain belt (PI: Henebry, South Dakota State U.)
- Ecological Monitoring in Semi-Arid Central Asia (PI: Geerken, Yale U.)
- Effects of Land-Use Change on the Energy and Water Balance of the Semi-Arid Region of Inner Mongolia (PI: Chen, U. Toledo, Ohio)
- Linking Biophysics and Socio-economics for Addressing Water Vulnerability in Central Asia (PI: Imhoff, NASA GSFC)
- Relationship between Land Cover/Land Use Change and Surface Hydrology over Arid and Semiarid Regions (PI: Zeng, U. Arizona)
- LCLUC-atmospheric dust interactions (PI: Sokolik, Georgia Tech.)
- C-land Use-Climate Interaction in the Semi-Arid Regions (PI: Ojima, Colorado State U.)

# Arid Zone Research



# Issues in the Arid Zone

- Soil and environmental degradation
  - accelerated erosion
  - salinization
  - depletion of soil organic carbon pool
- Conversion of natural and extensively used systems to agricultural ecosystems
  - Mineralization
  - depletion of the SOC pool with an attendant
  - emission of CO<sub>2</sub> from soil to the atmosphere
- Soil degradation => pollution, eutrophication and depletion of water resources of the region
- Shrinkage of the Aral Sea is just one of the examples of the serious problems with the water resources
  - Overuse of two major rivers feeding the Aral Sea for irrigation purposes
  - Lack of water for sustainability in the region



# Soil degradation

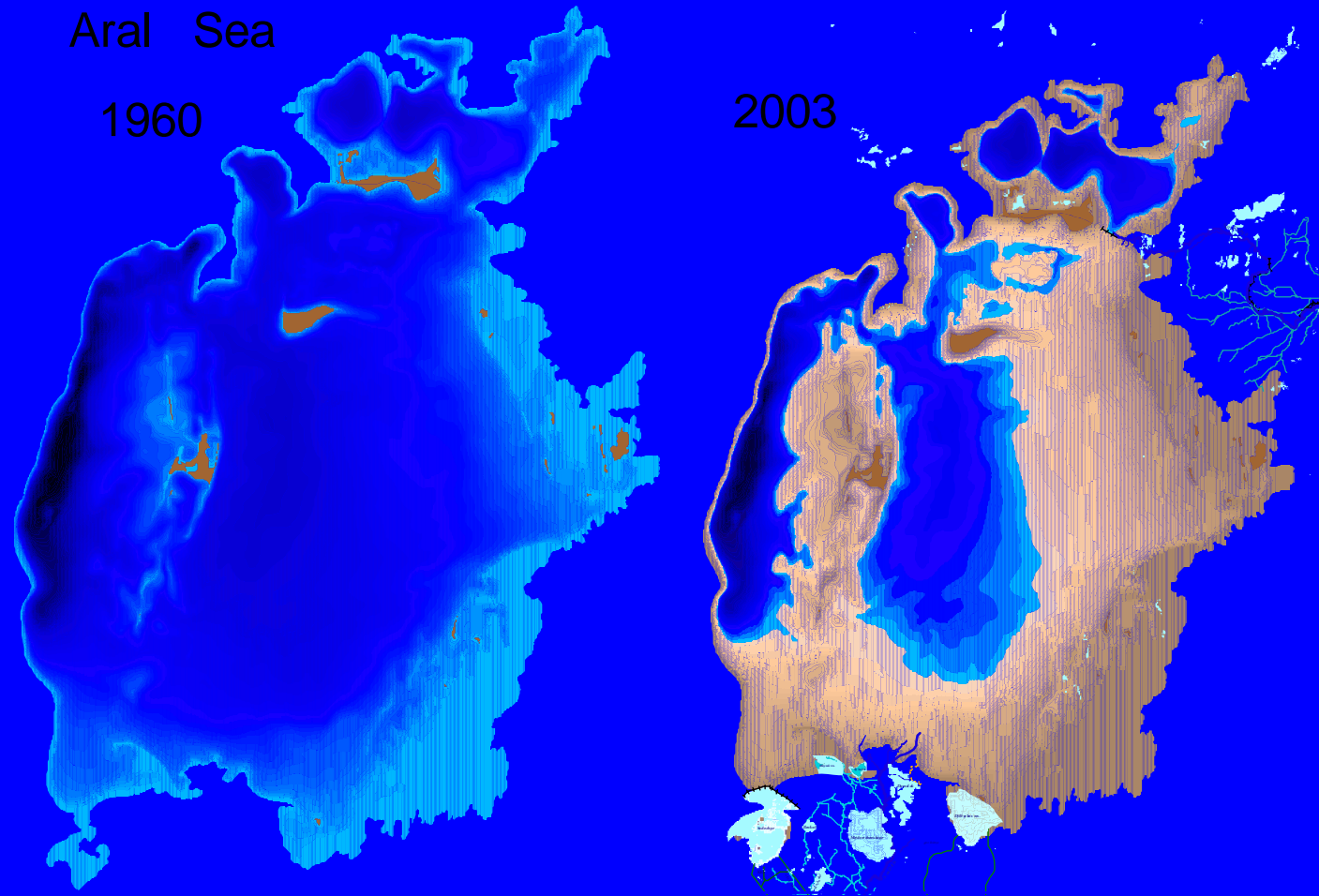
- Large areas of arable land are being lost to production as a consequence of use of inappropriate cropping systems and irrigation schemes => desertification, loss in soil biodiversity, carbon content, and other soil nutrients
- Inappropriate irrigation practices have led to considerable salinization => the quality of water for human/animal consumption worse
- Threat to production of food for the population of the region => a threat to food security in the region



2000



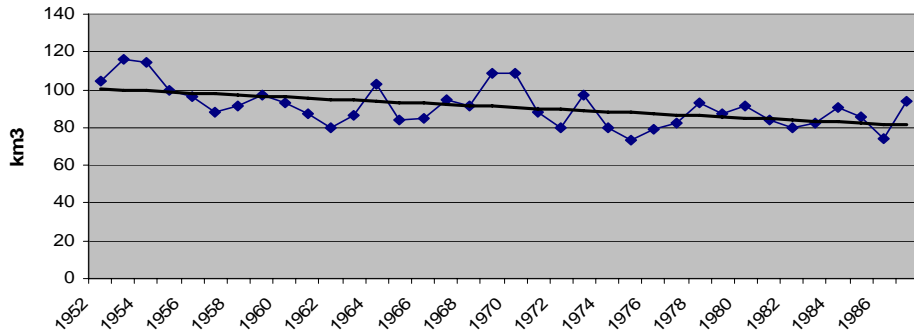
# Aral Sea's Change: 1960 to 2003



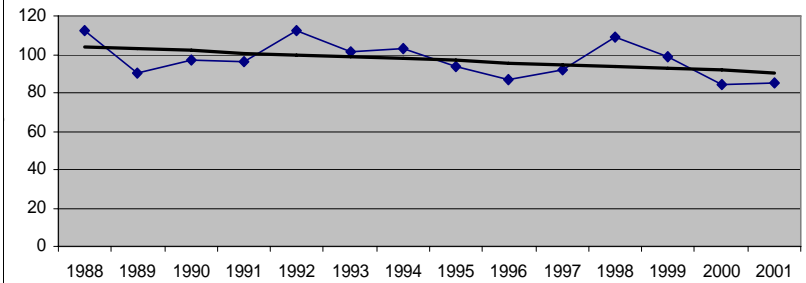
By 1999 the sea was divided into two parts – Northern and Southern sea. In 1997 water salinity in Southern sea was 40 g/l. Under existing situation sea will dry up and stabilize at the sea surface 13 th.km<sup>2</sup>; at this time water salinity will grow up to 100 g/l.

# Hydrology in Time

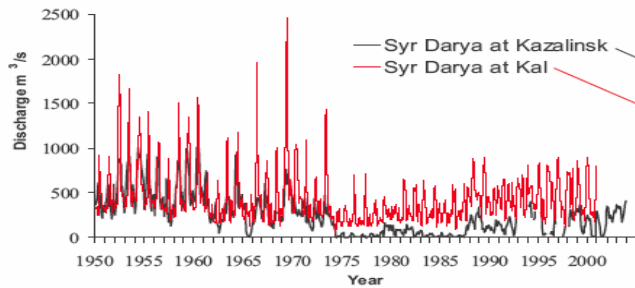
Summary water resources of Amudarya and Syrdarya for 1952 -1987



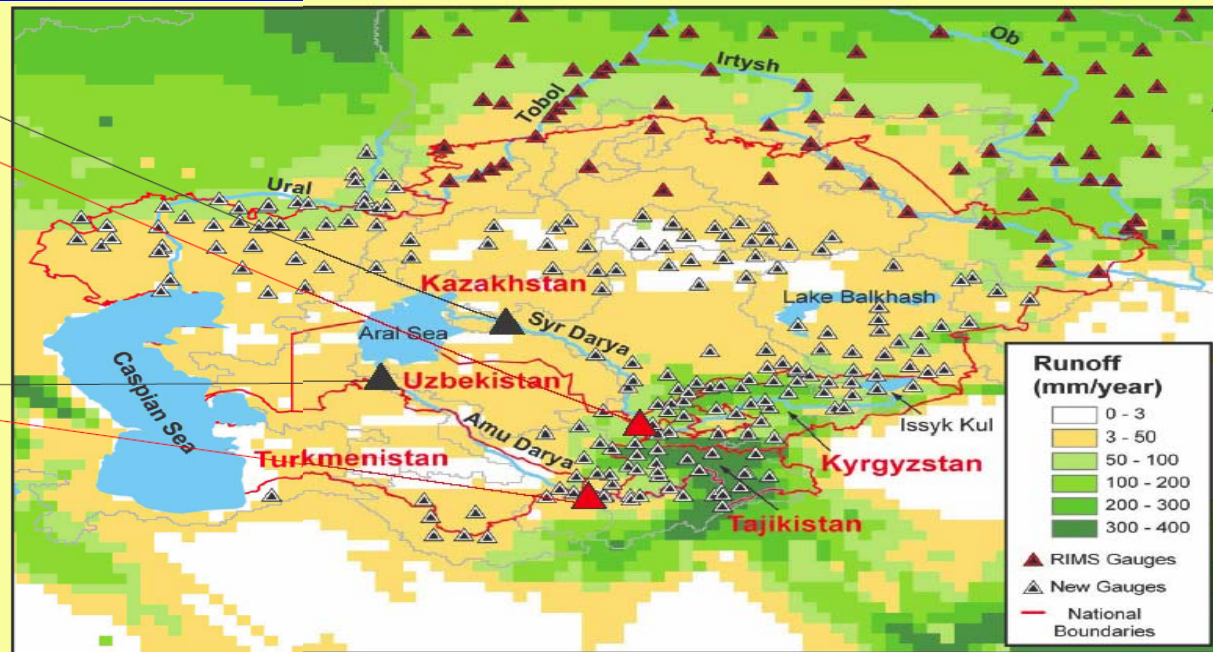
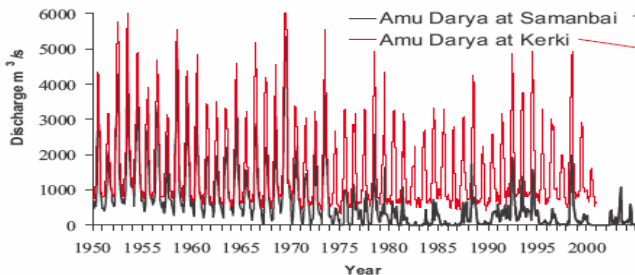
Summary water resources of Amudarya and Syrdarya for 1988 - 2001



Syr Darya



Amu Darya



**Runoff (mm/year)**

- 0 - 3
- 3 - 50
- 50 - 100
- 100 - 200
- 200 - 300
- 300 - 400

▲ RIMS Gauges  
 △ New Gauges  
 — National Boundaries

# Changes from 1960 to 1996

- water level dropped by 17 m
- water volume down by 70 %
- aquatic surface reduced from 67,000 to 30,000 Km<sup>2</sup>
- water inflow dropped from 60 km<sup>3</sup>/yr to 5-10 km<sup>3</sup>/yr
- Earlier number of species: 500 for birds, 200 for mammals
- Now: only 38 species of wild animals

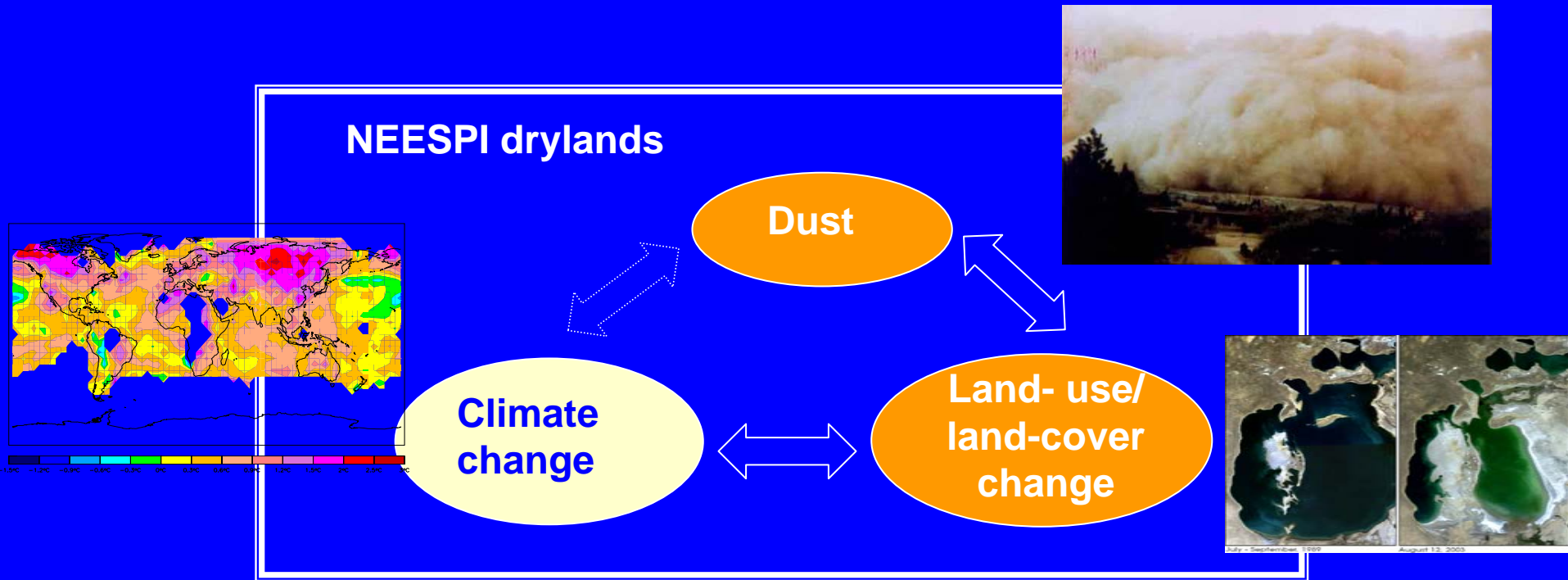


# Social Changes

- Population migration
- Health damage
- Reduction of the length of the human life
- Worsening of the living conditions

Sokolik, Dickinson, Curry (Georgia Tech)

NCAR WRF + DuMo + land model



**Objectives:**

***Development of a suite of the process-based models.***

***Development of Asian Dust Databank: 50-years climatology of dust events, climatic variables and land-use/land cover changes in Central and East Asia by merging available data from satellite, weather and monitoring stations, and historical records.***



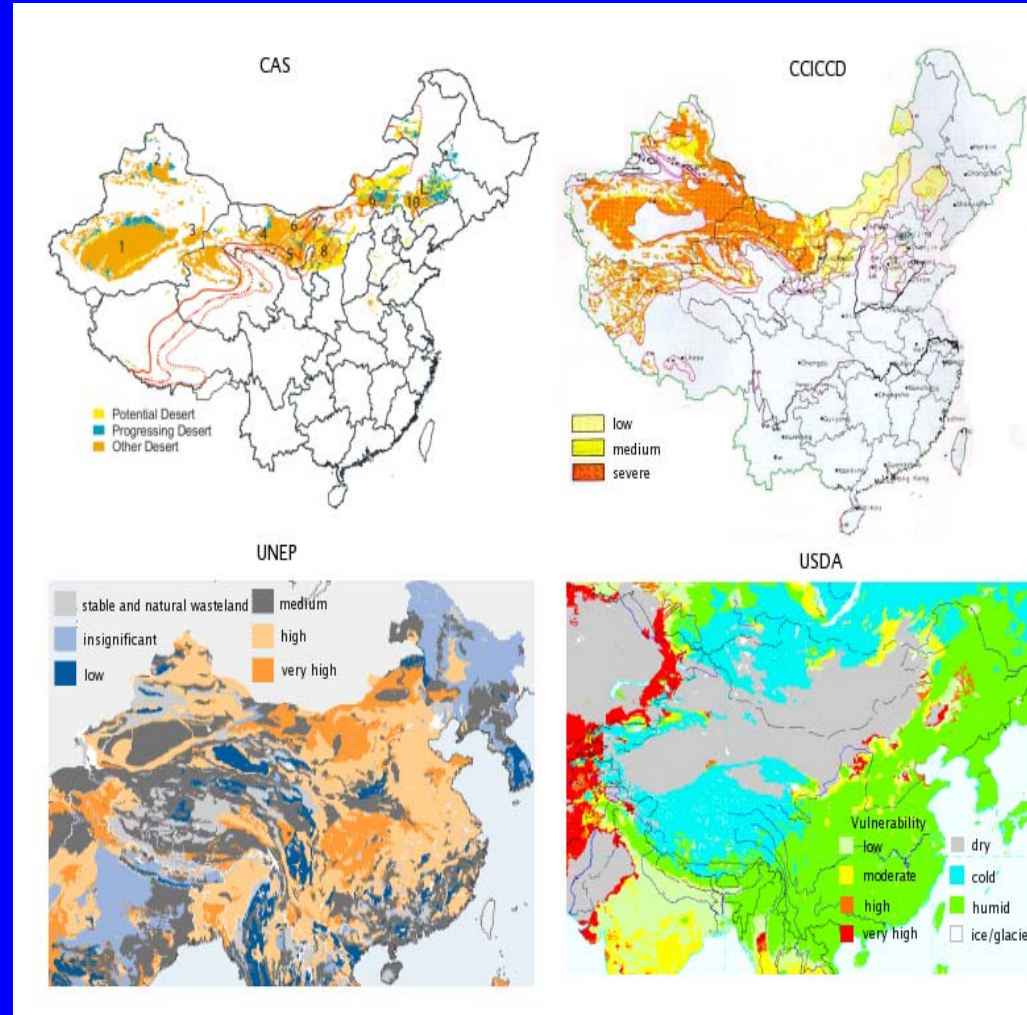


08.13.2007

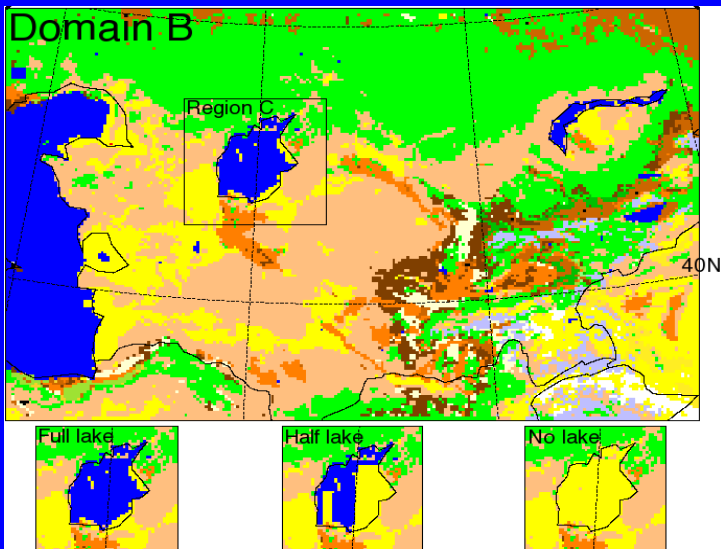
# Anthropogenic vs. natural dust: Need better linkages between dust emission and land-cover/land-use change

Study	Estimated anthropogenic dust fraction
Sokolik and Toon 1996	~ 20 %
GCMs estimates	
Tegen and Fung 1996	30 - 50 %
Mahowald et al. 2003	14 - 60 %
Tegen et al. 2004	< 10 %
Mahowald et al. 2004	0 - 50 %

## Desertification in China

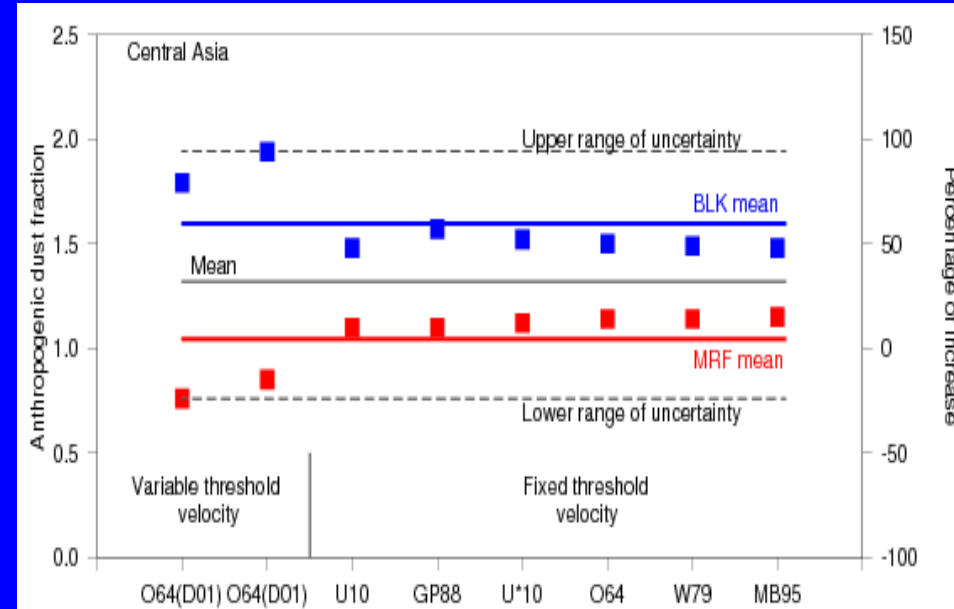
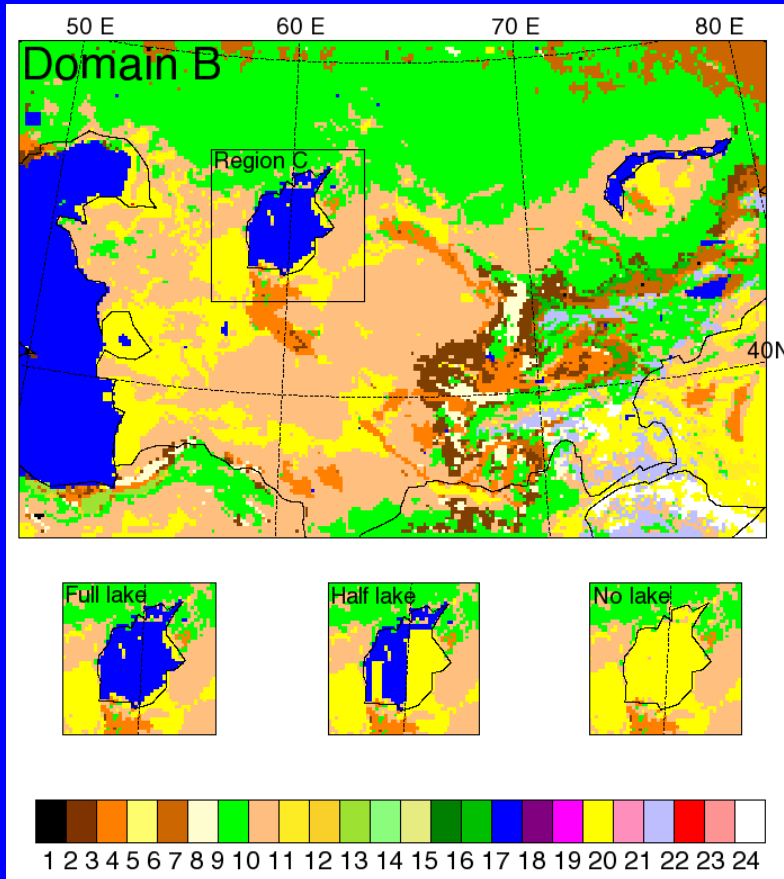


## Aral Sea



# Assessment of the anthropogenic dust fraction in Central Asia

*Darmenova and Sokolik (2007)*



The estimation of the anthropogenic dust fraction depends on the choice of PBL parameterization and dust production scheme

The anthropogenic dust fraction in the Aral Sea region depends on the combined effects of wind changes inside and outside the lake bed, the threshold velocity selected for dust production and the increase of source area.

# NEESPI

# НЕ СПИ

# 不要睡觉

# Don't sleep



谢谢

ありがとう

спасибо

Thank you!

