NASA-MAIRS
Research Update

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In this presentation

- History
- Achievements
- Future

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Worked with 14 Chinese key projects funded by MOST, NSFC and CAS, and 43 international projects funded by APN, NASA, JST&JSPS, EU FP7 and AusAID
MAIRS: MONSOON ASIA INTEGRATED REGIONAL STUDY

Study on the coupled human and environment system in the monsoon Asia region.
MAIRS Domain
MAIRS links to ESSP and other programs
Why Monsoon Asia

- World's highest mountains
- Heat source of Tibetan Plateau
- Seasonal monsoon affects water and food resources
- Range of natural hazards (TC to GLOF)
- 3.6 billion people
- Anthropogenic aerosols
- Vulnerable coastal development
- Rapid urbanisation and economic growth
MAIRS Objectives

MAIRS aims to promote integrated regional studies across monsoon Asia, in order

✓ To answer science questions on
  • The resilience of the monsoon system to human activities
  • The vulnerability of human societies to environmental change

✓ To promote collaboration across disciplines and regions

✓ To enhance scientific capacity across the region
Conceptual Framework

In 4 vulnerable zones
Integration across Vulnerable Zones

Coastal Zone

Mountain Zone

Dryland Zone

Urban Zone

- 2-3 million inhabitants
- 3-5 million inhabitants
- 5-10 million inhabitants
- More than 10 million
Challenges for Each Zone

**Mountain**
- Multiple stresses on ecosystem and biophysical resources

**Dryland**
- Vulnerability of ecosystems to changing climate and land use

**Urban**
- Changes in resource use and emissions from rapid urbanization

**Coastal**
- Rapid transformation of land and marine resources
History of MAIRS

- Planning in 2005 under auspices of START
- Chair SSC
  - Congbin FU (2006-2010) (Phase I)
  - Michael Manton (2011-2014) (Phase II)
- IPO supported by CAS at IAP, Beijing
- Link to Earth System Partnership (ESSP)
- Reviewed in Nov. 2010
- Commence Phase II in 2011
- Link to Future Earth in 2013
Promotion of Science

- Hosted about 60 international workshops with 2200 participants
- More than 200 scientists involved in activities
- 9 young and early career scientist training courses with about 800 participants
- $$$ to supported scientists from developing and under-developed countries to attend non-MAIRS conferences and workshops
- Worked with 14 Chinese key projects funded by MOST, NSFC and CAS, and 43 international projects funded by APN, NASA, JST&JSPS, EU FP7 and AusAID
Key Questions for Each Zone

- What are the major drivers for change and variability?

- What are the vulnerabilities of communities and ecosystems?

- What are the options for responding to those vulnerabilities?
Mountain Zone

- Rapid climate change
- Change in land cover
- Change in socio-economic conditions
- Adaptive capacity of communities

Next few slides are just examples of research finding
Climate Change in Eastern Tibetan Plateau over 50 Years

Duan et al. (2006)
Land Cover Change in Qomolangma National Nature Preserve area (1976-2006)

1) Glacier retreat and expansion of glacier lakes
- Glacier area decrease by 16%
- Glacier lake increase from 57 to 94 sq. km

2) Land degradation
- 19% of area degrading
- Wetlands decreasing
- 54% of area stable
- 27% of area improving

3) Drivers of change
- Mainly natural factors
- Degraded areas affected by human activities

Zhang, Liu et al. (2010)
RESOURCE USE DYNAMICS & LAND USE CHANGES ALONG HIMALAYAN TRANSACT

**DRIVERS**
- Fuel wood
- Fodder
- Grazing
- Timber
- Implements
- Roads
- Urbanization
- Agriculture
- Tourism

**IMPACTS**
- Deforestation
- Increased Run-off
- Reduced Groundwater Recharge
- Accelerated Erosion
- Increased Landslides
- Siltation of River Beds
- Increased Floods
- Low Agricultural Production
- Vulnerability to Food Insecurity

**HEADWATER AREA**
- Alpine Zone
  - Intensive Grazing
- Sub-Alpine Mountains
  - Sparse Population
  - Extensive Cultivation
  - Livestock Grazing
- Mid Temperate Slopes
  - Mixed Himalayan Forests
  - Acute Water Scarcity
  - High Population Density
  - Extensive Cultivation
  - Horticulture
  - Vegetable Farming
- Lower Temperate Zone
  - Mixed Forests
  - Water Scarcity
  - High Population Density
  - Intensive Cultivation
- Sub-Tropical Zone
  - Deciduous Forests
  - High Population Density
  - Intensive Cultivation

**Legend:**
- Mountain
- Slope
- Cultivated Land
- Degraded Land
- River

**Approximate Distance**
- 50 – 100 km

P.C. Tiwari (2012)
Community Responses & Adaptation

- 27% villages have replenished their water sources through water conserving forestry and horticultural practices
- 25% villages managed depleting water through rainwater harvesting schemes based on local indigenous knowledge and community participation
- 19% families cultivated less water requiring and drought resistant food as well as cash crops
- 21% households altered traditional cropping pattern & adjusted crop rotation
- 11% households cultivated abandoned land
- 27% families relocated their agriculture.
- 7% Families abandoned agriculture & switched over to secondary & tertiary activities
- 5% households out-migrated the region
- 11% decreased consumption of low productive and expensive food items

P.C. Tiwari (2012)
Improving Resilience and Adaptive Capacity to Climate Change in the Hindu Kush-Himalayan Region (China, Bangladesh, India and Nepal)

- Engagement with Government officials and community groups
- Collection of relevant bio-physical, socio-economic and cultural data
- Synthesis of scientific data and field investigations
- Capacity building through interactive research and training programmes
- Creation of a knowledge platform for dissemination and exchange
- Integration of evidence based policy analysis for the development of the Climate Change Adaptation Toolkit
- Development of a roadmap for the expansion of the toolkit methodology to other countries

Dryland Zone

- Significant land use change
- Analysis of socio-economic changes
- Evaluation of land surface models and terrestrial ecosystem models
Drought Impact on Rangeland Herders in Inner Mongolia

- Pastoral village of 80 households
- 10,000 livestock
- Decade-long drought & rising temperature affected pasture & water availability
- Herders' incomes significantly reduced
- But there are social factors

Xiaoyi Wang, CASS
Social Factors Interacting with Drought Impacts

- Sedentization
  - Less Grassland

- Segmentization
  - Unbalance & Differentiation

- Marketization
  - Conflict & High Cost

Social Vulnerability

Drought

transition from nomadic lifestyle to a society
division into segments

Disaster

Xiaoyi Wang, CASS
NEESPI and MAIRS Programs in the Dryland East Asia

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Abstract

Keywords: NEESPI, MAIRS, Regional Programs, Dryland, and Climate Change

Fig. 1. Dryland East Asia is the overlap area between NEESPI and MAIRS programs.

Central Asia is one of the most vulnerable regions on the planet earth to global climate change, depending on very fragile natural resources. The legacy has left the five countries (Kazakhstan, Tajikistan, Kyrgyzstan, Turkmenistan, and Uzbekistan) with an integrated system but they are facing great challenges such as land degradation, overgrazing, and drought. The NEESPI (National Ecological Scale, Ecosystems, and Biogeochemical Processes Initiative) and MAIRS (Multi-Aggregate Response of Integrated Regional Systems) are both programs that aim to enhance the understanding of climate change impacts in these regions. The overlap area between NEESPI and MAIRS in Dryland East Asia is crucial for the development of effective adaptation strategies.
“Snow” in the cotton field
Changes in livestock, policy, and climate in IM & MG

Qi et al. (2012)
Transformation towards sustainability in Asian Drylands: Food, Water and Environments
Urban Zone

- Rapid urbanisation
- Role of mega-cities
- Monitoring networks
- Regional climate change
Impact of Warming on Precipitation

Comparison of precipitation intensity for the two coolest years (blue) and two warmest years (red) over the period 1961-2005.

Find similar result for GPCP data.

Response is larger than expected from Clausius-Clapeyron.

S. Liu et al. (2009)
Coastal Zone

- Mega-city development
- Regional climate change
  - Impact of land use change
- Vulnerability studies
  - Hazard mapping for erosion, flooding and sea-level rise
Regional Climate Change due to Land Use Change in PRD

- Surface temperature: +0.09°C to +0.37°C
- Relative Humidity: -0.36% to -0.80%

Wenshi LIN (2011)
Urban Heat Island impact on Sea Breeze in YRD

Tang JP (2011)
Future MAIRS?
MAIRS and Future Earth in Asia

- MAIRS SSC initiative, in consultation with RIHN and others, to draft initial research plan for Future Earth in Asia
- Workshop in Hong Kong in late July 2013
- Draft being prepared for input from broad community
- Aim to commence dialogue amongst stakeholder communities on challenges of the transformation to sustainability across Asia
Scope of Plan

- Follows structure of Future Earth Initial Design
- Three themes
  - Dynamic Asia
    - Extend current GEC research
  - Asian Development
    - Stewardship of natural resources while enhancing human security
  - Transformation to Asian Sustainability
    - Trans-disciplinary research on major challenges for sustainable development of Asia
Crossing-Cutting Capabilities

- Trans-disciplinary research
  - Co-design, co-production, co-delivery to reduce time for impact of research; sensitivity to cultural diversity

- Observations and data
  - Existing international and national systems; socio-economic data; data sharing

- Education and capacity building
  - Existing programs; trans-disciplinary research; young and early career scientists

- Networking
  - Existing GEC programs; strengthen interfaces to all stakeholders
Theme 1 – Dynamic Asia

- Human system
  - Population, urbanisation, economies, inequality

- Geophysical system
  - Climate, anthropogenic effects, tectonic events

- Ecosystems and biodiversity
  - Forests, mountains, coasts, inland waters, small islands, agriculture, urban
Theme 2 – Asian Development

- Stewardship of ecosystems
  - Forests, mountains, coasts, inland waters, small islands, agriculture, urban

- Human security
  - Water, food, energy, health and well-being

- Collaboration of researchers and development communities
Theme 3 – Transformation to Asian Sustainability

- Uniqueness of monsoon climate and topography
- Vulnerability to natural disasters (tectonic and hydro-meteorological)
- Continuing urbanisation and economic growth
- Sustainable food, water and energy systems
- Survival of diverse ecosystems
- Contributions of traditional knowledge to regional sustainability
- Social equity (gender, education, well-being, governance)
So Far

- MAIRS has focused on cross-cutting global change issues for monsoon Asia
- Developed links between research groups across region
- Established links across disciplines
- Established links between regional and global research communities
- Promoted development of Future Earth across Asia
Conclusion of the MAIRS OSC
OSC Statistics

Promote the collaboration across the region
✓ 260 participants
✓ 110 overseas
✓ 24 countries

Promote collaboration across disciplines
✓ agriculture, chemistry, climate, ecology, economics, energy, geography, hydrology, remote sensing, social science

Promote capacity building
✓ 150 students and ECRs

Promote science
✓ 19 keynotes
✓ 26 parallel sessions
✓ 60 posters
Scientific Topics

Mountain
✓ land use change (LUC)
✓ socio-economic link to LUC
✓ adaptation strategies

Dryland
✓ land use change (LUC)
✓ socio-economic link to LUC
✓ grassland degradation
✓ hydrological processes
✓ dryland of northern Asia
✓ LSM and TEM

Coastal
✓ ecosystem services (ES)
✓ socio-economic links to ES
✓ sediment dynamics
✓ sea-level rise

Urban
✓ air pollution observations, modeling, and policy
✓ energy transformation
✓ urbanization
From the OSC

- move from sustainability concept to implementation is challenge
- co-design, co-production, co-implementation should enhance effectiveness of research
- Future Earth has potential to provide framework for sustainability research and action
- MAIRS had laid sound foundation for future research across Asia
Future MAIRS?

- Play a key role in FE in Asia –

- Lead FE in China –
Thank you!