An IRS program of ESSP

NONSOON ASIA INTEGRATED REGION STUDY (MAIRS)

Study on the coupled human and environment system in the monsoon Asia region.

Earth System Science Program



The significance of Integrated Regional Study (IRS) in Earth System Science

IRS represents a unique way to reconstruction the Earth System from its components and are thus an essential part of the Earth System Science toolkit.

Regions may function as choke or switch points and small changes in a critical region may lead to profound changes to the ways in which the earth system operates.





Earth System Science Partnership

Significance of IRS in sustainable development

RS must have relevance for people living in the regions and provide a sound scientific basis for the sustainable development of atmosphere, marine, terrestrial and human resources of the countries in the regions. Therefore, Regional study may contribute directly to the science for sustainability.

Tipping pointes in the Earth System



Rationale for Monsoon Asia Region

• Almost all aspects of societal and economic activities in the monsoon Asia region are critically dependent on the monsoon climate. It has direct impacts on water resources and air quality, and indirectly affects agriculture, industry, health, urban life and ecosystem services.



Rationale for Monsoon Asia Region

- As one of the most active human development regions, the intensive and large-scale human activities in Asia may have began to modulate the monsoon system;
- Both the natural process and human perturbation of monsoon system have profound impacts on the hydrological and biogeochemical cycles of earth system.

Development of MAIRS

- 1996-2000: Initial studies of integrated Asia monsoon system, including the development of a concept of General Monsoon System and Regional Integrated Environmental Model System for Asia;
- 2000-2004: Rational study, Hanoi meeting, Bangkok meeting and Rapid assessment project;
- 2005-2006: Planning for MAIRS, including acceptance of ESSP; Establish IPO, SSC and development of Initial Science Plan.



Earth System Science Partnership

Prof. Congbin Fu Director START Temperate East Asia Regional Center Chinese Academy of Science Beijing 100029 China

20 June 2003,

Dear Prof. Fu,

The Chairs and Directors of ICSU's four global change science programmes [DIVERSITAS, IHDP, IGBP, and WCRP], constituting the Earth System Science Partnership, just held their annual meeting in Paris (2-4 June 2003).

Prof. Roland Fuchs and Prof. Graeme Pearman, who represented START at that meeting, informed the Chairs and Directors about the offer of the Chinese Government to host the International Project Office for the ESSP Integrated Regional Study of Monsoon Asia at the Chinese Academy of Sciences.

On behalf of the Chairs and Directors of ESSP, it is my pleasure to thank you and the Chinese authorities for this very generous offer, and to indicate to you that we are very happy to formally accept it. Please convey our thanks to the Chinese Academy of Sciences.

Yours sincerely,

On behalf of the ESSP Chairs and Directors Anne Larigauderie Executive Director, DIVERSITAS

Cc:Roland Fuchs, Graeme Pearman, Sulochana Gadgil, START ,David Carson, Peter Lemke, WCRP Barbara Göbel, Coleen Vogel, IHDP, Michel Loreau, DIVERSITAS Will Steffen, Guy Brasseur, IGBP, Thomas Rosswall, ICSU

MAIRS International Program Office

MAIRS IPO is now located at the Institute of Atmospheric Physics, Chinese Academy of Sciences,Beijing and will be supported by CAS for 10 years(2005-2014), along with Ministry of Science and Technology of China;

Staff:

Frits Penning de Vries, director Ailikun, deputy director Yang Ying, information officer Liqin Shao, science advisor

Contact:info@mairs-essp.org www.mairs-essp.org



MAIRS SSC members as October of 2006

Congbin FU (Chair, China); **4**M. Manton (vice-chair, WCRP, Australia) **J. Matsumoto (vice-chair, MAHASRI, Japan) 4**A.P.Mitra (vice-chair, ABC, START-SA RC, India) **4**S. Anold (START-SEA RC, Thailand) **4**A. Chen (GCP,LOICS, China Taipei) **4**P. Kabat (IGBP-iLEAPS, Netherlands) **+**T. Koike (CEOP and GEOSS, Japan) **L. Lebel (IHDP, Chiang Mai University, Thailand) 4K. Seto (IHDP, Stanford university, USA)** Liqin Shao (MOST, China) **4**S.Liu (IGAC, China Taipei) **Frits Penning De Vries (IPO, Netherlands)**.

Initial Science Plan





To significantly advance understanding of the interactions among the humannatural components of the overall environment in the monsoon Asian region and

Vision

Implications for the global Earth System, in order to support the strategies for sustainable development.

Conceptual Framework of MAIRS



Lead questions for research

- Is the Asian monsoon system resilient to this human transformation of land, water and air?
- Are societies in the region becoming more, or less, vulnerable to changes in the Asian monsoon?
- What are the likely consequences of changes in the monsoon Asia region on the global system?



Earth System Science Partnership

∀ To better understand how human activities in the monsoon Asia region interact with atmospheric, terrestrial and marine environmental components.

∀ To contribute to the provision of a sound scientific basis for sustainable regional development.

• To develop predictive capacity for estimating changes in global-regional linkages in the Earth System and to recognize the future consequences of such changes.

4 critical zones in monsoon Asia





Aw

AF Am As

BWk BWh

BSk BSh Cfa Cfb

Cwb Cwc Dfa Dfb Dfc Dfd Dsa Dsb Dsc Dsd Dwa Dwb Dwc Dwd EF

ain climates	Precipitat
equatorial	W: desert
arid	S: steppe
warm temperate	f: fully hum
snow	s: summer o
polar	w: winter di

 Temperature

 h: hot arid
 F: polar frost

 k: cold arid
 T: polar tundra

 a: hot summer
 T: polar tundra

 b: warm summer
 c: cool summer

 d: cxtremely continental
 T

Cwa

EI

Cfc Csa Csb Csc

1-2 million inhabitants

2-3 million inhabitants

3-5 million inhabitants

5-10 million inhabitants

More than 10 million





Four research themes in critical zones



I: Coastal Zones

Coastal zones of monsoon Asia are unique because they are subjected to the influence of monsoon climate.

Coastal zones in Asia are threatened by combined effects of strong human activities, including population growth, urbanization and industrialization, offshore waste disposal, exploitation of freshwater and marine resources, coastal erosion, over extraction of ground water and the impacts of sea level rising.



Dramatic changes in Huang He Delta, China



Images show the mouth of the Yellow River and the emergence of a huge parrotheaded peninsula (1979-2000)

@ Huang He's yellow color is the result of huge loads of sediments

Land reclamation changes along Isahaya Bay, Japan



 1993: Turning tidal lands into farmlands

 2003: The area has been fully reclaimed from the sea

Main research areas for coastal zones

- **4**Coastal morphological change
- **4**Sustainability of coastal resources
- **4**Vulnerability of coastal society and adaptation **4**Coastal management

Leading research question

What affects rapid transformation of land and marine resources in the coastal zones in the context of global environmental change?



II: Mountain Zones

High mountains, particularly the Tibetan Plateau in monsoon Asia have a profound effect on the weather and climate of the region and world.

Mountains in monsoon Asia are the sources of major rivers of the region.

Mountain hydrological cycle and ecosystem are directly affected by global warming and regional climate.

Renewable water resources per capita (10^3xm^3) Global ratio to global 7.69 Asia 3.37 44% China 2.47 32% 2.1728% India **R.O.Korea** 1.45 18% Water pollution 70% of ground water polluted India: 54% of river polluted -300 - 021094

Retreating Gangotri glacier



Receding glacier tracked since 1780

In the last 25 years, Gangotri Glacier has retreated more than 850m (2 788 ft)



Retreating Glacier No.1 at the headwaters of Urumqi River in Tianshan Mountain (Yang H. *et al.*, 2005).

At 2004, the distance between eastern and western glacier tail was 45m, a lake with area about 30m² appeared between them.



Main research areas for mountain zones

- **4**Mountain glaciers and water resource
- **4**Ecosystem and biodiversity
- **4**Agriculture, forestry and food security
- **4**Extreme events and natural disaster

Leading research question:

What are the drivers and impacts of global environmental change on the fragile natural and human systems of mountain zones of monsoon Asia?



III: Semi-arid Zones

Water resource and ecosystem service goods are very crucial to the people living in semi-arid regions

Semi-arid regions are sensitive to climate variation and human perturbations

Semi-arid areas in monsoon Asia are one of the major sources of dust aerosol



Global drying trend over last 30 years(Dai, 2004)





Land degradation in semi-arid India





Indices of Northern China Plain

Land use/cover change in China during 1990's

Before

After



Liu Jiyuan et al.(2004)

Severity of soil degradation in South and Southeast Asia



Source: ISRIC/UNEP/FAO 1997

long distance transport of dust aerosol



Main research areas for semi-arid zones

- Interactions among global warming, monsoon variability and aridity
- **4**Atmosphere, land surface and ecosystem interaction
- **4**Dust aerosols, the hydrological cycle and regional climate

Leading research question:

How will semi-arid zones change in the next decades with respect to water resource, air quality, provision of ecosystem goods and services, extreme events and hazards?



IV: Urban Zones

Urbanization is a major driver, and outcome of economic and social development

■In 2000, 30% of Asian population lived in urban areas (47% world average).Of the 10 world's most populous urban agglomerations, 6 are in Asia

Urbanization in monsoon Asia is occurring at very rapid rate.by 2015, of an estimated 27 megacities (> ten million), 15 will be in Asia.





 As the most rapidly industrializing & urbanizing part of the world, the GHG emissions to double in Asia in next 20 years will exceed OECD emission by 2025;

 Asian cities are the "dirtiest" in world, 2xworld average in their pollutants;

High frequency of climate-related disasters such as flood and drought, particularly in the urban areas.

Global Emissions of Black Carbon (Bond et al., JGR, 2004)



Around 10 Tg/yr

Explosive growth in Beijing, China



Beijing, the capital city of China, has experienced explosive growth since economic reforms in 1979

Beijing in 1978

• 2000: Extent of urban expansion is clearly visible

Rapid urban growth in Karachi Pakistan



 1975: Karachi before the urban sprawl

2001: Note the change in aerial extent



Beijing, China

Bangkok, Thailand





Bombay, India



Main research areas for urban zones

Energy, emissions and urban air quality Urbanization, flood regimes, disaster management

Urbanization and water security

Leading research question:

what are the impacts of urban landscape change and emissions on the climate system, ecosystem, agriculture and human health?



Cross-cutting issues in implementation

Data availability and relevance Observation Modeling Capacity building Regional and international links Contributions to sustainable development

Enhanced observation experiments



A Regional Model of Earth System



Next steps (2007, 2008)

- Development of a couple of pilot projects with human dimension included;
- Activating structures (working groups, collaboration with ESSP projects in monsoon Asia);
- Capacity building;
- Resource mobilization

Three main points of MAIRS

- The concept of Integrated monsoon system study was originally proposed by Asian scientists;
- Differential from any on-going monsoon research project, MAIRS focus on Humanmonsoon system interactions and their linkages with Earth system dynamics;
- MAIRS perhaps will be consisted by a group of "LBA type" projects with components of enhanced field observation, modeling and integrated analysis.

Examples of "LBA type" Projects

- Land use -climate-water interactions in semi-arid Asia;
- Global warming-glaciers-river system interaction over the mountain Asia centered at Tibetan plateau;
- Energy-emission(aerosols)-regional climate interaction in coastal Megacites.

MAIRS related meetings in future

ESSP OSC Beijing meeting, Asian monsoon session and evening session, 9-11, Nov., 2006;
Symposium on Global Change: Asia monsoon, extreme weather and climate in Pacific Science Congress (PSC), 13-17, Jun. 2007, Okinawa, Japan;

- International Workshop on Semi-arid study , 25-27, Jul. 2007, Lanzhou, China.
- #Mountain group meeting,14-16, Nov. 2006, Beijing;
- +Modeling workshop in late 2007;
- **4**An MAIRS session in AGU 2007;

Thank you very much!

