International Workshop on

Vulnerability and Resilience of Land Systems in Asia

From

15 – 17 June 2009

At

Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, 11A Datun Road, Chaoyang District, Beijing, 100101, China
Organizers

Global Land Project, Beijing Nodal Office, China
Global Land Project, Sapporo Nodal Office, Japan
Institute of Geographic Sciences and Natural Resources, Chinese Academy of Sciences
Sustainability Governance Project, Hokkaido University, Japan

Sponsors

Asia-Pacific Network for Global Change Research

Chinese Academy of Sciences, China

Ministry of Education, Culture, Sports, Science and Technology (MEXT), Japan
(Special Coordination Funds for Promoting Science and Technology)

National Natural Science Foundation of China

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Vulnerability and Resilience of Land Systems in Asia
Logistics

Money

The Chinese currency is Renminbi (RMB). You can exchange currency upon arrival at Beijing Airport. Currently, 1US$=6.82 RMB.

Transportation and Accommodation

Workshop participants are lodged at Sardonyx Hotel located at 9 Minzuyuan Road, Chaoyang District, 100101, Beijing (Tel: +86 10 82023300; Fax: +82 10 82843741). It is very easy to locate Sardonyx Hotel from Beijing Airport. Taxi fare will be around 80 Chinese Yuan and the journey will take about 25 to 35 minutes depending on traffic congestion. Please show the map below to the Taxi Driver at the Airport. If you are still not confident of getting to Sardonyx Hotel yourself, then send an e-mail to Prof He Qing Huang (huanghq@igsnrr.ac.cn) to request Airport Pick up.

Buses will be available to transport participants from Beijing Sardonyx Hotel to the workshop venue at 9:00 am on June 15 and 8:30 am on June 16-17.

Vulnerability and Resilience of Land Systems in Asia
Food

Breakfast will be served in the Hotel. Lunch and Dinner will be provided at the meeting venue at CAS. Please do not drink water from the tap. Take bottled water only or boil tap water before drinking.

Opening Ceremony and Presentations

The workshop venue is Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences (CAS), 11A Datun Road, Chaoyang District, Beijing, 100101, China. The Opening and Closing Ceremonies will be held at Room 2602 (Designated as C). We will use two other rooms (Room 2321; Designated as A and Room 2421; Designated as B) for the presentations. Projectors will be available in each room for the presentations. Each session will last for not less than 90 minutes, and Session Moderators have been selected to coordinate the activities of each session. We would like to upload PowerPoint presentations to computers at the meeting rooms in advance. Kindly send your PowerPoint presentation to ecosmag@glp.hokudai.ac.jp by 11 June 2009. Note also that all PowerPoint presentations will be converted to PDF and posted on the websites of GLP in China and Japan.

Secretariat Contacts

If you need any assistance in connection with the Workshop whilst in Beijing, please contact any of the below listed colleagues.

Lin Zhen 136-936-448-74  
Huimin Yan 139-108-329-12  
Luguang Jiang 134-397-758-01
Background to the Workshop

Close to two-thirds of Asia’s 4 billion people live in the rural area and depend on natural resources for their livelihood. The continent is physiographically diverse – its northern part is located in the boreal climatic zone, the west and central part is predominantly arid, part of the eastern region is characterized by temperate rainforest, the south is notably rich in agrobiodiversity, whereas the southeast is typified by tropical rainforests and monsoon climates with high rainfall. Since 1990, Asia has witnessed impressive economic growth just as it has experienced diverse sustainable development challenges. Population growth and socioeconomic activities are important drivers of demand for ecosystem services, whilst climate change has adversely affected food and water security. Future climate change is predicted to profoundly affect agriculture, exacerbate water resource scarcity, and increase the threats to biodiversity as it compounds the pressure on ecosystem resources associated with urbanization and economic growth.

The primary goal of this workshop is to integrate knowledge on the vulnerability of land systems to multiple stressors in Asia. Presentations will be made by scholars who engage in research in assessment of system outcomes of multiple, interacting perturbations. Contributions will address major research challenges such as models, metrics and measures of land system vulnerability and resilience, scales and vulnerability teleconnections, social systems and resilience, institutional change and vulnerability, ecosystem services vulnerability and market-based mechanisms, urban ecosystems and vulnerability, and vulnerability of dryland systems.

The output of the conference will be in form of an edited volume published by Springer.
# Vulnerability and Resilience of Land Systems in Asia

Workshop Organized by the Global Land Project, Beijing and Sapporo Nodal Offices at Institute of Geographic Sciences and Natural Resources Research, Chinese Academy of Sciences, 11A Datun Road, Beijing

15 – 17 June 2009

## Time Table of Activities

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Room A = Conference Room 2321  
Room B = Conference Room 2421  
Room C = Conference Room 2602
Detailed Program for Opening Ceremony at Room C (2602)

Arrival from Hotel and Collection of Badges 09:00-09:30

Opening Addresses (Moderator He Qing Huang)

1. Banqin Chen. Research Activities of CNC-IHDP and CNC-IGBP and IGSNRR (09:30-09:50)
2. Mitsuru Osaki. Sustainability Science Initiatives in Hokkaido University (09:50-10:10)
4. Shigeko Haruyama. Land-Cover Change Research in Japan (10:30-10:50)

Practical Information on Workshop Organization (He Qing Huang) (11:50-12:00)

Group Photograph (12:00-12:15)
Session 1: Urban Systems [Monday, 15 June 2009, 14:00 – 15:30; Room A]

1. Peter Marcotullio. Vulnerability of the meat systems of New York and Tokyo
2. Jiaguo Qi. A Vulnerability Assessment of China’s Urban System: A Case Study of Lanzhou
3. Laras Tursilowati. Relationship between Urbanization and Climate Change in Indonesia
4. Wenze Yue. Spatio-temporal evolution of urban structure in Shanghai
5. Xiangzheng Deng. Modeling the vulnerability of agricultural production of the northern China plain under the rapid urbanization process

Session 2: Vulnerability Outcomes I [Monday, 15 June 2009, 14:00 – 15:30; Room B]

1. Peter Messerli. The poverty-environment nexus in the Lao PDR: spatial patterns of development contexts from a meso-scale perspective
2. Yanqing Wang. Drought resistant crops: potentials for adaptation to climate change and improving dryland ecosystem services
3. Yanji Ma. Factors influencing farmers’ willingness to participate in wetlands restoration program in Sanjiang Nature Reserve, China
4. Shigeko Haruyama. Land-cover change and impact evaluation using satellite data
5. Nazim Ali. Climate change and Vulnerability of Food Production System to Water Stress in Indus Basin, Pakistan

Session 3: Dryland Systems [Monday, 15 June 2009, 15:45 – 17:15; Room A]

1. Norio Yamamura. Collapse and Restoration of Ecosystem Networks with Human Activity
2. Chuluun Togtokh. Vulnerability and Resilience of the Mongolian Pastoral Social-Ecological Systems to Multiple Stressors
3. Myagmarsuren Altanbagana. Vulnerability of Pastoral Communities in Central Mongolia to Climate and Land Use Changes
4. Batbuyan Batjav. Resilience of herding communities to climate, socioeconomic changes in Mongolia
5. Yun-jie Wei. Land-use change and consumption of ecosystem services in Mongolian Plateau

Vulnerability and Resilience of Land Systems in Asia
Session 4: Models I [Tuesday, 16 June 2009, 9:00 – 10:30; Room A]

1. Jefferson Fox. Simulating land-cover change in Montane Mainland Southeast Asia and understanding its implications for watershed hydrology

2. Deyi Li. Vulnerability Assessment of Social-ecological Systems in Ha-Da-Qi City Belt of China Based on Information Entropy and Matter-element Model

3. Xuefeng Cui. Future land-cover and land-use change in China from a global perspective

4. Hanqin Tian. Carbon and water cycles in the land systems of monsoon Asia in response to multifactor global change

5. Hongyan Cai. Mapping potential land degradation with MODIS data in semiarid region: A case study in western Songnen Plain, China

Session 5: Models II [Tuesday, 16 June 2009, 10:45 – 12:15; Room A]

1. Reiichiro Ishii. Toward the prediction of vegetation transition at the topographical scale: Example study in the forest-steppe ecotone in Mongolia.

2. Maria Anaya-Romero. Land use planning in semi-arid regions of Asia using MicroLEIS DSS

3. Xiao-qian Liu. Using expert judgment to define indicators for assessing vulnerability from a conjoint choice analysis at multi-scales space in China


5. Erfu Dai. Modeling agricultural land change considering interaction of farmer’s decision-making and environment

Session 6: Institutions I [Tuesday, 16 June 2009, 9:00 – 10:30; Room B]

1. Luguang Jiang. Land-use change under the policy of “Returning farmland to lake” in the floodplain of Poyang Lake, the middle reach of the Yangtze River, China

2. Christian Webersik. Making Forest Preservation in Asia Work

3. Yogesh Jadhav. Measuring and monitoring vulnerability of land-systems in central India with community participation

4. Xing Lu. Management of Ecosystem Services of the Supa Watershed, Yunnan China


Vulnerability and Resilience of Land Systems in Asia
Session 7: Institutions II [Tuesday, 16 June 2009, 10:45 – 12:15; Room B]

1. Ole Mertz. Swidden change in Southeast Asia: land cover, demography, policy and consequences for livelihoods and environment

2. Gao-ru Zhu. Wetland Dynamic change of the new coastal region of Tianjin and the effects on ecosystem service

3. Fernando Teigao dos Santos. SPARK - Strategic Planning Approach for Resilience Keeping

4. Kathryn Bowen. Towards a better understanding of social capital as a modulating factor of resilient land systems in Asia

5. Fen Li. Impacts of Land Use Functional Change on WTA and Economic Compensation for Core Stakeholders: A Case Study in Poyang Lake

Session 8: Hydrology [Tuesday, 16 June 2009, 14:00 – 15:30; Room A]

1. Declan Conway. Climate change, water availability and future cereal production in China

2. Jian-Guo Huang. Tree-ring inferred-moisture change over the northeastern Tibetan Plateau

3. Yushu Zhang. Impact of Land Use Change on Land Desertification and Eco-Environment in Oasis region of Xinjiang, China

4. Vanessa Winchester. Dendrogeomorphological and sedimentological analysis of debris flows hazards in the northern Zailiiskiy Alatau, Tien Shan mountains, Kazakhstan

5. Zhiping Zhao. Regional moisture condition diversities and trends in China during the last 50 years

6. Junjiro Negishi, Mechanism based understanding of degradation of rivers and fringing floodplains: Lessons from a Japanese large river for biodiversity conservation and restoration

Session 9: Vulnerability Outcomes II [Tuesday, 16 June 2009, 14:00 – 15:30; Room B]

1. Mitsuru Osaki, Wise Management of Carbon and Water in Tropical Peatland

2. Hualou Long. The variation of farmland use and the security pattern of grain production in China since 1978

3. Yujun Tian Impact of labor rural-to-urban migration on land-use change in environmentally fragile areas

4. Joeni S. Rahajoe. Impacts of agricultural land change on biodiversity and ecosystem services in Kahayan watershed, Central Kalimantan

Session 10: Vulnerability Outcomes III [Tuesday, 16 June 2009, 15:45 – 17:15; Room A]

1. Maiko Nishi. Sub-global Follow-up to the Millennium Ecosystem Assessment (MA)
2. Xingyu Zhang. Impacts of Land Use Change on the Vegetation Carbon Storage in the Region around Taihu Lake
3. Shixin Wu. The spatio-temporal modes of reclamation in Xingjiang, China; An analysis in terms of remote sensing survey data
5. Suneetha Subramanian. Bridging Perceptions from Spatial Science and Society for Ecosystem Services Valuation and Management

Session 11: Models III [Tuesday, 16 June 2009, 15:45 – 17:15; Room B]

1. Karin Berkhoff. Modeling the vulnerability of rural areas to land-use change – the example of rubber growing in the district of Xishuangbanna (Yunnan province, China)
2. Zhongfeng Xu. Global and regional impacts of vegetation on hydrological cycle and energy budget as represented by the Community Atmosphere Model (CAM3)
3. Pan Lihu. An artificial society modeling approach to the understanding of the dynamic changes of a wetland in Monsoon climate
4. Chen Rui-shan. Application of Regional climate Model in Shiyang river watershed land-change study
5. Shuwen Zhang. The Impacts of Climate Change on the Hulunbuir Plateau Grassland Based on the Wavelet Theory and Spatialization Method

Session 12: Institutions III [17 June 2009, 9:00 – 10:30]

1. Lin Zhen. Land Use Functions: Conceptual Framework and Application for China
2. Yonik Yustiani. Critical Land Rehabilitation System in Pengalengan City, West Java Province, Indonesia
5. Peter Samuel. The challenging role of voluntary land registration process, the development policies and their impacts on the marginalized people in Papua New Guinea.
6. Zhiying Xu. Assessing the impacts of China’s ecological restoration programs on land use and livelihood
Abstracts

Session 1: Urban Systems

1.1 Vulnerability of the meat systems of New York and Tokyo
Peter J. Marcotullio, Alexandros Gasparatos, Mike Levay and Tatiana Gadda
Hunter College, New York

Livestock has long provided an important source of food, fiber, fertilizer, fuel traction and transport for society (Diamond, 1997). Recently, however, this key aspect of agriculture has come under scrutiny due to the "long environmental shadow" thrown by livestock production, processing and meat distribution (Steinfield, et al 2006). Moreover, given increasing globalization, the determinants of environmental impacts of meat systems are obscured. On the one hand, consumption of meat is increasingly disassociated from where the meat is produced. On the other hand, livestock production is increasingly disconnected from inputs including land, feed and water and use for animate power and manure fertilizer. It is therefore crucial to begin identifying the linkages between consumption, production and environmental impact of meat if we are to understand how these systems impact the vulnerability of social system to which they are linked. While studies are beginning to reveal important lessons at the global level, cross-scale analyses are necessary to fully understand trends. This paper provides a comparative holistic analysis of the environmental impacts due to consumption of meat in two global cities, New York City and Tokyo. Our analysis is divided into two parts. First, we use the concept of emergy (Odum 1996) as an environmental accounting tool to generate an indicator of the impact of producing, processing and distributing the meat needed to satisfy demand in each city. To developed emergy indicators a variety of biophysical and socio-economic data related to these processes must be collected. Second, we include a comparison of the complexity of “land teleconnections” for meat production to meet urban demand. We estimate the location and land requirements necessary to produce domestic and non-domestic livestock, including the inputs for this production. Using these two analyses we discuss the vulnerability of the meat systems in these two cities.

1.2 A Vulnerability Assessment of China’s Urban System: A Case Study of Lanzhou
Yaowen Xie,1 Pellei Fan,2 Jiaguo Qi3
1Key Laboratory of West China’s Environmental System (Ministry of Education), Lanzhou University, Lanzhou, 730000, China; Email: xieyw@lzu.edu.cn. Tel.: +86-931-8912725.
2School of Planning, Design, and Construction, Michigan State University.
3Center for Global Change and Earth Observations (CGCEO), Michigan State University

Studies on vulnerability of urban systems, the place where human is tightly coupled with environment have become the core of sustainability science. Lanzhou, the capital city of Gansu Province in China provides an example urban system in the China’s west, where, urban sustainability relies on surrounding fragile agricultural and pastoral lands that are being threatened by changing climate. This historical city, the major hub of ground and air transportation of China, is facing environmental and socioeconomic challenges. A multidisciplinary approach that encompasses urban development theories and analytical methods in ecology, human geography, and environmental science, was used in this paper to assess the vulnerability of Lanzhou. A vulnerability assessment approach, including multilevel indexes on urban sprawl, land use, ecological, and climate change, was used to analyze the socioeconomic development and environment conditions. Two phases, historical and modern times, were analyzed to assess the impact of the economy and society changes on the ecological environment in the past 2000 years, with a particular focus on the influence of institutional
change (i.e., planning policies) and market economy on the evolution of land system in Lanzhou. The results seem to offer invaluable information that can be used by decision makers on policy recommendations to effectively mitigate environmental issues while economically sustain Lanzhou. Lessons learned here can provide an example for other cities across the country that is struggling with future sustainability issues in China.

1.3 Relationship between urbanization and climate change in Indonesia

Laras Tursilowati1, Josaphat Tetuko Sri Sumantyo2, Hiroaki Kuze3, Erna Sri Adiningshi4
1-4 National Institute of Aeronautics & Space (LAPAN), Indonesia
2,3 Center for Environmental Remote Sensing (CERes), Chiba University, Japan

The world's population is urbanizing. In 1950, 30 percent of the world's population lived in cities. In 2000 this fraction grew to 47%, and it is predicted to rise to 60% by 2030. These facts suggest that urbanization contributes to climate change because rich urbanites produce more greenhouse gases than poor rural people. The International Panel on Climate Change (IPCC) has predicted that average temperatures worldwide will increase by 2.5°C by 2100. Urbanization in Indonesia also grew very rapidly especially in the big cities. Urbanization in Indonesia is growing very quickly, especially in big cities. In this research, we found land use and land cover change (LULC) in major cities in Indonesia (Jakarta, Semarang, Yogyakarta, Denpasar, etc) from the vegetation area to non vegetation due to population growth. This is also causing climate change in urban areas. Observed climate change is the spreading of urban heat island, the sun radiation energy balance, change of rainfall, decrease of human comfort. Harmful impact of climate change (disaster) in Indonesia includes floods, landslides, drought, reduced water resources, failed crops, forest fires, outbreaks of disease. This research used satellite data (Landsat TM/ETM), observation meteorology data, DEM (Digital Elevation Model) data, land use data, and tools ERMapper, ArcView GIS, Visual Basic, and MM5 (Mesoscale Model version 5/WRF (Weather Research and Forecasting) Model. This research is very useful for government assessment to plan the city development also contribution in global climate change and environmental change.

1.4 Spatio-temporal evolution of urban structure in Shanghai

Wenze Yuea, Peilei Fanb, c, Jiaguo Qic
aDepartment of Land Management, Zhejiang University, Hangzhou 310029, China
bSchool of Planning, Design and Construction, Michigan State University, East Lansing 48824, USA
cCenter for Global Chance & Earth Observations, Michigan State University, East Lansing 48823, USA

This study focuses on the distinct evolution paths of thirteen urban districts of Shanghai due to their different locations, historical experiences and development policies, especially during the reform era after 1978. A multidisciplinary approach, which is rooted in theories and methods in urban development, human geography, and environment sciences, was used to characterize and assess the differential evolution of the urban districts within Shanghai mega city. Data used included socio-economic data, remote sensing imagery, and detailed cases at community level. First, an overall picture of urban sprawl and transformation in urban population and environment of Shanghai is presented, followed by an analysis at district level to highlight the internal heterogeneity of evolution of land use, economic development, and environment conditions. The results suggested that while some districts (e.g. Pudong, Minghang and Xuhui) exhibited positive urbanization trends, indicated by rapid economic growth, better environment conditions, and more appropriate land use, others (e.g. Zhabei and Yangpu) showed a slow economic growth, worsening environment conditions, and less optimal use of land. This disparate development among districts was believed to be driven primarily by differences in market reform of urban land
and migration policy. Specifically, different impacts of industrial restructuring, urban planning policies, foreign investment strategies, and *Pudong* development initiative were prominent institutional effort at local level. The paper concludes with policy recommendations to mitigate the increasing disparity between urban districts and achieve a more sustainable future of Shanghai that encompass economic efficiency, social equality and environmental amenity.

1.5 Modeling the vulnerability of agricultural production of the northern China plain under the rapid urbanization process

Xiangzheng Deng\(^1\), Heqing Huang\(^1\), Qunou Jiang\(^1,2\), Lin Zhen\(^1\)

\(^1\)Institute of Geographical Sciences and Natural Resources Research, Chinese Academy of Sciences, Beijing, 100101;

\(^2\)Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing, 100101

The North China Plain, which experiences a rapid and continuing urbanization process during the past two decades especially in Beijing and Tianjin, is also one of the most important agricultural production bases in China. The area of cultivated land converted to housing, company or the transport infrastructure reaches 1.98×10^4 \text{hm}^2 from 1988 to 2000. To estimate the vulnerability of agricultural production under the macro backdrop of rapid urbanization, six kinds of data sets, including remote sensing data on land use, monthly weather data, crop phenology data, soil properties, the inputs level and managerial data in agricultural sector, and regional natural and social data of the Northern China plain in pixel level, are required. In this case study on the North China Plain, remote sensing data is provided by the Chinese Academy of Sciences, monthly climatic data obtained from the China Meteorological Administration, and other auxiliary data obtained from the questionnaire, statistical yearbooks and so on. Based on the land use data, this paper analyzes the conversion between the cultivated land and built-up area through GIS overlay analysis, and finds that large quantity of cultivated land in suburban areas has been occupied by non-agricultural construction. In addition, this paper employs the *Estimation System for Agricultural Productivity* (ESAP) to explore the vulnerability and diagnose the resilience of the agricultural production to urbanization over spatial and temporal dimensions. Our research results show that agriculture production in the north China plain were particularly sensitive to urbanization in the past twenty years. The major effects leading to the strong variability of agricultural production on urbanization could be generalized as changes in crop yields and impacts on agricultural systems. Thus, adjustments to urbanization are urgently in need of attention. Governments should revise zoning regulations to ensure that potential farmlands remain undeveloped. A variety of approaches are suggested to reduce vulnerability of agricultural production among which building more sustainable agriculture systems.

1.6 Urban land carrying capacity evaluation and resilience analysis

Yao Lv

Institute of Geographic Sciences and Natural Resources Research, CAS, Beijing, 100094 P.R. China

Urban land carrying capacity is an important index showing the human-land relationship in urban areas, symbolizing the compromise of natural resources, ecosystems, economy and society. Conflict between man and land resource becomes even more outstanding in China. For developing economy, increasing population increases land demand, while strict arable land protection policy limits the land use conversion from agricultural land. Thus, scarcity of land resource is prominent in China and Chinese cities are carrying increasing population. It is suggested that there is still resilience in urban land carrying capacity. However, the answers to what can be done to ensure that citizens live a sustainable life and for how long before the urban ecosystem collapse?, are mainly focused on the urban land carrying capacity and its resilience.
The goals of this paper are: (1) evaluate carrying capacity of large and middle cities in China; (2) extract the determinants of urban land carrying capacity; (3) find resolution to manage conflict between demand and supply of urban land in terms of improving the carrying capacity. As land use planning does not take natural resources basis and social-economic development objectives into account, inefficient land use coexists with over loading in most Chinese cities. Therefore, a multi-dimension evaluation model for assessing the urban land carrying capacity will be built in an all-round way, which includes indicators on endowment of natural resources, eco-environmental capacity, economic development and society harmony. Resilience analysis of determinants, and urban land carrying capacity will be carried out later. Then feasible suggestion will be promoted accordingly to improve the urban land carrying capacity.

Session 2: Vulnerability Outcomes I

2.1 The poverty-environment nexus in the Lao PDR: spatial patterns of development contexts from a meso-scale perspective

Peter Messerli, Andreas Heinimann, Michael Epprecht, Kaspar Hurni
Centre for Development and Environment, University of Bern. c/o Lao National Mekong Committee Secretariat (LNMCs), Prime Ministers Office, Lane Xang Avenue, Vientiane, Lao PDR.

Until recently, Laos was considered to have an abundance of forestland and natural resources, coupled with one of the lowest populations in all of Asia. However, in the last five years increasing regional investment, growing overseas development assistance and government interest in capitalizing on Laos’ rich natural resource base has led to a rapid transformation of the rural context, with a growing number of new actors claiming ecosystem goods and services at multiple levels. Even though a considerable number of studies is available that describe the complex interactions between livelihoods, natural resources, and governance, they mostly refer to specific case studies at micro level of spatial scale. At a sub-national to national level, where evidence-based policies should be designed, little generalized knowledge is available on the configuration of different land systems across the territory, their vulnerability in terms of livelihoods or natural resources. This paper presents a novel approach to describing the spatial patterns of poverty and landscape mosaics at a meso-level, i.e. covering the entire territory of Lao PDR at highest possible resolution. Analyzing spatial patterns of recurrent linkages between poverty and landscape mosaics, we are able to categorize and quantify different types of land systems. While in some parts of the country transitions from forested to permanent agricultural landscapes are accompanied by a decreasing poverty rate, others reveal counter-intuitive insights. A significant part of shifting cultivators still lives below the national poverty line, whereas a considerable number of people living in permanent agricultural landscape are very poor. This empirical data allows discussing how different land systems are vulnerable or resilient to the fast rural transformations in Lao PDR.

2.2 Drought resistant crops: potentials for adaptation to climate change and improving dryland ecosystem services

Yichao Shi1, Yanqing Wang2
1Graduate School, Chinese Academy of Science, Beijing, China; 2Biotechnology Research Institute, Chinese Academy of Agriculture Science, Beijing, China

Climate change is expected to exacerbate drought events throughout the world, resulting in large-scale ecosystem alteration and dryland agriculture is even more risk-prone especially in developing countries. Adaptations and innovations would help to reduce the vulnerability of dryland farming to climate change. Drought resistant crops, represented by drought resistant
maize developed by modern biotechnology might have great potentials to enhance the adaptation of dryland farming to climate change. This study provides a detailed analysis of potentials of drought resistant maize releasing into the Northern China based on an integrated risk assessment and management framework. Lack of water and low soil quality resulted in weak land self-restoration capability and crop production in Northern China. Besides that, the low level inputs for improving the production conditions were also the important factors contributing to the vulnerability of dryland ecosystem in northern China. In addition, risk and uncertainty of climate change which has been witnessed in recent years would impose new challenges in the future. Drought resistant maize developed by public and private sectors is supposed to be released in the coming years. For the purpose of better understanding of risks and opportunities of this innovation, level of drought resistance, release time and rate of drought resistant maize, potential risks and management strategies argued in the previous GMO environmental release were also assessed in this framework. There is no nostrum. However, drought resistant crop would be an important approach in managing climatic uncertainty and adapting to climate change, further improving ecosystem services in dryland ecosystem.

2.3 Factors influencing farmers’ willingness to participate in wetlands restoration program in Sanjiang Nature Reserve, China

Zhang Chun-Li, Tong Lian-Jun
Northeast Institute of Geography and Agricultural Ecology, CAS, Changchun 130012, China.

Sanjiang Nature Reserve, a state-owned natural wetland in China, has suffered severe degradation due to cultivation and increasing wetlands reclaimed. It was estimated that marsh area decreased from $1.61 \times 10^4$ hm$^2$ in 1954 to $1.7 \times 10^4$ hm$^2$ in 2005 as a result of the national commodity grain production base constructed and farmers’ disturbance. What’s worse, some cultivated lands still exist in the core zone and the buffer zone now. Cultivated lands in the core zone and the buffer zone should be converted into wetlands as soon as possible. The key of wetlands restoration program is that farmers allow a part of cultivated land to be converted to wetlands. It inevitably affects agricultural benefits and livelihoods of local farmers. Previous studies showed that lack of farmers’ participation and failing to take into account the interests of rural communities were proved to be a failure conservation strategy. Voluntary participation in program for wetlands restoration is an increasingly important tool for accomplishing environmental policy objectives. Based on data from a questionnaire and a random sample of 310 households in 11 villages, a typical analysis was conducted to study factors influencing farmers’ willingness to participate in wetlands restoration. It is concluded that age, education, the area of cultivated land, geographical location, farmers’ perceived advantages and risks from wetlands restoration are important influencing factors. Furthermore, policies for improving wetlands compensation system and sustainable alternative livelihoods are essential to strengthen farmers’ willingness to participate in wetlands restoration.

2.4 Land-cover change and impact evaluation using satellite data

Shigeko Haruyama
Graduate School of Bioresources, Mie University, Japan.

Land cover is changing dynamically and drastically in Holocene and also the rate of the changing has been accelerating in recent year. The Asia and Pacific region is one of the densely populated regions in the world and is one of the centers of drastic land use change and land cover change. Under the serious pressure from the land cover change, the coastal zone of Asia is experienced the land degradation and natural disaster have on occasion afflicted the coastal Asia. The global climate change and global warming will bring more natural hazard along the coastal plain and flood plain in Asia. On the one hand, regarding the land cover change in the whole watershed of the large river, the mass balance of the river is gradually changing and causing the one of the
2.5 Vulnerability Assessment and Protective Effects of Coastal Vegetation during the 2004 Tsunami in Sri Lanka

Marcus Kaplana,b, Fabrice Renauda, Guido Lüchtersc

aUnited Nations University, Institute for Environment and Human Security
bCenter for Development Research, University of Bonn
cUniversity of Bonn

The Tsunami of December 2004 caused extensive human and economic losses along many parts of the Sri Lankan coastline. Most people managed to restore their livelihoods completely but some sections of the communities had not recovered some four years after the event. The differential in recovery highlighted the various vulnerabilities and coping capacities of communities exposed to the waves. Understanding these elements is crucial to reducing the impact of future events, yet capturing the vulnerabilities at the local level is complex. This research aimed to capture the vulnerability of affected communities and to evaluate the role of coastal vegetation in buffering communities against the tsunami. The study area in Southwestern Sri Lanka was chosen because of its complex landscape, including an inlet connecting Maduganga estuary with the sea, and because of the presence of remaining patches of coastal vegetation. The vulnerability assessment was based on the framework by Turner et al. and on the Sustainable Livelihoods Framework in order to detect inherent vulnerabilities of different livelihood groups. Our study resulted in the identification of fishery and labour-led households as the most vulnerable groups. The study also showed that the inlet channeled the energy of the waves, so that severe damages were observed at relatively large distances from the sea. Some reports after the tsunami stated that coastal vegetation protected the people living behind. Mapping of the vegetation and linear regression revealed significant differences between the vegetation classes in the area with regard to water level and damages to houses.

Session 3: Dryland Systems

3.1 Collapse and Restoration of Ecosystem Networks with Human Activity

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I introduce the project “Collapse and Restoration of Ecosystem Networks with Human Activity”, starting last year for five years at our Institute. The aims are to clarify the mechanisms resulting in the collapse and deterioration of ecosystems, and then pave the way to restore and maintain healthier ecosystems with high biodiversity and ecological functions. The research areas for this project are tropical rainforests in Sarawak, Malaysia and grassland in Mongolia. At both sites, the terrestrial ecosystems are being devastated with the surge in the recent global economics. We are describing the existing ecosystem network structure in both regions using information obtained from fieldwork and literatures, and starting to construct models for making projections and evaluating the ecosystem networks there. As a topic of the studies in Mongolia, I introduce a simple mathematical model to clarify the advantage of a nomadic lifestyle raising livestock on common land-use against a rather settled lifestyle on private land-use. The utilities of different land-use are compared by the geometric mean for annual growth rates of livestock biomass of a family unit, where the growth rates fluctuate spatially and temporarily according to uncertain precipitation. The advantage of common land-use became higher when the fluctuation was larger or when the number of families joining to make a common area was larger. Considering

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costs of long movement on common land-use, I found the optimal number of families making a common area, which was larger when the fluctuation was larger.

3.2 Vulnerability and Resilience of the Mongolian Pastoral Social-Ecological Systems to Multiple Stressors

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Dust and sand storms originating from Mongolia and Northern China affects not only China, Korea and Japan, but travels through the Pacific Ocean and reach the USA. One source area of these dust storms originates in the Gobi and dry steppe of Mongolia. A complex interaction of climate and land use changes contributes for these teleconnections. Ecosystem services for water and forage are decreasing due to climate and land use changes. A Gobi-dry steppe boundary zone, southern slopes of the Khangai and Altai Mountains, and great lakes depression areas are the most vulnerable to climate change, particular to drying trends. Vulnerability of the rangelands to climate and land use changes increased since transition to a market economy. Since 2003, Mongolia has witnessed impressive economic growth due to market price increase of copper and gold just as it has experienced sustainable development challenges. Traditional resilience of pastoral community-cultural landscape systems, adapted to climate variability and extreme events tends to be lost and be replaced with tragedy of commons outcome. However, there is still opportunity for sustainable transformation pathway to conserve ecological, social and cultural resilience in the Gobi and dry steppes (in all dust and sand storm source areas), strengthening traditional pastoral community-cultural landscape systems with introduction of modern technologies such as renewable energy and wireless communication technology.

3.3 Vulnerability of Pastoral Communities in Central Mongolia to Climate and Land-Use Changes

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Climate change and its impact on rangeland ecosystems have been studied for 6 pastoral communities in central Mongolia. Not only temperature and precipitation current and future trends, but also zuud (severe winter for livestock) index have been calculated for particular sites. Plant biomass has a decreasing trend in Central Mongolia, and the Gobi-steppe boundary areas have plant onset delaying trends. Water resources such as rivers and springs are decreasing in this region. Pastoral systems were very sensitive to changes in climate and ecosystems. Not only spring and summer became harsher for herders due to reduced forage and water resources, even delayed snow or no snow conditions in winter are affecting herders because livestock use snow as water source. Vulnerability of rangelands to climate and land use changes has been assessed for the communities, and as well at the country level. Cultural landscape fragmentation appears to be one of the critical factors for vulnerability of pastoral communities. Pastoral communities, which use their traditional cultural landscapes, had less vulnerability relative to those, who have lost their traditional resilience to cope with climate variability and extremes.
3.4 Resilience of herding communities to climate, socioeconomic changes in Mongolia
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During the last 20 years Mongolia has witnessed complex changes to its environmental, socioeconomic, and political system. Grassland comprises over 80 percent of the territory and pastoralists, 50% of the population depend on native pasture, surface water, and wells for animal production. Pasture degradation is a serious problem. Due to climate changes there has been a decrease in surface water sources and pasture productivity. This significantly impacts pastoral livelihoods and pasture land sustainability. The paper presents a socio-economic study that aims to better understand both herder livelihood strategy and their ability to adapt to systemic changes. Findings show that climate and environmental conditions are key land management determinants. Mobility remains an essential adaptive strategy for herders. There is need to modify pasture management practices to resolve open access/land tenure issues and mitigate economic pressures. This will take community effort and cooperation within and among groups. There are many different forms of institutions (formal-negdel, collective farm, cooperative, customary- khot ail, neg nutgikhhan,) that have existed through which the herders participate in economic, social and cultural life. However, within the current socio-economic environment and uncertain land tenure regime there is a lack of institutions which can coordinate the management of pasture land in Mongolia. This paper presents potential institutional models and forms institutions that may be implemented to regulate pasture use. Community based pasture management is a key factor in addressing today’s challenges.

3.5 Land-use change and consumption of ecosystem services in Mongolian Plateau
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Mongolian Plateau is one of the most important fragile dry land ecosystems likely to be affected by global climate change. While climatic and environmental changes directly affect regional sustainable development and human well-being, they are also subject to the effects of regional land use change and ecosystem degradation. Based on the remote sensing images in different periods, as well as relevant statistical information, this study tries to analyze the integrated characteristics and the spatial heterogeneity of land use change in Mongolia, and its driving factors. Both natural (climate change and natural disasters) and social driving factors (policies, regulations, and the increase of population) are responsible for the land use change in the study area.

Based on primary survey data and corresponding statistic data from the point of view of ecosystem services consumers, this study analyzes the food and fuelwood consumption of ecosystem services in the typical pastoral areas of Mongolia, and discusses the spatial differences of consumption and its impact. Socio-economic factors, the availability or accessibility of ecosystem services as well as consumer behavior, such as consumer preferences may affect human consumption patterns and willingness of ecosystem services, and consequently affect space difference of the ecosystem of consumer service in the study area. A series of natural and social effects caused by land use change have far-reaching impact on the ecological environment and socio-economic development in Mongolian Plateau. We try to explore the consumption
differences of ecosystem services in Mongolian Plateau under different degrees of human interaction with ecosystems. Under different economic systems and different levels of socio-economic development, local people are facing serious problems about land use and degradation of ecosystems in both Mongolia and Inner Mongolia of China. The study will provide a scientific basis for ecological-environmental-economic sustainable development in Mongolian Plateau.

Session 4: Models I

4.1 Simulating land-cover change in Montane Mainland Southeast Asia and understanding its implications for watershed hydrology

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We used the Conversion of Land Use and its Effects (CLUE-s) model to simulate scenarios of land-cover and land-use change (LCLUC) in Montane Mainland Southeast Asia (MMSEA), a region on the cusp of change due to projected rapid intensification of agriculture and expansion of regional trade markets. Simulated changes affected approximately 10% of the MMSEA landscape between 2001 and 2025 and 16% between 2001 and 2050. Roughly 9% of the current vegetation, which consists of native species of trees, shrubs, and grasses, is predicted to be replaced by tree plantations, tea, and other evergreen shrubs during the 50-year period. Importantly, 4% of this change would be due to the conversion of native vegetation to rubber (Hevea brasiliensis). In a related project we collected hourly records of 2 m deep soil moisture profiles under rubber and three native land covers (tea, secondary forest and grassland) in an experimental catchment, Nam Ken (69 km2), located in Xishuangbanna Prefecture, Yunnan province, in 2005-2006. Observations show that root water uptake of rubber during the dry season is controlled by day-length, whereas water demand of the native vegetation starts with the arrival of the first monsoon rainfall. The different dynamics of root water uptake in rubber result in distinct depletion of soil moisture in deeper layers. Traditional evapotranspiration and soil moisture models are unable to simulate this specific behavior. Therefore, a different conceptual model, taking in account vegetation dynamics, is needed to predict hydrologic changes due to land use conversion in the area.

4.2 Vulnerability Assessment of Social-ecological Systems in Ha-Da-Qi City Belt of China Based on Information Entropy and Matter-element Model

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According to the social and ecological conditions of Haerbin, Daqing and Qiqihaer city belt (Ha-Da-Qi, short form) in the northeast of China, this paper selected 9 indices using DPSIR (Driving forces-Pressure-State-Impact-Response) conceptual frame, which was developed by European Environment Agency(EEA) in 1998. We selected population density to represent driving forces, and selected SO2 emission quantity of industries and proportion of areas that suffered agricultural disaster (including drought, flood, snow storm and plant diseases caused by insect pests) to

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represent pressure. Also selected are proportion of salt-alkali area, soil erosion intensity index to represent state, proportion of grassland degradation area to represent impact, gross domestic product per capita, arable land per capita, and investment of permanent assets to represent response. We used information entropy to calculate the power of different indices, and then evaluated the vulnerability of social-ecological systems of this region quantitatively using matter-element model that was developed by Professor Cai wen in 1994. The results showed that the vulnerability in the cities of Haerbin, Daqing and Qiqihar were high, moderate for Zhaodong, Anda, Zhaozhou and Zhaoqiao, and low for the cities of Shuangcheng, Lanxi, Dubo, Lindian and Fuyu. This evaluation results are in accord with the objective situation.

4.3 Future land-cover and land-use change in China from a global perspective

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A reduced-dimension global land use change model is newly developed to study the human environment interaction worldwide with 220-country units. The model is driven by changes in the demand-side from agricultural goods arising from trends in population, consumer preferences, economic development and international trade agreements and changes in the supply-side arising from climate change, technological development and management improvements. In this paper, the model will be applied to focus on future land use changes in China from a global perspective. We aim to investigate the trade-off between domestic food production and international import to meet the food demand of increasing population at a higher consumptive rate due to higher income. Chinese potential national land system management policy will be assessed in the model system by studying the possible implementation of environmental sustainable development plans and bio-fuel energy plant strategies. The model results will be discussed with the participants at the workshop to understand the adaptive capacity of the land system in China facing the domestic and international challenges.

4.4 Carbon and water cycles in the land systems of monsoon Asia in response to multifactor global change

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Monsoon Asia, home of more than half of world's population: the people of South, Southeast and East Asia, has experienced one of the most rapid changes in the past decade and is likely to undergo further rapid development in the coming years. The land system in monsoon Asia has been experiencing multiple environmental stresses including (a) climate change and climate extremes, (b) changes in land cover and use, (c) changes in fire disturbance, (d) changes in the chemistry of precipitation (particularly nitrogen), and (e) changes in the composition of the atmosphere (carbon dioxide, ozone). In particular, land-cover/land use changes (LCLUC) in Monsoon Asia are being powered by demand for food for its growing population and by the transition from a largely rural society to one in which more than half of its people are expected to live in cities within two decades. To address biogeochemical and hydrological consequences of LCLUC and non-LCLUC, we developed and applied the Dynamic Land Ecosystem Model (DLEM) to investigate the concurrent effects of multiple environmental stresses on terrestrial carbon and water cycles in monsoon Asia in the past 300 years and quantify relative importance of natural

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and anthropogenic disturbances. Our study also identified gaps and limitations in existing information that need to be investigated in the future to improve our understanding of carbon and water cycling and our ability to estimate terrestrial carbon and water fluxes in this region. Much uncertainty exists in how LCLUC caused by urbanization, deforestation/afforestation, desertification and biofuel production may affect local, regional and global climate and further influence the provision of goods and services by land system in the region of Monsoon Asia. To explore the complex interactions among land use, ecosystems and monsoon climate, we propose to develop a Coupled Regional Earth System Model (CRESM), which includes the submodels of the terrestrial ecosystem and carbon cycle, the climate system and the economy system, and land use/land cover change. To complete the CRESM, we will need interdisciplinary research as well as international cooperation.

4.5 Mapping potential land degradation with MODIS data in semiarid region: A case study in western Songnen Plain, China

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There is a pressing need for mapping large areas with high population growth rate and very low Net Primary Production (NPP) such as the western Songnen Plain in China. The Moderate Resolution Imaging Spectroradiometer (MODIS) holds considerable promise for land degradation mapping in this region given its global coverage, moderate spatial resolution and high temporal resolution, as well as cost free status of it’s data. The objective of this study was to investigate the applicability of MODIS 250m data for large susceptible area mapping over the western Songnen Plain in China. A time-series of MODIS-EVI data, MODIS 1-7 bands data and ancillary data were used with Maximum Likelihood method to classify the MODIS data into 10 classes and the obtained land cover map was served as one of base variables constructing fundamental assessment unit. This study employed Local NPP Scaling (LNS) approach, where a growing season sum NDVI (SumNDVI), an indicative of NPP, of each pixel was calculated to compare with the highest values of SumNDVI observed in all pixels falling within the same land capability unit. Then the paper tested if the LNS values coincided with the degraded areas mapped using Landsat TM and identified areas of spatial disagreement. Most areas reached spatial agreement except for some land capability units which may obscure human-induced impacts. Finally, this paper draws the conclusion that MODIS data is valuable material for mapping potential land degradation; however, future research is necessary to utilize multi-temporal MODIS data to reveal the land degradation trend.

Session 5: Models II

5.1 Toward the prediction of vegetation transition at the topographical scale: Example study in the forest-steppe ecotone in Mongolia.

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Vegetation change is induced by both climate change and human land use. Considerable efforts have been made to predict its future from both sides, but generally, most of the modeling studies featured either of these drivers but have not incorporated both in a comparative way. The mismatch in spatial scale between both mechanisms was a barrier: climate change and its models have much larger extent and coarser resolution than those of land use. For example, even within a vegetation grid of 1km², the smallest unit in climate modeling, we cannot include
the realistic spatially explicit land use often limited by the heterogeneity of topography or hydrology. To tackle this problem and to integrate these two main mechanisms into a vegetation prediction model, we elaborate a downscaling method of climate condition into topographical scale. Taking a sample area in the forest-steppe ecotone in northern part of Mongolia, we developed a vegetation transition model at the topographical scale, at which both the effects of soil water condition and herbivory are incorporated. The reduction in precipitation (and permafrost) and overgrazing by livestock, the most serious drivers of the vegetation change in the region reflecting global climate change and local human activity, respectively, thus could be dealt at the same scale. The vegetation properties and topography were obtained from satellite data and validated by insitu field survey. From the results of our model, extreme drought may induce a catastrophic and irreversible vegetation change from forest to steppe or steppe to bare states (i.e., regime-shift) at this scale, and this would be strongly enhanced by livestock inclement. This method not only provides the prediction of vegetation transition in higher resolution but to show the synergetical effects of the two drivers quantitatively and comparatively, which would be essential for planning the sustainable land use under ongoing climate change.

5.2 Land use planning in semi-arid regions of Asia using MicroLEIS DSS
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The decision support system, MicroLEIS DSS, was applied to evaluate the land use planning in Ahar soils, 9000 ha approximately, located in East Azarbaijan. In this way 6 agro-ecological land evaluation models constituents of this DSS software were selected in order to make strategies related to land evaluation at a regional level, such as segregation of agricultural lands, restoration of marginal areas, diversification of crop rotation, and identification of vulnerability areas. Results obtained from each evaluation models are presented and discussed in this research work. Soil morphological and analytical data were collected from 44 soil profiles representative of the study area and stored in SDBm plus database. Three control sections: 0-50, 25-50, and 0-100 cm were calculated by 'soil layer generator' to apply and run the models. Results show that in Ahar area, 45% of the total extension was classified as good capability land for agricultural uses. However, almost 12% of total area must be reforested by suitable shrub species, and not dedicated to agriculture, to minimize the land degradation. Additionally, soils with vertic properties used to present an excellent capability for most of the traditional crops. Wheat-alfalfa-soybean was selected as the best crop rotation. In summary, MicroLEIS DSS tool appears to be useful in this part of semi-arid regions of Asia, such as East Azarbaijan (Iran), to formulate sustaining agro-ecological systems. Additionally, information about land use planning in this part of Asia is rather scarce.

5.3 Using expert judgment to define indicators for assessing vulnerability from a conjoint choice analysis at multi-scales space in China
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Rapid economical development in China companied with undefined ecological problems has urged scientists to participate in the comprehensive survey of coupled human-environment ecosystem. Vulnerability is an effective description of the extent to which a system susceptible to sustaining damages from climate changes (IPCC, 2001). Former vulnerability assessments are mainly focused on countries, but variability among locations calls for more practical approach
especially on adaptive capacity management. Land-use and cover will be one of our focuses as the atomist manifestation of the systematic state. We maintain that vulnerability is a composite indicator integrated by three dimensions: Exposure, Sensitivity and Adaptive capacity, their definitions vary with researching spatial scales. Sensitivity is the key determinant in analyzing vulnerability of a macro-scale space than exposure, while comprehensive adaptive capacity analysis is effective on micro-scale when data for a thorough investigation to the ecological and economical background is available. Expert judgment questionnaire consisted with conjoint choice questions both at macro-scale (several ecological areas of China) and micro-scale (several typical counties in the Inner Mongolia land resource area) will be designed and delivered to 100 experts profession in several concerning field. Indicators used to character and identify the spatial diversity of vulnerability and their trade-off correlations according to the result of the questionnaires from experts. At the same time, we will develop a comprehensive method for future vulnerability regulation and adaptive management.

5.4 Assessment on Ecosystem Service of Carbon Regulation using GLOPEM-CEVSA Model
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Human alteration of Earth is substantial and growing. It is a long term challenge of managing trade-offs between immediate human needs and maintaining the capacity of the biosphere to provide goods and services. In assessment on the spatial-temporal pattern of ecosystem services, ecosystem modeling was regarded as a better way. In this study, a production efficiency model based on remote sensing was coupled with ecosystem process simulation, named as GLOPEM-CEVSA model, to assess the regulation capacity on carbon concentration in atmosphere by terrestrial ecosystem in China. As two sides of carbon regulation, net primary production (NPP), as an index on carbon absorption by ecosystem, and soil heterotrophic respiration (HR), as an index on carbon release from ecosystem, was selected and modeled with GLOPEM-CEVSA model with input remote sensed data from GIMMS, and interpolated meteorological data from the more than 650 stations in China. In 1982-2003, the modeled result show that, the NPP of ecosystem in China averagely was 327.82 (13.54 of standard deviation, sd) gCm$^{-2}$ a$^{-1}$. The productivity was higher in forest (above 800 gCm$^{-2}$ a$^{-1}$), and agriculture (above 500 gCm$^{-2}$ a$^{-1}$) while it was slower in grassland with a range of 50~200 gCm$^{-2}$ a$^{-1}$, and NPP was the lowest in desert area (below 50 gCm$^{-2}$ a$^{-1}$). The total carbon absorption by terrestrial ecosystem in China was 3.10 PgC a$^{-1}$ in 1982-2003. The HR of ecosystem in China averagely was 292.76 (2.65 standard deviation, sd) gCm$^{-2}$ a$^{-1}$, and showed decreasing gradation from southeastern to northwestern on spatial pattern. HR was more active in forest and agriculture ecosystem (above 500 gCm$^{-2}$ a$^{-1}$), while it was slower in grassland (152.10 gCm$^{-2}$ a$^{-1}$), and HR was the slowest in desert area (31.58 gCm$^{-2}$ a$^{-1}$). The total carbon release by terrestrial ecosystem in China was 2.77 PgC a$^{-1}$ in 1982-2003. Since as a difference between carbon release (HR) and absorption (NPP), the carbon budget in the terrestrial ecosystem in China is a carbon sink of atmosphere and net absorption 0.33 PgC a$^{-1}$ on the average in 1982-2003, which was similar to the result of Piao et al. (2009). By input with remote sensing, the heterogeneity of ecosystem, and by ecosystem process simulation, the whole production and exhaust process of ecosystem, the both were considered in GLOPEM-CEVSA, and by this method, the ecosystem services will be monitored and assessed with more precision and accuracy.
5.5 Modeling agricultural land change considering interaction of farmer’s decision-making and environment

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In recent years, there has been much attention on the application of agent-based model in land use /land cover change (LUCC) research, among which much work focused on urban spatial evolution while less was on the dynamics of agricultural land-use research. This paper presents a multi-agent based model to simulate the land use choices of farmers. Land-use decision matrix, which contains the probabilities of agricultural land-use choices distributed and possible land use types anticipated by farmers, was performed in this paper to accomplish the choice of land use with rule and order algorithm. This model was used to simulate the land-use dynamics of the Huadu district of Guangzhou City in 1990—2015 with the platform of Repast. Results showed that the method used in this paper can be used to simulate rural land use change process.

Session 6: Institutions I

6.1 Land-use change under the policy of “Returning farmland to lake” in the floodplain of Poyang Lake, the middle reach of the Yangtze River, China

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Inhabitants near Poyang Lake, in the Central Yangtze River drainage basin, China, are vulnerable to the loss of lives and livelihoods because of the interactions of flooding with land-use policies and decisions. Because grain production has been one of the central goals of the Chinese government, historically the primary means of increasing the total amount of agricultural yield has been to enlarge farmland area. One consequence of this has been the conversion of large areas of natural wetlands in fertile areas, such as Poyang Lake region, to farmland (wetland reclamation). During the past twentieth century, many levees were built to encircle new farmland in low elevation areas adjacent to lakes and rivers, forming a vast of polders that are protected against flooding. After suffered the tremendous flooding disaster in 1998, a “Returning Farmland to Lake” policy was launched by the central government of China. This policy aimed to enhance the flood retention capacity in the middle reaches of the Yangtze River, consequently reducing the increased flood risks to farmlands. In this paper, land use and cover change driven by the “Returning Farmland to Lake” policy were mapped by field investigation and using multi-temporal Landsat TM/ETM images of 1995, 2000, and 2005. Vulnerability to flooding was analyzed based on the distribution of land covers relative to the elevation and the quality of levees.

6.2 Making Forest Preservation in Asia Work

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The deforestation of Asia’s tropical forests is occurring at an alarming rate. An estimated 20 percent of total greenhouse gas (GHG) emissions result from deforestation and degradation, thus making deforestation and degradation the second largest source of green house gas emissions after fossil fuels. What is more, increasing demand for first generation biofuels could further increase GHG emissions when tropical forests are cleared for palm oil plantations or commercial crops. The climate talks in Bali in 2007 created momentum in dealing with emissions from...
deforestation of tropical forests in developing countries. A new mechanism, commonly referred to as REDD (Reducing Emissions from Deforestation and Degradation), could become reality under the post-2012 Kyoto regime. REDD initiatives seek to create financial incentives to preserve existing tropical forests. There are still many open questions and constraints. One of the major challenges of successful REDD implementation depends on how and in what way forest-dependent communities are involved. Another challenge is the role of governance in ensuring that forests are preserved. But instead of discussing the biological and technical aspects, this paper critically examines ongoing project implementation of REDD, and will discuss the potential benefits and risks involved in this mechanism. For the first time, preserving tropical forests could become a financially viable alternative to commercial logging. Additional benefits include biodiversity preservation, water and soil conservation, or opportunities for eco-tourism.

6.3 Measuring and monitoring vulnerability of land-systems in central India with community participation
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Vulnerability of land-systems in central Indian forests is more pronounced in terms of their exposure to multiple stressors, including: rapid land-use change due to intensive agriculture, unplanned urbanization and other anthropogenic activities. These stressors exacerbate water resource scarcity, threaten biodiversity, and adversely impact the ecosystem services. The human-environment systems (including land-use and land-use change stressors) play a crucial role, especially in rural and forested areas of India, where nearly 400 million people are dependent on forests for their livelihoods. But since the Joint Forest Management (JFM) regime (1990) the forest department and the communities are jointly managing the forests. Assisted by developmental interventions and projects, the communities are monitoring the forest sustainability and measuring its vulnerability through use of ‘peoples’ indicators’. These indicators are regularly monitored using indigenous techniques and simplified procedures for data collection and analysis. Due to the adaptive co-management of peoples’ institutions, the ecosystem vulnerability has been substantially reduced, thus helping to increase ecosystem resilience, and ensuring sustained livelihoods for local communities. The present study is based on peoples’ indicators and their role in measurement and monitoring of vulnerability of village forest-land, which are being jointly managed by a Joint Forest Management Committee (JFMC). Using resource survey questionnaires, focused group discussions and secondary data, the study tries to explore the role of peoples’ indicators in increasing resilience of land-systems in central India and assess the role of communities and social systems towards climate change adaptation.

6.4 Management of Ecosystem Services of the Supa Watershed, Yunnan China
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This paper analyzes the environment services of the Supa River Watershed which is a tributary of the Nujiang River and has rich water resource for developing hydropower. The ecosystem services in Supa Watershed include food production, water flow for hydropower generation, biodiversity conservation, timber production and non-timber products. The stakeholders are community, hydropower companies, forestry bureau, and local governments (county and prefecture). At present, community-based management is the main institutional form in this watershed. Their contribution is not fully recognized by other stakeholders. Based on secondary data, satellite image interpretation, field survey and participatory assessment, the paper examines value of environment services, management institutional arrangement and...
management issues related to environment services and discuss possible schemes of payment for environment services.

6.5 Community Based Peat land Management and Green House Gas Emission Reduction
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The amount of carbon stored in tropical area is about 83.3 Gt., of which 44.5 Gt. or about 53.1 % is found in Indonesia, distributed in the three main islands, Sumatra which stored 18.3 Gt.(41.1%), Kalimantan 15.1 Gt.(33.8%) and West Papua 10.3Gt.(23%). During 1990 until 2002, about 3.5 Gt. carbons of peat lands in Sumatra alone decline while during 1997, peat and vegetation fires released about 0.81-2.56 Gt. or equivalent of 13-40% of mean annual global carbon emission released from fossil fuel into the atmosphere. Official report published by Ministry of Forestry shows that during January to December 2007 it had been found that most of hotspot detected in Indonesia totaling about 10,280 (64.07 %) rooted from the community; 2,644 hotspots (16.48 %) were found in estate crops; 1,691 hotspots (10.54 %) in the forest concession and 1,430 hotspot (8.91 %) in the forest plantation area. This means that the community will be one of the most important players in managing the Green House Gas (GHG) produced from their land especially in peat land. One of the promising solutions seems to be land preparation without fire. The result of the research in peat land done by the community shows that the land preparation without fire which consist of 44 ton/ha fuel load that was not burned will prevent the release of 3.465 ton CO2, 0.036 ton CH4, 0.0014 ton NOx, 0.044 ton NH3, 0.0367 ton O3, 0.641 ton CO and 0.77 ton particles to the atmosphere during burning.

Session 7: Institutions II

7.1 Swidden change in Southeast Asia: land cover, demography, policy and consequences for livelihoods and environment
Ole Mertz, Christine Padoch, Jefferson Fox, Robert A. Cramb, Stephen J. Leisz, Nguyen Thanh Lam, Tran Duc Vien, Dietrich Schmidt-Vogt, Andreas Heinimann, Thilha, Peter Messerli, Michael Epprech, Pham Van Cu, Vu Kim Chi, Martin Hardiondo, Dao Minh Tuong, Kanok Rerkasem, Wolfram Dressler, Carol C.J.P. Colfer, Lesley Potter, Yayoi Fujita, Dimbab Ngidang, Nancy L. Peluso, Niken Sakuntaladewi, Janet Sturgeon, David Thomas, Pinkaew Laungaramsri, Le Quang Trung, Elo Mulyoutami, Alan Ziegler, Thilde Bech Bruun, Deborah Lawrence, Andreas de Neergaard
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Swidden cultivation is rapidly changing to other forms of land use throughout Southeast Asia. A review of 151 case studies shows that in about two thirds of the cases, swidden is being replaced by other land uses. Country by country analyses show an insufficient knowledge on the spatial extent of swidden and high variability in the quality of data on the number of people dependent on swidden. Using a new landscape mosaic approach, good data is available for Lao PDR and this method should be applied in other areas. Five main drivers of change in swidden systems were identified and include the definition of swiddeners as ethnically different, inadequate mapping, state control and conservation efforts, privatization efforts and promotion of industrial and market driven agriculture. The resulting livelihood impacts analysis concludes that while swiddeners are receptive to appropriate forms of development there are many examples of externally imposed change causing negative impacts on livelihoods. The impacts on biodiversity
can also be negative with large scale conversion to plantation agriculture, but changes in smallholder systems from swiddening to permanent agriculture may result in an increase in agrobiodiversity. Changes in hydrology and geomorphology are more likely to be negative as almost any type of intensification or conversion to other land use systems results in disruption of stream flow, decline in stream water quality, increased erosion and higher risk of mass failures. All other land use systems besides natural forests also appear to have lower carbon storage and soil quality than swidden cultivation systems, but data is inconclusive. It is concluded that interdisciplinary research that allows extrapolation at meso-scale is needed to understand past changes and build plausible future scenarios for development in areas formerly dominated by swidden cultivation.

7.2 Wetland dynamic change of the new coastal region of Tianjin and the effects on ecosystem service

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Landscape pattern of Wetland and its dynamic variation is the hotspot of wetland ecology and landscape ecology. The new coastal region of Tianjin is a wetland concentration zone which is affected fiercely by human activity. Based on four period TM images (1993, 1998, 2004, and 2008) of the new coastal region of Tianjin and other materials, we analyze the spectral signature of every land types and build a hierarchical stepwise model to extract remote sensing information. Then we divide the area into 8 land types, including salt marsh, beaches, salt water for aquaculture, reed swamp, river, lake/pool and paddy field. Based on GIS technology, we use land dynamic degree, land transition matrixes and improved landscape indicators to do comprehensive analysis of wetland dynamic spatio-temporal change of the new coastal region of Tianjin. Result shows that a lot of wetlands have been lost from 1993 to 2008. The main trend of transition is from wetlands to city. Besides, the natural wetlands change into man-made wetlands, and the driving factors are spread of city, impulse by policies and economical reasons. Finally, we evaluate its impacts on ecosystem service such as supply, adjustment, culture and support.

7.3 SPARK - Strategic Planning Approach for Resilience Keeping

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In a world in growing turbulence, complexity and uncertainty, where crisis is becoming the norm rather than the exception, resilience is increasingly seen as a critical feature that reflects the capacity of a system to absorb disturbance and reorganize without collapsing. Resilient systems are more adaptable to change, are more able to learn and are less vulnerable to disturbance and external shocks (e.g. natural phenomena, economic crises or political shifts). The resilience theories are re-emerging as a field of research and practice with application to socio-ecological systems, fostering new insights in the discussions about sustainable development. The main purpose of this paper is to explore resilience as a concept and as a framework for promoting more sustainable trajectories, highlighting its potentialities and advantages for policy and planning processes. SPARK, or the Strategic Planning Approach for Resilience Keeping is introduced in the paper as a new sustainability framework, following key underlying concepts and seven key principles that capture the essence of resilience theories, advancing the proposal of a methodological concept for resilience assessment and planning that aims to improve the connection from theory to practice, performing knowledge brokerage and enhancing policy learning.
7.4 Towards a better understanding of social capital as a modulating factor of resilient land systems in Asia

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Understanding the holistic and interdependent nature of physical and social (eco-social) systems is fundamental to develop appropriate mitigation and adaptation responses to the many challenges posed by global change, especially to the climate. The concept of social capital is increasingly viewed and studied as an important component of eco-social resilience. Social capital (“social connectedness”) is theorized in various ways by economists, geographers, sociologists and public health professionals. In common, these disciplines agree that social capital is centrally concerned with formal and informal connections between individuals, groups, communities and organizations, reflecting myriad cognitive links between these actors. Several methods have been developed to better understand and measure this concept, including proxy indicators for social capital, and primary data collection and analysis. This paper will review recent and current work on social capital and the natural environment in Vietnam and Cambodia, focusing on methodology. It will also present a framework for exploring the role of social capital within decision-making, using available critical measures of governance and social function such as the World Values Survey. Finally, national indicators which reflect human development will be compared with measures of social capital (where available) to explore possible links. A critical understanding of the role of social capital in land systems (as defined by this meeting to include the human dimension) is suggested by the authors as an important contribution to outlining the ways in which society can foster the resilience required to cope with the enormous challenges of global environmental change.

7.5 Impacts of Land Use Functional Change on WTA and Economic Compensation for Core Stakeholders: A Case Study in Poyang Lake

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This paper provides an insight into land use functional change and economic compensation for sustainable development in an ecological vulnerable region of China. Poyang Lake region of Jiangxi Province is selected for the study. Environmental protection policy for wetland restoration is one of the prioritized driving forces causing land use functions to change in the region. Data from statistics, household survey and relevant documents were collected and the logistic curve, Engel’s co-efficiency, willingness to pay and willingness to accept, benefit efficiency, and payment rate of the governmental organizations for eco-compensation were applied in our data analysis. By comparing land use types between two periods (1997~2000 and 2000~2005), and analyzing the income structure of farmers and industrial structure from 1997 to 2007, the result shows that land use functional change affects the income of farmers at micro-level and influence on industrial structure at macro-level, leading to unsustained economic development in the region. It is found that ecological compensation mechanism is a good way to resolve the above problems. Firstly, the research classifies stakeholders into 3 categories from 3 dimensions (voluntary, importance and urgency) based on the results of expert scoring, namely: core stakeholders including local government, farmer, research institute, enterprises; dormant stakeholders including research institutes, NGOs of environmental protection, community; and marginal stakeholders including public and media sectors. Secondly, it goes deep into analyzing the two core stakeholders: local government from 3 representative cities (counties) and farmers. The results show that farmers living in the area are very much concerned about their economic condition, their willingness to accept for wetland conservation is between RMB 1.3762~1.5525 RMB per hectare (the land use area per household is 0.225 hm$^2$) per year and the total willingness to pay is between RMB 5.7~6.5 billion RMB per year; the willingness to pay of the...
respondents varies with different backgrounds. The results show that the payment rate is 73.0%, 17.3% and 9.7% for Nanchang, Jiujiang and Shangrao respectively. We expect that the above results could provide advices to decision-makers on how to improve the living standard of farmers under the current land conversion program in Poyang Lake region or similar areas of ecological vulnerable region.

Session 8: Hydrology

8.1 Climate change, water availability and future cereal production in China
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Climate scenarios from a regional climate model are used to drive crop and water simulation models underpinned by the IPCC SRES A2 and B2 socio-economic development pathways to explore future water availability for agriculture in China. Various measures of water availability are examined at river basin and provincial scale in relation to agricultural and non-agricultural water demand and current and planned expansions to the area under irrigation. The objectives are to understand the influences of different drivers on future water availability to support China’s food production. Hydrological simulations suggest moderate to substantial increases in total water availability in response to increases in precipitation. Crop simulations exhibit moderate to large increases in cereal irrigation demand. Increases in water demand for non-agricultural uses limits future cereal production in China. Climate change plays an important role through interactions between changes in crop water requirements and renewable water resources. The effects caused by climate change on water availability for agriculture are small compared to the socio-economic developments, but with different directions under different combinations of climate and socio-economic scenarios. The combined impacts of climate change and socio-economic development produce decreases in future irrigation areas, especially the irrigated paddy rice area. Increasing water shortages occur for agriculture in most areas of China, particularly in the current water-rich areas of south China. This might have significant implications for future adaptation strategies and policies.

8.2 Tree-ring inferred-moisture change over the northeastern Tibetan Plateau
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The Tibetan Plateau acts as a water tower for sustaining life in eastern and southern Asia. Global warming is likely to result in potential change in regional and global hydrological cycles in high Asia. However, due to the high variability in precipitation and moisture conditions across regions
and to improve our predicative ability for global hydrological cycles under climate warming, it is of great importance to investigate the precipitation and moisture change at regional scale. Tree rings provide a valid tool for understanding past long-term changes in precipitation and moisture conditions in areas where plants are water-limited. In semi-arid and arid northeastern Tibetan Plateau, several Qilian Juniper (*Sabina przewalskii*) forested stands were sampled and four multi-centennial long ring-width chronologies were developed to investigate 1) major climate factors for limiting the radial growth, 2) the moisture change during past six centuries, 2) possible factors triggering recent growth anomalies. Correlation and response function analysis showed that May-June precipitation was the most critical factor for positively limiting the radial growth. Comparison with carbon isotope data indicates that growth enhancement during the 20th century were ascribed not only to regional late spring to early summer moisture availability, but also to the direct CO₂ fertilization effect on tree growth in an enriched-CO₂ world. Comparison with global sea surface temperatures (SSTs) indicates that early (late) monsoon season precipitation is closely related to tropical Pacific (Indian Ocean) SSTs, suggesting a possible seasonal shift in the dominant moisture source area for monsoonal precipitation over the northeastern Tibetan Plateau.

8.3 Impact of Land Use Change on Land Desertification and Eco-Environment in Oasis region of Xinjiang, China
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Located in Northwest China, the oases of Xinjiang are largely distributed in Tarim River basin with arid climate and a very fragile eco-environment. Over the past decades, economic development especially due to unreasonable land use and water resource usage led to a decrease in the amount of water from the mainstream of Tarim River, which has triggered desertification process in the middle and low reach areas of the river and caused oases shrink considerably. Firstly, based on the overall analysis on climate, population increase, farmland and water resource and its changes, the cause of expansion of land desertification are revealed. Secondly, the low reaches of Tarim River was chosen as a key research area, the character of land use and land desertification are analyzed based on land use data of 1980 and 2005 by using GIS technology and statistical methods. Thirdly, the relations between soil, vegetation and groundwater in the processes of land desertification were studied. The data analyzed were gain from sampling and testing in lower reach of Tarim River. The purpose of the study is to figure out the trend of soil evolution and character in process of desertification. Fourthly, changes and trend of some eco-environmental factors were studied. The Grey system method was applied to determine the main factor influencing the expansion of land desertification in the study area. Fifthly, the balance between land use and water resources were calculated and reasonable proportion of oasis was given in different areas in Tarim river basin. Lastly, some strategic countermeasures were put forward for land restoration and to prevent land from desertification.
8.4 Dendrogeomorphological and sedimentological analysis of debris flows hazards in the northern Zailiiskiy Alatau, Tien Shan mountains, Kazakhstan

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Valleys in the northern Zailiinski Alatau range of the Tien Shan Mountains, Kazakhstan are especially prone to large-scale debris flows due to increasing temperatures, high intensity weather events, glacier retreat, sediment availability and debutressing of glacially over-steepened slopes. To assess the area’s hazard status, this study uses dendrogeomorphological techniques and sedimentological analysis together with archival records to date debris flows in two valleys in the Bolshaya Almatinka river catchment. Our first study site on the Ozernaya valley floor in the upper catchment is divided into distinct sedimentological assemblages. Their dating, derived from tree rings, highlights two major debris flows periods: the first between 1607-1633 and the second between 1702-1728, 1725-1751 and 1769. Our second site in the lower Almatinka valley included four terraces beside Kumbelsu creek and terraces beside the Almatinka River in its lower reaches. Progressively younger trees on successively lower terraces indicate numerous but decreasing flood magnitudes since the 1970s. Sedimentary characteristics suggest that recent debris flow development has been associated with reworking of glacial sediments deposited during a previous phase of para-glaciation. Documentary evidence shows that, since the mid-nineteenth century, approximately two-thirds of large-scale debris flows in the region, including 14 in the study area, have been the result of moraine-dammed glacial lake outbursts, with the remainder due to intense summer rainstorms; thus the clear implications are that future work should urgently be directed to hazard assessment of vulnerable moraine-dammed lakes, head slopes and sediment supply areas.

8.5 Regional moisture condition diversities and trends in China during the last 50 years

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We used Penman-Monteith model with a modified net radiation part to calculate potential evapotranspiration and moisture index, and described the regional moisture condition diversities and annual trends from 1959 to 2008 in China. Observed climatic data from 711 meteorological stations of China and Anuspline technique interpolate method were used. The results showed that potential evapotranspiration varied between 305 mm to 2199 mm in China’s land surface. According to the moisture index, four moisture regional types were delineated gradually from the southeast to northwest, i.e. humid, subhumid, semiarid and arid throughout China. Arid area was located in Xinjiang Province and partial Tibet, Qinghai, Gansu, Ningxia Province and Inner Mongolia Autonomous Region, while humid area was located in the southeast province of China. The boundary of four new moisture regional had conflicts in some local area with traditional method. After linear regression, we found that the annual precipitation and moisture index of most area in China had increasing trends and potential evapotranspiration had decreasing trends. The results suggest that it is necessary to consider precipitation and potential evapotranspiration simultaneously to describe the moisture conditions exactly.
8.6 Mechanism based understanding of degradation of rivers and fringing floodplains: Lessons from a Japanese large river for biodiversity conservation and restoration

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Floodplains are among the most biologically rich ecosystems on earth. There is a global trend that floodplains are degrading at an alarming rate, to which those in Asia are no exception. We hereby report recent findings from floodplains in Japan and provide implications to the management of river-floodplain systems. Key literatures have demonstrated the importance of hydrological connectivity (surface or subsurface connectivity to river’s main stem) in determining biological and physicochemical properties of floodplain waterbodies. Nevertheless, mechanisms behind those patterns are rarely tested. Our study examined how the ecological integrity of floodplain ponds are maintained by high levels of surface hydrological connectivity, focusing on abundance, survival rates, and growth rates of universally imperiled freshwater unionid mussels. Field study was conducted in a low-land segment of Kiso River. A total of 68 ponds were selected within the segment, and surveyed to estimate the abundance of resident mussels and to measure various habitat variables. Both probability of occurrence and CPUE of mussels significantly increased with increasing frequency of inundation (FI) during floods. Three types of ponds with three replicates were selected and mussel individuals collected elsewhere were reared within enclosures: Type1, high FI with resident mussels; Type2, intermediate FI with mussels; and Type 3, low FI without mussels. Survival rates were significantly lowered with growth rates being almost zero in Type 3, where anoxic condition was frequently formed near the bottom. These findings suggest that frequent inundation have direct and positive effects on mussel habitat by preventing formation of low-oxygen conditions.

Session 9: Vulnerability Outcomes II

9.1 Wise Management of Carbon and Water in Tropical Peatland

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Tropical peat (including swamps and forests) found on islands in the Indonesian and Malaysian Archipelagos, the Amazon lowlands and Central Africa comprise some 42 Million ha, and are estimated to store approximately 148 Gt (1Gt = 1015g) of carbon. Because of their inferior nature, these environments remain undeveloped, possess relatively virgin forests, and are extremely fragile and very liable to disturbance. Much of the recent increased interest in peat globally has resulted from the importance of peatlands as carbon sinks and stores, and their role in carbon cycling between the earth’s surface and the atmosphere. Much detailed work has been carried out on carbon gas emissions from tropical peat in Southeast Asia in recent years and is contributing to knowledge of this topic. Throughout many research of tropical peat, the problems that result from development of tropical peat stem mainly from a lack of understanding of the complexities of this ecosystem and the fragility of the relationship between peat and forest.
In its natural state tropical peat is a vast carbon sink and store but once the carbon allocation to the system is discontinued by forest removal and the peat is drained, the air exposed surface peat oxidizes and loses previously allocated carbon rapidly to the atmosphere, which results in progressive subsidence of the peat surface and contributes to climate change. The Mega Rice Project in Central Kalimantan disrupted the peat swamp forest ecosystem over an area of at least one million hectares and it became fire prone. Eighty per cent of this landscape burned in 1997 releasing about 0.15 billion tonnes of carbon to the atmosphere while peat fires throughout Indonesia as a whole liberated 0.87-2.67 billion tonnes of carbon, equal to 10-30% of the annual global carbon emissions from the burning of fossil fuels. This was a disaster of catastrophic proportions that not only released vast amounts of carbon from the peat store to the atmosphere as carbon dioxide, methane and soot but it also affected human health. In addition, it has led to increased flooding of these vast landscapes and downstream habitations in the rainy season, because the peat has lost much of its water absorption and retention properties. There are increasing periods of protracted drought in the dry season because the drainage channels enable water to flow from the peat quicker than in their natural state. Fires reoccurred in Kalimantan in 2002, 2004 and 2006, although with less severity than in 1997 but never the less, this resulted in a further loss to the atmosphere of large amounts of carbon from the peat carbon store and also proved increased likelihood of recurring fire events on burned areas. Thus, it is essential that future land use of tropical peat takes fully into account the principles and practices of sustainable development and incorporates the ‘wise use’ approach. The wise use of peat involves several elements, foremost amongst which is the identification of the benefits and values that they can provide and the adverse environmental and human consequences resulting from their disturbance. Therefore, we discuss on how to establish management system of carbon and water in tropical Peatland.

9.2 The variation of farmland use and the security pattern of grain production in China since 1978
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The farmland use pattern has greatly changed with the rapid development of China's economy, since economic reforms were launched in 1978. The dual variation of farmland both in quantity and quality brought about the effects in different degree on grain production. This paper analyzes the spatio-temporal pattern of China’s farmland intensive use level between 1978 and 2004, and develops a farmland-grain elasticity coefficient to reflect the interrelationship between farmland and grain production, using the agricultural statistical data from local governments. The outcomes indicated that, since 1978, the pressure of tremendous farmland loss on grain security has been relaxed, to some extent, due to the increased investment and subsequent quality improvement in farmland. Since China initiated economic reforms, China’s farmland intensive use level has been generally improved due to rapid economic development, and the improving speed takes on a situation of gradient declining from southeast coastal China to hinterland, just as the declining gradient of economic development level. Furthermore, the existing posture will be passed from coastal China to hinterland with the economic development. However, unceasing improvement of farmland intensive use level cannot always bring about the sustainable and steady growth in grain outputs. Therefore, considering the law of diminishing marginal utility, in the economic relative developed country, the quantity of farmland will play a key role in maintaining the security pattern of grain production, which also provides a practical scientific basis for nowadays constituting strict farmland protection objective and strategy in China.

Vulnerability and Resilience of Land Systems in Asia
9.3 Impact of labor rural-to-urban migration on land-use change in environmentally fragile areas
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Labor migration is a pervasive feature of economic development and a routine part of agricultural activity. With the rising of migrant rural workers’ wage and enacting preferential policy for labor rural-to-urban migration at present, there are significant migration flows in China. Peasant workers out-migration will affect the farmer’s decision and eventually affect the land-use change. This is true with respect to impact of labor migrant especially in environment fragile areas. In this paper, we developed a household model to analyze the impacts of rural labor activities on land use in Ningxia Hui Autonomous Region. This methodology uses and integrates available statistic data and survey data on peasant workers out-migration, farmer’s land use management, input and output of agricultural production. Farm household’s preferential activities are compared within two market conditions: the imperfect market of food and labor, and the perfect market of food and labor. Results show that rural labor migration has obviously impacts on land use/land cover change and contributes impressively to environmental protection in environment fragile areas. This study demonstrates: 1) Acreage of crops with higher labor productivity has obviously increased. Reversely, the acreage of those with lower labor productivity has evidently declined. 2) Crops become less diversified in Ningxia Hui Autonomous Region. Households prefer to specialization of agricultural production. 3) Some of infertile arable lands have been abandoned. The survey showed that about 26.6% of households abandoned their arable land.

9.4 Impacts of agricultural land change on biodiversity and ecosystem services in Kahayan watershed, Central Kalimantan
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A study on the impact of agricultural land change on biodiversity and ecosystem services was carried out in Bawan Village, located about 60 km northeast of Palangkaraya in Central Kalimantan, Indonesia. Most of the area is covered mainly by heath forest with scattered patches of peat swamp forest. From 1968 until 1980’s, private forest concessions were rampant leading to wood and rattan exploitation. For easier accessibility, forest concession companies built a road for transporting forest products to the nearest river, from where they were delivered by boat downstream. This forest concession led to the degradation of the forest ecosystem and consequently affected the livelihoods of the local people (Dayak). Before 1980s, the main source of income to the local people was from the manufacture of small boats and wooden house rooftops, with supplemental revenue derived from agriculture. After forest concession, Bawan villagers converted the clear-cut area to rubber plantation. Rubber cultivation in the area has expanded to some 1100 ha by 2008. This expansion has influenced microclimate, biodiversity and water resources. The poor quality of the Kahayan River due to human activities has made the people to shift to consuming water from a spring located about 3 km from the village. Deforestation also increased river sedimentation, thereby increasing flood frequency. This research identifies specific policy interventions to reduce the vulnerability of the Dayak and their environments to undesirable effects of land change.
9.5 Drought and extreme climate stress on human-environment systems in the Gobi Desert

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The Gobi Desert of southern Mongolia and northern China is susceptible to drought and extreme winter conditions that in combination create the region’s most serious natural hazard. In this dryland environment low precipitation and high climatic variability impact both the landscape and livestock raising, the dominant rural livelihood. Currently the two hazards are thought to be related, with drought exacerbating extreme cold, snow and/or ice conditions resulting livestock mortality. Herder vulnerability and landscape challenges as a result of the phenomena is stressed the government and international organizations yet poorly documented. This study uses the Standard Precipitation Index (SPI) to identify drought in southern Mongolia. It then investigates the relationship of drought with climate factors and its interaction with vegetation (derived through Normalized Differential Vegetation Index (NDVI) data), local human and livestock populations, and the extreme winter disasters of 1999-2001. Work evaluates the resilience of human-environment systems in the Gobi. Results indicate that drought is recurrent in the region, reaching extreme intensity most recently in 2005-2006. In contrast to the prevailing concept of drought impacting severe winters, the study did not find a connection between the two natural hazards. Climate variables show warming temperatures (>1°C), fluctuating precipitation patterns, and a recent decline in vegetation cover. The principal long-term correlation of drought is with human population rather than natural factors, extreme conditions, or livestock numbers. Findings reflect human and landscape resilience when encountering drought and extreme winter conditions.

9.6 Problems and Strategies for Sustainable Development of Agriculture in Northeast China.

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Northeast China, including three provinces (Hei-long-jiang, Ji-lin, and Liao-ning) and eastern part of Inner Mongolian autonomous region, is the most important national bases of grain commodity and animal husbandry, as well as the safeguarding region for ecological safety in China. Because of its greater acreage of cultivated lands, fertile soils and higher rate mechanization, greater yield gap between actual yield potential lands with 2/3 of lower, medium soil fertility farmlands, and possible potential lands to be reclaimed, this region has been proposed as the primary contributor to the newly projected 50 billion kg grain production in 2020 by State council. However, the region encountered the problem of fluctuated yield, unstable production and unbalanced productivity in the past 10 years with average yield in 2006 declined 6.4% compared to 1996. This paper analyzed key reasons existed in causing the yield suppression, including speedy soil degradation, escalated formation of sandy and saline-alkaline soils, severe water and soil losses by erosion, hydrological equilibrium by paddy rice development, adaptability and yield stability of crop variety, and poor repetition of small-scale super-yielding practice. Issues of water and soil fertility improvement, practice standardization, and variety breeding were addressed. Basic, applied and strategic research for sustaining grain production in the region was proposed. Specific basic research titles include examining the processes of elements coupling in agroecosystem, understanding the maintenance mechanism of higher productivity in agroecosystem, investigating genetic and physiological mechanism of super-yield in crops. Applied research titles involve establishing soil fertility-oriented practices, exploring yield-increasing cultural practices in main crops, developing water and nutrient higher use efficiency
products and system, applying information technology. For strategic research, rational planning for the use of water and land resources in the region, land transfer and agricultural intensification, special grain production zone establishment policies were initiated.

Session 10: Vulnerability Outcomes III

10.1 Sub-global Follow-up to the Millennium Ecosystem Assessment (MA)
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The inclusion of thirty-four sub-global assessments (SGAs) undertaken at different scales in various locations across the world increased the legitimacy, credibility, and salience of the Millennium Ecosystem Assessment (MA) which was the first comprehensive assessment on the links between ecosystem health and human well-being. The SGAs were designed to meet needs of decision makers at specific scales, and to strengthen both the global and local finding mutually through the perspectives with different scales. The SGA in Japan, which began in later 2006—over a year after the completion of the MA—building on the MA findings, was initiated with the scale of a prefecture within Japan, and has evolved into a multi-scale assessment with the national scope. This has resulted in the involvement of a wider range of stakeholders/users in the assessment work, more likely policy impacts at different levels, and the inclusion of the issues and characteristics specific to the sub-national and national levels. At the same time, it has brought a number of challenges including the conflicts in agenda and interests, the increased work volume for co-management and coordination, the lack of funding and human resources, and the lack of capacity in cross-scale interactions and integration. This presentation aims to examine the dynamics of the assessment process evolving from the local to the national, and to analyze the challenges and significance of the multi-scale assessment in Japan. It also seeks to explore implications and lessons learned to deal with the cross-scale interactions in a multi-scale assessment.

10.2 Impacts of Land Use Change on the Vegetation Carbon Storage in the Region around Taihu Lake
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Land use change is the main drive factor for the ecosystem carbon storage change. Based on data from remote sensing TM imageries in 1980, 1990 and 2005, the changes of land use in the region around Taihu Lake had been analyzed by GIS technology. We calculate the change of vegetation carbon storage caused by land use change with the method supplied by the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, then compared the results with other researches in China. The main results as blow: (1) The area of cropland, forestland and grassland had decreased by 223.26 km², 1182.50 km² and 178.90 km² in the region around Taihu Lake during 1980-1990, and the cropland had translated to forestland and settlements mainly. The area of grassland had increased by 1270.47 km², adversely, the cropland and forestland land decreased by 5929.51 km² and 1381.94 km² during 1990-2005. (2) The vegetation carbon storage had decreased by 642171.27 Mg because of land use change in the region around Taihu Lake during 1980-1990 by the method of IPCC, and decreased by 683125.18 Mg during 1990-2005. (3) The results of vegetation carbon storage change which calculated by the IPCC method had some errors to other domestic research results, so we suggest the government should compile the greenhouse gas inventories which accord with the situation of China.
10.3 The spatio-temporal modes of reclamation in Xingjiang, China; An analysis in terms of remote sensing survey data
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On the land use spatio-temporal change information platform developed in the Chinese Academy of Sciences, this study develops a land use database for Xinjiang area that includes land use data in the later 1980s, later 1990s, 2005 and 2008 and consequently extracts land use change data for the corresponding three periods. Taking the environmental database of Xinjiang as the background, this study performs a detailed analysis of the spatio-temporal changes of cultivated land in Xinjiang over the last 20 years. The results show that during the later 1980s to later 1990s, the use of cultivated land was characterized mainly with the coexistence of reclamation and abandonment, proportionally about 2.92:1 on the map. The total reclaimed land reached 56.94×10⁴ hms, 5.69×10⁴ hms per year on average. The main land reclaimed was grassland and forest, accounting for 96.28%, while only 0.058% and 0.25% sandy land and salted land gained respective use. During the later 1990s to 2005, the characteristic of the coexistence of reclamation and abandonment became more significant, with the proportion reaching about 14.93:1 on the map. The total reclaimed land reached 79.22×10⁴ hms, 13.2×10⁴ hms per year on average. The main land reclaimed was still grassland and forest, accounting for 75.66%, while the reclamation of sandy, salted and bare land gained 10.4%, 5.22% and 3.73%, respectively. In the recent 3 years (2005-2008), the proportion of reclamation and abandonment remained stable, maintaining 15.75:1 on the map. The total reclaimed land reached 25.88×10⁴ hms, 8.63×10⁴ hms per year on average. The main land reclaimed was still grassland and forest, accounting for 66.4%, while the reclamation of salted, sandy, Gobi and bare land gained 13.16%, 8.42%, 6.10% and 3.18%, respectively. Over the last 20 years, it can be noted that the abandoned land decreases considerably and the reclamation turns from mainly grassland and forest gradually to salted, sandy, Gobi and bare land, which has previously been regarded as non-claimable. Due to the increase in rainfall owing to climate change, application of water saving technology, expansion of irrigation using groundwater and other factors, Xinjing has seen a rapid reclamation in recent years, one of the most significant land use and cover change areas in China. However, care needs to be taken because Xinjing is located inland and lacks sufficient fresh water in most places. In other words, such a rapid reclamation will definitely cause many ecological problems, and further detailed study is needed on how to use the available land in a sustainable way.

10.4 Vulnerability assessment of coastal land of Bangladesh
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Vulnerability of coastal land of Bangladesh was assessed using secondary resources. The study revealed that coastal land of the country is under threat of saltwater intrusion, erosion-accrretion, land subsidence, water logging, cyclone, storm surge and tidal flooding. A one-metre sea-level rise will inundate 17.5% of landmass of the country that belongs to the coastal zone, affecting 20% of rice field of the country and destroying UNESCO declared world heritage site Sundarban. Coastal soil is affected by salinity intrusion at a higher rate than coastal water. Six districts of Jessore, Magura, Narail, Faridpur, Gopalgonj and Jhalokhati were affected by new salinity intrusion in only 24 years, during 1973-97. Salinity induced coastal land degradation cost could be as high as 587 million US dollar. South central coast was accreted at a rate of 7.0 km²/yr near the Ganges-Brahmaputra-Meghna (GBM) mouth and the southwest coast was eroded at a rate of 1.9 km²/yr, during only 20 year time period. Coastal land of the country was subsiding at a rate of 4 mm/year. A total of 19,670 ha of salt pan of Southeast coast in Cox’s Bazaar district is

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vulnerable to storm surge. Vast agricultural land of Southwest and south-central coast of the country is highly vulnerable to tidal flooding and storm surge. Developing local level land vulnerability index and formulating adaptation policies are priority areas to be considered for a sustainable management option of coastal land of the country.

10.5 Bridging Perceptions from Spatial Science and Society for Ecosystem Services Valuation and Management

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The utility of Participatory Rapid/Rural Appraisal (PRA) as a methodology to identify revealed preferences of a group/community has been well established. Similarly, integrating PRA methods as a means of ground-truthing satellite data on changes to natural systems has also been explored successfully by several researchers. In the current study, a multi-stakeholder PRA approach is being deployed to capture revealed preferences and values that the ecosystem services of sub-montane ecosystems hold to the different stakeholders who gain utility from them. Multi-stakeholder PRA approach provides a better representative set of ‘preference’ values of ecosystem services, fosters validation of data between the different stakeholders, and enables a communication and planning process among the stakeholders to sustainably utilize and manage their ecosystems. The use of spatial maps validates the relevance and utility of diachronic observations of communities and other stakeholders directly dependent on the ecosystems. At the same time, maps can be used to strengthen local planning processes for the developmental activities. Integrating spatial information with multi-stakeholder concerns acts as a catalyst to a social process of coordinated action to address local issues of global relevance. Preliminary data from field studies in Asia demonstrate the utility of such an approach to facilitate ecosystem services management.

Session 11: Models III

11.1 Modeling the vulnerability of rural areas to land-use change – the example of rubber growing in the district of Xishuangbanna (Yunnan province, China)

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Deforestation in subtropical regions affects forest ecosystem services and reduces biodiversity. In the case of Xishuangbanna district (Yunnan province) rubber plantations replace tropical rainforests to reach economic growth. We developed an integrated modeling framework (NabanFrame) to assess the vulnerability of the study area for different scenarios of regional development. NabanFrame comprised an ecological, agro-economic, social and hydrology model, altogether interacting with a land use change model (CLUEnaban). CLUEnaban based on the CLUE-S model (Verburg et al. 2002). Land use was allocated according to empirically quantified relations (regression analysis) between land use and its driving factors combined with the modeling of competition between land use types. We modelled the distribution of farm types (and their land use) in the study area. Input data were biodiversity field studies, questionnaires on farm structure, interviews about social relations and physical characteristics. The allocation rules were adapted to the scenario storylines to simulate the impact of disturbances on land use change. In a post-modeling evaluation phase, we assessed the vulnerability of the region for each scenario using spatially explicit indicators like water availability/quality, biodiversity, income and level of social integration. We present an integrated modeling approach for assessing the vulnerability of land systems to land use change at the regional scale. Through modeling farm
types, the approach allows to integrate detailed information on ecological, agro-economic, social and physical factors. The evaluation module provides information about the vulnerability of a region under a certain scenario; this result can be used in land use planning.

11.2 Global and regional impacts of vegetation on hydrological cycle and energy budget as represented by the Community Atmosphere Model (CAM3)
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The effects of vegetation and its seasonal variation on energy and hydrological cycle were examined using a state-of-the-art community atmosphere model (CAM3). Three 15-year numerical experiments were completed: the first with realistic monthly varying vegetation characteristics (VEG run), the second without vegetation over land (NOVEG run), and the third with the vegetation characteristics held at their annual mean values (VEGMEAN run). It is found that the hydrological cycle and land surface energy budget are widely affected by vegetation. Globally, the annual mean evapotranspiration significantly increases by 11.8%, while runoff decreases by 13.2% when the realistic vegetation is incorporated. Vegetation plays different roles in different regions. In the tropical Asia, vegetation-induced cooling of land surface plays a crucial role in decreasing tropical precipitation. In the middle latitudes and Amazon region, however, the vegetation-induced increase of evapotranspiration plays a more important role in increasing precipitation. The seasonal variation of vegetation also shows evident influences on the hydrological cycle and energy budget. In the boreal mid-high latitudes where vegetation shows a strong seasonal cycle, the evapotranspiration and precipitation are increased in summer in the VEG run compared to those in the VEGMEAN run.

11.3 An artificial society modeling approach to the understanding of the dynamic changes of a wetland in Monsoon climate
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Artificial society (AS) is a new research subject that applies computer technology to simulate the evolving process of artificial societies in a way to understand how mankind and other lives develop their societies. It provides a new research platform and method to the study of the complex interactions of mankind-nature systems. The application of this modeling approach for studying the behavior of complex systems has infiltrated into numerous research fields in recent years. The integration of this approach with resource science theory has provided an interdisciplinary approach to the study of complex natural resources management. This study applies the agent-based artificial society modeling approach to study the problem of land use in the Poyang Lake area of Jiangxi Province, China. Through observing the responses of an artificial society to the rules that govern the behaviors of agents and the changes of hydrological process, economic development, and policy implementation, this study focus on how the society uses land resource. This study simulates the mechanism of the factors, include population, polities of agriculture and education, in the process of water and land resource use. The primary simulated results indicate that urbanization and raising labor salary attracted more young farmers to work in urban and then more castaway land is appeared; efficient policies supporting agriculture will prompt the farmers work in cities back to land; developing universal education will help the laborers in country to enter urban area. It can be predicted that, evolution with current speed of
social development, the labors farming in country is largely decreased twenty years later, and which make it possible to manage land large-scale and intensively. It is indicated that the approach of artificial society modeling can provide an efficient method for us to study the problems of natural resource use. Along with our further in-depth study, this approach can help us understand the complex spatio-temporal interaction between human and natural resource more vigorously.

11.4 Application of Regional climate Model in Shiyang river watershed land-change study
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Land Cover determines the distribution of solar radiation on the land surface; this distribution formed the boundary environment of climate system in different scales. It will induce the energy redistribution when the land surface changed, thus affecting the climate change. So land change research has been the focus of globe change research. Regional climate model is a quantitative approach to simulate the effect of land cover change to regional climate. In this thesis, the RegCM3 was applied to study the climate factor such as monthly-averaged wind, temperature, humidity, convective precipitation and evapotranspiration change in four different land cover scenario with the same boundary conditions in July of 1998, to investigate the sensitivity of regional climate change to land cover change. The results shows that the land cover change can make great impacts on the climate.

11.5 The Impacts of Climate Change on the Hulunbuir Plateau Grassland Based on the Wavelet Theory and Spatialization Method
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Hulunbuir Grassland is located in the transition zone between Great Khingan and Mongolian Plateau, belonging to high latitudes, with its environment vulnerable and not easy to restore. The growth and yield of Hulunbuir Grassland is close to the climate conditions of three key growth periods, including the matching degree of the precipitation and temperature of the regreening period, the water supply of the blooming period and the temperature of the overripe period. So the methods of cumulative filter, Mann-Kendall test and Morlet wavelet are employed to analyze the climate change of the above three periods, and then to spatialize the change trends based on the cokriging interpolation method in ArcMap environment. The impacts of climate change on the grassland is further analyze by coupling with the grassland dynamic datasets, which are acquired through artificial visual interpretation based on the relief maps of mid-1950s, the Landsat5/TM remote sensed images of mid-1980s and the year of 2000 and 2005. The results show that: (1) The climate condition of study area is becoming warmer and dryer by and large; (2) The climate conditions of the three key periods during 1959 to 1986 is suitable for grassland growth and high yield, while since 1986 the climate conditions had become inclement. Taking into account the change characteristics of population and livestock, it is evident that the climate change is the main factor of the grassland degradation during 1959 to 1986, and the adverse human activities led the grassland further to degrade since 1986; (3) From the spatial coupling relationship, the grassland cover reduction in the southwestern basin is in high relation with the bad matching of precipitation and temperature of the regreening period, and the scattered grassland salinization in the western basin is related to the inadequate water supply during 1959-1986. The grassland reclamation was the most notable phenomenon since 1986.
12.1 Land Use Functions: Conceptual Framework and Application for China
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Land Use Functions (LUFs) are the goods and services provided by the different land uses that summarize the most relevant economic, environmental and societal issues of a region. The LUFs framework integrates the changes observed in a large set of indicators into LUFs, which is used to assess the impact of policies on land sustainability at various levels of spatial aggregation. In China, significant changes in land use over the past decades calls for a need of assessment of sustainability of such changes, the relevant study is of both theoretical and practical importance for sustainable development. This paper establishes a conceptual framework for assessing LUFs, and demonstrates its application by tracing land use changes and associated functional changes in China from 1985 to 2005. The major steps are identification of environmental, economic and social indicators related to land use change and impact; investigation of the nature of the relationship between indicators and LUFs through establishing matrix of indicators charactering each LUF; identification of the importance (weighting) of each key impact indicator for the sustainability of the regions; assessment of sustainability limits for the regions and normalization of indicator values; and integrated assessment of the effect of a policy scenario on the sustainability of the land use in a region. Following those steps, altogether 10 LUFs is identified for China, and the results indicate that the overall LUFs of China had been increased over the past 20 years extending from 1985 to 2005. Specifically, among the 10 LUFs, provision of employment opportunity decreased more than 30 percent, maintenance of ecosystem processes was over-explored, and reduction of pollutant emission weakened. However, rest of the LUFs was enhanced, out of which human health and artificial land productivity functions increased by 3 folds. Beside, achieving rate of the total LUFs to the top value increased to 0.37, doubled the value in 1985, of which resource maintenance and provision function increased to 0.83, implying that there is only 0.17 gaps to reach its full value of 1.00. However, environmental functions are still at a lower level and need to be improved. It is concluded that land use policy would have to consider its impact on LUFs of land resources for its sustainable use.

12.2 Critical Land Rehabilitation System in Pengalengan City, West Java Province, Indonesia
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In the year 2007, the government planned to conserve 29% of the West Java area as protected forest. But based on satellite images, the forest was only 18% of the whole West Java Area. The degradation of land condition was caused mainly by economic pressure in the surrounded community. Many people converted forest to other usage/ function or simply took the logs illegally. Critical land rehabilitation programs failed to be implemented due to the lack of interest of the community. The long-period of rehabilitation program was the main obstacle. The community assumed that reforestation will not directly give any advantages to them. A new concept was then formulated, involving several scholars, stakeholders, and coordinated by the government. The critical land was reforested simultaneously with the plantation activity of other productive trees. The productive trees act as secondary plants which will give their product in shorter term period than the major trees. Pengalengan City successfully implemented this rehabilitation system. The program was modified by adding the tertiary trees which have very

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short production period. Coffee trees act as the secondary trees and Tree Tomatoes (Cypomandra Betaceae) function as the tertiary plants. The community obtains economical advantages from the tree tomatoes every 5-6 months. The coffee trees can be harvested first time after 2 years old. Both coffee and tree tomatoes need to be planted in the shadowed area. This condition was supported by the major trees existence. The community is now fully preserving the area as they have the direct and indirect merits from it.

12.3 Agrarian nature management: sustainable development of unstable systems
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Agrarian nature management is ecological-economic system, the formation and functioning of which depends on the character of nature and anthropogenic impact. This is a set of economic fields and subjects associated with the production and processing of agricultural products as well as the conservation, management and reproduction of natural resources used. The stability of agrarian nature management is determined by natural conditions of a specific region and the factor of “rationality” of the available resources (material and immaterial) use and how the existing systems fit in with the environmental conditions. It is of importance to define the reasons or instability vectors of objective and subjective character determined by the biosocial nature of agrarian nature management. Among the objective factors of instability the temporal (annual and within-year) and spatial (fluctuation of natural and climatic conditions in transitional zones) changes in the relationship between heat and precipitation come to the forefront. These reveal themselves in the floating boundaries of regional systems. The neutralization of the objective factors of instability is possible through the introduction of subjective economic-organizational mechanisms including the improvement of engineering processes and territorial organization with due regard for landscape differentiation of regional systems and their economic-geographical position.

12.4 An Enquiry into the Nature and Causes of Deforestation, Land Vulnerability and Resilience in Western Ghats of India
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Western Ghats region of India, characterized by rich biodiversity, is perceived as one of the two important world’s biodiversity hotspots located in India. Some of the richest forests of the country are found in the study area, Kodagu district of Southern India with different types of climatic climax forests - wet-evergreen, semi-evergreen, moist-deciduous and dry-deciduous. Therefore, the district is regarded as “environmentally high potential area”. The forest biodiversity has profound influence on the economy and environment of the district as agriculture, commercial plantations and forest based activities are the mainstay of the district’s economy with 74 per cent of the population engaged in farming and 60 per cent of district’s income originates from agricultural and forest products (agro-biodiversity). The area under plantation crops represents 24 per cent of the coffee plantation area of India and the district alone produces 23 per cent or one-fourth of coffee produced in India. The river, Cauvery, springs from this district serves agricultural and drinking water needs of five southern states of India. The unique biodiversity has been depleted and degraded due to prevailing root and proximate causes resulting in colossal loss of ecosystem services. The land and forest property rights in the district are highly complicated and ill defined due to historical, political, economic and other reasons. Consequently, the district has lost 52 per cent of forest cover during the last 70 years owing to illegal extension of plantation and agriculture in forestlands. Deforestation has seriously caused
land degradation, loss of agricultural and plantation crops productivity, decline of water table, change rainfall pattern and loss of ecosystem services. Farmers fail to adopt resilience strategies owing to ill-defined property rights over their land, increase in cost of cultivation and declining agricultural yield. These multiple factors have changed forests, land and mountain ecosystem services which are crucial for the well-being of the local community. As a consequence rural-urban migration has increased in finding alternative livelihood opportunities.

12.5 The challenging role of voluntary land registration process, the development policies and their impacts on the marginalized people in Papua New Guinea

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Papua New Guinea (PNG) is located on the eastern half of the island of New Guinea which is the second largest island in the world. In 1884 it was divided and ruled by Germany towards the north and Great Britain towards the south. The latter area was transferred to Australia in 1905, which occupied the northern portion during World War I and continued to administer the combined areas until independence in 1975. Land in PNG is divided into two categories: (1) alienated land; and (2) unalienated land. Alienated land is governed by the formal legal system while unalienated land is governed by customary law. Unalienated land or customary land comprises 97 percent of the total land area of PNG while only 3 percent is State land. Access to and use of land in PNG is one of the most sensitive issues in the country. As PNG develops, the government is intent on finding appropriate ways to access customary land to promote its development aspirations. Access to customary land for development has been a very difficult and cumbersome task since independence in 1975. Given the underlying tensions regarding land and the need for development, the country has developed various legal and policy mechanisms to enable customary landowners to voluntarily register their traditional land. However, the concept of land registration is quite new thus has become problematic for ordinary people. Apart from this, in major development areas such as mining, major coastal towns, etc, land is rapidly becoming scarce because land has either been offered for sale to businesses or people from other parts of the country without following correct procedures or forcefully obtained through illegal means. This has happened because of the socioeconomic hardships combined with rising population growth. Today, many urban and development site landowners have become marginalized and are deprived of the benefits to their land. This paper focuses on the nature of voluntary land registration process, the development policies and their impact on the marginalized people and the vulnerability and resilience of their traditional land tenure system.

12.6 Assessing the impacts of China’s ecological restoration programs on land use and livelihood

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Induced by high population pressure, widespread poverty, and maladapted institutions, deforestation and land degradation in China were considered the primary causes of accelerated rates of erosion, flooding, desertification, and biodiversity loss. To alleviate these environmental challenges, as well as to reduce rural poverty and promote agricultural restructuring, the government launched several ecological restoration programs (ERPs) in the late 1990s and early 2000s, such as the Sloping Land Conversion Program (SLCP), the Natural Forest Protection Program (NFPP), and the Desertification Combating Program around Beijing and Tianjin (DCBT). The objective of this paper is to assess the impacts of these ERPs on both land-use and livelihood for selected study sites in western China. The land-use changes are detected from satellite images, whereas the livelihood changes are derived from household survey data. Overall, our results show that the SLCP has dramatically reduced farming on sloping cropland and thus
increased forest and grass covers, the NFPP has stabilized the natural forests, and the DCBT has reversed the trend of grassland degradation. Meanwhile, the income of local participants has significantly increased and a large number of farming and herding laborers has been transferred to off-farm and/or off-community sectors. While these findings are encouraging, it must be recognized that a large portion of the retired cropland has not been adequately re-vegetated, the structure of the natural forests has not been much improved, and a lot of the planted trees and restored grass covers remains in poor growth. Similarly, many of the transferred laborers remain transitory and the prospects for continued income growth are worrisome. Thus, China must implement the ERPs more effectively and take a more proactive management approach to improve the environment and the well-being sustainably.