

## SLUAS and the Great East Japan Earthquake Disaster

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SLUAS (Sustainable Land Use for Asia, 2009-2013) is a research project sponsored by JSPS Science Fund Basic Research (S). It was created in response to the proposal of the Science Council of Japan entitled "Towards Sustainable Nature-Human Co-existence on the Land and in the Coastal Sea". The proposal warned the danger of the coastal area because it is where serious incidences related with global environmental problems are concentrated and where large-scale disasters which threaten sustainable nature-human co-existence are frequent. Therefore, SLUAS from its start in 2009 put high priority on large-scale disasters as major threat to sustainable land use in Asia.

Land Use/Cover Changes are inter-related with various global environmental problems and problems associated with human-induced as well as natural disasters. The damages caused by global changes and those created by disasters have been increasing, and they are often inseparable. The Great East Japan Earthquake Disaster, which includes all sorts of direct and indirect losses generated by the M9.0 earthquake of 11 March 2011 and its aftershocks, the huge tsunami that followed, and the accident of Fukushima Daiichi Nuclear Power Plant, was a reminder of the danger of the coastal lowlands, and the inter-relatedness of global changes and major disasters.

GLP (Global Land Project) is a joint core project of IGBP (International Geosphere-Biosphere Programme) and IHDP (International Human Dimensions Programme), and it has the following three research themes:

Theme 1: dynamics of land systems

Theme 2: consequences of land system change

Theme 3: integrating analysis and modelling for land sustainability

The Great East Japan Disaster was a major blow to the existing land systems and land sustainability, and hence it is a major common concern of entire GLP. Theme 3 in particular claims "vulnerability and resilience of land systems to hazards and disturbances" as one of its three main issues, indicating its strong commitment to hazards. It is therefore anticipated that GLP is ready to play a key role in incorporating global change research and disaster research for the sake of realizing sustainable land use in Asia.

The presentation will demonstrate how SLUAS has been involved in the study of the Great East Japan Earthquake Disaster, what it has achieved through its activities, and what roles GLP can play towards sustainable land use in Asia.

Keywords: GLP, sustainability, human geoscience, land use, Asia, Great East Japan Earthquake Disaster

## Natural disaster triggered by landuse change on the former river course

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The reclaimed land located on the lowlands of the Tone River plain was suffered by riquerfaction after 11th March 2011 Mega earthquake. The damaged area is assessed by landform, underground water, sedimentation of the surface soil and recent landuse change in this study and the author got the important land form series such as former river course and boundary between former river course and sand spits along the present Tone River using mesh maps including landuse change maps, geomorphologic land classification map, bore hole data maps, underground water maps.

Keywords: former river course, landuse change, disaster, assessment

## Land Use/Cover Changes in Puncak Area (Upstream of Ciliwung River)

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Ciliwung River is one of two major rivers that pass through Jakarta City. The river flows from its source Puncak Area on the highlands of Mount Pangrango, Bogor District, West Java. The Ciliwung river is heavily polluted and very frequently contibuted on flood evidences in Jakarta City as well as other factors such as land subsidence, sea tide, and poor drainage system. The lack of spatial planning systems in this region results on poor land use dynamics control. This study analyze the impact of land use/cover change in Puncak Area as the upstream of Ciliwung River Watershed to the dynamics of floods along the river areas. Satelite images of 1990, 2000 and 2010 have been analyzed to describe the land use/cover changes. Daily precipitation data from three stations located in Puncak area and daily river discharge data recorded at Katulampa station during the period of 1990-2011 were collected. The study shows the impact of land use/cover changes on the increasing of vulnerability to flood, especially due to the increase of settlement areas and the decrease of forest cover and agroforestry activities. This land use/cover changes with one-day extreem precipitation, and one-week continuous high precipitation have significant impacyt on flood evidences.

Keywords: land use/cover changes, upstream of Ciliwung watershed, flood dynamics, Jakarta City

## Recent Regional Changes in the Urban and Neighboring Rural Areas of Wuxi City

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A remarkable economic growth has been accomplished in Wuxi City located on the lower basin of Changjiang Plain since 1990s from its industrialization. The author made field surveys on land use changes of the city, and had interviews with planning officials, local government staff and local farmers in 2008 and 2009. There have been numerous kinds of urban development in and around built-up areas such as large-scale newtowns containing several urban functions, industrial development and residential houses for villagers in rural areas. Driving forces of such changes were the advancement of urban functions as a strategy of a local development under the global economy and the improvement of the residential environment using profits from industrial development in rural villages.

Keywords: land-use change, economic growth, industrialization, environment, lower basin of Changjiang Plain

## Climate change and changing glacial landscape in Garhwal Himalaya, India

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Glaciers have reduced all over the world. Many scientists have attributed glacial recession to global warming. However, global warming does not tell anything about varying recession rates of glaciers in different parts of the world. Even in Nanda Devi Biosphere reserve area, the responses of glaciers in the form of retreating snouts to global warming are different. Many local factors such as local physiography, orientation, slope of bed rock, order of stream etc. have important influence on glaciers. Paucity of relevant information related to climatic conditions and glacier parameters renders glaciological studies very difficult. Observation close to glacial environment are rare and of very short duration. It is difficult to tell whether the glacial retreat is due to rise of temperature or decline of snowfall. Conclusive results about causative factors of glacial retreat are far from reach. However, there is no doubt about glaciers over the world have declined significantly. Glaciers are promising indicator of climate change. They have been receding rapidly in the Himalayan region over last few decades. Glacial retreat and mass loss have significant implications on fresh water supply, hydropower and other economic activities in Himalayan highland-lowland interactive system (Indo-Gangetic Plains). Therefore, continuous monitoring of Himalayan glaciers is immediately required. The snout, surface area, volume and elevation change of glacier of Himalaya were examined using Survey of India (SOI) topographical sheets and ASTER images together with intensive field investigation. Snout positions and other glacial feature e.g. moraine and glacial lakes were surveyed using GARMIN Etrex GPS in 2010. Two DEMs generated from SOI and ASTER data were compared for calculating change of volume and surface elevation of Milam, Dunagiri and Tipra glaciers. The study of Tipra glacier reveals that area of glacier decreased from 9.09 sq km (1962) to 8.54 sq km in 2004. The loss of glacial area is estimated to be about 0.55 sq km. The snout retreated about 288, 404 and 600 meters in right, central and left part of the glacier respectively during 1962 to 2010. The Dunagiri and Milam retreated about 60 and 1589 meters along central line respectively during 1962 to 2008 (Dunagiri) and 2009 (Milam). Altitudnal retreat of the snouts of Tipra, Dunagiri and Milam is about 60, 53 and 114 meters respectively. Presently, the snout is located at 3820, 4265 and 3622 meters above msl respectively. The range of elevation of Tipra glacier has significantly changed from 3760-5739 meters to 3820-5532 meters during 1962 to 2004 and the average width reduced by 10.39 meters. The snout retreat rate is of Tipra glacier is not much as it is heavily debris covered. Very low retreat rate of Dunagiri glacier is due to its higher snout position and low altitudnal range. Besides, the Tipra glacier appeared empty during field survey in lower ablation part with many longitudinal cracks and debris cover making its surface more vulnerable to collapse and it also suggests higher melting rate for this glacier.

Keywords: climate change, vulnerability, glaciers, snout retreat, Garhwal Himalaya, India

## The Relationship between Outbreak of Asian Dust and Ground Condition in East Asia

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In East Asia, Dust is called yellow sand, and spring in particular has much outbreak. Not only from a scientific viewpoint but also from a standpoint of environmental problems, it is considered as an important problem to discuss the generation factor. It is thought that although dust is a natural phenomenon, the human activities are related to the outbreak.

According to the observed total days of dust in Japan, which has been made public by the Japan Meteorological Agency, the observation days are greatly different year by year. The number of dust events observed in Japan increased in 2000, and continued to 2002, following sharp drop in 2003. There must be a factor in such a rapid change. It is thought that the factor includes which on an atmospheric side and the ground level side. In this study, we will focus on the state of the ground level, aim to clarify the change in the ground level, which corresponds to the change of the dust observation days. So, we discussed the relationship between outbreak of dust and the ground condition, with monitoring the state of ground level by satellite data and analyzing the change by meteorological data.

As satellite data, we used SPOT/VEGETATION 1km 10-day data, which can be downloaded free of charge from the following URL, <http://free.vgt.vito.be/>. Each data file is comprised 10-day maximum-value composite (MVC)NDVI bands. The sensor has 4 spectral bands: blue, red, near-infrared (NIR) and mid-infrared (MIR). We can extract the information on the snowfall and vegetation from this band data. The red and NIR bands are used to characterize vegetation with normalized difference vegetation index  $NDVI=(NIR-R)/(NIR+R)$ . The foliation of vegetation made the period a map each year by expediently using  $NDVI=0.1$  as a threshold. And the red and MIR bands are used to characterize snow with normalized difference snow index  $NDSI=(MIR-R)/(MIR+R)$ . A value of 0.2 was used as a threshold based on Kondoh and Suzuki (2005) for the identification of the snowfall region and non-snowfall region.

In the semiarid area in east Asia, the period of bare land is able to be made a map by taking the difference of thaw and foliation each year. There seems to be a good correlation between the two when the length of the bare land is compared with the dust observation total days each year. So, we choose the meteorological observing station in Inner Mongolia of China, to do the same. As the result, when the length of bare land was long, the dust observation was high.

As a statistic of the yellow sand outbreak using SYNOP data, in the year of the longer bare land duration, the thaw was earlier, and the average temperature of spring was higher. Therefore, it is thought that is related between the earlier thaw and the higher temperature of the snow melting period. On the other hand, the foliation in the year of earlier thaw is later. In East Asia spring is dry season when precipitation is a little. In the semiarid area, the growth of herbs depends on the moisture condition (Kondoh et al., 2005). Therefore, in the year of earlier thaw, it is possible that dryness controls the germination and growth of the herbs vegetation.

It was similar to the result of last year to here, but as a result of having added more detailed examination, it became clear that an earth surface characteristic to be concerned with yellow sand outbreak every area was different, that, in addition, inter-annual variations was big. Therefore, adding the examination of the topography condition and the consideration of ecology zone, the reexamination result of the yellow sand outbreak condition will be reported from a viewpoint of time and space.

Keywords: Asian dust, remote sensing, East Asia, landcover, interannual variation

## Land degradation in the Alai region, the Kyrgyz Republic, before and after the 1991 independence

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The Kyrgyz Republic has experienced the great changes of social system and economic system since 1991 when the Soviet Union collapsed. These changes also led to the transformation of a grazing style especially in the high mountain areas. The aim of this study is to verify the land degradation changes before and after 1991 in the Alai area, southern Kyrgyz Republic.

In August 2011, we conducted field survey on 43 grazing slopes (19 slopes without grazing terraces and 24 slopes with grazing terraces) to examine the degree of grazing intensity: observation of vegetation coverage, terrace measurement, and slope measurement. Further, 20 local families were interviewed.

The grazing model of Howard and Higgins (1987) was used to understand the degree of grazing intensity on the 24 slopes with terraces. The result suggested that 13 slopes were overgrazed and other 11 can accept use by more livestock in the future.

The interview survey shows that most local people account for the occurrence of the land degradation before their settlement and even before 1991.

The interview survey showed that six families live in the study area all year around. Five of them (83.3%) have moved there before 1991, and have located in the west part of the study area, which is close to the river.

Twelve families stay in the study area only in summer, and 11 of them (91.7%) are located in the east part of the study area, where rivers dried up and 2 families stay here only in winter.

From the slope measurement and the interviews, it can be concluded that both the grazing slopes with no terraces and the overgrazed slopes are located close to the families who live there all the year, which corresponds to the west part of the study area. On the other hand, the grazing slopes that can accept more livestock are located around the families, who stay there in the summer time only, which corresponds to the east part of the study area.

Keywords: land degradation, Alai area, transhumance, terrace, vegetation coverage

## Evaluating human impacts on tree diversity and ecosystem functions in East Asia from forest inventory database

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Forests hold the majority of the world's terrestrial species. Human activities have caused and will cause species diversity loss, which leads to changes in ecosystem functions that provide various ecosystem services for human well-being. However, the relationship between species diversity and forest ecosystem functions is still unclear and we cannot predict the impacts of biodiversity loss on the ecosystem functions, one of the core research questions of Global Land Project. In this presentation, we introduce a new research program aiming to evaluate how the loss of tree species diversity affects functions and services of forest ecosystem in East Asia. We developed forest inventory database which has already archived more than 700 plots covering all over Japan. Model to predict forest ecosystem functions will incorporate drivers such as land use change, environmental changes and global climate change. By using the forest inventory database, we tested human impacts on tree species diversity in Japan.

Keywords: forest, ecosystem functions, ecosystem services, GLP, biodiversity



## Land use scenarios for evaluation of ecosystem services - A case study in the Kushiro watershed -

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For appropriate decision making in ecosystem management for global warming prevention and biodiversity conservation, a reliable and practical method to evaluate ecosystem services is necessary. The research objectives are (1)integration of biophysical and socio-economic data related to ecosystem services, (2)development of a practical evaluation method of ecosystem services and (3)contribution to mitigate conflicts between environmental mitigation options such as climate change prevention and biodiversity conservation.

For the purpose, the pre-evaluation of ecosystem services was conducted relating to climate regulation and reservoir of biodiversity. The study area, Kushiro watershed was preliminarily mapped using the InVEST, which is the mapping tool of ecosystem services developed by Natural Capital Project. The change in ecosystem services was spatial-explicitly quantified based on the land cover maps in 1970s and 2000s. The climate regulating service and the biodiversity reserving service were totally degraded, and the change was depends on location due to various land use change happened in the area. Furthermore, the scenario analysis was applied to provide more practical evaluation to communicate with stakeholders. Four scenarios were developed to evaluate ecosystem services: BAU scenario, biodiversity conservation scenario, agriculture and forestry scenario and climate adaptation scenario. The trade-off analysis based on the scenarios will improve understanding of the ramifications of land management choices.

Keywords: land use change, ecosystem services, scenario analysis, biodiversity conservation, climate mitigation and adaptation

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## Discussion on GLP

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To discuss the issues related with GLP, or Global Land Project, namely dynamics of land systems, consequences of land system change, integrating analysis and modelling for land sustainability, and disasters.

Keywords: GLP, IHDP, IGBP, land use, sustainability, disaster

## Parameter selection and its strategy for quantifying GHG emissions from Asian tropical paddy fields using a DNDC model

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Agricultural activities highly contribute to greenhouse gas (GHG) emissions, particularly in Asia. Rice paddy fields are a major and increasing source of entire methane (CH<sub>4</sub>) and nitrous oxide (N<sub>2</sub>O) emissions. According to a report of IPCC, rice paddies account for 11% of all global methane emissions. Previous studies have shown that water management has a significant effect on methane emission in the period of rice cropping season. Consequently, paddy water management has become a target scenario for GHG mitigations over rice-producing districts and it is expected to have accurate grasp of GHG fluxes in Asian tropical paddy regions.

The Mekong Delta is one of the most important rice producing regions in Viet Nam. However, in this area, quantification of the GHG emissions is still not very clear, and studies related to the mitigation potential remain limited, and we hence set up an experimental site in farmers' fields in Can Tho City, Viet Nam, the rice in which site is cropped 3 times a year. Two different methods in field water management were adopted in the experimental field in order to evaluate their effects on GHG emissions. Two kinds of irrigation technologies are applied to the fields as; 1) a continuously flooding condition (CF), and 2) an alternate wetting and drying (AWD) condition. It will require a great deal of labor and time to measure and monitor GHG emissions in situ due to the varieties in environmental and agronomic conditions. In this aspect, numerical modeling is a superior approach to estimate GHG emissions at various spatial and temporal scales. A dynamic, flexible and robust model is possible to predict the changes in GHG flux under different agricultural management scenarios, and a process-based model can take account of inter-relationships among various input factors (e.g. climate, soil types, water management, farming practices). The de-nitrification and de-composition model (DNDC) has been used extensively to predict GHG emissions for a wide range of agricultural activities in many countries around the world (Li et al., 1992; Li, 2000). In recent years, a revised DNDC model called DNDC-Rice has been developed and was successfully used to estimate CH<sub>4</sub> and N<sub>2</sub>O emissions in Eastern Asian countries, in particular in Japan and China (Fumoto et. al., 2008; 2010).

In this study, we applied the DNDC-Rice model to rice paddies in the Mekong Delta Region. DNDC-Rice model requires parameters dealing with soil characteristics, daily climate, and agricultural management strategies, such as tillage, fertilization, irrigation, flood, manure amendments, and weeding. Because individual input datasets are obtained from various sources in different format and levels of spatial resolutions, and that quite a number of missing observed data occur, parameter tuning is a matter of great importance. We laid stress on parameter selection strategies and have tested the functionality in response to input parameters by using the DNDC-Rice interface under a set of scenarios that reflect AWD and CF water management. Currently, we are carrying out a simulating program to quantify GHG emissions based on the DNDC-Rice model and constructing a local and semi-regional DNDC database specific to this area. The predicted values of CH<sub>4</sub> and N<sub>2</sub>O emissions vary in a large range in proportion to the changes in water management of CF and divisions. It is clear that CH<sub>4</sub> and N<sub>2</sub>O emitted from the paddy rice fields are characterized by the periods of flooding in the Mekong Delta Region. Further simulations discussing these issues are currently underway.

Keywords: Greenhouse gases (GHGs), Methane emission, Simulation, DNDC-Rice model, Alternate wetting and drying (AWD), paddy fields in the Mekong Delta Region