Japan Geoscience Union Meeting 2013
(May 19-24 2013 at Makuhari, Chiba, Japan)


HTT09-01 Room:102A Time:May 20 14:15-14:30

# An ALOS-derived glacier inventory of the Bhutan Himalaya

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Glacier inventory provides fundamental information of glacier settings such as number, area, and horizontal/altitudinal distribution, which make possible to study management of water resources, glacial response to climate change, and glacier-related hazards. In the Bhutan Himalaya, heavily debris-covered surface and seasonal snow cover under the humid climate hamper automated mapping of glaciers. We present a novel glacier inventory manually delineated from high resolution (2.5m) ALOS-PRISM images along the Bhutan Himalaya including Tibetan side. We delineated 1273 glaciers with area of 1408.3 $km^2$, in which 210 debris-covered glaciers with area of 951.2 $km^2$ were identified.

Scatter plot of top and terminus altitudes of these glaciers shows that the terminus of debris-covered glaciers tend to be located at lower altitude than those of debris-free glaciers. Classifying surface aspect into eight directions, surface of the debris-free glaciers tends to be exposed northward (16.7%) while the southwestward surface is minimum (9.2%). No remarkable aspect tendency is found for the debris-covered glaciers. We compare the locations of debris-free glaciers with annual precipitation of TRMM 3B43 data. Median altitude, at which glacier surface is divided into two equal areas obviously increases northward (toward Tibet) along latitude. Additionally the median altitude averaged over basin scale (˜2500 $km^2$) shows a significant negative correlation against the annual precipitation ($r = -0.48$, $p < 0.05$). Our results suggest that the high latitudinal gradient of annual precipitation crossing the Bhutan Himalaya contrasts the glacier altitudinal distribution within a scale of 100 km.

Keywords: Glacier Inventory, ALOS, TRMM, the Bhutan Himalaya

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# Temporal changes in erosion rates and patterns in Ichinosawa subwatershed of Ohya-kuzure landslide, central Japan

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Erosion of hillslopes has been active within the area of Ohyakuzure landslide since its formation in ca. 300 years ago, and the Abe River is characterized by a vast amount of sediment input from the landslide. Although many portions in the landslide have been controlled by landslide prevention strategies and vegetation on hillslopes is being recovered, hillslope erosion and debris flows frequently occur in uppermost steep subwatersheds in the landslide area. Ichino-sawa catchment is a typical one among such subwatersheds. In the catchment, freeze-thaw weathering of fractured bedrock on hillslopes (shale and sandstone) in winter to spring season provides abundant sediment onto channel beds, which act as a source of debris flows frequently occurring by heavy rainfalls (Baiu rain front and typhoons) in summer season. Although detailed monitoring of debris flows and related topographic changes have long been performed in a field scale, high-resolution assessment of erosion patterns and rates at a catchment scale has been limited due to the inaccessibility of steep slopes therein. Here we examine topographic changes in the Ichinosawa catchment using a time series of high resolution DEMs for 5 years (from 2005 to 2010) obtained by repeated airborne laser scanning (ALS). The 5-year mean basin-averaged annual erosion rate in the Ichinosawa catchment is roughly estimated to be ca. 0.1 m/y. Spatial patterns of erosion and deposition show clear contrast between channel beds and hillslopes, indicating that, as an inter-annual trend, erosion dominates on hillslopes whereas the sediment particles tend to be stored in channel beds. Relationships between the temporal changes in rates and patterns of erosion/deposition and morphometric parameters in the catchment are also examined.

Keywords: airborne laser scanning, debris flow, GIS, erosion, geomorphometry

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# Basin hypsometry and topographic evolution in the Arabian Peninsula

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Hypsometric Integral (HI) and hypsometric curves have long been used as indicators of stages in landscape evolution. They are also used as a geomorphic tool to detect tectonically active regions. The Tertiary Red Sea rifting, subsequent uplift and formation of drainage basins in the western part of the Arabian Peninsula provide an arena to study the relation between basin hypsometry and topographic evolution. This study analyzes 36 drainage basins whose main axes are perpendicular to the Red Sea coast. The basins were extracted from the 30 m ASTER GDEM. The size of the basins ranges from 522 to 8292 $km^2$ with an average of 3121 $km^2$. These basins were further divided into subordinate basins according to the Strahler orders. Mean HI values for the main 36 basins are approximately 0.3, but HI varies significantly according to the distance from the southwerstern tip of the Arabian Peninsula. High values of HI ($>$0.35) are found for distances up to 400 km from the tip, and at distances between 1200 and 1400 km. This pattern may be attributed to the lithological variation. Higher values of HI are associated with the Cenozoic flood basalts, while low values of HI are associated with Precambrian crystalline rocks. This empirical study may thus useful to discuss the nature of the topography and their evolutionary stages in relation to bedrock geology.

Keywords: Arabian Peninsula, hypsometry, drainage, DEM, topography

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HTT09-04 Room:102A Time:May 20 15:00-15:15

# Analysis of river profiles and knickpoint distribution in relation to slope failures

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The topographically diverse, mountainous watersheds of Japan are prone to frequent mass movements including slope failures and debris flows. Hillslopes there are constantly modified by slope failures induced by frequent rainfall and earthquakes to achieve dynamic equilibrium. A river course and surrounding hillslopes are coupled in terms of local erosion. The relationship between slope of a river longitudinal profile versus drainage area and that between the slopes versus profile curvature has often been used to study landform development. Here, a 10 m DEM of a mountainous region near Mount Ontake in the Northern Japanese Alps was chosen for this analysis. This highlights the separation between incised and aggraded reaches, and the analysis of river longitudinal profiles and knickpoint distribution are performed. The location of knickpoints is a significant boundary condition for fluvial and slope processes: knickpoints set the base level of erosion in reaches upstream of knickpoints, while incision in reaches downstream of knickpoints may influence failures in surrounding slopes. This study has provided insight into how intense erosion at knickpoints and related slope failures affect morphological development of mountainous watersheds.

Keywords: DEM, knickpoints, longitudinal profiles, watersheds

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HTT09-05 Room:102A Time:May 20 15:15-15:30

# Using back-propagation networks to predict landslides based on an airborne LiDAR DEM

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Landslides are one of the most destructive geological disasters affecting Japan every year, causing huge loss of human lives and properties in Japan over past decades. Although many methods for predicting landslides have been proposed, accurate predictions of landslides are not always realized. This study aims to develop an accurate and efficient method for landslide prediction based on an artificial neutral network (ANN) built from seven factors using a back-propagation (BP) algorithm. The method of this study consists of two major phases: 1) data integration and analysis, 2) ANN training and prediction. This study analyzed a mountainous region of Niigata Prefecture. Landslides data are taken from the database of the National Research Institute for Earth Science and Disaster Prevention (NIED). The first phase involves GIS-based statistical analyses related to landslide occurrence, geology, and geomorphological properties derived from a 2-m airborne LiDAR digital elevation model (DEM). The seven factors are elevation, slope angle, curvature, aspect, lithology, distance to geological boundaries, and density of geological boundaries. A total of 1225 potential cases of landslides were used to test the BP algorithm for training and testing the model. The accuracy of the prediction reached $>$90%, indicating that the presented model with the seven factors is reliable and can be used for hazard mitigation and warning systems.

Keywords: Airborne LiDAR DEM, landslide prediction, Artificial Natural Network, Back-propagation

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# Evaluation Method for topographical and Geographical Characteristics of Flooded Areas

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In Tokyo Metropolis, inland flooding has caused much damage. Recently, many local-scale floods have been induced repetitively by torrential downpours. Thus, we focused on topographical and geographical characteristics of the flooded areas. In this study, we analyzed topographical and geographical characteristics of flooded areas in Shinjuku, Toshima and Bunkyo wards and visualized potential for inland flooding in these wards. In these wards, inland flooding has occurred frequently and repeatedly in recent years.

According to the records of flooding that were compiled by Tokyo Metropolitan Government, there were 107 inundations between 1989 and 2009 in the study area. We classified these flooded areas into three groups: lowland type, upland type and valley on upland type, and extracted topographical and geographical parameters of flooded areas by using ArcGIS10, 5-m DEM and 1:2500 Digital map of Tokyo. We extracted 12 parameters: depression depth, depression volume, catchment area, land coverage of catchment area, mean slope of catchment, mean slope from a flooded area to a discharge point of catchment, difference between these two slopes, length from upper most of catchment to a flooded area, length from a flooded area to a discharge point of catchment, difference between these two lengths, valley depth, valley width. These parameters were examined by principal component analysis (PCA) to evaluate topographical and geographical characteristics of the flooded areas and extracted the areas that have potential for inland flooding.

Keywords: inland flooding, GIS, topographical and geographical characteristics, principal component analysis

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HTT09-07 Room:102A Time:May 20 15:45-16:00

# Smart Data Collection and Real-time Digital Cartography

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The development of the Global Navigation System and wireless networking technologies have changed the way we live, communicate, share information and even the collection of geospatial data in the field. Along with wireless networking technologies, the improvement in computational power of handheld devices such as smartphones, tablet PCs, ultra-mobile personal computers (UMPCs) and netbook computers allow field users to connect, store and stream large amounts of geospatial data from the web-server. We are now more flexible and able to collect geospatial data in a timely and convenient manner. In this paper we discuss field data collection using a smartphone and Web-based GIS system, which collects, integrates, visualizes and analyzes the collected data in real-time. We built a Web-GIS system for creating a user account, acquiring coordinates from GPS embedded devices or wireless access points, and providing a user-friendly survey form. The collected data can be instantly visualized and analyzed, such as by thematic mapping, labeling, symbolizing, querying and generating a summary report. We have tested this system on a university campus and management system, in which we collected information on illegal disposal sites and parking events within the university campus.

Keywords: Smartphone, Web-GIS, Real-time Digital Cartography

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HTT09-08 Room:102A Time:May 20 16:15-16:30

# Road network and transportation facilities in Sri Pada Mountain area ? influence on flow of people along the trails

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Sri Pada Mountain is one of the most sacred pleases in Sri Lanka in the Peak Wilderness protected area which is covered by 3 districts. The purpose of climbing the mountain ranges mainly from worshiping the foot print on the top of the Mountain (believed to be the footprints of the ”Load Buddha” and other religions have their own perspectives) to site seen. There are many trails to climb the Sri Pada Mountain. Sri Pada Mountain season starts from full moon day (Poya day) of December of each year and ends in full moon day of the following year. Average climbers to the top of the mountain said to be 2-3 million per season each year.

This paper discusses the distribution of road network and other associated facilities with the transportation to find the influence on the flow of people for future planning.

Keywords: Road Networks, Transportation, Historical trails, People flow, Sri Pada, Peak Wilderness

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HTT09-09 Room:102A Time:May 20 16:30-16:45

# Spatial Predictive Modeling of Agricultural Land Sustainability using Geographic Information System

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Indonesia is one of countries with a big population growth. The population growth impact the food needs and land necessity for settlement. When the population increased, the needs of land for setlement is rising and it may diminish the agricultural land. To ensure food security, each districts are obligated to maintain the extent of agricultural land in their region so they can comply their own food need. For example Kulonprogo District as a research area, with the population growth reaches 0,47 percent per years, requires at least 5029 hectares as stated in the district regulation no. 1 of 2013. It requires a way to predict the extent and distribution of agricultural land to establish a policy that protect the sustainability of agricultural land.

The aim of this research is map the agricultural land that would be exist for five years later (2018) based on the spatial predictive modeling of landuse change and trend of land necessity for settlement. Multitemporal remote sensing data from 2003 until 2009 used as an input in GIS modeling. This model consider physiographic aspects such as topography, accessibility and land use to distribute spatially the number of agricultural land required.

Based on the model, the result of this research is the built up area ascension due to the settlement needs does not trigger the shortage of agricultural land in Kulonprogo District. At least there are still over than 1000 hectares of land that can be preserved for agriculture until 2018. In this case, GIS plays a role as a prediction tool of sustainable agricultural land management and the scenario resulted can used as a reference for land preservation policy.

Keywords: spatial predictive modeling, agricultural land, Geographic Information System

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HTT09-10 Room:102A Time:May 20 16:45-17:00

# Capturing built-up expansion patterns in the major cities of South and Southeast Asia using GIS and RS techniques

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The purpose of this study is to capture the built-up expansion patterns in the major cities of South and Southeast Asia for the last two decades using GIS and Remote Sensing (RS) techniques. The major cities considered in this study include Bangkok (Thailand), Dhaka (Bangladesh), Hanoi (Vietnam), Jakarta (Indonesia), Manila (Philippines) and Yangon (Myanmar). The RS satellite data (LANDSAT) were downloaded from http://earthexplorer.usgs.gov/ and http://glovis.usgs.gov/. The best available images (i.e. with minimum cloud cover or cloud-free) were prioritized in the image selection. The epochs considered in the analysis were 1990, 2000 and 2010. Except for the 1990 time period for Jakarta and Manila, all the capture dates of the satellite images for all the cities were close to these time periods.

In this study, we considered only two land cover categories, namely built-up and other lands. The built-up category includes buildings, roads and all paved areas and concrete structures, while other lands include vegetated areas, water bodies, among others. The land cover classification was accomplished by employing the Iterative Self-Organizing Data Analysis Technique (ISODATA) unsupervised classification algorithm available in ArcGIS software. Using this technique, 30 clusters or classes were first generated for each satellite image for each time period for all the cities. This is the optimum number of classes we found through empirical examinations. After generating these classes, each class was individually examined whether it belonged to built-up or other lands category by visual interpretation and with the aid of Google Earth maps especially for the latter time periods. The classes that belonged to the same category were eventually merged.

Based on the extent of our study area for each major city, the initial results revealed that from 1988 to 2009, the built-up area of Bangkok has expanded by 95,641 ha; 59% of which occurred between 1999 and 2009. For the case of Dhaka, its built-up area has increased by 10,566 ha from 1989 to 2010; of which 61% happened between 2000 and 2010. For Hanoi, its built-up area has expanded by 8,553 ha from 1989 to 2009; 62% of which occurred between 1999 and 2009. Jakarta has also experienced rapid urban growth in the last decades. From 1994 to 2010, its built-up area has increased by 39,729 ha, of which 67% happened between 1994 and 2001. For Manila, its built-up area has increased by 21,643 ha for the past 12 years (1996-2008); 57% of which occurred between 1996 and 2001. And for the case of Yangon, its built-up area has grown by as much as 15,382 ha from 1989 to 2009, of which 56% happened between 1999 and 2009. These results show that among the six major cities, two of them (Jakarta and Manila) exhibited a comparable trend, i.e. greater increase in their respective built-up areas during the 1990s. In contrast, the other four major cities showed a similar trend, i.e. greater increase in their respective built-up areas during the 2000s. In terms of the rate of built-up increase, Bangkok had the highest rate (4,554 ha/year), followed by Jakarta (2,483 ha/year). Hanoi had the lowest rate (428 ha/year), followed by Dhaka (503 ha/year).

Our future plan for this research is to examine the built-up expansion patterns for each major city along the gradients of spatial variables (e.g. distance to city center, distance to major roads and elevation). The resulting patterns will be used to calibrate a spatially explicit land cover change model, which will then be used to project future built-up expansions.

Keywords: GIS, remote sensing, urbanization, land cover change, South and Southeast Asia

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# Development of bridge maintenance system for asset management

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In Japan, a lot of structures were built in the period of high economic growth. Because these structures have been used for 30 to 50 years since the completion of construction, they are assumed to age quickly in near future. Under the circumstances, appropriate and efficient maintenance is going to be an important theme for the social infrastructure in Japan. Especially in most of railway structures were built earlier than other social infrastructure in Japan. Therefore, there are many old structures that exceeded the service life in the railway structures. Particularly the railway bridge has passed for an average of 60 years after completion, while the road bridge has passed for an average of 30 years. Thus, the maintenance of the railway bridges is the problem which now confronts us. Under such circumstances, this study focuses on the railway bridges.

It is necessary to manage various data in order for maintaining bridge structures appropriately. However, in the drawing that has recorded conditions and repairs on the bridge structures up to now, the following problems exist. The first problem is that the extend elevation in the drawing is only a schematic illustration without dimensions. The second is that the drawing is not shared in both repair and inspection. The third is that the drawing management cannot be performed in chronological order. So, the authors thought that it would be effective to use 3D data excellent in visual representations. In this study, the authors developed 3D models which can make the extend elevation easily and manage the drawing to record the conditions and repairs to maintain bridge structures.

In addition to system development, the authors developed the stereo photo measuring device. They verified the measurement accuracy with an apparatus, and the results are shown that measurement accuracy is secured clearly. This device does not need the measurement from the close distance in on-site work, and the engineers have only to take photos from the distant place to structures in on-site work. Also, the weight of the device is less than 1.5 kg; therefore there are few burdens in the engineer's photo work. Both work efficiency and safety improvement were provided by development of this device.

This system can modify the sizes of 3D model by using detailed dimensions acquired from existing drawings and stereographic photos. As a result, 3D model is created into the more realistic model. It can generate accurate 2D diagrams (extend elevations) based on 3D models, too. In other words, no matter how complicated structures are, this system can output diagrams quickly and exactly. In addition, because the actual size of inspection and repair point is expressed in 3D models, this system can integrate and manage the photos and data (area, length, position, etc.) for inspection and repair.

In maintenance management, it is important to manage the appropriate positions of photos. However, it has become very troublesome work to attach the positional information to photos. In order to solve these problems, this system is created so that positional relationship can be grasped visually. Therefore, even if the photos are taken by different engineers or taken on another day, this system can easily connect the photos with 3D models, that is to say, can manage the photos effectively.

The authors verified the validity of this system by comparing with the conventional method. First, they verified and compared about the number of engineers and working hours. As a result, they found out the reduction of the number of working hours and engineers. Next, they verified the measurement accuracy. They extracted each repair part and calculated the difference of the area by the conventional method and the measuring method of this system. From such results, this system can be applied to maintenance management enough because measurements are reliable.

Keywords: bridge maintenance system, asset management, three-dimensional model, photogrammetry

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# Spatial Methodologies for the Analysis of Vulnerability in Urban Areas - A Case Study for Terrorism in Tokyo, Japan

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The geographic analysis of crime risk, criminogenic factors and their spatial influence has gained legitimate interest in the past, most notably by the increased popularity in the Risk Terrain Modeling (RTM) methodology by Caplan & Kennedy. Our research is an attempt to apply this concept to the analysis of vulnerability to terrorism in urban areas. In the course of this effort we developed a generic Spatial Urban Vulnerability Analysis (SUVA) framework. The aim is to analyze the distribution of vulnerability in space based on the attributes of the objects defining that space (such as people, buildings and infrastructures).

This paper is a case study of an application of the SUVA framework in a central area in Tokyo, Japan. First we outline the underlying vulnerability concept, which consists of two factors: susceptibility and disutility. Then we explain the general SUVA framework and analysis methodologies. In the next part we briefly introduce the study area, present the selected vulnerability factors for this case study, and explain their selection process. This is followed by a detailed description of the operationalization of the vulnerability factors using spatial and non-spatial methodologies. We move on to the object-based vulnerability maps and the calculation and visualization of the vulnerability factors' spatial influence. Lastly we combine the single factor maps to a comprehensive vulnerability map of the study area. We conclude the paper with an evaluation of possible target audiences and the overall usefulness of the presented methodology.

Keywords: GIS, spatial analysis, vulnerability, urban, terrorism, Tokyo

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# Geospatial simulation of tsunami evacuation using agent-based modeling

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In the last decades, applications using agent-based modeling (ABM) and geographical information systems (GIS) have increased. Previously, GIS was focused on representing the world as the static aggregation of population holding information that was queried and cross-related by the user. Therefore, for years one of the main criticisms to the past GIS models is the use of largely homogeneous entities with the same characteristics (e.g. population). However, certain systems cannot be represented only statically. Most of the social phenomena fall into the category of complex and dynamic systems. To understand such systems with its geographical features (e.g. congestion, segregation, risk), agent based models have contributed on the simulation of human systems and their individual behavior and decisions. Thus, with the integration of ABM models, capable of exploring the system at the level of their constituent elements (agents); plus the GIS technology, suitable for the spatial representation of the world; much more social phenomena can be more adequately represented and simulated.

Geographical Information Systems (GIS) contain powerful tools to analyze phenomena in nature that are particularly static and in some cases dynamic. For years, temporal representation has been a challenging task in GIS platforms. However, application programming interfaces (APIs) allow the use of GIS tools as optional libraries on software. Then, GIS data and tool routines can be imported or linked to simulations of other nature. An example of this is the multiagent programmable modeling environment known as NetLogo. The library extension of GIS permits the use of spatially projected data into the NetLogo world for agents to recognize them in the space.

This study aims on the integration of GIS urban data and the spatiotemporal tsunami numerical simulation output database into an agent based model of human behavior for tsunami evacuation. Agent-based modeling is a powerful technique to simulate social phenomena such as tsunami evacuation. Each agent or evacuee evaluates the surrounding environment provided by the spatial and temporal data to schedule and adjusts his actions. The tsunami propagation inland and its features are updated at each simulation step to evaluate the human body instability using the inundation depth and velocity.

The geospatial simulation of individuals during tsunami evacuation and the analysis of the emergent behavior and outcomes will contribute on the decision process for future tsunami mitigation measures.

Keywords: tsunami evacuation, geospatial simulation, evacuation model, agent based model