

## Rainfall conditions and magnitude of landslides in Taiwan

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This study analyzed 172 landslides in Taiwan during 2006-2012. These landslides were compiled from the reports of the Soil and Water Conservation Bureau of Taiwan. The area of each landslide was mapped and calculated using FORMOSA-II images. The volume and depth were also calculated according to the empirical formula. Comparing the landslide size with rainfall conditions interpolated from data for surrounding rain gauges, this study found that deep landslides usually occurred due to long duration and moderate intensity rainfall, whereas shallow landslides occurred due to short duration and high intensity rainfall. This observation is consistent with some previous studies and is ascribable to the fact that deep landslides need a high ground water level caused by a prolonged rainfall. Concerning the area of landslides, their frequency-area distribution correlates well with a power-law relation having an exponent of  $-1.1$ , over the range  $6.3 \times 10^2 \text{ m}^2 < A_L < 3.1 \times 10^6 \text{ m}^2$ . The slope of the power-law relation for Taiwan is lower than those for other areas around the world. It indicates that for the same total area or total number of landslides, the proportion of large landslides will be higher in Taiwan than in other areas. This study also proposed a landslide-event magnitude scale  $m_L = \log V_a$ , where  $V_a$  is the average volume of landslides associated with an event. The average  $m_L$  for all landslides during 2006-2012 was estimated to be  $= 6.4$ . In conclusion, the power-law relation of frequency-area distribution is valid for recognizing characteristics of landslides in a specific area and the magnitude scale can be used to assess historical landslide events.

Keywords: landslides, rainfall, frequency-area, power-law, magnitude

## Representation of landslide events and DEM sensitivity in relation to landslide susceptibility analysis

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Landslides are naturally occurring complex geological phenomena that cause significant damages in mountainous regions receiving heavy rainfall. Landslide susceptibility mapping is an important approach to mitigating such disasters. This study highlights two important issues related to landslide susceptibility modelling. The first issue concerns the scale of a DEM. We found that a single scale of topographic data does not correctly represent all the landslide conditioning factors making a landslide susceptibility model very sensitive to the scale in terms of DEM resolution. The second issue is related to the representation of landslide events for a susceptibility study. We found this important because all the raster cells in a landslide are not equally responsible for its occurrence; neither can any single cell be representative. This consideration is often ignored in the studies of landslide susceptibility. We analyzed five different approaches of landslide representation concerning seed-cells, landslide-polygons and landslide-points and found that the seed cells around the landslide perimeter best represent the landslide characteristics. The inferences were made from landslide susceptibility studies at Niigata and Shikoku in Japan using a Random Forest model, together with the landslide inventory collected by the National Research Institute for Earth Science and Disaster Prevention (NIED) and the 10 m DEM from the Geospatial Information Authority of Japan (GSI).

Keywords: Landslide, susceptibility, DEM, Random Forest

## Analysis of the landslides in Hiroshima caused by the typhoon-12 based on bivariate statistical landslide susceptibility

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Following the heavy rainfall caused by the typhoon-12 on 20th August 2014, Hiroshima city in Japan was struck by a series of landslides including numerous mudslides and debris flows. The landslides affected several suburban residential areas mostly in the Asaminami and Asakita wards causing a great loss of property and the death of 74 residents. This study concerns a bivariate statistical approach to analyse if a landslide susceptibility study would have been able to identify the vulnerable areas beforehand. Firstly, we prepared a landslide susceptibility map (LSM) using a 10 m DEM, geological information and past occurrences of landslides. The landslides after the typhoon event were later used to assess the accuracy of the LSM. The inventory of landslides before and after the typhoon event was interpreted from the high-resolution satellite images. The results show that a similar landslide susceptibility study could have identified vulnerable areas and helped in mitigating the disaster.

Keywords: Hiroshima, landslide susceptibility mapping, typhoon, rainfall

## Delineation of karst depressions using different digital elevation models

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The objective of this study is to investigate the effectiveness of DEMs derived from ASTER images, SRTM data and topographic maps to detect and quantify natural depressions in a karst area of Zhijin County, southwest China. Two methodologies were implemented. The first method is a semi-automated approach for stepwise identification of the depressions using DEMs: 1) DEM acquisition or arrangement; 2) filling sinks; 3) sink depth calculation using the difference between the original and sink-free DEMs; and 4) removal of spurious depressions based on a threshold value of sink depth, morphometric parameters and TPI (Topographic Position Index). The second method is the traditional visual interpretation of depressions using high-resolution aerial photographs and topographic maps. The threshold values of the depression area, shape, depth and TPI appropriate for identifying true depressions were determined based on the comparison between the maps from the semi-automatic method and the visual interpretation. The results show that the best performance of the semi-automatic method was achieved when the DEM derived from the topographic maps was used along with the thresholds of area = 60 m<sup>2</sup>, ellipticity = 0.2 and TPI = 0. The accuracy of the best method ranges from 0.78 to 0.95 when the DEM spatial resolution varies from 75 to 2.5 m.

Keywords: Karst depression, DEM analysis, Remote sensing, GIS

## Automated measurement of sand dune migration rates using multi-temporal LiDAR data and GIS

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Understanding how sand dunes form and migrate has long been a research topic in Earth and planetary surface processes. An automated method was developed for measuring sand dune migration rates along the prevailing wind direction using multi-temporal light detection and ranging (LiDAR) data and geographic information systems (GIS). Compared with traditional methods which involve labor-intensive and time-consuming measurements at individual locations, the new method allows for automated measurement of sand dune migration rates at hundreds or thousands of locations in a study area, and generation of continuous raster datasets showing the spatial pattern of sand dune migration rates. Multi-temporal LiDAR data from White Sands, New Mexico (USA) were used to demonstrate the application of the new method.

Keywords: Multi-temporal LiDAR, GIS, Digital elevation model, Sand dune migration, White Sands

## Evaluation of Erosion Rates on a Global Scale

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Understanding the mechanisms and controlling factors of erosion rates is of great importance as it is a vital component of both geochemical and sediment mass balance studies, and a deep understanding of these processes will enable us to develop accurate landscape evolution models. During the past decades scientists have been studying and measuring erosion rates using different methods. Some examples use sediment yield, measure the rates of active surface processes, and estimate exhumation rates through fission tracks, denudation rates using cosmogenic isotopes and even erosion rates through mass land wasting. A major objective of these studies is to try and discover what the controlling factors of erosion rates are. Although most scientists think that the two most important factors are climate and relief, no clear cut conclusion has been unanimously agreed upon in the scientific community.

Although erosion rates and sediment yield on a global scale have been studied before in relation to topographic conditions, due to lack of available data in the past, the analysis was relatively basic. Thanks to abundant newly obtained erosion rates data, mainly using cosmogenic isotopes, combined with new DEM data, a more complete and comprehensive analysis can be made, and a correlation of erosion rates with factors such as basin morphometry or tectonic plate movement can be made. This paper presents some results from the analysis.

Keywords: GIS, erosion rates, basin morphometry

## Developing a system of geospatial data sharing and visualization for disaster management in the Philippines

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We have been conducting a collaborative research of Japanese and Philippine researchers to construct a system for disaster management in the Philippines. We focus on climatological data from numerous sensors with special attention to heavy rainfall. We also construct a database including various geospatial data for natural and social environments, and develop a prototype of data sharing and visualization system, which effectively connects the database and GIS (geographical information systems) and can be used for disaster management. The Japanese researchers contribute mainly to the applications of GIS and open source software based on their expertise. The Philippine researchers contribute to the applications of network and hardware based on their knowledge on information technology. The system, after further development for practical usage, will be used for preparation and mitigation of natural disasters in the Philippines.

Keywords: data sharing, data visualization, natural disasters, Philippines

## Tsunami Vertical Evacuation Potential Analysis in the Shizuoka Metropolitan Area

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The City of Shizuoka directly faces the Nankai Trough which has given two M8.1 earthquakes in modern history (1944 and 1946), which were tsunamigenic. After the great Tohoku earthquake the Japanese government updated its worst case scenario for a tsunami from the Nankai trough, which is expected to have a maximum run-up of 34m. This study aims to use GIS in order to locate vertical evacuation sites in the City of Shizuoka within the existing urban structure, and to assess their potential in supporting the city's population for immediate evacuation under variable tsunami inundation scenarios (34m, 20m, 10m and 5m run up). A building population estimation model was applied to estimate the daytime and nighttime population of the buildings in the city in order to determine the affected people and potential empty structures for evacuation. For the 34m inundation scenario 599,367 people are estimated to be in buildings touched by water in the nighttime and 326,554 people in the daytime. For the weakest scenario of 5m run-up, 78,503 people are estimated to be in buildings affected by tsunami waters in the nighttime and 54,264 people in the daytime. Inundation ratio analysis was conducted for all four scenarios. The inundation ratio shows the percentage of a buildings height that is flooded in a certain scenario. Results show the largest amount of buildings to be flooded by 75% or more in the case of the 34, scenario with numbers dropping significantly with the scenario severity.

Keywords: Shizuoka City, Vertical Evacuation, Nankai Trough, Tsunami, Population Estimation



## Simulating Urban Heat Island Effects by Rapid Urbanization: A Case Study of Shanghai, China

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As one of the most concerned urban climate events, to accurately represent the urban heat island phenomena from the past scenario to the future scenario is my purpose. To achieve this task, a surface-atmospheric coupled model system was established, which included the image classification, urban growth model simulation, calculation of satellite retrieved LST data, calculation of anthropogenic heat flux density and atmospheric model simulation process.

On the other hand, in order to verify the surface-atmospheric coupled model system, as one of the most changing cities in the world, Shanghai was selected to test the coupled model. As one of the main objectives of this study was achieved with the demonstration of the successful coupling two model system to simulate the urban heat island phenomena for Shanghai in three selected study periods since the 1990s, when is the start year for Chinese economic reform in Shanghai.

For the results of the model simulation, the urban heat island phenomena in Shanghai can be excellently represented with the coupled model. Furthermore, the coupled model can provide a spatial-temporal continuity solution to represent the urban heat island during 30. Through these analyses, the availability of the methodology was proved. Finally, an attempt is made to utilize the verified coupled model to evaluate and estimate the urban heat island effect of other mega cities or metropolitan areas.

Keywords: coupled model, land surface temperature, LULC, OBIA, urban growth model, urban heat island

## Investigation Between Urban Traffic Accidents and Urban Structures from Spatial Perspective

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Urban Traffic Accidents have been and continuing to be a major contributor of human and economic costs to requiring concerted multi-disciplinary efforts for sustainable effective prevention. Traffic accidents rank in the top ten causes of the global burden of disease and injury, and will probably be in third place by 2020, when measured in disability-adjusted life years lost (WHO, 2013). Urban structure and urban activities in a city or metropolitan area, make a significant involvement in generating interactions and accidents. Investigation of traffic accidents and urban structures such as road networks, land use patterns, public facilities, etc. from spatial perspective is important for future urban planning processes. The urban interactions and activities can happen between districts or within a district, on different roads and different time and space.

The study area of this study is Tehran city which include 22 districts. Tehran is the largest city in Iran and also its capital. Its population is close to 12 million during day time and over 8.5 million people at night. The analysis in this study is based on data obtained from the Police Department of the Islamic Republic of Iran, Tehran. The main database contains information about all police-reported urban traffic accidents that occurred in 2011 in Tehran. Tehran has experienced a rapid growth of urban population. With the expansion of the city boundaries, even though there is an occurrence of urban transportation and large usage of cars for daily urban trips and large number of accidents, make the Tehran accident problem more serious. The Tehran spatial structure has a high density structure combined with a several central pattern. The lack of strong and unique essence, as easily as the spatial distribution of employment, are mostly associated with the build-up density and accidents but less dangerous accidents. The current spatial structure of Tehran, which is a high density city unaccompanied by influential Central Business District (CBD) creates several limitations, so that we can see the distribution of the accidents whole of the city. A rapid and continued rise in living accommodations and land costs is expected in cities with transportation improvements and rapid economic and population growth. Humans, nations, regions and the world would be seriously limited in development without transportation, which is a central element for physical and economic growth. Urban growth occurred as physical and functional changes took place, due to the transition of the rural landscape to urban forms, which has been studied by various researchers (Thapa and Murayama, 2010). These changes as well influence the urban density, which would be the increase of the growth rate in several dimensions. Transportation network systems, urban construction and urban traffic accidents are interdependent each other. Urbanization is taking place at a rapid pace in Tehran, and this expanding city is changing the urban structure. Land use is one of the most important pillars in creating urban areas, and thus, creating transportation and road patterns have a direct impact on urban traffic accidents. The combination of high population and growth of land use causes the increase of daily trips that produce urban traffic accidents in the city. Agreeing to this varying communication between land use and the road network, which is causing traffic accidents, also calls for an agreement on how the land use is associated with urban traffic accidents. An explanation of the connection between the several land uses and occurrence of urban traffic accidents in Tehran's metropolitan area indicates that land use generates different kinds of causes, which are brought about by various actions. It is necessary therefore to have an understanding structure of urban and accidents for improving safety on the roads which will be done with GIS as GIS is a comprehensive management tool for traffic safety.

Keywords: Urban structure, Urban Traffic Accidents, Spatial Analysis, GIS

## Geospatial analysis of urban landscape patterns in four hill stations of Southeast Asia

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Hill stations are commonly used to refer to a town or city in the tropics founded by a Western colonial power during the nineteenth and early twentieth centuries. Most hill stations are located in mountain regions at an altitude between 1000 and 2500 m above sea level, and thus enjoy relatively moderate temperatures than those recorded in the surrounding lowlands. Hill stations are known for their relatively good natural environments, which generate valuable ecosystem services that benefit the local population. In recent years, there has been a resurgence of interest in hill stations for 'quality environment' and other socioeconomic development-related activities, resulting in the rapid urbanization of some. However, rapid urbanization affects the fragile natural environment and threatens the sustainability of these areas. That said, not much is known about the landscape patterns of these areas. Hence, this study aims to contribute to our understanding of some of these areas by examining the urban landscape patterns of four notable hill stations in Southeast Asia, namely Baguio City (Philippines), Bogor (Indonesia), Dalat (Vietnam) and Pyin Oo Lwin (Myanmar). Geospatial tools and techniques, including remote sensing and GIS, will be used to facilitate the analysis.

Keywords: hill station, geospatial analysis, land use, land cover, GIS, remote sensing

## Spatial Analysis of Land Use/Cover Changes and Urban Expansion in Lusaka City, Zambia

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Major cities in Sub-Saharan Africa have experienced an unprecedented rate of urban expansion, including Lusaka, the capital city of Zambia. Urban expansion has increased the exploitation of natural resources and has changed Land Use and Land Cover (LULC) patterns. In this study, Geographical Information Systems (GISs) and Remote Sensing (RS) were used to spatially analyze the LULC changes in Lusaka City as a determinant of urban expansion. Multi-temporal Landsat Thematic Mapper (TM) and Enhance Thematic Mapper Plus (ETM+) images from 1990, 2000 and 2010 were classified into three categories (Built, Non-Built and Water) and the magnitude of LULC changes are presented. The results show that there has been rapid increase in the built up area of Lusaka City especially between the periods 2000 and 2010. It was observed that the expansion in the built up area is highly characterized by increase in unplanned (slum) settlements. The study has also utilized Census data from the year 2000 to 2010 to determine the driving forces of Urban Growth and express the social economic profile of the city.

Keywords: Spatial Analysis, Land Use/Cover, Urban Expansion, Lusaka City

## A WebGIS Platform for Repository, Processing and Disseminating Urban Land-Use/Cover Maps

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This paper discusses a WebGIS designed to open up an ample opportunity for researchers and information holders to store, maintain and disseminate remote sensing-derived urban land-use/cover maps. The WebGIS platform consists of the acquisition engine, repository engine, processing engine and service engine, visualizing engine, and the disseminator engine. Firstly, the acquisition engine uses the input server to acquire classified images and other relevant source imageries and then passes it to the repository engine. The repository engine manages the data storage by extracting metadata related to imageries and by keywords, together with other metadata related to users. The repository engine also checks if there are any classified images currently stored in the system related to the same geographic location and time period. If the image is a derived work from an existing image then an image stack is created and stored with the new set of metadata. The processing, aggregation and comparison of images are done and stored in the system therefore another person can examine, use and improve with further modifications. The open source modules are created to provide visualization of urbanization process as a by-product by acquiring and processing data from the repository. Based on the classified data in the repository, the system gives a service to any website or user to display and visualize the urbanization process of any particular geographic location. The goal of the research is to establish a self-evolving WebGIS platform for repository, processing and distribution of remote sensing-derived urban land-use/cover maps for the purpose of visualizing urbanization process and other relevant geospatial analyses.

Keywords: Geo-data Repository, Geospatial Analysis, Land-Use/Cover, Remote Sensing, Urbanization, WebGIS

## Functional and Morphological Dynamics: Colombo city, Sri Lanka

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The urban functions and urban morphology of Colombo city has been dramatically changing over last decades. Main objective of this study is to fundamentally analyze the spatiotemporal changes of urban morphology of Colombo city and explains the relationship between urban morphology changes and functional changes in Colombo city. Three methods are used to achieve its objective. First, the Landsat imageries 1992, 2005 and 2014 are classified to represent the urban and non-urban areas using Random Forest (RF) approach in Remote Sensing (RS). Second, the accuracy of the classification results is assessed. Third, the horizontal changes of urban morphology is analyzed in quantitatively using Geographical Information System (GIS). Moreover, the study analyzes how the socioeconomic functions of Colombo city has changed in different time period and its relationship with urban morphology changes, in order to understand the causes of spatial pattern of changes of Colombo city. The outcome of the study can be used to model the urban morphology changes in horizontal manner but vertical expansion should be detected in order to model it in a comprehensive manner in future.

Keywords: GIS, Random Forest, RS, Urban morphology

## Hedonic Price Modeling of New Residential Property Values in Xi'an City, China

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With the urban growth in Chinese cities, residential property values have become one of the most important determinants measuring urban economic development. However, it is complicated to carry out quantitative analyses focusing on residential property values in a whole city. This thesis estimates the implicit premium of several location influence factors affecting new residential property values in Xi'an, using hedonic pricing technique. Three types of given explanatory variables are created or collected to measure the location characteristic, characteristics specific to the housing itself and neighborhood characteristics from a 378-samples database. Hedonic pricing model is employed to estimate the capitalization effects of these influence factors in new residential property values. The empirical results show that the accessibility indices such as distance to CBD have well been capitalized into the residential property values. In particular, results indicate that a within-zone housing unit is sold 9.4% more than if it was outside the attendance zone of a Key Primary School. Besides, this study deduced a specific threshold value (825 meters) about the residence inside a Key Primary School's attendance zone from several repeating regression processes in order to achieve the target with statistical significance at 5% level. An attempt is made to quantize the premium on the residential property from the influence of educational resources, i.e. home buyers have willingness-to-pay for the high-quality educational resource. In addition, we get a corollary that it is distinctive comparing with other metropolises that the accessibility to subway stations has not well and significantly been capitalized into residential property values in the real estate market of Xi'an City until April 2014. In other words, advantages of rail transportation had not yet adequately been brought into full play in Xi'an City.

Then, it is verified that spatial local singularities caused by unobserved variables or estimation bias can be associated with Multi-regression errors. This thesis has explored an unconventional viewpoint to residual error problem, which combines the spatial particularity related to location differences (Coming from the aspect of real world) and the spatial distributions of singularities (Feedback from the aspect of data).

Furthermore, this thesis classifies the new residences in Xi'an City into 5 agglomerations and aims to prove some hypotheses that following with results of the residual analysis, which can reveal the trend of housing price and the real estate market prospects of new residential properties within each region of Xi'an City.

The author takes Xi'an City, which is thought as a comparatively un-modernized city, as the study area, which can provide one new research example of hedonic pricing model comparing with the other metropolises in China. Besides it is effective to provide scientific basis of decision-making for the real estate investors and planners.

Keywords: Cluster analysis, Hedonic price modeling, New residential property values, Residuals, School's attendance zone

## Evaluating Walkability through Neighborhood Design Qualities using GIS: A Case Study of Suburban Areas in Tokyo

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Suburbanization leads to a new neighborhood structure compared with traditional ones which have plenty of spaces and destinations for residents to walk. This new structure consists of residential dwellings mostly with only few places for daily activities such as shopping or working. Such a neighborhood is considered as a low ? walkability neighborhood which causes physical inactivity. Walkability is a measure of effectiveness of neighborhood design in promoting walking and improvement of walkability has been found as a solution to achieve healthy life style. The purpose of this study is to figure out important factors for evaluating walkability in such areas and find a proper model with these factors to calculate walkability of suburban areas in Tokyo.

Six main factors (dwelling density, road accessibility, land use diversity, public transportation facilities, aesthetics and safety) are selected and GIS methods, combined with questionnaires, are used for collecting and analyzing data. Dwelling density, road accessibility and public transportation facilities are evaluated by census data while land use diversity, aesthetics and safety are evaluated by data from both questionnaires and census. Zonal analysis is used to include the effects from the surround cell values. Then in order to detect the importance of each factor, expert opinion in Analytic Hierarchy Process (AHP) analysis is used by giving weights to each factor. Subsequently, all the six factors are shown with their own weights through map layers and these map layers are overlaid to get the final walkability map in the study area. Based on the final walkability map and field data obtained, powerful factors and weak factors are summarized with the characteristics of each study area. Possible ways in promoting walkability is concluded according to the walkability map and questionnaire results.

Keywords: GIS, walkability, neighborhood design, suburban areas, physical activity