Tectonics and Global Erosion Rates

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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 a development of accurate landscape evolution models. During the past decades scientists have been studying and measuring erosion rates on local and global scales. A major objective of these studies is to try and discover the controlling factors of erosion rates. Due to limitation of available data in the past, the analysis used to be relatively basic. Thanks to abundant newly obtained erosion rates data, combined with new high resolution DEMs, a more complete and comprehensive analysis can be made, and correlation of erosion rates with factors related to basin morphometry, climate and tectonics is possible. The study is based on previously obtained and published erosion rate data and sediment yield measurements published by the U.S. Geological Survey and an analysis using GIS. In this work we focus on the connection between erosion rates and tectonic related factors: fault distribution, peak ground acceleration (PGA) and distance to tectonic plate boundaries. Bivariate correlation analysis shows the following characteristics. 1) Erosion rates are strongly related to tectonic activity factors. They are positively correlated to PGA and negatively correlated to distance to tectonic plate boundary. 2) Distance to tectonic plate boundary is an indirect measure of tectonic activity as generally, the further away from a plate boundary the more likely the basins are in a tectonically stable environment. Despite this being the case, this parameter is as good an indicator for erosion rates as PGA. 3) There is a correlation between slope and tectonic related factors. A positive correlation with PGA and a negative one with distance to tectonic plate boundary. This might mean that tectonic related factors affect erosion rates through slope. Tectonically active areas tend to develop steep slopes which in turn are responsible for higher erosion rates. 4) On a global scale almost 30% of variance in erosion rates can be explained by a combination of only two factors –distance to tectonic plate boundary and PGA.

Keywords: GIS, Erosion rate, Sediment yield, Tectonic plates, PGA

Sediment yields during typhoon events in Taiwan

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Debris sourced from landslides will result in environmental problems such as increased sediment discharge in rivers. This study analyzed the sediment discharge of 17 main rivers in Taiwan during 14 typhoon events that caused landslides. The measured suspended sediment and water discharge, collected from hydrometric stations of the Water Resources Agency of Taiwan, were used to establish rating-curve relationships. Then sediment discharge during typhoon events were estimated using the rating-curve method and the measured data of daily water discharge. Positive correlations between sediment discharge and rainfall conditions for each river indicate that sediment discharge increased when there is a greater amount of rainfall or a higher intensity rainfall during a typhoon event. In addition, the amount of sediment discharge during a typhoon event is mainly controlled by the total amount of rainfall, not peak rainfall. Differences in the correlation equations among the rivers suggest that the catchments with larger areas produce more sediment. Catchments with relatively low sediment discharge in a normal condition show more distinct increases in sediment discharge in response to the increase in rainfall. The positive correlation between the average sediment discharge and the average area of landslides during typhoon events indicates that when larger landslides are caused by heavier rainfall during a typhoon event, more loose materials from the latest pre-existing landslide debris are flushed into rivers resulting in higher sediment discharge. The high proportion of large landslides in Taiwan contribute significantly to the high annual sediment yield of the world top class, in spite of the small area of Taiwan.

Keywords: sediment discharge, river, catchment, rainfall, landslides

Optimal onshore wind farm siting using Spatial Analytic Hierarchy Process: A case study of Fukushima prefecture, Japan

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Fukushima was the most damaged prefecture by the nuclear crisis as a result of the powerful earthquake of March 2011. Its government adopted a strategy to focus on renewable energy to drive its energy structure into a safer and more self-sufficient status. Wind energy stands firm as one of the important renewable energy sources in Japan and plays an important role regarding energy vision goals of Fukushima prefectural government. However, various obstacles are on the way of such approach, mainly because the dispersal of onshore wind farms implies many negative impacts on the environment as well as the communities neighboring such facilities. The aim of this study is to develop a GIS model to identify and evaluate the optimal locations for the siting of onshore wind facilities that combines multi-criteria analysis with geographical information systems. The model incorporates a set of environmental, economic and social criteria. Using a newly designed and developed web application, we apply the Analytic Hierarchy Process (AHP), where a group of wind energy experts and stakeholders was asked the pairwise comparison of the criteria in order to judge their relative importance in site evaluation.

Keywords: Onshore wind farms siting , Multi-criteria decision making, Analytic hierarchy process, GIS, Fukushima prefecture

Challenges of Spatio-temporal Transformation of Urban Wetlands in Sri Lanka: A Case Study of Muthurajawela Marsh and Negombo Lagoon

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Urban wetlands are affected by both human activities and climate changes. The spatio-temporal transformation and seasonal inundation determine the structure and functions of tropical wetland ecosystems. The information on the spatial and temporal changeability of inundation is necessary to understand and mange these ecosystems. The western region of Sri Lanka represents one of the most emerging growth center in the country. There is an extreme pressure on the natural environment and wetland ecosystems. Combination of method of environmental history, urban ecology and wetland science based on geographical information system (GIS) and remote sensing (RS) have been applied. Moreover, this research focuses on understanding and assessing the current potential spatial stress on a regional wetland ecosystem due to human interference. This study uses remote sensing images of three time periods (during 1996-2016) to interpret the chronological spatial data of the wetland landscape changes over the 20 years time span. The result shows that the wetland system in this study area presents trend of widely extend urban- rural situation with rapid land use changes urban expansion, wetland degradation, rapid urban built up land and that different driving forces make a complicated patterns of this wetland ecosystem.

Keywords: Wetland Science, Urban Ecology, Remote Sensing

Modeling Land Use and Land Cover Dynamic Changes in Tianjin City

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In recent years, urban areas are expanding at a very high speed in the developing world, and with the rapid urban growth, many environmental and social problems are emerging. Under these circumstances, analysis of the land use and land cover (LULC) changes is a useful method to catch the urban trend and to forecast the feature of LULC conditions. LULC changes exert a direct impact on biodiversity, water and radiation budgets, emission of greenhouse gasses, carbon cycling, and livelihoods. The study of LULC and its dynamics is necessary for environmental management, particularly regarding sustainable agriculture and forestry.

Taking Tianjin, China as a study area, an attempt is made here to study land use changes and their driving factors. China is a developing country, and Tianjin is a municipality under the central government. Tianjin, one of China’s four municipalities with a famous international port, is a birthplace of modern industry. Tianjin is also one of the earliest coastal cities opening up the north China’s shipping and industrial centers. From 1995 to 2015, many factors such as land price, environmental damage, population and GDP increase have caused the rapid transformation in the LULC. The general trend of LULC is unalterable. Therefore how to forecast and evaluate the urbanization tendency is critical for planning the healthy city development.

Remote Sensing and Geographical Information Systems are useful tools for detecting geographical objects and phenomena changes. Landsat images are used in this study. All the Landsat images are pre-processed in ENVI and ArcGIS. The processing techniques include bands composition, mosaic, classification, etc. IDRISI software is adopted for analyzing summary statistics, Markov probabilities, and cellular automata simulation. First of all, using remote sensing to make classification maps in 1995, 2005 and 2015 respectively. And then using simulation models, an attempt is made to evaluate the land use and land cover changes during the 20 years. At last, by employing Markov Model and Cellular Automata Model, the LULC scenario in 2025 and 2035 was simulated and forecasted on the basis of land use type interpretation using DEM, slope, and range of distance in 2005 and 2015.

The result of the land use map analysis in 1995, 2005 and 2015, shows that most of the cropland areas were transformed into the built-up. The expanding speed into the built-up was in accordance with the growth of GDP per capita. Some of the medium cities were transformed into the regional hubs. Water and forest areas were stable with few changes. Protected areas were maintained as the preservation of natural resources.

This study demonstrates that the integration of satellite remote sensing and GIS is an effective approach for analyzing the rate of growth and spatial changes in land use and land cover in growing megacities. Furthermore, the combination of these two technologies with Cellular Automata Modeling and Markov modeling are useful for understanding the LULC change process.

Keywords: Urban Growth; Cellular Automata Model; Markov Model; Neighborhood Interaction; Remote Sensing; GIS

Keywords: Urban Growth, Cellular Automata Model, Markov Model, Remote Sensing, GIS

