

# National Conference on

Geospatial Sciences & Disaster Management

January 2016



19<sup>th</sup> January 2016  
Colombo, Sri Lanka



Institute of Human Resource Advancement (IHRA)

University of Colombo

Sri Lanka

**National Conference on  
Geospatial Sciences and Disaster Management  
2016**

**Conference Proceedings**

ISBN: 978-9-55046-087-8

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## **Message from the Director - Institute of Human Resource Advancement**

It is with great pleasure that I welcome you to the National Conference on Geospatial Sciences & Disaster Management-2016 on 19<sup>th</sup> January 2016 at the Sri Lanka Foundation Institute. I am writing this message in the midst of development and change that we have embarked on with the aim of taking IHRA into greater heights. This is the second time in its history, IHRA organizes an event in this nature, and without any doubt this event will help in our endeavour to make IHRA as a National centre of Human Advancement. Therefore, let me express my sincere gratitude to those who involved in organizing this event.

This conference provides an excellent forum for exchanging knowledge and discussing issues pertaining to Geospatial Sciences and Disaster Management, which are new and still emerging as disciplines of study and professions in Sri Lanka. They have a great potential to contribute to economic and social development of the country thus are close to lives of our people. While reading the abstracts, I found that the scholars attending to this conference wish not only to debate over theoretical issues of these fields but also to discuss limits and opportunities that they encounter in engaging in these fields. A conference that sets a platform to cover such wide spectrum of topics in Engaging disciplines indisputably, contributes to its advancement. I, being 'an outsider' to these fields, am pleased that I could contribute to the advancement of these fields by facilitating this event.

I take this opportunity to express our sincere gratitude to the Chief Guest Professor Lakshman Dissanyake, Vice-Chancellor, University of Colombo for accepting our invitations in spite of his busy schedule. I would like to extend my sincerest thanks and appreciation to Professor Ranjith Premalal De Silva, Professor of Agricultural Engineering, University of Peradeniya for accepting our invitation to deliver the keynote speech. Last but not least, my special thanks go to Professor Samantha Hettiarachchi, Professor of Civil Engineering, University of Moratuwa who willingly came forward to serve as the Conference Chair.

While congratulating all the paper presenters, we, the IHRA look forward to exiting day with insightful presentations, dialogs and finally initiating long-lasting collegial relationships.

I wish to congratulate all the paper presenters a successful research career.

Professor JASK Jayakody  
Director  
Institute of Human Resource Advancement  
University of Colombo

19<sup>th</sup> January 2016

## Forward

Geospatial Sciences and Disaster Management are emerging areas with a National importance. Especially after the Tsunami and few natural disasters faced during the last two decade, the requirement of education of such areas became a National requirement. In response to the Institute of Human Resource Advancement (IHRA); one of the leading institutions in Sri Lanka; having 15,000 student base, inaugurated higher education in Geospatial Sciences and Disaster Management in 2009 and 2011 respectively. The programs acquired higher popularity and recognition in the country serving various sectors of the industries such as NGOs, Government Related Organizations, Forces, Tele-Communication, Civil Engineering and Natural Resource Management. Professionals in various disciplines were also attracted.

In order to establish a strong network among all interested parties on Geospatial Sciences and Disaster Management and to give them a knowledge storming with an adequate knowledge, IHRA decided to organize a National Conference on the same theme. The conference offers an interdisciplinary forum in the field of Geospatial Sciences and Disaster Management. All important personalities in the fields of academics, national disaster management authorities, industries, leading technological organizations, stakeholders, decision makers, policy makers, researchers, engineers, scientists, administrative officers and public will be brought together at the conference with respect to participation in the open forum discussion to advance the knowledge in the area of Geospatial Sciences and Disaster Management. The conference includes three technical sessions covering 47 abstracts.

Publishing such a huge volume is not an easy task. The contribution made by all academic and non-academic staff, industry experts, panel of reviewers and authors is invaluable. The support and the guidance given by the Vice Chancellor of University of Colombo, Director, Academic Syndicate, Academic members and Administrative officers of the IHRA, should mention with highest gratitude. I sincerely convey my appreciation to the staff of IHRA who immensely contributed to make this conference a success.

I believe and wish that the effort we made shall extend to enhance the knowledge of Geospatial Sciences and Disaster Management in a meaningful way.

ENC Perera  
Conference Secretary  
Coordinator - Extension Programmes  
Institute of Human Resource Advancement  
University of Colombo

19<sup>th</sup> January 2016

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# Proceedings of National Conference on Geospatial Sciences & Disaster Management - 2016

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# Possibility of Earthquakes Occurring in Sri Lanka and the Effective Retorting Mechanism for Colombo Municipal Council Area

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## Abstract

Natural disasters are increasing significantly across the globe since the recent past. There were 1,720,502 deaths reported from 1990 to 2012 due to 529,502 earthquakes worldwide. The highest number of deaths amounting to, 320,120 was in 2010 and the highest number of earthquakes amounting to, 22,289 were recorded in 2011. According to the records available, the first earthquake in Sri Lanka had occurred on the 14 April 1615 killing more than 2000 people and causing heavy material damage. Since 1615, 95 earthquakes and 19 tremors have been recorded. Seven tremors have been recorded in 2012. The above statistics indicate the deadly effects of earthquakes and the present trend of increasing earthquakes. Considering the geographical location, size, plate tectonic and earthquake science, the vulnerability is comparatively less but cannot be ruled out. Moreover, it is observed that seismic activities in and around Sri Lanka have increased. As there are no early warning or prior indication of earthquakes, it is important to conduct this type of studies in order to ensure minimum damages. To achieve the ultimate aim, it is necessary to evaluate the vulnerability, response capability, awareness and preparedness. According to the details available, Sri Lanka is also vulnerable to earthquakes and is exposed to heavy damages due to the existing building code/ regulations, search & rescue capability, awareness and preparedness of the country. This study has been conducted to highlight the requirement of Specialized Urban Search and Rescue Mechanism along with an awareness programme for the largest and the most densely populated Colombo Municipal Council (CMC) area which is most vulnerable to devastating damage. According to findings, there are no healthy actions to improve mitigation and create awareness. Further, seismic activities seems to be more challenging in the future. It is suggested to improve the mitigation and awareness by introducing proper building codes and internationally recommended safety techniques such as "Drop-Cover-Hold". It is the quickest reaction that one can adhere when staying inside a building. Primary and secondary data were collected from relevant organizations, publications and websites. Questionnaire survey of fifty various persons in the CMC area revealed that 98% of the population is unaware of precautions that has to be taken during and after an earthquake. It is significant to note that devastating consequences must be expected even from a moderate earthquake due to the existing condition of building structures, unpreparedness and unawareness that have been identified by this study. Therefore, more attention and studies would help to mitigate heavy damages in terms of lives and property.

**Keywords:** Earthquakes; Vulnerability; Plate tectonic; Seismic.

## Evaluation of Flash Flood Occurrence and its Variations due to Construction of Southern Expressway: (Kahatuduwa to Gelanigama)

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### Abstract

Predominantly, there are three types of floods; flash, riverine and coastal flooding. Conversely, anthropological activities play a great role in inducing floods. Flash flood is the mostly accelerated type caused by human activities. Due to the current development process in Sri Lanka there was a high demand for road transportation and the necessity for an expressway network has emerged. The first expressway constructed in Sri Lanka was the Southern Expressway and initially it extended from Kottawa to Galle. The project was a multimillion investment and several studies were carried out on various aspects of it in order to minimize the environmental damage. This study is aimed at assessing the occurrence of flash floods and their impact on stakeholders. Fifty percent of the Southern Expressway is running over paddy fields and the morphology of the area is varying. The study area extended along 7.8km length and covered 46.8km<sup>2</sup> on either side (Eastern and Western) of Southern Expressway from Kahathuduwa to Gelanigama. A field survey was carried out to collect flash flood data. The flood data were collected from the special unit of the Road Development Authority (RDA), the Disaster Management Center (DMC) and the Department of Meteorology involved in expressway construction. In order to collect primary data, 50 households were selected as a sample by simple random sampling method and the interviewed information was recorded. The collected flood data were analyzed to replicate flood hazard before and after construction. According to results, 51% of the population has not faced flash flood either before or after the construction. 8% faced flash floods before the construction but did not experience flash floods after the construction, while 22% has not faced flash floods before the construction and experienced flash floods after the construction. Out of areas which experienced flash floods before the construction of the expressway, 10% experience fewer flash floods after the construction, while another 12% experience more flash floods; therefore, the flash flood experiencing segment after the construction of the Southern Highway is 12%. The study reveals that there is a high possibility of flash floods in the Eastern side of the expressway and low possibility in the Western side. The values obtained clearly indicate that the expressway is working as a barrier for the surface water flow. The main reasons are the inadequate number of culverts at appropriate locations and the unsatisfactory maintenance of the drainage channels.

**Keywords:** Flash floods; Mitigation; Construction; Seaside; Landside.

## Effectiveness of the Housing Construction Approving Practices in Sri Lanka to Determine the Impact on Adjacent Buildings

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### Abstract

As per the reports on the stability of buildings issued by National Building Research Organization (NBRO) in Sri Lanka, in many circumstances damages to one another the existing buildings have been reported due to the construction of houses adjacent. This has of late become a serious problem to the persons concerned. Due to scarcity of land, rising population and urbanization, this problem may further aggravate due to future development activities. It may then turn out to be a kind of man-made disaster. Therefore, there is an urgent need to investigate this problem early and take necessary steps to prevent or minimize such problems in future. The procedure involved in, house construction has to go through many stages such as approval stage, design stage, and construction stage. However, many social, physical, and environmental issues still arise in the process of house construction. The study deals with the issues associated with the approval stage which could cause physical damages to adjacent buildings resulting from new constructions. The research aims at developing a set of recommendations that will help improve the current approval procedure for new constructions, thereby enabling to minimize the physical damage to the existing adjacent buildings. Study of the current housing approval practices, the identification of the shortcomings of the current regulations, holding discussions with officers in the relevant organizations, the gathering of information from related internet resources, the perusal related previous studies, field observations and reports issued by NBRO were the methods followed and the sources of data for this research. Updating of building construction application forms issued by the local authorities incorporating all the current regulations, the addition of new requirements such as prior survey reports of the adjoining properties, and a clear statement of the method of compensation in case of damage were identified as some of the major findings to improve the effectiveness of the current procedure. The above findings are useful for the relevant government agencies to revise the current building regulations and procedures to ease the problem.

**Keywords:** Adjacent buildings; Construction approval practices; Physical damages; Building settlement.

## Spatial Pattern of Crop Vulnerability due to Drought in the Jaffna District

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### Abstract

Drought is a disastrous natural phenomenon and is generally viewed as a sustained and regionally extensive occurrence of below average natural water availability either in the form of rainfall, river runoff or groundwater. According to the historical information of Sri Lanka, there has been increasing trend toward the occurrence of drought in recent past. Especially, the Jaffna District faced several spells drought during the last ten years resulting in low crop production. Therefore this study focuses on the assessment of the drought vulnerability on crop production in the Jaffna District. For this study, multi-scale and multi-indicator method was used to analyze the crop yield data (1990-2014), rainfall data (2001-2014) and socio-economic data to determine the sensitivity index, exposure index and adaptive capacity index for each Divisional Secretariat Division (DSD) in the district. A combined index was introduced to analyze the crop vulnerability. In order to determine the crop yield sensitivity index, the linear trend for each yield for each division between 1990 and 2014 was calculated. To develop the exposure index, the average of the 13-year rainfall period (October – February, from 2001-2014) was divided by each year's average rainfall for this period. Two indicators, human capital (signified by educational level for farmers) and financial capital (signified by poverty rates) of adaptive capacity were also considered. In addition that the overall mean vulnerability of the particular region was estimated. Jaffna's agricultural crop drought vulnerability, presented in a map, is classified into the following categories: very low, low, moderate, high and very high. According to the sensitivity index it is identified that one division is very highly sensitive in terms of exposure to drought and 07 DS divisions are moderately sensitive areas. Other regions are low sensitive regions according to the index. Overall adaptive capacity of the various divisions in the Jaffna District was also measured and it was identified that there are two regions with very lowest values. Only one region has the capacity to protect the crops from the drought. The results of the study show that the vulnerability of crop production to drought in the Jaffna District has discernible geographical and socio-economic patterns, with Kayts DS division having the highest vulnerability to drought. Chavakachcheri DS division is identified as a very lower vulnerable region. The results show that the Kayts and Velanai DS divisions are mostly affected by drought.

**Keywords:** Drought; Vulnerability; Sensitivity; Exposure; Adaptive capacity.

# Natural and Human Induced Risk Management A Systematic Approach to Disaster Management

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## Abstract

This paper is based on the consideration of hazards as being inherent aspects of both natural as well as anthropogenic processes. The interaction of these hazards with human populations may cause injury or death to *Homo sapiens* and/or destruction, or disruption to their primary (ecosystem) and/or secondary (structural/ infrastructural/ technological/ processes) species support and survival systems which when of a magnitude greater than can be coped with by the affected population without outside assistance constitute disasters. Based on this definition it perceives disaster management as consisting of the formulation, initiation, support, sustenance, driving, guiding and development of processes that enable the perception of processes and the hazards that are generated by their nature and dynamics and the engagement of these hazards so as to enable the management of their impact on human populations through the generation of structural, infrastructural and behavioral resilience. It perceives this generation of resilience as being a vital element of sustainable development and one that is essential to the survival of a sufficient number of the species *Homo sapiens* so as to sustain, preserve and develop the high levels of autonomy generated within the species and its consequent culture, knowledge and technology through the increasing volatility of earth-processes which increase is said to be the outcome of anthropogenic forcing of these earth-processes. It recommends the adoption of a systems approach to disaster management in order to avoid duplication of efforts, reduce resource consumption and environmental impact, increase management control and accountability and at the same time generate the spaces and flexibility required for autonomous individual actions while ensuring sharp and selective focus of responses at a first level of prevention, preparedness, a second level of emergency response and systems stabilization a third level of relief and temporary shelter, and a fourth level of restoration, reconstruction and rehabilitation. It maintains that this systems approach to disaster management is more comprehensive and focused than the currently used sector based approaches and that it may form an important element of the basis of processes of civilization transformation and conscious evolution towards the generation of a credible, sustainable and resilient global civilization dedicated to perceivable goals at species, planetary, stellar, galactic and cosmic levels that is now underway. This paper is also the basis of ongoing research aimed at selecting, collecting, configuring and nesting within processes of constant updating, of the data required to quantitatively support its recommendation. Its methodology consists of the synthesis of available work on Disaster Management Methodology and related conceptual frameworks and the articulation of conclusions based thereon.

**Keywords:** Systems; Synthesis; Civilization; Evolution; Consciousness.

# Climate Change Impacts on Fisheries in the Western Sri Lankan Waters

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## Abstract

There are significant evidences from previous researches to confirm climate change impact on aquatic life, fisheries and disaster frequency. Hence this study responded to identify the trend of climatic factors' changes in the Western waters of Sri Lanka. Subsequently this research examined the effects of climate changes on the changing pattern of fish catches and assessed the climate change impact on the livelihood of fisheries communities in the Western coast of Sri Lanka. The findings of this study are based on the analysis of data from 1. NOAA satellite data (1980-2013), 2. fish catch data in the Western Sri Lankan waters and 3. socio-economic survey data obtained from fishermen in the Western coast of Sri Lanka. The analysis of the study is supported by graphical representations, scatter plots, time series model and t-test. The results of the study revealed a decreasing trend in the sea level pressure and increasing trends in Sea Surface Temperature (SST) and air temperature. Except the precipitation rate in the North East (NE) monsoon and relative humidity for the first inter monsoon in North West (NW) and NE monsoon in the South West (SW) region, precipitation rate and relative humidity showed a decreasing trend. The fish catch data also indicated a declining trend except for the Long Tail Tuna. The results also proved that 1. Yellow Fin Tuna catch depends on SST and air temperature, 2. Long Tail Tuna on surface perceptible water, 3. Frigate and Bullet Tuna on SST, air temperature, precipitation rate and 4. Kawakawa and Narrow-barred Spanish Mackerel on precipitation rate. There were significant differences among the Catch per Unit Effort of NW and SW areas of Sri Lankan waters for all the above mentioned species except for Long Tail Tuna. Furthermore, except for SSTs and precipitation rates, significant differences were seen between NW and SW regions in relation to sea level pressure, air temperature, surface perceptible water and relative humidity. The survey results also re-confirmed that the physical parameters such as temperature, currents, roughness of the sea and the sea level have increased during the last 33 years. Fishermen also experienced a significant harvest decline in Shrimps, Prawns, Crab, Sharks, Rays, Rock fish and several other Tuna species. Survey results of the survey also corroborated that the climate change severely disrupts the fishermen's income due to the changes in fish catch and increased frequency of coastal hazards during the last 33 years. Hence, it is a timely need to take measures such as awareness programmes, increasing the green belt and frustration and also introducing alternative livelihoods to fishermen to manage their day-to-day lives if the climate change severely affects the distribution of fish.

**Keywords:** Climate change; Satellite data; Fisheries; Socio-economic survey; Aquatic life; Sea surface temperature.



## **Study the Changes in Land use Patterns and Current Water Pollution Status in Lunawa Lagoon, Sri Lanka**

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### **Abstract**

Lunawa lagoon is one of the major lagoons in the Colombo District and is situated 14km to the south of the Colombo city, Sri Lanka. The total area of the lagoon is 20ha and with 6.15km<sup>2</sup> catchment area. Unplanned urbanization surrounding the Lunawa lagoon has resulted in identifying Lunawa lagoon as one of the most polluted water bodies in Sri Lanka. The Lunawa catchment has been identified as an area with inter-mixed land use patterns, which includes industrial, commercial, institutional and residential areas. Different anthropogenic activities within the last decades have been dramatically changed the natural resources and land use patterns in the area. Lunawa lagoon provided lively hood for the fishing community until 1970s. The lagoon and its aquatic resources have been degraded over the last three and a half decades with the increasing industrial establishments in the area after 1970s. The study was carried out to identify the canals and lagoon water pollution and non-pollution point sources including stakeholder's involvement in the Lunawa lagoon area. The primary data was collected through field observations and interviews with institutions and authorized people. The changes in land use patterns were identified using the Google Earth image interpretation and GIS analysis. The studies have identified that there are 80 industries with high pollution and 45 industries with low pollution. The study revealed that the land use pattern has changed significantly from 1970 to 2010. The GIS map interpretation indicated that 90% decrease in the vegetation cover was due to the establishment of various industries since 1977 in Rathmalana and Moratuwa areas. More than 55% of the total land area is utilized for residential purposes. Out of which, 3% are temporary houses built on reservations, 8% has taken by the industrial sector and 11% of the area is taken up by beach and coastal lands. Currently, land available for future developments are only about 2%. Furthermore, the results revealed that the main pollution variation is anthropogenic. Considering the current development trends and the proposed development plans, it is not possible to re-establish the previous environment condition of the area. Nevertheless it is widely felt that planning & zoning is needed to achieve an improvement in the environmental condition of the area. For the rehabilitation of the lagoon, it is recommend to improve the waste water treatment system in a more efficient manner, and to adopt rules and regulations on waste water discharge and dumping garbage to the canals.

**Keywords:** Land use patterns; Urbanization; Lagoon; Water pollution; Anthropogenic.

# A Study on Inter Rainfall Times in the Ratnapura District of Sri Lanka

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## Abstract

The weather is a collection of status of solar radiation, temperature, humidity, clouds, pressure, rainfall and wind taking place at a given time which may affect our daily life. Rainfall is one of the primary important factors of weather to both physical and landscape of any region. Statistical models of the rainfall are important for many applications like agriculture, hydrology and disaster management. One interesting way is to characterize the temporal structure of inter-rainfall time. This study focuses on modeling inter-rainfall time of Ratnapura District which is located in the wet zone of Sri Lanka. Ratnapura town is situated in the flood plane of the Kalu Ganga basin. Being located in the wet zone, Kalu Ganga basin experiences the highest annual rainfall in the region. During certain years when floods reached higher, the damages were heavy and widespread. Floods in the Kalu Ganga basin affect rural agricultural lands as well as urban areas. It is reported that floods cause heavy damage to life and property while disrupting the day-to-day activities of the communities for several days. In 2003, flood damage to the Ratnapura area was estimated at Rs. 1,140 Million and the death toll was 122. Although Ratnapura is a disaster prone area it is the centre of a long standing industry of gem mining and cultivation of rice, rubber, tea and fruits. Therefore an accurate weather forecasting system important to minimize the hardships caused by the adverse weather conditions. Daily rainfall records from 1<sup>st</sup> January 2010 to 31<sup>st</sup> December 2014 collected at the Ratnapura rain gage station of Meteorological Department used in this study. Two extreme rainfall indices of R95p and R99p were used to identify "Heavy" and "Very Heavy" rainfalls respectively. Inter-rainfall time, which is the time between two consecutive spells of rain is calculated. Different probability distributions were used to describe the distribution of inter-rainfall spells. Statistical inferences for the scale and shape parameters of these distributions were obtained using two different method namely: Maximum likelihood estimation and Method of L-moments. Goodness-of-fit tests such as: Chi-square test, Anderson-Darling test and Kolmogorov-Smirnov test were conducted according to the sample size. These results reveal that different threshold values inter-rainfall times are distributed differently. Degam, Johnson SB, Log-Pearson 3, Pearson 6, Burr, Generalized Pareto and Weibull distributions provides the best fit to the extreme rainfall recurrences in Ratnapura for different rainfall gauges. This study also analyzes the estimated recurrence interval and conditional probability curves. The Cumulative function concludes that, given it has rained a Very Heavy rain today there is 80% probability that Ratnapura will face another Very Heavy rainfall within next 110 days. The conditional probabilities for different elapsed time and waiting time have been calculated to identify the probabilities of occurring the event given that it has not occurred for a given elapsed time. These values have significant implications in a variety of practical applications including water waste management, disaster management and hazard analysis. Using these predicted probabilities disaster management process can be improved to take precautions before a disastrous event occur due to rainfall.

**Keywords:** Inter-rainfall time; Probability distributions; Statistical modeling; Extreme rainfall indices.

# Artificial Neural Networks Based System for Extracting Buildings Automatically from Quick-bird Satellite Imageries

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## Abstract

Automatic feature extraction from high resolution satellite imagery has been an active research area from many decades. Automatic building extraction from high resolution satellite imagery is highly significant in many fields: disaster management, sustainable development, cartography, urban planning, 3D city modeling, mobile communication, visualization, visual simulation and telecommunication to save the time and get updated spatial data while minimizing the cost & time. Traditionally, the building boundaries are extracted through manual digitization from digital images in stereo view using the photogrammetric stereo plotters. However, this process is a tedious, subjective and time consuming task and requires qualified people and expensive equipment. Presently, there are several semi-automatic methods to extract buildings from satellite images but fully automatic methods are limited. In this study, an effective fully automatic method for building detection from high resolution satellite imagery was tested with the use of Artificial Neural Networks (ANN) in MATLAB R2010b. The methodology was tested for Quick Bird optical images in the Battaramulla area in Sri Lanka. The system has two stages as learning and application. In learning stage, developed network is trained using a subset of a high resolution satellite image which has been taken from Quick Bird sensor. In application stage, a subset of previous image is used to test the system. Vector layer of buildings is provided as the final output of the approach. The accuracy of the extracted buildings has been estimated at 94% detection percentage and 6% branch factory comparing vector layers taken from automation and manual digitizing methods.

**Keywords:** Artificial Neural Networks; Satellite image; Building extraction.

## Effect of Changing Atmospheric CO<sub>2</sub> Concentrations on the Growth Performance of Weedy Rice (*Oryza sativa f. spontanea*) in Sri Lanka

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### Abstract

Many scientific evidences suggest that changes in the level of atmospheric greenhouse gases (GHGs) cause changes in the global climate. Recent and projected changes in global concentration of CO<sub>2</sub> will possibly induce differential responses among crop and weed species within the agricultural community. The elevating CO<sub>2</sub> concentration headed to variations in rice yield due to diverse physiological plasticity among different rice varieties and associated weeds. Weedy rice (*Oryza sativa f. spontanea*) has become a major weed in paddy cultivation which reduces crop yields and affects quality of yield. Weedy Rice (WR) which is now spread into many rice growing areas irrespective of the agro-ecological zones is currently considered as the most troublesome, difficult-to-manage and economically damaging weed problems in Sri Lanka. The present study was conducted to observe the growth responses of WR to changing atmospheric CO<sub>2</sub> concentrations in Sri Lanka. Five eco-types of WR were collected from five different districts (Matara, Matale, Kurunegala, Anuradhapura and Ampara) representing wet, intermediate and dry zones. Seeds of WR eco-types, Bg300 (inbred-rice) and Pachchaprumal (traditional-rice) were used for the experiment under controlled environmental chambers. CO<sub>2</sub> concentrations in the chambers were set at 300 and 500ppm 24h d<sup>-1</sup> and temperature; humidity and light intensity were adjusted to ambient conditions. A control experiment was carried out with same WR eco-types and rice varieties. Randomized Complete Block Design (RCBD) was used with four replicates (4 Blocks, in each block a replicate). The data (Seedling-Height, Leaf-Blade-Length, Leaf-Blade-Width, Leaf-Blade-Color, Basal Leaf-Sheath-Color, Number of Leaves, Culm-Number, Internode-Color, Fresh-Weight, Shoot-Dry-Weight, Root-Dry-Weight, Panicle-Length and Awn-Length) were collected at vegetative and reproductive stages at 40, 65 and 80 DAS (Days after Sowing) respectively. Destructive sampling was done at each DAS for biomass determination. The results indicated that increasing CO<sub>2</sub> concentrations led to differential responses in vegetative characters; Leaf-Blade-Length, Leaf-Blade-Width, number of leaves per plant and biomass (shoot, root, and total). Panicle-length increased with increasing CO<sub>2</sub> concentrations. Elevating CO<sub>2</sub> showed a significant ( $p \leq 0.05$ ) increase in vegetative growth and accumulation of biomass in WR eco-types than cultivated rice varieties, Bg300 and Pachchaprumal. Results clearly indicated a greater physiological plasticity in WR than cultivated rice in adjusting to increasing CO<sub>2</sub> concentrations, facilitating WR to be adapted as a successful weed in rice fields in Sri Lanka.

**Keywords:** CO<sub>2</sub> concentrations; Weedy rice; Physiological plasticity.

## Spatial Model for Electric Transmission Line Routing

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### Abstract

This study demonstrates the value of the integration of Electric Transmission Line (ETL) routing with Geographic Information Systems (GIS) to find ways to make routing decisions automate, standardize, more quantifiable, consistent, and defensible. With the increasing population and the economic development of the country the demand for energy and electricity is also increasing. However, as the population indicator of Sri Lanka continues to sprawl gradually into more rural areas especially to the Northern and Eastern provinces, there is a need to build up a new transmission line to meet their demand for electricity. One of the most important problems in energy transmission is finding the best route in any area. Many people from different disciplines have been summoned together to find the best routes by manual methods such as [using paper maps for the determination of which route is the Least Cost Path (LCP) to the destination]. In order to find the best route it is very important to consider several criteria such as slope, landslide, road, railway crossing, distance to buildings, national parks, archaeological areas, residential areas, forests and river crossing etc. In GIS tools & techniques, statistical methods and stakeholder collaboration are used to produce the new siting methodology; Multi Criteria Decision Methods (MCDM) like as Analytic Hierarchy Process (AHP) have been used to weight the criteria which were considered in ETL routing for decision making. By this study, the mistakes identified by manual methods are mitigated in ETL routing and other routing problems. This study was implemented within a limited scope to find out the best route between given two points. However, according to the introduced rules, conditions and parameters the new transmission lines were accurately drawn between given source and destination locations. The prepared model has been converted to a computer programming language to create a tool for easy access. Once the tool is executed, required inputs parameters can be changed depending on the geographic conditions of the project area in order to find the best route. Introduced weighted ranking system has been used to develop a suitability index for geographic factors, which affect the ETL Routing process. Finally, it is intended to highlight the need for the standardization and automatic integration of the system for the effective management of electric transmission line routing.

**Keywords:** Electric transmission line routing; Geographic Information System; Least cost path; Least cost path.

## Determination of Long Term Sea Level Rise in the Northern Indian Ocean

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### Abstract

Ocean based disasters and the rising sea level threaten the sustainability of coastal habitats and community. Forecasting of hazards and assessment of vulnerability are critical to the development of appropriate coastal plans and management strategies to facilitate preparedness and mitigation of impacts. A study is carried out to determine the long term sea level variability in the Indian Ocean. Sea level records from islands in the Northern Indian Ocean namely: Diego-Garcia, Maldives, Mauritius, Sri Lanka, and Zanzibar and one station each from the Northern Bay of Bengal (Bangladesh) and Arabian Sea (Pakistan) were selected to assess the temporal and spatial sea level rise in the Northern Indian Ocean (NIO). Sea level rise is independently estimated using the data of high frequency permanent sea level stations during the period from 1993 to 2012 and monthly average means of AVISO Satellite data during the last 19 years. Seasonal and inter-annual sea level variability in the NIO reveals that the seasonal cycle has large variation of mean amplitude variability, approximately 40–60cm along the northern most part of Bay of Bengal with maximum values in October to November and minimum values in July-August. The analysis of the development of the seasonal cycle in the NIO indicates no long-term changes in the amplitude and phase but a large inter-annual variability. On the seasonal timescale, mass variation dominates the sea level variation in the coastal regions of the NIO. Gravity recovery and climate experiment observes an obvious water mass variation in the deep basin, which is consistent with the result from steric-corrected altimetry. On the inter annual timescales, the mean sea level variation in the NIO shows large oscillations, which are mainly caused by the steric effect. The trend of mean sea level variation inferred from altimetry in the NIO is  $5 \pm 0.4\text{mm/year}$  for the period of 1993-2012, which is significantly higher than the global sea level rise rate of  $3.6 \pm 0.4\text{mm/year}$  in the same period. There is a significant difference in sea level variation trends in the Bay of Bengal and the Arabian Sea; trend is twice higher in the Bay of Bengal than in the Arabian Sea.

**Keywords:** Sea level rise; Steric height; Northern Indian Ocean; Vulnerability.

# Assessing of Coastal Erosion due to Reduction of Mangroves Vegetation Cover in Negombo Lagoon

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## Abstract

Coastal zones are facing intensified natural and anthropogenic disturbances including sea level rise, coastal erosion, over exploitation of resources among others. Mangroves vegetation provides another natural barrier to fast moving water and therefore aids in flood speed reduction. The result of mangroves activities during the floods is mainly the decreased damage in the surrounding areas. The Negombo lagoon (7.4°-7.12°N; 79.47-79.51) is situated in the west coast of Sri Lanka. Eight coastal sites in the Negombo lagoon were selected for detailed study. The problem behind the study is that mangroves are removed for different development activities from the coastal environment. Damage to this ecosystem can result in irreversible coastal erosion. It leads to increasing risks to the coastal community. The aim of this study are to conduct a risk assessment for coastal erosion in the face of the mangrove cover reduction and conducting a detailed examination to a study the region's historical shoreline changes. A rapid participatory rural appraisal was carried out using field observations and community level group meetings with different stakeholder groups in the adjacent forest areas, from May to October 2014. A multi scale coastal vulnerability index was developed specifically by integrating erosion impacts. Landsat and Google images were used for analyzing shoreline changes. The imageries span over a period of 10 years. The shoreline positions were compiled in Arc GIS 10. According to the result, Site 01 is shown at highest Coastal Vulnerability Index (CVI) value. There is lower CVI value in site 02, site 03, and site 07. Reasons for that result, above each site have mangroves vegetation. Site 02 and site 07 CVI index is lower than site 03 value, because site 03 mangrove cover is smaller than the other sites. Due to coastal erosion and mangroves plant removal a part of coastal line acquired by the land and another part of acquired by the lagoon. Main natural protective mechanism of coastal belt has been weakened and caused with illegal lagoon filling. Therefore it can be concluded that people who are living along the Negombo lagoon will face high risk for coastal erosion and other coastal hazard and Lagoon shoreline erosion is slower than open sea shoreline erosion.

**Keywords:** Coastal; Mangroves; Coastal erosion; Remote sensing.

## De-vegetation Caused by Rock Quarrying over the Last Decade in Kalutara, Sri Lanka: A Geospatial Assessment

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### Abstract

In the Kalutara District in a significant number of rock quarries has been opened during the last decade: from the recent past. De to implement of this mega development projects of the country, such as port expansion project, expressway projects, port city and airport projects etc. which were. In general, mining is considered as a destructive industry, which affects the environment and the surrounding echo-systems; and hence it is important to assess the resulting environmental impact. The removal of the vegetation cover is often considered as one of the worst consequences of mining. However, assessment of the impact of mining on the vegetation cover is a difficult task. This study is an attempt to assess the impact of the de-vegetation caused by new quarries started from 2005 to 2015. The objective of the study is to assess the area affected by de-vegetation by using Google Earth imagery. A remote sensing and geospatial approach was adopted to analyze the ill effects caused by the removal of the vegetation cover. Google Earth images, extracted from 2005 to 2010, were used to monitor the change in vegetation cover due to mining activities. Initially, locations of 10 rock quarries, opened during the specified time period, are identified by visually inspecting the Google Earth images. Since the Google Earth imagery consists of high resolution satellite imagery, the clarity was significant enough to visually demarcate the boundaries of vegetation and quarry sites. Images extracted from January to March from the two consecutive years for each quarry. Two images, representing 2005 and 2015, for each quarry were exported to a GIS platform and georectified. The georectified images are then classified into two classes (namely vegetated area and non-vegetated area) and subsequently assigned with pixel values of 1 and 0 respectively. Changes in the vegetation cover due to rock quarrying during the considered period were delineated by computing the arithmetic difference between the two images acquired in the bounding years through a raster calculation. The result depicts that an average of 17,000m<sup>2</sup> of vegetation has been removed by a rock quarry in the Kalutara District over the time period from 2005 to 2015. The approach in this study has the potential for monitoring and assessing the de-vegetation over much broader scale.

**Keywords:** Rock quarrying; De-vegetation; Digital image processing; Remote sensing.



## Web Based Application for Disaster Risk Analysis: Prevention and Mitigation

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### Abstract

As Sri Lankans, we have experienced many disasters such as Tsunami, landslides and flash floods etc. Impact of the disasters could be minimised by sending early warnings to the inhabitants based on pre-analysed results of the disaster. Hence an automated comprehensive system which is capable of analysing, managing and sending early warnings is a timely requirement. Collaboration of both the general public and the responsible authorities is the key factor for the accomplishment of such a system. This application was exclusively designed to analyse the risk levels and manage early and post-disaster scenarios and facilitate respective health organizations to diminish the impact and manage epidemic disasters like dengue, cholera outbreaks, yellow fever etc. This system incorporated advanced Android mobile technologies, Global Positioning System (GPS), Web GIS technologies and ArcGIS server. This web application consists of six pages. Each page facilitates the end-user with attractive user-friendly features. The disaster map page provides updated maps of the disaster areas since disasters can temporarily make existing maps obsolete. The best source of information often comes from the satellite images or aerial photographs. Map engine of this application is updated using quad copter aerial photographs and the system automatically geo-references the image and overlay on the existing maps. This system facilitates the users to create 3D maps of the disaster ground within a short period of time. This web page is capable of using 1:50000 local maps, Google maps and disaster analysed maps. Meanwhile users can use latitude and longitude or a local army grid reference system. Live video streaming from the quad copters provide a clear idea about ground conditions for rescue teams. Hazard warning map page facilitates users to analyse Sea Level Rise (up to 5m, 10m, 15m), flash flood data, landside data, nearest shelters, communication tower locations and the 3D view of the ground using Digital Elevation Model (DEM). Rescue operation map page is based on android mobile applications. Tracking application provides the exact locations of rescue teams on the ground and Incident reporting application allows users to report incidents immediately with current location and geo-tagged images within 10 seconds. Demand application facilitates the responsible officers to demand the items such as water, foods, medicine and etc. from the authorities in proportion to the strength of the disaster camps. ArcGIS application page is powered with ArcGIS desktop and ArcGIS server. Early warning system is developed using ArcGIS model builder and it automatically sends e-mails and SMS to the people in the hazard warning zones with calculated risk factors. This page allows android applications to send data directly to the ArcGIS server. Epidemic map page is based on Android mobile applications and ArcGIS applications. These applications introduce GIS and mobile communication based, Geo-tagged epidemic data accumulation by installing a specially developed android application on mobile phones of the front line Public Health Officers (PHO). It enables them to enter basic data on patients from the field on real-time basis. Consequently, the accumulated data and information are used for analyzing and displaying patients and breeding locations in Google Earth, ArcGIS desktop or ArcGIS server to provide better visuals for general public and interested organizations.

**Keywords:** Early warning system; Android applications for disaster; ArcGIS server; Web GIS.

# Flood Monitoring in Greater Colombo River Basin Using Hec-Ras Floodplain Analysis

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## Abstract

Floods are a more of common occurrence in Sri Lanka than other natural disasters. As the country is governed by monsoon climate, Sri Lanka is subjected to repeated flood disaster. According to the statistics available at global level, the worst natural disasters are related to floods events. Flood always lead to widespread disasters which can not prevented, but it can be controlled to a certain extend. Monitoring floods is one of the important steps in flood management. To achieve that, hydraulic model analysis could be applied and it will be better solution for monitoring flood. This study aims at monitoring flood by analyzing floodplains in terms of discharge of flood water during different return periods, using one dimensional hydraulic model. This will discuss the capability of GIS approach, incorporate with HEC-RAS for analyzing the extent of floods. Accordingly, this approach establishes a connection between one-dimensional HEC-RAS hydraulic model, RAS Mapper to spatial display and ArcGIS to analyze the floodplain data, allowing to improve three-dimensional visualization and analysis of floodplain data. It also permits GIS to function as an effective planning tool by making hydraulic data which is easily transferable to flood monitoring. Extracting dynamic flooding information and mapping flooded area accurately, made the main purpose of monitoring floods and assessing the damages a reality. Methodology was applied to the canal network in the Greater Colombo river basin. A digital terrain model was synthesized from measured bathymetric and photogrammetric data and the required data sets were prepared in HEC-GeoRAS. Flood discharges for different return periods were derived by a rational equation. The flow data were entered in the steady flow data editor for considered return periods (2, 5, 10, 25 & 50) and water surface profiles are calculated. Results of the hydrological analysis were applied to monitor flood by developing raster and vector floodplains. Inundated areas were monitored using few selected factors such as, flood depths, affected buildings, inundated roads, crop lands submerged and the number of schools affected. Findings were tabulated according to the Divisional Secretariat Divisions, falling within each floodplain. Flood depths of each floodplain were found by subtracting flood levels (contour heights) from average area heights. Where the affected buildings are concerned the floodplain of Kotte Swamp is the most vulnerable. Road inundation is highest in the floodplain of Parliament Lake area. Local roads, extending to length in 225km were flooded in 2 year probable flood while 9215m in 50 year flood. Meanwhile, the largest extent of paddy lands submerged was in the Parliament Lake floodplain (6.6ha in 2 year flood while 34.5ha in 10 year flood) floodplain, and to the Kolonnawa Canal (0.04ha in 2 year flood while 0.09ha in 10 year flood) floodplain, and to no other floodplains with flooded paddy. Three affected schools were identified only in St. Sebastian Canal, Kirillapone Canal and Mahawatta Canal floodplains, where water level rises up to 25 and 50 year probable floods GIS related technologies are very useful in flood monitoring and damage evaluation. In this study GIS and HEC-RAS combination provided a better evaluation that is useful for understanding the overall flood scenario.

**Keywords:** Flood monitoring; Hydraulic model; HEC-RAS; River basin; Flood plain.

## Determination of Aerosol Particles and Risk Analysis of Asthma in the City of Colombo

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### Abstract

Air Pollution is one of the major environmental problems which has identified due to urbanization in the developed and developing countries. It is getting worst in the South and East Asian countries such as China, India, Bangladesh and Sri Lanka. It has resulted in a number of problems in the commercial capital city of Sri Lanka. Having better understanding the situation researchers and government agencies have conducted various studies in order to evaluate the air quality. Mapping of air quality over the study area is a difficult task due to the high cost, lack of instruments and limited number of air quality stations. Therefore, satellite remote sensing technology can provide a better solution at a low cost with high accuracy in extracting air quality parameters. The objective of this study is to determine Particulate Matter up to 10 micrometers in size (PM10) concentration within the Colombo Municipal Council area using algorithm model. PM10 has been extracted from the Land sat image by using algorithm model which is considered as one of the simplest algorithm models. In this model, the tasks are statically or semi-statically mapped onto the processes and each task performs similar operations on different data. Particularly, following algorithm has been developed to achieve the PM10-determination over the study area. To run the algorithm visible bands reflectance and thermal infrared band signals have been considered as independent variables. Basically, the equations applied to find out atmospheric reflectance which can be calculated using molecule and particle reflectance, which was run in Python to obtain overall picture of the air quality. Atmospheric correction was done in Python. PM10 measurement locations have been demarcated by using GPS at random and PM10 values were extracted from these locations. A maximum concentration of PM10 ranging from 88.88 $\mu\text{g}/\text{m}^3$  to 106.66 $\mu\text{g}/\text{m}^3$  has been covered 26.88% of the total area. It is a risk for the health of city dwellers. According to the Clinical data, the number of asthma patients has gone up from 51% to 61.81%, within the city limits from 2005 to 2007. An analysis of this study revealed that the highest concentration level of PM10 can be observed in the central part of the city. This is due to the high traffic flow towards to the city center from the periphery. Further asthma patients in the central part of the city has gone up from 33 to 122, because of these areas have been identified as highly vulnerable to air pollution. Furthermore, the results demonstrate that satellite images can be a useful tool for measuring the air quality in urban areas and also forecast that PM10 level is very high within the city limits. Final results have exposed that there is a strong relationship between the people who have lived in vulnerable areas have suffered from Asthma and level of PM10 as well as other air pollutants.

**Keywords:** Air quality; Land sat TM; PM10; Algorithm model; Asthma patients.

## Developing Tsunami Fragility Curves from the Field Survey Data of 2004 Tsunami in Hambantota, Sri Lanka

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### Abstract

Among all the disastrous natural hazards, Tsunami is well known for the ominous destruction it brings upon both human lives and property. Tsunamis are triggered by a number of events such as deep ocean earthquakes, landslides, volcanic activities or meteoric impacts. However, the most dominant cause for a Tsunami is well identified as deep ocean earthquakes. Although the general belief suggests the magnitude as the main contributing factor for a Tsunami to be triggered, it is often observed that the belief is contradicted by the orientation of the faults, the amount of slip and the earthquake dynamics. Over 30,000 Sri Lankan lives were claimed by the Boxing Day Tsunami in 2004. Preparedness becomes the key, to counter the inevitable destruction Tsunamis bring due to its characteristic infrequency of occurrence. Authorities have to be vigilant as Sri Lanka is located in the middle of the Indo-Australian Plate and a new plate boundary is forming to the south of the island. Therefore, implementation of safety measures based on predetermined risk prone areas in the case of a Tsunami will become beneficial in saving human lives and property. The objective of the study was to deduce a mechanism to forecast the structural vulnerability of the buildings with respect to Tsunami inundation in Hambantota, Sri Lanka. The study concentrated on developing fragility curves to determine the possible damage to the general building type (brick or wooden structures) in Hambantota area by the Tsunami of 2004. The curves were developed using the post damage assessment field survey data collected by the Disaster Management Centre (DMC) for Hambantota area. Presented curves were computed as normal distribution functions and the median and the standard deviation were calculated by least square fitting. The resulting damage was divided into four main categories namely minor, moderate, major and complete damage. The curves present the damage probability on the four categories with respect to the Tsunami inundation level. The results were compared with the modeled Tsunami outputs of other studies. The curves show high correlation with the modeled Tsunami inundation outputs, which determine the hazard prone areas. Most of the modeled Tsunami outputs of other studies had utilized remote sensing data for the damage interpretation whereas fragility curves are based on actual field measurements, which are expected to be much accurate. A further extension of the study can be carried out for different types of constructions such as concrete or mixed buildings in a specific area in the coastal belt, depending on the availability of data. In addition to the analysis for damage on different building types, different geographical locations (coastline) can also be assessed. The developed fragility curves from the extended study will assist the authorities to adopt codes in regulating the design and the construction of structures along the coastline of Sri Lanka in order to preserve both human lives and property.

**Keywords:** Fragility curves; Risk assessment; Tsunami modeling.

## An Analysis of Landslide Along the Mountainous Roads in Sri Lanka

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### Abstract

Ancient Sri Lanka had been subjected to Landslides since pre-historic times. In the recent past many instances of landslide has taken place due to human activities. One major activity is road construction in the hilly areas. Extreme weather conditions such as high rainfall result in land slide resulting in loss of life and damaged to property. This study assesses the factors that influence the occurrences of landslides in Beragala-Haputale (A-16) road in the Badulla District and their impact on the livelihood of the people and the infrastructure. These landslides occur on steep slopes that are Plano concave and are between slope angles of 14 to 41. Slopes facing the North-East are mostly prone to landslides which coincide with the dominant rainfall direction. The soil types in this area are conditioned by topography and tropical & monsoonal climatic seasons. The texture of the soil in the area is favourable to the occurrence of landslide especially during rainy seasons. In the intermediate seasons, soil profile horizon is significant in some of the landslides but in the shallow landslides the slope and the shallow depth which creates a discontinuity between the soil layers, causing water stagnation is the main cause. The knowledge of the farmers is almost similar to scientific observations. Farmers are of the view that steep slopes, areas with cavities and those with flow of water from underground are areas prone to landslides. Their observations have a limitation, they cannot determine the threshold. The soils contain silts and medium to high plasticity clays. According to the Atterberg limits, the top soils have a high infiltration rate which allows fast flow of water into the deeper clay rich horizons promoting water stagnation causing slope failure. The soil profile in most of the study area consist of silt and clay soils. This type of soil is inorganic, poorly graded and has gap grade water absorbing properties. Therefore, these have the tendency of sliding down the earth mass. During the months of February, March to October, November and December rainfall is very heavy and these periods vulnerable community should be evacuated.

**Keywords:** Landslides; Road cuts; Hilly areas; Steep slopes; Soil profile.

## An Assessing Aquifer Vulnerability Adjacent to Vadamardchchi Lagoon: Jaffna Peninsula using Drastic Index

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### Abstract

Groundwater is often a forgotten resource in Sri Lanka, despite the fact that groundwater covers over 90% of Sri Lanka's coastal freshwater consumption. Groundwater is a hidden prime resource and it is the only source of freshwater in the Jaffna Peninsula. Saltwater intrusion from both the lagoon and the sea can lead to lesser and lesser freshwater for drinking and irrigation purposes. Due to the saltwater intrusion, hundreds of acres of land and hundreds of wells are in an abandoned stage in the Jaffna Peninsula. Therefore, this study was conducted to assess the aquifer vulnerability around the Vadamardchchi lagoon in the Jaffna Peninsula. Electrical Conductivity (EC) of groundwater was measured in 42 wells dug from March to June 2014 which is intermediate between the monsoon and the dry season. The DRASTIC hydro geologic vulnerability ranking method uses a set of seven hydro-geologic parameters (rating & weight) to classify the vulnerability or pollution potential of an aquifer. The parameters are depth of groundwater, recharge rate, the aquifer type, the soil media and topography impact of the Vadose Zone and the hydraulic conductivity of the aquifer. Calculated DRASTIC Index value was modified by EC rating and weight to assess the potential risk of groundwater to Salinization in the study area i.e. Modified DRASTIC Index value. Average Modified DRASTIC Index value is 172 that deviate by +3.6 ranging from 170-84 and classified as 'High' in vulnerability. Rainfall plays a significant role in the recharge of groundwater and also influences solute transport in underground via pours medium. Therefore, vulnerability of Modified DRASTIC Index values were adjusted and/or validated by different rainfall rating by expected probability of rainfall return period in Jaffna. One year return period of rainfall average index is 177; two years return period of rainfall average index is 181; ten years return period of rainfall average index is 185; and twenty five years return period of rainfall average index is 189.

**Keywords:** DRASTIC Index; Electrical conductivity; Groundwater; Saltwater intrusion.

# Internal Migration After the Tsunami Disaster in Galle District Sri Lanka: Lessons Learnt for Disaster Management

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## Abstract

Among the challenges of natural disasters in Sri Lanka, displacement is a crucial area which can adversely affect the well-being of the disaster affected population. However, research has shown that the patterns and trends of internal migration have accelerated after the Tsunami disaster in Sri Lanka. Natural, as well as man-made disasters that have occurred in Sri Lanka so far have proved that displaced people need a proper mechanism to resettle in a better environment. However, as a result of the unavailability of an adequate disaster management plan at the time of the Tsunami disaster which occurred in Sri Lanka, several issues have emerged in terms of relocation of displaced persons. The main objective of this study is to examine the internal migration patterns after the Tsunami disaster in Sri Lanka and issues faced by migrants (re-settlers) to improve their living standards. This study has used both quantitative and qualitative data gathered from the Galle District and selected Hikkaduwa Divisional Secretariat Division (DSD) to carry out a detailed investigation. Quantitative data was collected through survey questionnaire, while qualitative data was collected through in-depth interviews and a focus group discussion. Purposive and simple random sample techniques were used as sample techniques of the study. The sample consisted of 450 households selected from Galapalawatha resettlement scheme in Hikkaduwa DS Division, which was the largest resettlement scheme in the Galle District. By-variate and multivariate analysis techniques were used, followed by SPSS and thematic analysis. This study attempts to find whether the massive displacement that took place due to the Tsunami has made any significant impact on the physical and social mobility pattern of the affected people. It is also important to mention here that available literature on disaster and migration were also reviewed in order to understand the mechanism underlying that relationship and also to interpret the results obtained through the study in a more meaningful way by placing the study in a theoretical context. The findings of the study showed that the majority of the displaced people were reported from the Galle District and the Hikkaduwa DS Division in Galle District; therefore, this area is determined as the highest Tsunami risk prone area. In addition, an attempt was made to show the significance of the magnitude of the displacement in Hikkaduwa by analyzing the pre-Tsunami and displacement population within and outside the GN divisions of the Hikkaduwa DS division. The analysis of in-migration into the resettlement areas showed that affected people have been relocated in the interior areas on non-fertile lands. Therefore, a significant community is observed to have returned to their previous occupation from the present settlement. In fact, the majority of returnees are not satisfied with the new settlement because of lack of public utilities, limited avenues of earning and the high cost of living. Majority have changed their original occupation and moved to new occupations as a result of loss of income from their previous occupation, mainly from self-employment activities. The suggestions made by the displaced population showed the need to consult the affected population before relocating them, and the need to carry out an assessment, and create awareness in the host community about their mental conditions and introduce laws and regulations to ensure the security of the affected population, etc. These measures can be useful for policy planners to enhance the disaster management plan in the country.

**Keywords:** Internal migration; Tsunami; Households; Community.

## Lessons for Medical Groups: from Nepali Earthquake 2015

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### Abstract

April 25, 2015 earthquake with a magnitude of 7.8Mw and a maximum Mercalli Intensity of IX struck Nepal and killed over 9,000 people. It injured more than 23,000 and destroyed human habitats and vegetation including UNESCO world heritage sites. Mammoth destruction shocked the world and support reached Nepal in various forms. Medical support was one of the responses from other countries. Several lessons were learnt about the deployment of medical teams during the disasters of this nature and they can be used in future operations. The objective of this study is to identify the problems that we found in Nepali earthquake response properly and the need to develop a protocol for the medical response for earthquakes. A survey was conducted among responders of Nepali earthquake, the problems they faced during the missions and the methods to overcome such problems by using multiple choice questions. In this study 37 persons responded to the questionnaire out of 50 candidates. Large number of responders (91%) identified that lack of coordination among medical groups and lack of unified command. Out of these persons who answered the survey, 87% stated that medical response needs to change for the betterment of the patients. 81% stated that overall responses of search and rescue effort and medical support were delayed. Responding to the question of required of training on Disaster medicine and Extreme medicine, 78% stated they badly felt the need. 59% stated they were thinking of withdrawal of responders when they were hit by aftershocks. For the question of use of forensic experts in disasters, only 35% said there was a need. 43% stated that they were expecting to meet trauma patients and meeting patients with special needs were unexpected. Disaster medical response should be a specialized task of personnel exclusively trained on Disaster or Extreme medicine. Preparation of well-educated, thoroughly motivated and properly trained dedicated response groups on urban search and rescue as well as medical response must be undertaken before the disaster strikes again. Use of randomly collected personnel for specialized tasks risks both the victims and the responders. Proper command structure should be established before rescue operations begin. The much needed human and material resources could be scientifically and economically utilised as per the requirements of the victims. The health care team has to be well trained before visiting the disaster area and has to be well vaccinated and must adhere to the safety and sanitation rules in practice. Working in disaster situations were very stressful and provisions for rest and relaxation of responders must be considered. Preparation of medical utensils has to be properly done to correspond to the influx of medical cases. All things have to be well prepared and this can be satisfactory done if there is a prior earthquake management program. Hence the need for development of a new protocol to respond to earthquakes is identified.

**Keywords:** Disaster medical response; Protocol; Disaster medicine; Extreme.



## Abundance of Phytoplankton in Unnichchai Reservoir with the Special Reference to Toxic Algae

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### Abstract

Unnichchai reservoir is located in the Batticaloa District in the Magalawattan river basin. It supplies water for irrigation and drinking purposes in the Eastern Sector. Unnichchai reservoir is being polluted by agricultural runoff, domestic wastes, runoff from the catchment area, cow dung and also elephant excretion. Abundance of Phytoplankton were studied in six sampling points (On shore, at a distance of 10m from the shore, at a distance of 10m from the spill gate and closer to the pump house, At the spill gate and at a distance of 3m depth from surface) in Unnichchai reservoir from February, 2012 to February, 2013 with fortnight sampling. Water samples were collected by using sterilized and wide mouthed glass container (300ml) at each sampling station and were immediately fixed in Lugol's solution at the ratio of 100:1 per sample. The samples were reduced to 10ml by decanting the supernatant aliquot and were centrifuged in Gallenkamp centrifuge for 20 minutes at 4 speeds. Identification was done by using hemocytometer and binocular microscope (Olympus). There was 27 genera belonging to in 5 divisions including Cyanophyceae, Chlorophyceae, Basillariophyceae, Dinophyceae and Euglenophyceae. Cyanophyceae were the most abundant (73.2%) while Chlorophyceae, Basillariophyceae, Dinophyceae, and Euglenophyceae also contributed to 16.1%, 8.9%, 1% and 0.2% respectively in the total of algal population of the Unnichchai reservoir. Higher abundance of Cyanobacteria and lower distribution of Green Algae were observed closer to the spill gate. Near the pump house the highest Chlorophyta was observed in the reservoir. At a distance of 3m from the surface a lower number of Phytoplankton was reported. Within the total of Cyanobacteria, the predominant species was *Cylindrospermopsis* sp (33.7%) and *Microcystis* sp was followed by the second distributed one (26.7%). *Anabaena* sp, *Oscillatoria* sp, *Nostoc* sp and others appeared as 7.4%, 11.8%, 4.5% and 16.1% respectively during period of study conducted in the Unnichchai reservoir. Therefore, higher concentration of phytotoxin producing algal population [*Cylindrospermopsis* sp (17% at a distance of 10m from spill gate), *Microcystis* sp (23.6% on shore), *Anabaena* sp (7% close to the spill gate) and *Nostoc* sp (6.1% close to the spill gate)] will pose threats to the humans as water consumers and to the wild life.

**Keywords:** Reservoir; Phytoplankton; Abundance; Toxic Algae.

## Interpolation Mapping of Seasonal Variation of Water Quality of Batticaloa Lagoon: Sri Lanka

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### Abstract

The water quality of the lagoon varies widely due to the anthropogenic influences, the width of the lagoon mouth varies causing a dynamic situation of mixing and circulation of waters during various seasons such as dry season, pre-monsoon, monsoon and post-monsoon seasons. The resultant variation affects the primary production, plankton, biodiversity and fisheries in this lagoon. However, physical and chemical parameters play a key role to support the existence of biological parameters. The present study aims at utilizing Geographic Information System (GIS) for mapping surface conditions of the Batticaloa lagoon, Sri Lanka in relation to physico-chemical water quality parameters. The precise locations were marked using handheld GPS unit at previously defined 16 sites based on different usage patterns, river association, bottom profile, different eco zones and surface water samples were collected just few centimeters below the water column at each sampling points fortnightly on seasonal basis during the period from March, 2012 to February, 2013 using calibrated Hanna portable water quality instruments by standard methods. The data were used in the attribute table for preparing spatial distribution maps through interpolation techniques by Arc GIS 10.2.1 licensed version. Water quality characteristics show remarkable trends with respect to seasons. The mean salinity was not identical along the sampling stations ranging between 0 to  $30.25 \pm 1.30$  ppt and peak value obtained at site 1 in second inter monsoon, Dissolved Oxygen varied from  $4.94 \pm 0.09$  to  $10.75 \pm 0.38$  mg/L. The maximum value recorded at site 5 in first inter monsoonal period while lowest in North-East monsoonal period in site 15, the lagoon water is quite clear during the South-West monsoon but turbid at the peak of North-East monsoon ranging from  $5.14 \pm 0.44$  FTU (first inter monsoon, site 8) to  $36.43 \pm 1.25$  FTU (second inter monsoon, site 11). Highest mean Nitrate ( $5.06 \pm 1.3$  mg/L) found in the Southern Sector of the lagoon during the North - East monsoon period at site 16 while lowest value was recorded at site 14 ( $0.75 \pm 0.21$ ). However other parameters like varied as follows: Phosphate ( $0.09 \pm 0.01$  to  $1.13 \pm 0.38$ ), Temperature ( $28.18 \pm 0.26$  to  $33.26 \pm 0.47$ ) and pH ( $7.15 \pm 0.07$  to  $8.55 \pm 0.09$ ). Statistical analysis reveals that salinity ( $p=0.002$ ), DO ( $p=0.002$ ), Phosphate ( $p=0.005$ ), temperature ( $p=0.000$ ) and pH ( $p=0.002$ ) shows temporal statistical significance among the season for ANOVA while no statistical significance was found on turbidity ( $p=0.190$ ) and Nitrate ( $p=0.585$ ). The study confirms that GIS could afford an integrated scheme for mapping water quality. This ensured that trends of specific water quality indicator and diffuse pollution characteristics across the lagoon basin were better presented with the variations shown along the lagoon than the traditional line graphs. The production of water quality maps will improve monitoring, enforcement of standards and regulations towards better pollution management and control. This strategy holds great potential for real time monitoring of water quality in the lagoon. Further this water quality mapping is designed to assist policy makers to take suitable measures to restore the lagoon ecosystem.

**Keywords:** Batticaloa lagoon; GIS; Interpolation; Water quality; Ecosystem.

## Paddy Land Spatial Information System for Sri Lanka

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### Abstract

The main objective of this research paper is to develop a spatial information system on paddy lands in Sri Lanka. Currently in Sri Lanka, information regarding farmers and their cultivation practices are kept in paper basis (hard copy) that cannot be analyzed for further development of the paddy cultivation industry. Moreover actual geo parameters of paddy land lots; such as shape, size, perimeter and elevation are not considered for cultivation. Findings of this research will help for quick access of basis information of land owners as well as historical background of cultivation information and geo parameters. Rather than cultivating same crop over and over again in the same land lot; type of crop can be selected by having regards to above mentioned information on land. Basic agriculture theory indicates that crop diversification leads to more production and less consumption of fertilizers and spatial information system on paddy lands will increase quantity and quality of production. In order to use the technology of Geographic Information System (GIS), the Global Positioning System (GPS) was utilized to measure the distance from water sources (Tanks and Anicuts) to main canals, distribution canals and field canals. The collected data (measured data) were transferred to Google Earth to develop data layers. However as a result of this interoperability functionality of the spatial technology, the accuracy of output needs to produce manually by observing at the satellite image of Google Earth. Subsequently the paddy fields (lots) connected to each field canals are marked on Google Earth. The Google Earth is not suitable for database management. To overcome that, ArcGIS can effectively be used. The Google images were downloaded using Google Earth Professional version to overlay irrigation canal network that connected the paddy lands. The downloaded images are geo-referenced with the known coordinates in ArcGIS environment. Then, field data had been collected with reference to the co-ordinates collected using GPS technology concerning the type of crops, seasonal variations of crops, farmers' information and inserted to the paddy land information system. This information system can be further developed to identify the drawbacks of current cropping system and introduce an efficient system in the future.

**Keywords:** Google Earth, GPS, Database management.

## Impacts of El-Niño and La-Niña Events on Rainfall in Sri Lanka

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### Abstract

Influences of El Niño Southern Oscillation (ENSO) extremes such as El Niño and La Niña events on the seasonal rainfall for four climatic seasons in Sri Lanka are examined by using monthly rainfall data from 90 rainfall stations for the period from 1950 to 2011. Strength of El Niño and La Niña events are categorized according to the Ocean Niño Index (ONI) provided by NOAA Climate Prediction Center. When separately considered El Niño and La Niña events, it can differently affect on the four monsoon seasons; North-East Monsoon (NEM), First Inter Monsoon (FIM), South-West Monsoon (SWM) and Second Inter Monsoon (SIM) in Sri Lanka. Out of four climatic seasons, the strongest impact can be seen during the SIM season with probability of receiving of above median rainfall over most parts of the island is high on La Niña events. Western slope of the central hills has a considerable influence during ENSO extremes with suppressed seasonal rainfall during El Niño events and enhanced seasonal rainfall during La Niña events in SWM season. Enhanced and suppressed rainfall activity is evident in the North-Western parts of the island during La Niña and El Niño events respectively, during NEM season. Weakest impact of ENSO extremes can be seen during the FIM season. The analysis provides a useful reference as to when and where the ENSO extremes have significant impacts on seasonal rainfall during four climatic seasons that can be used to enhance the skills of seasonal forecasting in Sri Lanka.

**Keywords:** El Niño; La Niña; Monsoon; Inter-Monsoon.

## Impacts of Saltwater Intrusion on Ground Water in Poonagary Kilinochchi District

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### Abstract

The large number of coastal aquifers are threatened by the Salt-Water Intrusion (SWI) in Sri Lanka. Climate change and over abstraction of water due to the high demand are the main cause of SWI. Coastal aquifers are vulnerable to sea water intrusion which reduces the quality of groundwater. Poonagary and Karachchi Divisional Secretariat Divisions (DSD) in the Kilinochchi District are still affected by the SWI for more than twenty years. That area covered falls with in the dry zone of Sri Lanka. The quality of ground water changes to salinity and it affects the people in respect of livelihood, economy and health. During the dry season, surface water and ground water are rapidly changed into high salinity water. This sudden change of water quality results in lower crop production. The objective of the research is to identify the factors affecting SWI and thereby formulate a strategy to conserve the source of ground water. Electrical Conductivity (EC) is the main indicator which was used to determine the quality of water together with Total Dissolved Solid (TDS). According to Sri Lankan standard, potable water quality has considering as that the highest desirable level is 750 $\mu$ S/cm & maximum perusable level is 3500 $\mu$ S/cm. The secondary data were collected from the authorized organizations. The locations of the wells were mapped by the Global Positioning System (GPS). Selected seventy three (73) wells were mapped and used for sampling in every five months. As an onsite measurement, water level measured for each month and the EC were measured at the laboratory of the National Water Supply and Drainage Board (NWSDB) in Jaffna. Salinity of the ground water of the study area and its diffusion were spatially mapped using ArcMap10.1. The study found that, the area close to Kudamuruddy and Mandakallaru has high salinity condition comparatively other areas due to intrusions of sea water along the stream during the dry season. It is recommended that establish a barrier along the river mouth during the dry season to reduce the SWI.

**Keywords:** Saltwater intrusion; Mitigation; Aquifers; Electrical conductivity; Extrusion of sea water.

## Design Rainfall Events for Colombo Basin using Newly Developed Intensity Duration Frequency Curves

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### Abstract

Extreme rainfall can result in rising various hazards such as flooding, landslides, etc. This causes risks to human life, damage to buildings and infrastructure, loss of crops and livestock, disruption of transportation and communications. The designing of an urban drainage system is very difficult due to the randomly varying nature of storm water runoff in time and space due to the uncertainty of precipitation in frequency, magnitude and temporal distribution. Apart from that, the process of runoff may be non-homogeneous due to expanding urbanization of the watershed giving rise to changes in the land use pattern over time. For instance, natural drainage systems have been replaced with impermeable areas such as roads and buildings. Further, the hydrologic cycle at different temporal and spatial scales is expected to be changed due to climate changes. Quantification of rainfall for designing structures associated with collection, conveyance, and storage of rainfall runoff is one of the main tasks of Hydrologists, in order to build long lasting drainage systems. Water resources engineers should consider the above mentioned potential impacts and incorporate them in their hydrological simulations. In order to develop improved estimations of precipitation patterns or design rainfall events to be used in Hydrological and Hydraulic simulations, it is necessary to develop and update Intensity-Duration-Frequency (IDF) curves periodically at different spatial scales. Design rainfall events for various durations have been derived based on newly developed rainfall IDF curves for 2, 5, 10, 25, 50, 100 years return periods for Colombo basin. Annual Maximum Series and Annual Exceedance Series of durations 0.15, 0.3, 1, 3, 6, 12, and 24 hours were analyzed for the development of IDF curves. The best fitted distribution for a particular duration was selected based on the goodness-of-tests approach. EasyFit software was used for statistical analysis. In the case of Annual Exceedance Series, Generalized Parito distribution was the best fitted distribution for 15 min duration and for 0.3, 1, 3, 6, 12, and 24 hour durations General Extreme Value Distribution was the best fit. For annual maximum series, General Extreme Value Distribution was the best fitted for all durations. Based on newly developed IDF curves, design rainfall events were derived for different durations using Alternate Block Model method and recommended for use as input in rainfall runoff simulations.

**Keywords:** Rainfall; Simulation; IDF curve; Extreme value.

## Development of a GIS Based Traffic Accident Management System

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### Abstract

Traffic accidents in Sri Lanka is increase and many reasons are cited which include the soaring increase of vehicle ownership, highway development and the poor traffic control systems. Preventive accident reduction is preferred for obvious reasons, however, it needs a better Traffic Accident Analysis System (TAAS) which can store, visualize, retrieve, edit and analyze accident data. An aim of this study is to develop a TAAS to assist in the identification of accident black spots and develop a mathematical model to forecast traffic accidents. When developing TAAS extra care is taken to make sure that the process is more user friendly than the current software used by the Sri Lankan traffic police namely MAAP. TAAS is developed as a set of python tools and deployed as a toolbox in ArcGIS 10.1. At present TAAS toolbox has four tools "Filter Traffic Data Tool", "Graph Analysis Tool" and "Select by Division Tool" and "Export to Excel Tool". When tools were executed relevant results appear in the ArcGIS as a map or bar chart. TAAS consists of data for 20,041 traffic accidents reported in the Southern province of Sri Lanka during the past eight years (2008-2014). All relevant details of the accidents collected by the traffic police using the "B form" such as date of occurrence, time of occurrence, day of week, urban or rural, light condition, weather condition, type of road surface, highest severity, collision type, age, gender of driver and dependence on alcohol usage are included in TAAS. In addition new data can easily be updated to the TAAS. As for the second aim of this study a logistic regression model was developed to forecast the traffic accident severity. Traffic accident severity (dependent variable) in this analysis is a dichotomous variable with two categories of Fatal and Grievous accidents. Model achieved a R square value of 0.80. Resulting model showed that out of nine independent variables used, four were significantly associated with traffic accident severity-they are namely, 'Area of occurrence (Urban/Rural)', 'Days of Week (Monday/Friday)', 'Light Condition' and 'Whether Condition'.

**Keywords:** Traffic Accident Analysis System, Python tool box.

## Estimation of Vehicle Emissions due to Vehicle Age in Sri Lanka A Case Study for Toyota and Nissan Cars

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### Abstract

Due to the increased number of vehicles on the roads comparatively emissions have been increased. When fuel is properly combusted, CO<sub>2</sub> and water vapour are given as main emissions. A proper emission can be expected from new motor vehicles. With the wearing away of engine parts fuel combustion is partially hampered. If fuel is not combusted well, the portion of Carbon Monoxide (CO) and partially burnt carbon emission are increased. This research is focused on the results of a study which is aimed at modeling the effect of vehicle age on vehicle emissions, using 0.2 million vehicle emission testing reports from 2011 to 2013 on Toyota and Nissan petrol motor cars which represent a major portion of motor cars in Sri Lanka. In addition, only vehicles having a service life of less than 30 are considered. Variations of CO<sub>2</sub>, Hydrocarbons, and CO with the vehicle age and type are analyzed. According to the analysis carbon monoxide and the hydrocarbon emission is increasing with the vehicle age while carbon dioxide emission is decreasing. There was a significant variation of CO and Hydrocarbons emissions with the vehicle brand, but there was no considerable variations of CO<sub>2</sub> emission with the vehicle brand. In this study Europe based model called 'FOREcast of EMISSIONS from MOTOR VEHICLES' (FOREMOVE) was selected and it was modified according to the Sri Lankan context to estimate the total emission during a particular year. FOREMOVE contains three equations they are; 1) to find the presence probability of certain types of vehicles, 2) the number of scrapped vehicles during a particular year and 3) the amount of carbon dioxide, carbon monoxide and hydrocarbon emission during a particular year. Data for nine years obtained from the Department of Motor Vehicles on vehicle registration was used to estimate the 'failure steepness' and the 'characteristic service life' of the Sri Lankan vehicle fleet which are the two parameters in the first equation of FOREMOVE. According to the Sri Lankan vehicle registration data, failure steepness is 1.21 and the characteristic service life is 15.21 years. The modified first equation of FOREMOVE is used in the second equation along with emission test data to estimate the number of scrapped vehicles during a particular year for Toyota and Nissan petrol cars separately. Results indicate that in 5,210 Toyota cars and 1,429 Nissan cars were scrapped in year 2012 while this number was 7,431 and 2,918 respectively for year 2013. Third equation of FOREMOVE needs emission factors and vehicle kilometers travelled. Using the vehicle emission testing data emission factors were estimated for CO<sub>2</sub>, CO and Hydrocarbons separately as a function of service life and make of the vehicle. Vehicle kilometers travelled too were estimated from the odometer readings available in the vehicle emission testing data. For example new Toyota car (0 age) will have a emission factors of 0.2g/km while 20 year old Toyota car will have 15.8g/km for CO. Overall results indicate that emission of CO<sub>2</sub> decreases with age while CO and Hydrocarbons emission factors increase.

**Keywords:** FOREMOVE; Vehicle emissions; Failure steepness.



# Monitoring of Spatial Variation Pattern of Urban Heat in Relation to Changes in Urban Land use and Physical Densities Using GIS and RS Techniques: A Case Study in Kandy Municipal Council

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## Abstract

Land Surface Temperature (LST) increases of urban areas becomes a significant problem in association with urbanization in the global context. This phenomenon is used as a significant parameter in urban environmental analysis. The existing research studies conducted by various scientists considered various factors and methods for such analyses using Geographic Information Systems (GIS) and Remote Sensing (RS) techniques. Most of these studies have considered the major factors influencing the surface temperature but certain urban centers have very specific as well as significant other factors like topography, elevation, soil, wind and transportation which contributes to change the temperature levels in various ways. The Kandy Municipal Council area was selected for this study and to analyze the levels of surface temperature variation in to enable remedial action to be taken by the authorities if the city is to accelerate its development programs as proposed with large scale investment on urban development projects which signifies the selection of the study area as a breakthrough in the series of studies conducted in the area. As technology is being rapidly developed, the knowledge of the scientists and the city administrators cannot turn a blind eye to the problems created by urbanization like surface temperature which increases over the years due to various man made activities in connection with population and urbanization. Therefore this study initially analyzes the methods and sources of data used by the other scientists in this type of studies. Then define the positive and negative factors which contribute to the increasing temperature levels of urban areas which includes land use distribution pattern, building density and its spatial variation, population density, soil type and Normalized Difference Vegetation Index (NDVI) calculated from remotely sensed data. These individual factors were comparatively analyzed with surface temperature values generated by 2001 and 2011 using Landsat Enhanced Thematic Mapper (ETM+) images. Results indicated that the highest temperature zones clustered in the South Western direction from the Kandy City Centre. NDVI linked to land use data and building plinth area further investigated with the relationship between temperature and urban structures. The pedestrian flow and vehicular flow are two other factors considered for surface temperature analysis which could be attributed to using regression analysis in order to justify the relationship in various spatial locations to differentiate the levels of such influences. The results of the study can be applied as the theoretical basis for improving urban planning for mitigating the effects of urban heat islands.

**Keywords:** LST; Building density; Physical density; Remote sensing; Urban heat;

## Heavy Rainfall Simulation over Sri Lanka Using Weather Research and Forecasting Model

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### Abstract

Rainfall forecasting is one of the difficult tasks in the tropical countries, because it mostly happens at unexpected times, associated with meso-scale phenomena. Flash floods and landslides are the common hazard linked with the heavy rainfall. Every year, Sri Lanka faces enormous economic losses due to loss of lives and property damages due to flash floods and landslides. Many approaches have been used to forecast heavy rain fall in recent past together with satellite techniques and Doppler weather radars, but scientists are now trying to estimate heavy rainfall spells with Numerical Weather Modelling. Weather Research Forecast (WRF) model is the most common user friendly tool for the numerical modelling in the research community, because the model can be run even in a high performance personal computer. The aim of this study is to simulate heavy rainfall spells in Sri Lanka from 2000 to 2004, with WRF model outputs. WRF version 3.0.1 was used for the modeling and six hourly NCEP Re-analysis (FNL)  $1^{\circ} \times 1^{\circ}$  GRID data use as an initial condition for the WRF model. The predicted rainfall in four dimensions (space and time) has been calibrated with the observational rainfall data recorded at rain gauge stations. It was found that WRF model was able to capture the heavy rainfall spells in greater extent over different regions in Sri Lanka. Overall accuracy stands at 72% in the analysis. Therefore it can be observed that WRF model was able to forecast rainfall in a significant consistency with real measurements.

**Keywords:** Heavy rainfall simulation; Rainfall forecasting; Numerical weather modelling; Weather Research Forecast.

## Climate Change and Economic Growth: Impact on SAARC Countries during the Last Decade

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### Abstract

Climate change and its impacts are current issues for every country irrespective of whether they are developed or not, but the research is focused only on the South Asian Association for Regional Cooperation (SAARC) countries and the economic impact on them as a result of climate change. Sea Level Rises, Cyclones, Deeper Penetration of Saline Water, Erratic Rainfall, Flood, Drought, River Bank Erosion, impact of Health, Agricultural and Food Security and Livelihoods are arisen due to climate change and as a result of them. Economic growth can be restricted or limited in such countries. The hypothesis of the research is that there are impacts on economic growth in SAARC countries as a result of climate change. The research questions are what are the climate change issues in SAARC countries and how climate change impact on the economies of SAARC countries and what are the types of regional protection afforded to subjected areas to protect themselves from bad impacts during the last decade through documents such as declarations, treaties and conventions which are made by SAARC. Main objectives of the research are based on the answers to the research questions. The research is qualitative research based on the theoretical aspect statistics and details which are related to the topic. Therefore it uses secondary data which are published by internet, paper articles as well as books and research of other authors which are relevant to the topic. Presently there are eight countries in the SAARC. The Maldives and Bangladesh are countries most vulnerable to climate change impacts. Furthermore, the economies of India, Sri Lanka, Nepal, Bhutan, Afghanistan and Pakistan are also facing some economic impacts due to climate change. Moreover damage to infrastructure, barriers to urban development and energy development, matters of water management, impact on agriculture, fisheries and forestry as well as damage to Investment in a healthy economy and education, connectivity of trade and tourism, can be experienced result of climate change in SAARC countries. Climate change will affect the poor in those countries it undermines all development goals and threatens the basic human securities because in most of these countries the Gross Domestic Product (GDP) derived from agriculture and a greater part of expenditure is on agricultural food production. Not only that tourism, trade and industrial activities of those countries are also affected by climate change. However there are more support for protection and management of the environment through declarations and conventions in SAARC countries such as Dhaka Declaration and SAARC Action Plan on Climate Change, Delhi Statement on Cooperation in Environment, Thimphu Statement on Climate Change, SAARC Convention on Cooperation on Environment and etc. However in the final analysis, the climate change impacts on the economic growth of the SAARC countries. Furthermore in order to ensure economic development in those countries a reduction of the impact of climate change by using documents and conventions which are enacted for protection of environment is essential.

**Keywords:** Climate change; SAARC; Economic growth; GDP.

## Effectiveness of Available Agricultural Insurance Schemes for Farmers

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### Abstract

Agriculture is always associated with risk and uncertainty with natural calamities, price fluctuations and pests and diseases. Crop insurance is one of the useful risk management strategies to reduce the impact and magnitude of agricultural loss of farmers due to risk and uncertainty, which stabilize the farmer's income by indemnifying damages and uplift their economic condition. In Sri Lanka, Agriculture and Agrarian Insurance Board had introduced a crop insurance scheme for the first time as a government institute and subsequently with the approval under the amended Agriculture & Agrarian Insurance Act 1999, private sector also entered into the field of crop insurance. Though there were paddy Insurance Schemes in place to safe guard the farmers from natural hazards, it is necessary to analyse whether the existing insurance schemes are effective, identify the farmer's capacity to join with paddy insurance and their awareness on paddy insurance. This research focused on the analysis of the effectiveness of the existing paddy insurance schemes and the perception of the farmers on paddy insurance. Amuradhpaura District was selected for this study which is one of the main paddy producing districts in Sri Lanka. Secondary data were obtained from Agriculture & Agrarian Insurance Board, Sanasa Insurance Co. Ltd, Annual Reports of the Central Bank, and research publications and research papers. The research revealed that the crop insurance schemes carried out by the private sector organizations are effective than those of the public sector. Though there are public and private sector organizations involved in paddy insurance schemes few decades back, still the farmers' awareness on this is very poor. They joined the paddy insurance schemes to obtain crop loans without knowing the details of paddy insurance, and there were no effective mechanisms by the insurance companies to educate the farmers on paddy insurance. Although the farmers are a poor segment of the society, they have the capacity to pay the premium according to existing premium structure.

**Keywords:** Agriculture insurance; capacity; Mechanism; Premium.

## A Commonsense Knowledge System for the Development of Bio Mass Electricity Market in Sri Lanka

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### Abstract

Exploitation of biomass electricity generation is gaining a new momentum in Sri Lanka. Forest products and agricultural residues are of central importance to Sri Lanka's overall primary energy supply. Energy statistics of 2004 shows that biomass use accounts for about 48% of the total primary energy supply. Nearly 90% of the biomass supply is from fuel wood. Biomass fuels are consumed mostly in the households, but also in tea, rubber and brick & tile industry to a great extent. Biomass energy consumption has been increasing by 3% annually. Sawdust, a potential fuel, is still wasted in Sri Lanka. Commonsense knowledge is the key to bio mass electricity market equilibrium on the management of ecological innovations in electric utilities. However commonsense knowledge in the process of information gathering has not been modelled into a formalized way. The aim of this research is to implement commonsense knowledge system for Bio mass electricity market in Sri Lanka on the management of ecological innovations in electric utilities. The objectives should be a) to contribute to a better understanding of the ecological processes in the bio mass electricity market and b) to provide guidance for the development of commonsense knowledge system that foster a more sustainable bio mass energy marketing equilibrium in Sri Lanka. This paper presents a novel tool, which is incorporated of modelling of commonsense knowledge in bio mass electricity market based on a modified version of Sugeno defuzzification technique. A questionnaire based on Forest products, agricultural residues and Sawdust for determination of electricity market in Sri Lanka has been used as an input for the commonsense knowledge systems. Here a Principal Component Analysis has been used to reduce the dependency of questions in the questionnaire. Fuzzy sets for Forest products, agricultural residues and sawdust in bio mass electricity market for classified knowledge have been computed based on extracted principal components. In the defuzzification process Sugeno defuzzification technique based on an integrated. Principal Component Analysis approach has been used for the determination of electricity market equilibrium. Here singleton fuzzy sets have been constructed based on extracted principal components. Results of the research are to determine classification of electricity market and bio mass electricity marketing equilibrium in Sri Lanka. It has been evaluated by using the concept of diagnosis of human constituents in Ayurvedic medicine using a sample of 100 laymen to find constituent types in percentage and balancing point of constituent's type. With these results of the applications of the system, this appears to be more general and customizable for any domain. As an immediate step of further work, It was collected questionnaire of commonsense knowledge pertaining to bio mass electricity market domain and customize the system for reasoning in a novel manner. Commonsense knowledge system has been implemented by using FLEX expert system shell, SPSS, XML and VB. The system has a capability of classification of forest products, agricultural residues and sawdust in bio mass electricity generation. Further, system has a facility to compute % level of energy types such as forest products - agricultural residues, sawdust-agricultural residues and sawdust-forest products of the bio mass electricity market. Therefore research is exploited to implement commonsense knowledge system for bio mass electricity market in Sri Lanka on the management of ecological innovations in electric utilities.

**Keywords:** Bio mass electricity; Commonsense knowledge; Principal Component Analysis; Sugeno defuzzification technique.

## Development of a GPS Tracking System (Model) by Applying Helmert Transformation

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### Abstract

The purpose of this tracking system model development is to emphasize the importance of tracking information in public transformation sector where the position and time information are made available to the public and the governing authorities for the betterment and the improvement of efficiency and productivity. This piece of software model acts like a simulation where the GPS information is entered through an Excel sheet as if it comes from a remote GPS receiver and transmitted to the computer to be displayed. Not only the displaying of the current position in National Grid system coordinates in meters on local projected topographic digital map based on 1:50,000 but also the Grama Niladari Division (GND) based location information of the GPS position. The GPS Tracking is widely used in day to day applications throughout the world. The transferring of tracking information from the GPS receiver to the base station is done over a data communication network. Displaying of these updated information on a map is the most important and essential part. The data communication part is not included in this research. Main focus of this research is the data conversion from WGS 84 datum to the local grid system that involves the seven parameter datum transformation and the Transverse Mercator Projection as per the following equation that involves three axis translation and rotations of axis and scale factor ( $XT = C + \mu RX$ ). The simplified Helmert Transformation method is used here with the intention of improved position accuracy. In geodesy, Helmert Transformation is used to produce distortion free transformation from one datum to another. The Seven parameters used in SLD99 system are used in the axis translation matrix and the Transverse Mercator projection parameters used in SLD95 system are used. All the calculations are made by using the original formulae by locally developed functions from the fundamentals in visual C Sharp environment in Microsoft Visual Studio. The Coordinate transformation also involves projection using Redfeam projection formulae. The accuracy of the coordinate transformation was evaluated by a comparison of GPS primary control points established. The RMS error of the compared position was found to be in the range of 2-3m. The comparison results show that error in y axis less than one meter and the x axis error lays between 0-4m. It was also found that the datum transformation was quite accurate and the reason for this error is the Transverse Mercator Projection formulae. The mapping of the position of the moving object on ESRI standard Shape file is done by using objected oriented programming techniques. The open source Sharp Map mapping library have been used for this purpose. This library files were used on top of the Visual C Sharp Studio 2012 environment. The loading of Shape file layers such as roads, GND boundary, provincial boundary and text labels have been done on Sharp Map.

**Keywords:** WGS84; Helmert; Transformation; SLD95; NMEA; Sharp Map; Datum Transformation; Projections; Transverse Mercator projection.

## Study on the Spatial Distribution of the Incidence of Cancer in Sri Lanka Using GIS and Remote Sensing

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### Abstract

Cancer is a critical health issue in Sri Lanka because it ranks as a leading cause of death in the country. In this study, distribution of cancer cases were compared against geographical risk factors implicated in the etiology of cancer in order to determine the possible causes of cancer in Sri Lanka. The overall aim of this study is to analyze the distribution pattern of cancer to determine whether location has a direct influence on the incidence of cancer. The objective is to determine the geographical variability of the disease pattern. For this purpose patient registration data published by the National Cancer Control Program were used. All cases of cancer, irrespective of the type, site or the age of the patient were considered as one entity. The patient distribution at district level was the main factor used in detecting how the patient distribution appeared by using Geographical Information System (GIS) software. Initially cancer distribution maps were prepared. Then spatial statistics were applied to cancer data of each year for which cancer patient data was published, to comprehend about the distribution of cancer patients in each time period. Later these thematic maps were compared against maps of other areal phenomena. Geographical risk factors and connections with cancer too were examined. Geographical clustering of cancer was observed, with cancer being more prevalent in districts along the South Western to Southern coast particularly in the Western Province. It was also observed that these districts have a higher population density and more industrial activities. Possible correlations between cancer and some environmental features such as rainfall were observed suggesting the suitability of applying spatial correlation techniques to further analyze the relationships between cancer and these geographical features.

**Keywords:** Etiology of Cancer; Geographical Variability; Cancer distribution maps.

## Evaluation of the Effectiveness of the Tsunami Early Warning System in Sri Lanka

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### Abstract

On December 26<sup>th</sup>, 2004, an earthquake measuring 9.0 on the Richter scale struck the western coast of Sumatra in Indonesia triggering massive ocean waves or "Tsunamis". Humans were confronted by an unprecedented catastrophe impacting the lives of people not only in the Indian Ocean region but all over the world. The death toll is believed to be over 270,000 with billions of dollars in damage cost. While many people are believed to have died in the earthquake, the main cause of death was trauma and drowning from the flux of seawater and waves pouring into coastal areas without warning. It is widely acknowledged that if an effective early warning systems had been in place in the Indian Ocean region, the death toll would have been drastically reduced. While a relationship between locally, felt earthquakes and Tsunamis was realised in ancient times in many societies, it was much later in human history that it was realised that destructive Tsunamis can propagate great distances, far beyond the range of human perceptibility of the causative earthquake. The present system of communication from national level to district/ divisional/ local authority/ Grama Niladhari levels or other specific identified locations is mainly through the Police and military communication systems, radio communication, multi-hazard early warning towers, media and the normal telephone systems. Alternative coast wide communication systems have already been established for the Tsunami disaster. Main initiatives were taken by the Disaster Management Centre which was established after the Tsunami in 2004. Over a decade, many systems and activities have been provided to enhance the Tsunami Early Warning System in Sri Lanka. Two Tsunami evacuations (2007 & 2012) and one Tsunami warning (2011) were issued after the 2004 up to now. A Tsunami Warning System (TWS) is used to warn coastal communities in advance and issue warnings to prevent loss of life and damages. Meteorological Department issue the warning and Disaster Management Centre is catering all communications from national level to the local level but up to now no studies have been conducted to evaluate the current Early Warning System for Tsunami disasters. As per the District Disaster Management Coordinating Unit, gaps observed at last mile dissemination. It is essential to ensure the capacity of the Early Warning System to save more than 2 million lives along the coastal area of Sri Lanka. Gaps in disseminating and community reception at night time have also been identified.

**Keywords:** Tsunami Early Warning System; Richter scale; earthquake.



## Potential Hazards Related to Gem Mining in Rathnapura

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### Abstract

The Gem Industry plays a major role in the Sri Lankan economic sector and whilst creating job opportunities, it brings a large amount of foreign exchange to Sri Lankan Gross Domestic Product (GDP). On the other hand, many social and environmental problems have erupted in related to the gem mining industry due to illegal gem mining and the lack of adhering to approved methods and techniques. Soil resource is one of the primary and main resources for survival of life on Earth where gem mining industry is based on the top soil and deep soil layers. Under the Soil Act (1996), and NGJA Act No 15 of 1993, there are several institutions responsible to protect soil resources in Sri Lanka. The Soil Act clearly proposes measures and activities and also research in order to protect the soil resources from various damages. In the NGJA Act No 15 of 1993 it's clearly laid down that the legal frame work of the industry, highlighting the limitations to be maintained by everyone involved in this field. Although the soil management regulations is well outlined in legislation, the implementation of such regulation is very limited due to various reasons. Since the poor implementation of regulations and lack of public awareness, the rich soil fertility has deteriorated in gem mining areas like Rathnapura. The aim of this study is to understand the soil fertility deterioration due to gem mining and improving the awareness among the general public with the matters related to same and further, to assess the associated risk and proposed slandered procedures and amendments to legal frame work for better implementation. Both secondary and primary data were collected to achieve objectives and analyzed the data semi-quantitatively using SPSS and MS Excel. According to results 31% of the people in gem mining industry, don't have sufficient scientific knowledge the industry and 80% of them gained their knowledge by experiences only. Gem and Jewellery Authority conducts awareness and educational programmes for peoples in the industry but in this study it is found that participation keep under 11%. It is clearly indentified that gem mining is affecting to deterioration of the soil fertility, but awareness of public in this regard is keep under 20%.

**Keywords:** Hazards; Gem mining; Soil Act.

## Urban Expansion Analysis using Remote Sensing & GIS

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### Abstract

Remote sensing techniques and Geographical Information System (GIS) always play a vital role in analyzing spatial context of urban expansion and differentiate urban lands from non-urban lands, it can organize a spatial configuration of urban built up areas. The spatial and spectral resolutions of the satellite observations provide globally consistent and repetitive measurements of the changes in the Earth's surface conditions. This research mainly applied remote sensing techniques to extract urban built up land features using low resolution satellite images such as Landsat Thematic Mapper (TM), Enhance Thematic Mapper Plus (ETM+) and Landsat Multispectral Scanner (MSS). The selected area was Colombo Core area which consists of highly urban characteristics. The process uses the multispectral images and three thematic index oriented images were produced from the multi-date (year 1992, 2001 & 2005) Landsat ETM and Landsat TM satellite images. Using ERDAS Imaging 9.2 Model Maker facility mainly produced new index oriented thematic images such as Normalize Different Soil Index (SAVI), Normalize Different Built up Index (NDBI), Modified Normalized Different Water Index (MNDWI) and also produced new thematic images applying Tasseled Cap (TCAP) transformations. Finally all these images were layer stacked and produced new thematic images to well separate Water, Soil & built up lands. For the Landsat image which was taken in year 1975, applied TCAP transformation to create a new thematic image to process for the extraction of urban built up lands. Finally applied supervised classification for the Landsat ETM+ Landsat 5 TM images & unsupervised classification method for the Landsat MSS image. Acceptable accuracy was gained through these classification methods for selected images. The highest accuracy was gained for the image in year 1992 while slight decrease (86%) in year 2001. In year 1975 & 2005 images have gained up to 90% accuracy. For the interpretation of the results, GIS techniques such as spatial analysis were performed with ArcGIS 9.3 software facilities. The results obtained from the analysis, show that there is a wide expansion of urban or built up area within a 30 year period. It is exposed with the calculated built up areas extent. It clearly displayed that some urban centers which are included in Core area have a great extent of urban built up lands. Significantly, the City of Colombo area has a large extent of urban built up lands. In 1975, it was the highest urbanized urban area than other local authority areas in the core area limits. After 20 years other urban centers also obtained specific urban built up area values, specially Kolonnawa, Sri Jayewardenepura Kotte, DMMC and the Battaramulla Planning Unit. After the commencement of the Sri Jayewardenepura Kotte as an administrative city, urban built up area extended to this urban center. Especially urban built up area forecast for year 2015, was close to 20,000ha. It is a great increase in the context of the existing built up area results. This expansion was specially attracted to the main and arterial roads throughout the study area.

**Keywords:** Urban expansion; Normalized different soil index; Normalized different built up index, Modified normalized different water index; Remote sensing.

## An Integrated Assessment of the Community Resilience to Natural Disasters in Sri Lanka: Cases of Landslides and Subsidence in the Matale District, Sri Lanka

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### Abstract

Sri Lanka as a small island state located in a tropical region, is highly vulnerable to a number of natural disasters. Community resilience is a quality that enables an organization, ecological system, household or nation to recover quickly from disaster shock and it emphasizes the coping up with disasters rather than promising to control or avoid their underlying physical energies. Local communities are on the frontline of both immediate impact of a disaster and the initial emergency response for saving most lives. Enhancing local community resilience is essential to minimize losses and to reduce risk due to unprecedented frequency of natural disasters along with the projected increase in their severity posing significant challenges for vulnerable populations. Landslides are one of the frequent hazards in central highlands triggered by tropical monsoon rain. Matale is one of the ten districts in the central highlands which are at risk of landslide hazards. In addition Matale district is highly vulnerable to subsidence hazards and such incidents were common during the last decade. The frequency of landslides and subsidence has increased throughout the past decade causing damage to property and loss of lives. A large number of proximate and underlying causes is responsible for this condition. Therefore, building a framework is a high priority in enhancing community disaster resilience. An integrated approach essential to enhance the resilience capacity may consist of different tools and methods and the involvement of different but relevant stakeholders. The main objective of this study was to conduct a baseline assessment to enhance community resilience using an integrated approach. Specific objectives were to identify existing resilience capacity in the community and to evaluate potential different approaches adopted to enhance the resilience capacity. Landslides and subsidence prone four Grama Niladari Divisions namely Dorakumbura, Panch-rattota, Dunkolawaththa and Bodikotuwa located in the high risk zone were selected for the study. The study was based on secondary and primary data obtained through a household survey followed by field observations and conducting interviews with key informants. The assessment was carried out using Baseline Resilience Index for Community (BLIC). Six different dimensions were used as indicators for this index. They were Natural (6 variables), Social (5 variables), Economic (5 variables), Infrastructural (4 variables), Institutional (4 variables), and Community competency (8 variables). Based on 1-5 Likert scale scores were obtained and three levels of resilience namely poor, moderate and good were generated. Baseline Resilience Index results revealed different levels of resilience to each dimension assessed. Natural, Social and Community competence demonstrated poor resilience whereas Infrastructure, Economic and Institutional dimensions demonstrated moderate resilience. The level of resilience demonstrates the resilience capacity of the community based on those dimensions. This study further revealed various reasons for different resilience capacities. The outcome of this study is highly useful to build up an appropriate framework model to enhance community disaster resilience capacity to cope up with landslide and subsidence hazards in the Matale District and the model can be applied to other districts too.

**Keywords:** Land Slides; Subsidence; Community Resilience.

## A review of the Effectiveness of Current Disaster Management Practices on the Disabled in the Jaffna Divisional Secretariat Division

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### Abstract

In the global trend of the declarations and agreements related to disaster risk management practices, the essential actions to be taken related to inclusive in disaster risk management. In the perspective of disasters across the world, the disabled are highly vulnerable during the natural and manmade disasters. In this context it is one of the major priorities to consider all phases of disaster management practices. The Jaffna Divisional Secretariat Division is located in a vulnerable multi hazard prone area in the Jaffna District and out of 59,227 members, 550 are disabled persons. Recent studies have discovered the exclusion of the disabled from the disaster management process in the past. This exclusion leads to high vulnerable conditions and adverse effects on the disabled persons during a disaster. The aim of this study is to review the effectiveness of Disaster Management practices on the disabled in the Jaffna DS Division. This study mainly utilized the primary and secondary data sources from various departments, focus groups and key informants. The secondary data extracted from existing maps of the survey and land use policy planning departments enabled the use of simple statistical analysis and Geographical Information System (GIS) technology for categorization of the demography data extracted from the Divisional Secretariat Division, Jaffna. The primary data were collected from focus groups and key informants through a questionnaire. Duly filled 82 questionnaires analyzed information on managerial and non-managerial staff from various institutions which deals with disaster risk management and disabled rehabilitation activities in the Jaffna DS Division. 112 questionnaires collected from first hand information or primary data from focus group discussion with the method of simple random sampling from 04 disabled persons from in each Grama Niladhari Division. The study considered the three main phases of disaster management practices such as preparedness, early warning & emergency response and recovery. Based on the result, 86% of the disabled are not involved or excluded from the preparedness planning activities, 83% of the disabled are not considered or involved in early warning & emergency response phrase and 75% of the disabled are not satisfied with the facilities during the stage of emergency recovery. The study found that 81% of the disaster management practices are not included or involved with the participation or consideration of the disabled in Jaffna DS Division. This study has been designed to encourage the disabled's inclusive actions relating to disaster management practices and strengthening regulatory and coordinating mechanism and implement them among the stakeholders. The possible effective actions could reduce the vulnerability and make sure the creation safer and resilient disabled community in future.

**Keywords:** Disaster risk management; Vulnerability; Preparedness planning; Early warning.

## **A Suitability Analysis of Rubber Lands using Multi Criteria Decision Model and Geographical Information Systems: A Case Study in the Kalutara District**

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### **Abstract**

Rubber is one of the major crops grown in Sri Lanka, which generates foreign exchange earnings to the country. Rubber plantations of the Kalutara District are being replaced gradually with other cultivations which earn quicker profits to the growers, with no consideration the climatic and land quality requirements. Such replaced crops such as tea, palm oil may have reduced rubber harvest, causing reduced income to the rubber growers. The percentage extents under rubber, tea, coconut, paddy and other cultivations are 32%, 2%, 1%, 14% and 51%, respectively in 2001. Therefore the study is carried out in GIS environment using Multi Criteria Decision Model (MCDM), to find suitable lands for rubber cultivation in the Kalutara District. Several variables (criteria) namely land use map, temperature, rainfall, soil, slope, elevation and pH were used to develop a land suitability map for rubber cultivation in the Kalutara District. Multi Criteria Decision Making (MCDM) is a discipline aimed at supporting decision makers to face numerous and conflicting evaluations. In this study MCDM techniques were applied to calculate the contribution of each criteria for the land suitability analysis and assigned calculated weights to each and every considered criteria. GIS has a high potential to handle a large number of spatial data layers together and make decisions. Finally overlay operations were run in GIS environment to the developed land suitability map for Rubber cultivation in Kalutara. The area categorized under the most suitable category can be effectively used to expand rubber with minimum effort. The total extent under most suitable, suitable and moderately suitable are 316km<sup>2</sup>, 73km<sup>2</sup> and 1054km<sup>2</sup>, respectively. These lands can be effectively used for rubber cultivation in Kalutara. It is identified through the land suitability model that the most of the areas where rubber is currently grown are found within the most suitable, suitable and moderately suitable. 72% of the total suitable area has already been cultivated the rubber in Kalutara District. Therefore, it can be concluded that the existing rubber plantation in the Kalutara District can achieve higher yields through adopting proper agro-management practices.

**Keywords:** Multi Criteria Decision Model; Land suitability; Rubber cultivation

## Socio-Economic Risk Assessment of Soil Erosion in the Nillambe Catchment: Kandy District

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### Abstract

Soil erosion is a widespread problem in the Nillambe catchment which is mainly based on agriculture. Consequently it is important to identify the socio-economic risk in the area in order to carryout necessary mitigation measures to minimize the potential risk. This study attempts to categorize socio-economic risk levels of soil erosion. Based on the Universal Soil Loss Equation (USLE) apply with the geo-spatial input data such as rainfall, soils, slopes and land to model soil erosion hazard. The selected set of socio-economic vulnerability and coping capacity indicator variables were spatially modelled based on Analytical Hierarchical Process (AHP) and the outcomes of hazard, vulnerability and coping capacity measurements were further processed using GIS based Disaster Risk Equation to obtain the socio-economic risk index for the Nillambe catchment area. The study revealed that approximately 25% of the catchment is in moderate to extremely high socio-economic risk, with regards to soil erosion. Furthermore, it indicates that a large proportion of such lands are covered with moderately managed tea having a slope greater than 10% with a moderately high rainfall erosion level. The study was identified that socio-economic vulnerability, the coping capacity and the risk levels to the soil erosion can be utilized to identify areas where different vulnerabilities and coping capacities to promote necessary mitigation actions. The socio-economic capacities of the community involved would eventually minimize the socio-economic risk of soil erosion in the area.

**Keywords:** Soil erosion hazard; Socio-economic risk; Socio-economic vulnerability; Analytical Hierarchical Process.

## Preparation of Landslide Hazard Zonation Map in Upcountry Railway Line Using GIS & Remote Sensing

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### Abstract

The area extending from the Edalgashinna to Bandarawela has become more vulnerable to landslide disasters than the other areas in Sri Lanka's upcountry railway line. As this situation of landslide hazard along the upcountry railway line has turned into a national level issue. Due to the highly intensity rainfall, soil erosion, soil structure, slops, geological structure, deforestation and other anthropological activates are increasing the landslides along upcountry railway line and this landslide risk also affected to day to day activities. Therefore identification of landslide hazards areas along the upcountry railway line is important. The objective of the study is to the preparation of a landslide zonation map and identify the landslide high-risk areas from idalgashinna to Bandarawela along the milway line. This study based on secondary data. Mainly used Digital Elevation Model (DEM), rainfall, river network, soil and land use data. All the data were analyzed with Analytic Hierarchy Process (AHP) to calculate three weighted class such as, High, Moderate and Low. After that all vector data were converted into raster formats. Final risk map cratered using weighted overlay techniques. According to findings the risk map can be classified into high risk (40%), moderate risk (34%) and low risk (26%). Most of the landslides occurred in the high risk and moderate risk areas are represent the reactivation of historical landslides. Therefore it is proved that validation of the hazard zonation map with real incidences. In the study area, most of the high and very high hazard class areas were found occupying the areas of railroad.

**Keywords:** Upcountry railway line; Landslide; Hazard zonation.

## The Role of ICT in Creating Awareness of Disasters: Sri Lankan Perspective

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### Abstract

Many countries around the world are well-known for the heavy concentration of all kinds of disasters including natural and man-made disasters. Many disasters are potentially dangerous to economic and social development. Since Sri Lanka is situated in the Indian Ocean it has become vulnerable to many disasters. Even though during the past few decades some areas in Sri Lanka were affected by various disasters, the disasters affect the poor and developing areas of the country in equally due to their different vulnerability. With the new policies, the government of Sri Lanka has paid its attention to the development of information and communication technology. This approach is to increase the life standards and efficiency of accessing information. In this sense, ICT plays an enormous role in creating awareness of natural disasters in the Sri Lankan context. While ICT cannot prevent most hazards, somehow it can be used for Disaster Risk Reduction. Making decisions with today's environmental data is a big task, handling effortlessly with the assistance of ICT and its supportive services, ICT is beneficial in supporting four major components of disaster management mitigation or risk reduction, preparedness, response and recovery. Monitoring disaster possibilities with the help of satellite communication using GIS assist in disaster risk reduction which facilitates the development of maps, village locations and locations of health related infrastructure. Real-time systems such as bio-surveillance system assists in disaster mitigation and prevention. In disaster management awareness on major issues of risk and vulnerability is the main task. It can be done through proper data collection and communication. A quantitative approach with a survey has been used to collect data from a sample based on Kandy and Colombo Districts. The sample units were selected based on simple random sampling. The results of this study were shown as the key to effective management of information which has been done with the support of ICT. Information Communication Technology which is essential to reduce the effects of disasters is available in many cases at low cost. ICT should be incorporated with training and made available to everyone at any time without geographical barriers. Appropriate use of ICT is used as a tool to reduce the impact before, after and during a disaster qualitatively.

**Keywords:** Disasters; Mitigation; Preparedness; Recovery; Response.



## Finding a Suitable Location for a High Frequency Receiving Antenna Tower

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### Abstract

Airport and Aviation of Sri Lanka (AASL) is the Sri Lanka's legally authorized institute to facilitate the air traffic controlling system for the domestic and international airlines. It further assists the Sri Lanka Air Force on air traffic controlling. High Frequencies (HF) from 3MHz to 30MHz are used to do the air traffic signaling systems due to its special characteristics. The ionosphere often refracts HF radio waves quite well. This phenomenon is known as sky wave propagation. Because of these characteristics this range is extensively used for medium and long range radio communication. High frequency radio provides aircrafts with an effective means of communication over long distance oceanic and trans-polar routes, where VHF communication is not possible due line of sight characteristics. Advantage of HF communication is due to the sky wave propagation, and aircrafts in long distance routes can be contacted effectively at any time of the day. One disadvantage of HF communication is, it needs powerful transmitting consume high power and large transmitter antenna sites and receiver antenna sites with high maintenance cost. In the field of aviation 3470 kHz, 567 kHz, 8879 kHz, 11285 kHz and 13306 kHz frequencies are used for air to ground communication. The former HF Signal tower located at Thalanganu had been removed due to increasing disturbance from the vicinity and the urgent need to construct the military base at the place. The disturbances were due to urbanization and increased constructions. Currently the AASL uses a mobile transmitting unit for this purpose and in a process of searching for an ideal location for the same. The manual search takes longer duration and the cost and the resources allocation are other issues. The focus of this study was to find out a suitable location for HF receiving tower and provide a better solution for the above mentioned issues. The improvement of communication including the Geographical Information System (GIS) is the best method one can use to find optimum location for any given reason. The effort is for finding an ideal location for a HF Transmission Tower and found a location with a good level of accuracy. In most parts of Sri Lanka communication towers are widespread for mobile communication and even for handlines and radio and television broadcasting. The central part of Sri Lanka present a challenge to the transmission of radio signals. Mountains, Valleys and other topographically varied features hinder the transmission signals sent in the portion of the electromagnetic spectrum. Finding ways to get a signal from the aircrafts to and from communication tower becomes a spatial problem involving line-of-sight between the meter and the tower. A suitability model was built that took land features along with other data inputs to help narrow down potential building sites for new radio communication towers. The main variables taken into account by this model were elevation, slope, and the distance. After the model identified appropriate sites for building a tower, additional location-allocation methods were employed which further reduced the potential tower construction sites to the most optimal locations.

**Keywords:** Communication; Radio signal; Airtraffic.

**National Conference on  
Geospatial Sciences and Disaster Management  
2016  
Conference Proceedings**

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