

Integration of Deviation and Dip Angle Concepts using GIS in Landslide Hazard Zonation Maps of Sri Lanka

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ABSTRACT

Many techniques have been proposed for landslide hazard zonation (LHZ) mapping. Those can be generally divided into two groups: direct or semi-direct hazard mapping. In direct mapping, the degree of hazard is determined by the mapping expert, and in indirect mapping, either statistical or deterministic models are used to predict landslide prone areas based on information obtained from the inter-relation between landscape factors and the landslide distribution. With the introduction of GIS, in particular, indirect methods made substantial improvements due to its capacity to handle and analyze data with high spatial variability.

In the context of Sri Lanka, LHZ maps are prepared using a model developed based on the analysis of more than thousand major landslides which occurred during a five-year period from mid 1989 to mid 1995. For the zonation maps based on this model, field data are collected considering six major factors and the corresponding weight maps are prepared manually. GIS is only used finally as an overlaying and reclassifying tool. In this workflow, a very laborious effort is needed for the preparation of geology weight maps, especially when complex terrain conditions and large amount of data are involved. One of the reasons is that, unlike all other factors where basic mapping units are areas, the geology map consists of two major parts: lithological units as areas but structural geological measurements as lines or points.

In this paper, an approach is discussed by which GIS capabilities can be used efficiently to integrate the influence of structural measurements such as strike or dip directions and dip angles for the preparation of geology weight maps which is an essential part of the LHZ model used in Sri Lanka.

Simple and Inexpensive Approaches in Identifying and Early Warning of Landslides - Some Case Studies

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ABSTRACT

Instrumentation for monitoring of landslides is normally regarded as a very expensive exercise and hence is always discouraged due to funding limitations. However, there have been several preliminary monitoring studies carried-out in Sri Lanka with locally available knowledge and techniques to suit conditions at a specific locality. Some of the basic parameters of interest useful in landslide monitoring are rainfall, subsidence, heave at landslide toe, tilt and development of cracks, water level measurements, magnitude of displacement, structure slope interaction etc. The following case studies are discussed in detail in this paper.

Trees tilt backward or forward to respond to ground displacements. During a long period of quiescence following a very long spell of movement, one should be able to estimate the period of quiescence by comparing the growth rings (ages) of a vertical tree with that of a tilted tree at the same location. Structures on active slopes may develop cracks and tilt. One of the most significant and at the same time very clear indicator is the presence of a discrete boundary between the stationary and the sliding masses. An outstanding Sri Lankan example is the Watawala earth slide where the discrete earth slide boundary shears are evident.

The simplest and the easiest approach to monitor the slope behaviors is to take recourse to (i) surveying measurements on a pre-established surface grid, (ii) measurement of displacements of surface boundaries, rock outcrops, trees, pillars posts, pegs, monuments or such other observation points on that grid. For remote measurement of slope movement, the observation points can be coupled to an appropriate measuring system. The debris cum rock-fall in Viharagala on the Beragala–Haputale road had destroyed and blocked the road. Many dangerously positioned boulders still remain on the slope. A heavy rainfall could easily slide them down again. These dangerously positioned widely-spaced boulders cannot be dealt individually. Therefore, rock-fall fences with electrical wire detection have been installed on the slope.

In Matale area, several cracks were found in walls and floors of houses. Crack monitoring inside houses is essential in giving warnings against catastrophic failures. The monitoring data confirms their non-uniform behavior and even an extremely low rate of displacement in landslides may endanger human life and property. The crack-gauge developed by NBRO as the monitoring device in this study at Matale has confirmed its reliability for measuring in-plane displacements in severe conditions with simple manipulation, minimum maintenance requirements and at a reasonable price. Though these approaches described above are simple and inexpensive, those provide very valuable information in mitigating landslides.

Evolution of Geochemical Properties of Tsunami Affected Soils in Southern Coast of Sri Lanka

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ABSTRACT

The giant tsunami wave of 26 December 2004 contaminated the surface soils in inundated regions with marine sediments and oceanic water containing various salts and organic matter. This severely changed the physical and chemical nature of coastal soils, making those not suitable for agricultural activities, though those may recover with time. In order to investigate the physico-chemical properties of tsunami affected soils, sampling was carried-out in the south-western coastal zone from Akurala to Hikkaduwa in 2010, five years after the tsunami event. Twenty soil samples were collected from 0.2 – 0.5 m depths along seven traverses which run approximately perpendicular to the coast line. Three soil samples were obtained as reference samples from an area which was not inundated by the tsunami and about 200 m away from the inundation line. The soils were predominantly sandy clay and lateritic clay. Sandy soils which contained more than 50% sand were not considered for chemical analysis. Samples were analyzed for their pH, electrical conductivity, Na, K, Mg, Ca, Cu, Ni, Co, Zn, Mn, Pb, Cr and Fe and the results were compared with available data from previous studies.

The average soil salinity in the Tsunami Affected Areas (TAA) is $389 \mu\text{S cm}^{-1}$. It is $265.6 \mu\text{S cm}^{-1}$ in Reference Samples (RS) indicating the general salinity levels in the coastal areas. The average pH of TAA is 6.75, which is 6.6 in RS. It is evident that the trace element concentration is higher in the TAA compared to RS. The concentrations of trace elements in TAA and RS are (in mg/kg) Cu (6.26, 5.91), Ni (6.82, 5.82), Zn (18.91, 20.80), Co (91.88, 46.79), Mn (17.97, 10.71), Pb (7.34, 3.94) and Cr (11.30, 10.10). Except Zn, all other trace elements are higher in TAA compared to RS. The major elements also showed a similar trend. Higher concentrations of trace elements are observed in Thelwattha and Peraliya regions which were severely affected by the tsunami. The values are compared with soils and sediments collected just after the tsunami in the same region and with soils from Bundala National Park, located in the southern coast that was not inundated by tsunami. It is evident that the soils of south-western coastal zone are gradually alleviated to its natural conditions.

Effect of Tide-Surge Interaction on Storm Surge Levels Around The Coastline of Sri Lanka

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ABSTRACT

Storm surges associated with tropical cyclones are more likely to occur along the northern and eastern coasts of Sri Lanka. Cyclone landfalls on the north and east in the recent past include those of December 1964, November 1978, November 1992, and December 2000. In the present study, we examined the effect of tidal fluctuations on the surge heights due to wind forcing along four selected stretches of the northern, eastern, southern and western coasts of Sri Lanka. The coastal stretches selected for the study also represent different shelf geometries with respect to the slope and the width of the continental shelf. Numerical simulations were carried out for each of these sites for three different wind speeds, first with tide only and wind only scenarios, and then for the tide and wind combined scenario in order to investigate the significance of the interaction between the two components. The results confirm that the tide-surge interaction is non-linear; the non-linear term enhances the surge levels when the tide is near its lowest, while weakening the surge levels when the tide is near its highest. Accordingly, for the cases of high-tide and low-tide landfalls, respectively, the tide is destructive and constructive to the total storm tide. We also find that the width of the continental shelf and shallowness of bathymetry have a significant influence in enhancing the tide-surge interaction.

Restoration and Improvement of Blasted Kalmadu Dam and its Socio-Economic impact on the Displaced Northern Community

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ABSTRACT

Northern war of Sri Lanka has caused immeasurable damage to the culture, economy, wealth and health of the community and inflicted great suffering on humanity. One of the most remarkable events of the war was the blast of Kalmadu dam in January 2009 which carried 11.7 million cubic meters of water intended for agriculture and livestock. Kalmadu Dam is fed by Nethali aru River basin, having a Catchment area of 6800 ha and an area irrigateable under gravity irrigation system is 1397 ha, which is 0.2% of the total extent of paddy land in Lanka. It consists of 1.575 km long earth embankment with a maximum height of 8 m a 122.5 m long concrete clear over fall spillway and two sluices. Bund-top level, high-flood level and full-supply level are, respectively, 32.46 m, 31.40m and 30.18m above mean sea level (msl). Both sluices are corn tower type with a spill level of 22.9 m above msl. Barrel length and diameter of right and left bank sluices are 50 & 1 m, 46.3 and 0.75 m, respectively, with maximum discharge rates of 6.2m³/s, 2.97 m³/s.

Due to an intended blast, entire reservoir water has passed through a 125 m long breach and resulted in a 15 m deep scour hole. An initial investigation estimated that 80,000 m³ of earth works is required to close the breach. Materials in the tank bed contain silt, SC, Gravel, stones and debris and these can be used in the repair of the breached dam. The closure of the breach is expected to be completed before the forthcoming *Maha* season to assist in the resettling of people of this scheme for their livelihood.

The Kalmadu settlement scheme consisted of 18,335 people consisting 4647 families, about 1500 ha of irrigated lands, 2 hospitals, 9 schools, 20 Kovils and a Church, all of which depended entirely on the Kalmadu tank and other 20 minor tanks augmented by the Kalmadu tank, for all water requirements for drinking, domestic use, irrigation and other livelihood and industries. In addition, it is a national loss as the estimated capacity of paddy production is 8382 tons/year after the completion of the construction. Average per capita consumption of 108 kg amounting to 23.6% of the production would self sustain the Kalmadu area and rest 76.4% can be fed to the national market. Disappearance of well-water after the blast indicates that Kalmadu Tank indirectly contributed to the drinking water supply by recharge. Reconstruction of the dam would thus provide drinking water for the resettled Internally Displaced People. Native and endemic plants species recorded are 86% and 8% respectively. Fauna and flora found are common and habitats are secondary in origin. Similar habitats have been identified in the surrounding area, hence, there is no possible threats to any important ecosystems. After repairing the dam, Kalmadu Tank can be brought to its operational efficiency, and overall impact would be positive because it would result in more favourable conditions for the aquatic life in the reservoir and the river downstream. Thus, restoration of breached Kalmadu dam would bring positive benefits and impacts on Socio-Economic Environment for the Resettled Internally Displaced People in Kalmadu.

Risks, Threats and Disruption to Business: Assessing the Perceptions of Estate Managers of the Plantation Sector in Sri Lanka

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ABSTRACT

Risk perception is considered as a critical social-cognitive factor in terms of disaster preparedness among businesses; thus, the threats that have a wider perceptual ground would receive response and action by the management. The rationale for such response and action by a firm emerges from two theory-centred assumptions: (1) it is the prime responsibility of the management of the firm to ensure the continuation of its operations at all times, and (2) such disruptions can have a greater impact upon the viability of the firm.

In this scenario, this study was aimed to assess empirically how managers of tea and rubber estates of the plantation sector in Sri Lanka located in different geographical regions perceives potential risks/threats/disruptions to their businesses. Based on Stratified Random Sampling techniques, Senior Estate Managers from 52 tea and/or rubber plantations belonging to seven Regional Plantation Companies (RPCs), from: (a) Up country (Central province); (b) Mid country (Sabaragamuwa province), and (c) Low country (Southern province) were selected for the study. A validated structured questionnaire was administered from June to August 2010 with a cluster of managers from a single RPC at a time, followed by a personal interview with each manager to verify certain issues. The questionnaire comprised of a series of traditional and emerging risks that can have a disruptive impact upon an agro-enterprise were evaluated by means of multi-point attitudinal rating scales. Both qualitative and quantitative data analysis techniques were used to analyze data, including Pair-wise comparisons, Box-plots, Histograms, Frequency charts etc. and derivation of Mean Importance Scores, Mean Ranks (MR) and Indices. The outcome of analysis revealed that, irrespective the location of firm, crop type and the RPC to which an estate belongs, the estate managers have perceived mostly that the destructions associated with "extreme weather" (e.g. flood, land slide, drought) as the biggest threat to their business. However, geography plays a key role with regard to other factors deciding the fate of a business, for example, those managers from the Low and Mid country judged that "loss of people", "industrial action" and "loss of IT/telecommunications" to have a serious impact in this respect. Interestingly, the managers from the estates located in different geographical regions, but belonging to the same RPC, congregated on different factors, including "negative publicity/coverage", "customer health issues" and "environmental incidents" highlighting that geography, amongst the other factors, can have a greater impact on managing the catastrophic risks linked with the natural environment. Also, this implies the importance of setting appropriate market friendly risk management tools and institutions as well as information sharing mechanisms beyond the traditional premium-based insurance schemes to ensure performance of a business, as managers perceived the risks they face are external to the business and the firm itself cannot provide efficient solutions merely through their expertise and experience.

Assessment of Tsunami Damaged Buildings using High-Resolution Satellite Imagery, GIS and GPS Data

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ABSTRACT

Due to an increase of natural hazards in coastal areas, satellite remote sensing has been used as an important tool for recognizing, rescuing, management and recovery tasks in the event of a disaster. This paper presents a methodology and results of an assessment of tsunami damaged building detection algorithm employing an object recognition task based on Differential Morphological Profile (DMP) for Very High Resolution (VHR) remotely sensed images. Its applications include both urban and rural mapping, natural disasters, and change detection. Automatic extraction of damaged and undamaged man-made structures is a fundamental task in image processing. In this research, a method is applied to assess damages to buildings using high-resolution satellite imageries and GIS and GPS data. In this method, after the building position is extracted using ENVI 4.7 programme, the extracted structures in both images are located in the pre-event and post-event satellite images. Results of the proposed method, indicates the capability of this method for tsunami damaged assessment of building structures from high-resolution satellite images. IKONOS-2 satellite panchromatic gray color images consisting of a pre- and post-tsunami damaged site of Kalmunai area in the East coast of Sri Lanka and an earthquake site of the Sichuan area in China were used.

Assessment and Retrofitting of Structures

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ABSTRACT

Numerous concrete and steel structures require retrofitting due to various reasons such as ageing, environmental attack, increase of load, change of function, design or construction errors. Retrofitting is also required to avoid/mitigate disaster. In order to determine retrofitting schemes and methods that are most desirable in terms of costs and technical advantages, it is essential to do a structural assessment of a given structure. This study introduces the principles of assessing and retrofitting of structures and also the relevant modern retrofitting techniques. A few examples of retrofitting structures with materials such as steel and concrete, pre-stressed concrete and fibre reinforced polymer (FRP) composites are included. Practical applications of seismic structural retrofitting are also discussed.

The structural condition assessment procedures and guidelines include preliminary investigation and planning, condition surveys, material testing (destructive and non-destructive testing) and field load testing. A structural analysis is performed following these procedures and guidelines, and the data collected forms the basis of the final conclusions made. Once it has been decided to retrofit, a detailed structural analysis is a requirement, and is usually based on loads and stresses specified by the client. A detailed structural analysis should have two objectives: (a) to take advantage of the methods available today with emphasis on structural behaviour, and (b) to identify those elements that need retrofitting. Based on the results of structural assessment and the detailed structural analysis, the method(s) and material(s) for retrofitting are proposed. Where deficiencies are observed, retrofitting should be combined with the necessary level of repairs. If the structural analysis is satisfactory, the proposed retrofitting will be implemented. Otherwise the structure is re-analysed considering some more improvement of retrofitting method(s) or material(s) until it satisfies the required improvement of the structure.

Rabies Post Exposure Treatment: Cost Reduction through Responsible Pet Ownership

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ABSTRACT

Dog bites is the primary mode of transmission of rabies to humans. Given the financial burden to the government, the annual death toll from rabies, physical and mental trauma of bite victims and their families etc., rabies can be considered as a disaster. Although the human death toll is on the decrease, the number of bite victims and therefore the cost of human post exposure treatment are escalating, despite the different strategies which have been adopted in Sri Lanka to curb this national menace. This study was carried out to ascertain the possibility of reducing public spending through responsible pet ownership (RPO). RPO encompasses regular vaccination and sterilization of pets and maintenance of their proper records and prevention of pets from roaming in public etc.

Data were collected through a questionnaire from randomly selected 213 patients at the rabies treatment unit of the National Hospital. One stunning finding was that only 36.6% of the patients (n=213) knew that rabies was a 100% fatal disease. Also, of the dog/cat owners (n=102), only 12.7% had their pets sterilized, while as much as 45.1% of owners allowed their pets to roam. Moreover, vaccination cover against rabies was not up to the accepted standards. These figures clearly depict the unsatisfactory RPO situation in Sri Lanka. Further, the percentage of bites caused by house-hold pets, stray or community owned dogs/cats and wild animals were 46.5%, 31.9% and 21.6% respectively. Expense-wise these figures stood at 32.3%, 54.7% and 13% respectively. 32.3% cost caused by house-hold pets is the primary emphasis in this study for it could have been prevented or substantially minimized through RPO. Moreover, 54.7% cost caused by stray or community owned dogs/ cats too can be minimized, because these same owners are responsible for generating such stray/community owned populations by dumping excess puppies of their bitches in roads, schools, temples etc.

Unsatisfactory RPO situation together with high percentage of costs due to pet dogs and cats confirm the high potential of cost reduction on human rabies post exposure treatment by creating awareness on responsible pet ownership among Sri Lankan pet owners.

Air Power as a Tool for Disaster Management - A Sri Lankan Experience

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ABSTRACT

Search and Rescue Forces (SARF) primary role is to rescue aircrew that have ejected or crash-landed their aircraft. But most of SARF's operational missions are spent in its secondary role, conducting civil search and rescue. This entails the rescue of civilians from the sea, on mountains, from flooded regions or other locations of disaster.

Sri Lanka Air Force, being an air arm of the third world country, the inventory number of air craft's and persons may be comparatively small. Yet the dedication, valor and professionalism of the air men during the battle and peace proved that they are to be recon with their counterparts in the world. My intention here is to identify the role played by the Sri Lankan Air Force during natural hazardous situations such as Asian Tsunami, Maritime rescue and flood situations.

During the Asian Tsunami SLAF has flown more than six thousand sorties of air transportation, casualty evacuation operations, search and rescue missions and cargo/medical distribution operations with its meager inventory of air craft. Air Force also deployed medical and dental teams to treat people; they maintained and fed refugee camps, soon after the northern war. The missions, equipment and air craft capabilities under the very capable hands of SLAF pilots are discussed here. Apart from the above the lessons learnt are documented for future references too.

Preliminary Flood Risk Intensity Map of the Southern Province of Sri Lanka

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ABSTRACT

Floods are one of the common natural hazards experienced in Sri Lanka. This is more significant during Southwest and Northeast monsoonal rainy periods. When compared to urban flash floods, coastal and river floods are more frequent in Sri Lanka. In 2003, severe urban flash floods seriously affected Ratnapura, Kegalle, Galle, Kalutara, Matara and Hambanthota districts in the central highlands and the coastal regions of the country. In the recent past Gampaha, Colombo, Kalutara and Galle districts were flooded badly and many people were affected. According to the geomorphological setting and the drainage network of the country, coastal lowlands have high flood risks. Therefore, it is extremely important to demarcate flood risk areas within coastal lowlands.

Southern province has been badly affected by floods during the past two decades. Aerial photographs, Geographical Information Systems (GIS) and satellite images have proven their importance in demarcating preliminary flood risk areas. A few principal factors such as, drainage density, rainfall intensity, geomorphology, land-use pattern, etc., have an influence on floods, thus, these were considered during preparation of preliminary flood risk intensity map of the Southern Province. These factors behave in different manner to accelerate flooding. Therefore, different weightages were assigned to each factor using Multi Criteria Decision Analysis Method (MCDAM). The influence of a single factor on creating a flood varies with its intensity or conditions. Considering this phenomenon, different index values were assigned using pair-wise comparison method. Using weightage values and index values, Flood Risk Indexes (FRI) have been introduced using overlay analysis method. Finally, using Flood Risk Index values, a flood risk intensity map has been prepared for the study area.

Decoding the Link between Planetary Configurations and Earthquakes

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ABSTRACT

Earthquakes result from sudden release of strain energy stored in the earth's crust. Earthquakes are triggered in many ways: rupture of the crust, movements along lineaments, burst of volcanoes, mine collapses and impounding of new reservoirs etc. Among them, fresh rupture of the crust and movements along already existing ruptures are the most common. The seismic waves generated by the earthquakes violently shake the ground destroying buildings and sometimes reducing whole cities into rubble. Earthquakes also generate tsunamis sometimes inundating large islands. Despite advanced a technical and scientific knowledge and measuring equipment, earthquakes are difficult to predict although the geologists have clearly delineated the zones of active seismicity and the cause of this sudden and irregular phenomenon is well understood.

While the Sun and the Moon play a major role in controlling almost all the surface environmental processes such as wind, tides, currents, seasons etc., it is believed that those can cause "tides" in the interior of the earth at all levels too. According to the ancient Asian mathematicians who introduced "Astrology" to the world, other than the Sun and the Moon, the other planets also have a decisive role on earth processes. Ancient Sri Lankan astrologers believed that the planetary configurations/positions in the sky at a given point of time are crucial to most of the earthly phenomena. The gravitational pull of the planets on the earth's surface is evident throughout the history of mankind as recorded in ancient chronicles and experienced today. Thus, the triggering of earthquakes can be considered as resulting from cosmic interactions rather than as independent happenings within the earth. The present study focused on this cosmic interaction, specifically, the planetary configurations at times of great earthquakes for over a period of past 100 years, to identify the genetic relationship between the two.

The study revealed that the angular momentum of the Earth is influenced by the planetary configuration at a given point of time. The law of conservation of angular momentum, however, requires internal crustal arrangement which in turn leads to build up of stress along plate boundaries. This stress is believed to be the cause of earthquakes.

Statistical Analysis of Thunder-Days to Assist Forecasting Natural disasters

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ABSTRACT

Lightning is a natural disaster causing more than 50 human deaths every year, injuring many and damaging significant amount of property. As thunder is caused by lightning, hearing thunder is the best audible proof of occurrence of lightning. A thunder-day is defined as an observational day during which thunder is heard at a given location.

Eleven meteorological regions, Colombo, Badulla, Kurunegala, Nuwara-Eliya, Hambanthota, Trincomalee, Anuradhapura, Katunayake, Ratmalana, Ratnapura and Galle were selected for their reliability of thunder-day data for the 30 year period 1961 to 1990. Mann-Kendall rank statistic, Spearman's rank statistic and the least-square regression method were used to detect the trend of thunder-days and their significance. The chi-squared test was used to compare the proportion of thunder-days among the regions for a year and for all monsoon periods and significant differences have been found among them. Further, pair-wise comparison of proportions of thunder-days among the regions was also carried out. Normal approximation to the binomial distribution was used to compute the probabilities of occurrence of thunder-days for each region in all monsoons. Percentages of proportion of thunder-days were calculated and bar charts were drawn for each region. Contour maps were drawn which demonstrate frequencies of lightning activity in all eleven regions of Sri Lanka for the period 1961–1990 on yearly and seasonal basis.

Annual lightning activity shows considerable variation from year to year. It is at a maximum in Ratmalana and at a minimum in Hambanthota. Maximum lightning activity is in Ratmalana and the minimum is in Badulla in NE monsoon and first inter monsoon. During the SW monsoon period, the maximum lightning activity is confined to Badulla and the minimum is in Hambanthota and Galle. In the first inter-monsoon period, the maximum lightning activity has been confined to Ratmalana and the minimum to Galle.

The annual trend of thunder-days in Colombo and Badulla is significant ($p < 0.05$) and upward and is significant ($p < 0.05$) and downward in Katunayake and Ratmalana. In NE monsoon, there is downward trend in Hambanthota and Katunayake ($p < 0.05$), but in SW monsoon there is an upward trend in Colombo and Badulla ($p < 0.05$) but a downward trend in Ratmalana ($p < 0.05$). In first inter-monsoon there is downward trend in Kurunegala, Katunayake, Ratmalana and Nuwara-Eliya ($p < 0.05$) but an upward trend in Badulla ($p < 0.05$). Significant ($p < 0.05$) upward trend in thunder-days was found in Badulla in second inter monsoon. A number of groups of regions experiencing similar lightning activity were seen. Anuradhapura-Nuwara Eliya, Hambanthota-Badulla, Trincomalee-Ratnapura were three pairs of such regions.

Proportion of thunder-day occurrence is higher in first and second inter-monsoon seasons, the highest being in the month of April. The probability of getting a given number of thunder-days in a year is high in Colombo, Katunayake, Ratmalana, Badulla, Ratnapura and Galle and low in Hambanthota. The probability of getting thunder-days is highest in Ratmalana in NE monsoon and is lowest in Hambanthota and Galle in SW monsoon, Trincomalee and Badulla in first inter monsoon and Galle, Trincomalee and Nuwara Eliya in second inter monsoon season.

Statistical Analysis of Road Accidents in Kandy, Sri Lanka

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ABSTRACT

Road traffic accidents contribute to nearly 1.2 million deaths annually around the globe. Countries like Sri Lanka contribute nearly 75% of those victims. The objective of this study is to identify the factors that cause the accidents and to predict the severity of the accidents using the associated factors. In this study, chi-squared test was used to identify the correlations between accident severity with various factors and Ordinal logistic regression models were fitted to predict the severity of accidents using the most significant factors.

The study was conducted in the Kandy police area in Sri Lanka. Data on all road traffic accidents and vehicles involved reported to Kandy police stations were collected for the period from 1st September, 2002 to 31st August, 2005. The study covered all 24 hours of the day and all seven days of the week. A total of 3929 objects involved in accidents were included in the analysis.

Among the vehicles Cars, Vans, Private Buses and Three Wheelers were more involved in the accidents. Of these accidents, 1.17% was fatal, 3.07% caused serious injuries, 16.59% caused minor injuries and 79.17% caused property damage. Out of the 3798 drivers 98.24% were males. A majority of drivers involved in an accident was between 20-40 years of age and the victims were of the age group of 30-40 years. In a majority of the accidents the drivers had a temporary driving license, and had <10 years of experience. A majority of accidents took place on Mondays and the least occurred on Sundays. The peak time of accidents was between 7 am to 9 am and between 2 pm to 3 pm. Out of 3924 drivers (2.27%) were found to have consumed alcohol. A large number of accidents (62.38%) were collisions between two vehicles. A majority of the accidents occurred while the vehicles were moving along a straight road.

There were associations between time of the day, experience of the driver, reason for the accidents and collision type with accidents severity. Ordinal logistic regression model confirms that the time of the day, age of the driver, victim, gender of the victim, consumption of alcohol, cause of the accidents and location were the most significant factors that affected the accidents severity. When considering the driver behaviour, time, type of the vehicle, age of the driver, experience of the driver and collision type were the most significant factors that affected the severity of accidents. When considering the victim behaviour, time, victim category, gender of the victim and cause of the accidents were affected to accident severity.

**Toxic Metals in Soils Contaminated by Landfill Leachate in Gohagoda
Dumpsite, Kandy, Sri Lanka**

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ABSTRACT

Landfill leachates contain toxic metals posing a potential risk to water and soils in the environment. The aim of this study is to characterize the availability and mobility of heavy metal ions (Zn, Cu, Pb, Ni, Cr and Cd) in the soils contaminated by the Gohagoda leachate to aid in decision making on any remedial measures. The characterization includes determination of total, exchangeable and bio-available heavy metal concentrations, cation exchange capacity (CEC), zero net proton charge (pH_{zpc}) and specific surface area determination. Leachate contaminated soils from 0.5 m above bed rock and closer to bed rock at Gohagoda municipal solid waste dump site were used for analysis. When the total metal concentration is considered, the soils above the bed rock layer contain heavy metal ions in high concentration showing significant leaching patterns indicating heavy contamination of the soil by the landfill for a long period of time. Furthermore, heavy metal ions recorded in exchangeable and bio-available fractions in considerable amounts suggest that those have been removed to the mobile aqueous phase in large quantities. The recorded CEC; 49.09 meq/100g, pH_{zpc} ; 4.64, specific surface area; 9.25 m^2/g and material characteristics led to the conclusion that the soil is rich in kaolinite and poor in organic matter. These findings suggest that the heavy metal retention capabilities of the landfill are decreasing, thus, a considerable amount of heavy metal can penetrate into the surrounding environment by passing through soils to ground water and surface water. Consequently, mitigation of this serious threat to the environment requires urgent remedial measures.

Defluoridation Behaviour of Laterite under Different pH, Contact Time, Fluoride Loading and Co-existing ions

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ABSTRACT

Fluoride contamination in water is a worldwide problem. In this study, the efficacy of laterite was tested on removing fluoride in drinking water. The particle morphology of laterite was characterized by XRF, XRD and FT-IR analysis. Diffused Double Layer (DDL) model was used to calculate surface reaction constants for $>FeOH$ and $>AlOH$ sites in laterite. Defluoridation of drinking water using laterite powder as an adsorbent was studied in batch process. Different parameters influencing adsorption, such as the pH, ionic strength, common cations and anions, dose and contact time were examined. Maximum fluoride uptake was 11.5 mg/g at pH 5.10. Freundlich model showed the best fit for the fluoride–laterite interaction indicating heterogeneous surfaces as well as multilayer adsorption. High adsorption of fluoride was observed at low pH levels (pH < 6.5) however, adsorption decreased with increasing pH. Fluoride adsorption did not show any variation with the ionic strength indicating inner-sphere bond formation with laterite surface sites. The impact of major anions on fluoride adsorption followed the order: $PO_4^{3-} > HCO_3^- > SO_4^{2-} > Cl^-$, reflecting the relative affinity of these anions for laterite. With the presence of PO_4^{3-} fluoride adsorption decreased and due to the inner-sphere complexation of PO_4^{3-} with laterite surface. However, Ca^{2+} and Mg^{2+} increased adsorption affinity of fluoride. Adsorption of fluoride resulted in changes such as disappearance of bands, shifts and decrease in the percentage of transmittance in the IR spectra of the solid surface. Continuous flow experiments showed the maximum removal efficiency at the initial stage where there are many free surface sites and the efficiency gradually decreased reaching equilibrium after 180 minutes. Therefore, laterite can be considered as an alternate material for defluoridation but further studies are necessary to determine efficiency and replacement time using different size fractions in flow through columns.

Suitability of Groundwater for Domestic Consumption in Gampola Town

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ABSTRACT

Gampola town is a rapidly developing commercial and residential area. There was a viral hepatitis out break in May 2007 in Gampola town due to faecal contamination of pipe born water. Later, it was found that ground water is also contaminated in this area. People of Gampola town prefer to use ground water despite availability of pipe born water. This study was conducted to find out the suitability of the ground water, specially the microbial quality, in Gampola town for domestic consumption, and to analyze the reason for inclination of people to use ground water.

Most of the wells in the study area are manually drilled shallow tube wells. We have selected 20 shallow wells to monitor there bacteriological quality, electrical conductivity and the water level from the ground surface for a period of 5 months. Questionnaire survey was done to find out the usage and the reason for the use of ground water. 80% of the wells were below the Sri Lankan drinking water quality standard throughout the period with spatial and temporal variations in the degree of bacterial contamination. There was a spatial variation of ground water table from 0.9 to 11.0 meter from the surface. Most probable reason for the faecal contamination of ground water could be due to seepage from the toilet pits located around the wells. Pumping water from shallow wells is cheaper than the pipe born water and it is the main reason for the trend to use the shallow wells. Using untreated ground water could lead to outbreaks of waterborne diseases.

Carbon Sequestration in Plants of Reforestations in Tank Cascades of the Dry Zone of Sri Lanka

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ABSTRACT

Reforestation can be used to mitigate global warming since trees absorb carbon dioxide through their photosynthesis cycle promoting a green environment, and deforestation can be discouraged. Tank cascade reforestation programs are beneficial to cascade communities in the dry zone but due to limited studies on small tank systems of Sri Lanka, little is known on carbon sequestration on tropical tree species as compared to that in temperate areas. Therefore, under a reforestation program, *Plan Sri Lanka* planted a total of 97,986 plants of different species between 2005 and 2009 Maha seasons in selected tank cascades of Mahawilachchiya, Medawachchiya and Nuwaragam-Palatha-divisions of Anuradhapura District in the dry zone in order to assess the carbon sequestration of planted trees. However, only 46,090 plants in *kattakaduwa*, catchment areas of the tanks, and home gardens survived at the time of this survey.

During the study, green and dry weight of a tree was used to calculate the weight of carbon acquired by the tree per year through the carbon sequestration process. The average carbon sequestration rate depends on many factors, such as diameter of the trunk, height and weight of the tree and the age, growth characteristics of tree species, the conditions of growth at the tree site, and the density of the tree's wood. For example, a coconut tree planted in 2005 sequestered ~ 138kg/carbon/per year compared to ~ 3.88kg by a mango tree of same age. Based on tree counting in randomly selected plots, survival rate of the plants was ~ 98% in home gardens, whereas in catchments and *kattakaduwa* the maximum was 34%. Most plants in *kattakaduwa* have rotted during long periods of inundation. Cattle and goats have damaged the plantation and adversely affected the forest plants in some areas and reservations. Despite these setbacks *Plan Sri Lanka* has continued its activities to identify critical regions, promote use of alternative timber species, ensure conservation of natural forests, and banned clearing of natural forests for commercial purposes aiming at more rewards from the carbon sequestration process advantageous to the farming community.

**A Study on Establishment of Flora and Fauna along Rocky Shoreline of
Ahangama after Amanath Shah Oil Spill**

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ABSTRACT

Oil spills are potential sources of marine pollution. Amanath Shah Oil Spill (ASOS) is one of the major oil spill disasters experienced by a Sri Lankan coast in the recent past. The merchant vessel Amanath Shah sank nine nautical miles away from the shoreline off Koggala, Sri Lanka, on 8th of September 2006 spilling 160-200 metric tons of furnace oil into the surrounding Indian Ocean. A week after the spill, a study was conducted to estimate the temporal variations of oil content in soil of splash and vegetation zones of the impacted area and to understand the establishment of secondary vegetation and associated fauna along the rocky shoreline at two sites. Total hydrocarbon concentration in soil was measured using a modified version of Bligh and Dyer method. A measure of the Faunal and floral establishment was carried out by quadrat sampling along transects of varying lengths. According to the results, in splash zone, oil disappeared approximately within 166 days (± 6). In vegetation zone, there were residues of oil even after 2 years of the spill. Study revealed that degradation of hydrocarbons occurs faster in splash zone than in vegetation. Shannon Wiener Index for floral and faunal communities declined initially in all three transects in the splash zone but recovered with cyclic oscillations for some species. Sorenson's Similarity Index of rocky shore fauna of the two sites in splash zones was over 0.8 after 7 months of the disaster, indicating that regeneration processes of these impacted sites are proceeding in a similar pattern. The study highlights the importance of post monitoring of oil spill disasters to understand the actual impacts on the environment to implement environmentally sound recovery programmes.

**Environmental Impact of Gem Mining:
A Case Study in Kalu Ganga Catchment, Ratnapura**

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ABSTRACT

Ratnapura district is the most renowned and well known district in Sri Lanka for its high concentration of gem deposits from the ancient days. Even though gem mining is economically important and helps to generate a high income and employment opportunities, at the same time it causes adverse effects to the environment. Hence, a study on environmental impact of gem mining in Ratnapura has been carried out and primary data gathered from field surveys have been analyzed to make recommendations to mitigate or avoid the disastrous issues.

Gem mining along Kalu Ganga and its tributaries has directly interrupted continuity of sediment transport and has resulted in induced sedimentation in the river. It has also made channel bed and bank prone to erosion producing channel incision, destruction of fauna and flora along the channel bed. Furthermore, degradation of land, damage to the vegetation cover, land use, and to man made structures have been observed. A decline of potential gemming areas, generated income, agricultural production, and education, were also noted. Increase in the cost of raw materials and shortage of capital expenditure are some of the socio-economic issues faced by the mining industry today.

Among the different gem mining methods, river bed mining with the use of gravel pumps and other mechanized mining methods such as bulldozers have caused hazardous effects. Therefore, it is vital to introduce suitable eco-friendly mining methods which are in conformity with factors such as geomorphology, weathering condition, and sensitivity of the area to minimize or avoid damage to the environment. Management and monitoring of gem mining in the area must be carried-out on a regional basis. Once licenses are issued, continuous assessment should be carried out regularly to prevent further destruction of the environment and gem industry.

Reduction of Excess Hardness and Fluoride in Groundwater by Electro Coagulation

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ABSTRACT

The Sri Lankan standard (SLS 614: 1983) for desirable levels of hardness and fluoride in drinking water is given as 250 mg/L CaCO₃ and 0.6 mg/L F⁻, respectively, but the drinking water wells in most of the dry zone areas of Sri Lanka exceed these levels by 4 – 5 times. The hardness makes the life inconvenient to the public in the form of scaling in the plumbing material, insolubility of soap in laundering, while fluoride causes health effects known as dental and skeletal fluorosis. These could be mitigated through a process called Electro Coagulation. The basic features of Electro Coagulation are dissolution of metal ions from an electrode by an applied potential, simultaneous evolution of hydrogen gas bubbles, destabilization of suspension, coagulation and sedimentation.

The aim of this study is to reduce hardness and fluoride in drinking water by Electro Coagulation using locally available raw materials. It is a very simple process, and a pilot project is in operation in a community based water supply scheme which serves 105 households in Asokamalagama, Vilachchiya. Its processing capacity is 100 liters/hour. The hardness level of raw water is 180 mg/l CaCO₃ and the fluoride content is 5.2 mg/l. In the processed water, the average hardness level and the fluoride content are 80 mg/l and 1.2 mg/l, respectively. Thus, the hardness is reduced by 50-60% and the fluoride by 80-90%, attesting to the effectiveness of Electro Coagulation. The processed water quality is in conformity with the SLS 614: 1983 drinking water standards. The pilot project which started in August 2010 is continuing and the plant is operated by two females, thus, empowering village women. The processed water is distributed in the community at the rate of Rs. 2.00 per liter of water, thus, the concept of SAFE WATER SHOP is established in Asokamalagama, Vilachchiya.

Relationship between Stratigraphic Condition and Load Bearing Capacity: a Case Study from Peraliya

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ABSTRACT

Foundation & Waterwell Engineering (Pvt) Ltd. conducted drilling investigations for the proposed Tsunami Museum at Peraliya, on relatively flat 120 m x 120 m terrain close to the coast. Five borehole locations (BH-1, BH-2, BH-3, and BH-4 and BH-5) were drilled to identify the sub soil stratification and load bearing capacity at the site. Depths of the boreholes varied in BH-1, BH-3 and BH-5 as 14.0 m, 15.0 m and 12.4 m, respectively, with bedrock level. Similarly, the BH-2 and BH-4 were drilled up to 21.0 m to depth. Load bearing capacity was tested at 1.0 m interval depths in all bore holes by in-situ Standard Penetration Test (SPT). Also soil samples were collected by the Standard Split Tube Sampler to analyze the grain size distribution, moisture content, specific gravity and carbonate content. All drilling and field test procedures were carried out in compliance with BS 5930 and BS 1377 standards. The sub-surface stratification across the site can be generated from the five boreholes drilled. All boreholes exhibited similar sub-surface soil types though some variations in consistency or relative density were observed.

In each borehole the stratigraphic changes were noted by careful observation of returned wash water. The soil types of each stratum were determined by analyzing the soil recovered in the Standard Split Tube Sampler. Results from the SPT ('N' Value) were used to determine the load bearing capacity at each depth. In all boreholes, the near surface horizon is dark grayish clayey-sand down to 0.60 m depth. The SPT was not done for this horizon, because SPT was carried out at 1.0 m intervals. From 0.60 m level to about 3.90 m depth grayish loose fine- to medium-sand with some seashells were observed in BH-1, BH-2 and BH-3. But towards the BH-4 and BH-5, this stratum extended to about 3.0 m depth. The SPT 'N' values in this horizon varied from 1 to 5. Reddish-brown lateritic clay with some sand was encountered up to 5.5 - 6.5 m depth in boreholes BH-1, BH-3 BH-4 and BH-5. In BH-2 this horizon extended down to 8.5 m. The SPT 'N' values increased in this horizon, but in some points it was not considerably increased due to clay content. From 8.5-9.0 m depth to end level of all boreholes, silty-clay or sandy-clay of completely decomposed rocks were encountered. But in boreholes BH-2 and BH-4 traces of mica appeared. The SPT 'N' values of decomposed rock horizon have considerably increased, except at some points where these values have been lowered due to the clay content.

Based on stratigraphy, SPT test values and other laboratory tests such as particle size distribution, moisture content, Attenberg limits, specific gravity etc. in soil samples, it is possible to conclude that the upper soil layers at the site are very weak down to about 4.0 m depth, and consequently shallow foundations cannot be employed without ground improvement by soil replacement or perhaps by dynamic compaction. In view of shallow ground water table at site, soil replacement down to such a depth is not feasible and the possibility of having dynamic compaction or preloading can be considered.

Oil Exploration in Mannar Basin and Sustainability of Gulf of Mannar

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ABSTRACT

Mannar Basin, 45, 000 kms² in area and located of the western coast of Sri Lanka, is a sub basin of the Cauvery Basin. Seismic data suggests that the Mannar Basin might have a viable petroleum system. It has been blocked out to 9 exploration blocks out of which the exploration block (SL 2007-01-001) has been offered to an international oil company following the first licensing round conducted by Sri Lanka in 2007.

The Gulf of Mannar has a higher biodiversity to sustain in excess of 3500 flora and fauna species out of which 11 species have been endangered and 250 have been threatened since 1980. In case of an accidental well blowout during offshore drilling in the Mannar Basin, there could be adverse socio-economic impacts on fishing, shrimping, tourism, wildlife, ocean and coastal environment and local population along the western coast of Sri Lanka. Stringent guidelines have to be enacted to ensure marine environment protection and safety of drilling, workplace and drilling crew. To minimize marine environment degradation only water based mud should be used and oil based mud should be averted. Certification requirement should be mandated for Blowout Preventers (BOPs). It is also imperative to use a back up control system such as acoustic switch to trigger the BOP in case of a primary trigger failure at an accidental well blowout due to formation kick. A tight offshore inspection and regulation program should be implemented during offshore drilling.

Indian Monsoon Currents encountered in the tropical regions of the northern Indian Ocean are varying seasonally and are directed westward from India and Sri Lanka towards Arabian Sea during January through March. Accordingly, the most suitable period for offshore drilling in the Mannar Basin is November through April. If offshore drilling could be done during this period, any toxic substance or fine particles emanated from a drill site would drift away from the Gulf of Mannar.

Glacial Landforms and their Geological Significance in the Area of Kymenlaakso Region, Southern Finland

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ABSTRACT

Pleistocene glaciations began in Finland and surrounding countries around 125,000 BP and ended around 10,000 BP. The ice cap ~3,500m thick at its origin covered the Gulf of Finland, the Baltic Sea and other lakes, and its southern edge had extended encompassing northern British Island, Poland, Germany, Netherlands, Estonia etc. around 125,000 BP. It retreated by the year 8000 BP leaving behind different types of depositional (moraines and eskers) and erosional landforms (pot holes - hiidenkirnun and striations -uurre). We investigated glacial landforms in two sub-regions of Kymenlaakso in Southern Finland using 1:20,000 topographic maps.

The moraines (Salpausselkä) composed of sand, gravel, pebbles and boulders (erratic) form arcuate ridges that are occasionally more than 2 kms wide and 100 m high. These ridges form two distinct arcs termed Salpausselkä I and II. In some regions a third arc, Salpausselkä III, is recognized. The intervening areas of hollows or bottoms are composed of dark peat bogs (sponge) give rise to a hummocky topography which is characteristic of a retreating glacier. The eskers range from 5 -50 m in height, 50-500 m in width, and 100s of m to 10s of km in length. They occur as unbroken or detached segments. The sediments are sorted according to grain size, and cross-laminations showing one flow direction are common. Kettle holes (Suppa) and terraces (Kame) are the salient topographic features in esker areas. In many places of the moraines and eskers, glacial erratics (pieces of rocks) native to the area are found. The erratics differ in size from pebbles to large boulders weighing as much as 15,000 to 17,000 metric tons. The silt, sand, gravel, pebbles and boulders of moraines and eskers are mined for land filling, cement industry and are used in the construction industry. Forest felling and land degradation are the consequent outcomes of such mining.

Glacial striations oriented in the direction of ice movement are seen as long, delicate, finely cut, commonly straight and parallel furrows or lines inscribed on a bed rock surface by the rasping and rubbing of rock fragments embedded at the base of a moving glacier. In our study, good examples of striations were observed in the Verla Sapinvuri rocky area and along the Rapakivi granite bedrock located inside the Kotka Fortification. Askola area in southern Finland underlain by mica schists and migmatites belonging to Svecofennian granite-migmatite zone is significant for formation of potholes (hiidenkirnu).

Fractionation and Availability of Heavy Metals in Ratnapura Gem Bearing Alluvium

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ABSTRACT

The sedimentary gem deposits in Ratnapura District are alluvial deposits. Gem minerals are concentrated as gem bearing gravel layers predominantly with different types of clay materials and other heavy minerals, locally referred to as "illama". This study is carried out to investigate the availability and mobility of heavy metals in gem bearing sediments in Ratnapura alluvial gem deposits. In order to determine the abundance and leachability of heavy metals in gem sediments, multi element (Pb, Zn, Cu, Co, As, Mn, Ni, Cd and Fe) analysis was carried out on 35 gem sediment samples from 15 gem pits located in Ratnapura District. The analysis was based on the total, exchangeable and bioavailable metals. The material characteristics of gem sediment observed by FT-IR analysis, the result confirm gem bearing sediments (63µm fraction) predominantly consists of kaolin type clay. Total metal concentrations were recorded as Fe>Mn>Zn>Pb>As>Ni>Cu>Co>Cd. Iron, Zn, Mn and Pb concentrations are reported high. The average values of Fe, Mn, Zn and Pb respectively as 49362, 218, 233, and 153 mg/kg. Nickel, Pb, Zn and Co exceeds the regulatory limits of various countries for contaminated soils. Exchangeable fractions results were observed as Fe>Ni>Mn>Co>Zn>Pb>Cu>Cd>As. Mobilization may increase due to changes in the pH and the presence of other ions in the environment. In some places Fe, Ni, Cu, Zn reported high in bioavailable fractions 70, 25, 20, 10 mg/kg respectively. High concentrations of toxic metals in exchangeable and bioavailable fractions indicate the risk on plant and animals as well as the open water bodies and groundwater sources.

Evolution of Geological Landscape at World Heritage Sites of Anuradhapura, Polonnaruwa and Sigiriya

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ABSTRACT

Landscapes evolve slowly over long time-scales due to weathering, erosion and re-deposition in the natural environment but short term rapid changes occur due to diverse human interaction with the environment at all scales. Utilization of stones for construction is one such activity evident in many historical cultures of the world.

A study was carried out to understand the human impact on the evolution of landscapes at Wessagiriya, Deegapasanaya, Polongala, Galviharaya, Pothgulviharaya and Rock Gardens of Sigiriya in the historic cities of Anuradhapura, Polonnaruwa and Sigiriya. Stone monuments, stone quarries and bed rock geology of these UNESCO World Heritage Sites are made-up of Proterozoic high-grade gneisses, and the geomorphology of these sites is characterized by small ridges with exposed rocky areas, runnels and broad valleys on generally flat ground. Most of the constructions at the historical sites are based on quarried stones, natural rock caves and stone quarry sites. Geological landscape of the sites had been altered by three historical anthropogenic processes which can be categorized as constructive, destructive and combination of both. The constructive process is characterized by raising the buildings and monuments by quarried stone blocks on earthy basements. Guard chambers are a special construction that had been established on rock boulders at Sigiriya premises. Natural rock shelters had been converted into meditation monasteries or residential places for monks and increasing extra living spaces had been added by attaching additional constructions. As per the destructive process, rocky hills, exposed bed rocks and boulders had been quarried altering the volume and shape of the landscape that existed. Main purpose of such alteration was only to quarry the rocks and not for creating space for any construction. According to the third process, some rocky hill sites have been flattened by quarrying the exposed rocks, and buildings were erected on that flat ground. Pothgulviharaya and Galviharaya are two good examples from Polonnaruwa World Heritage Site. Finally, it can be inferred that geological landscape had been altered by anthropogenic processes to establish the historic built environment.

Microfossil Evidence from Sri Lanka

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ABSTRACT

In the Andigama, isolated, small, faulted basin containing sedimentary rocks, a number of plant micro fossils have been identified. Micro-flora assemblages from Andigama consist of upper Jurassic *pteridophytic* spores with dominance of *Contignisporites* sp, *Cicatricosisporities* sp., and to a lesser degree *Classopollis* sp., *Dicheiopollis* sp. and *Elphedrepites* sp. No angiosperm members have been found so far from this basin. *Gymnospermae* spores are rarely represented. On the basis of macro-fossil and palynological evidence, it is inferred that the plant fossil-bearing carbonaceous shale of Andigama is of upper Jurassic age. Micro flora have not been reported in the Jurassic sedimentary rocks found in the other two known sedimentary basins in Tabbowa and Pallama, Sri Lanka.

From the preliminary analysis of findings of this research, palyno-flora in Andigama, Sri Lanka indicates a warm but shady micro environment in an arid region. They can well be compared with the contemporary Indian Rajmahal palyno-flora assemblages. Some of the spores also represent existing *pteridophytes* at present.

A comparison of 1-D and 2-D Resistivity Techniques - A Case Study on Mahagama- Embilipitiya Vein Quartz Occurrences

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ABSTRACT

Application of DC resistivity technique to assess subsurface extension of mineral occurrences is a common practice in Sri Lanka. Application of conventional 1-D resistivity surveys for mineral exploration has been gradually substituted by 2-D resistivity method due to its high resolving power and rapidity of data acquisition. A survey that was conducted to quantify reserves of Mahagama Vein Quartz deposit provided an ample opportunity to compare and contrast the applicability of 1-D resistivity and 2-D resistivity techniques. For this comparison seventeen 1-D locations were selected where the spread of 1-D survey coincided with three 2-D profile lines.

1-D data were acquired by ABEM SAS 300C Tetrameter in Schlumberger configuration (Vertical Electrical Sounding -VES) with maximum electrode spread of 400m allowing depth of penetration deeper than 50m on average. Acquired raw data were processed both in RESIST free software and R1X1 licensed software packages with less than 5% RMS error margin to obtain true resistivity values from apparent readings. 2-D data were acquired along 28 multi-electrode spread and inverted in 2-D Earthimager software. For comparison, 1-D data sets were extracted from 2-D profiles at locations where 1-D VES coincide with the 2-D profile.

The comparison of two data sets revealed that the near-surface anomalies are enhanced by 1-D technique whereas the 2-D technique generalizes the near- surface lateral anomalies. However, below certain depth, the two methods agree with each other regardless of the near-surface dissimilarities. Therefore, it is concluded that if the target is highly resistive and beneath the inhomogeneous overburden, then both 1-D and 2-D resistivity techniques are reliably applicable and would provide almost similar results.

**Vein Quartz Occurrences in Southern Sri Lanka –
An Overview of Subsurface Characteristics and Extent**

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ABSTRACT

The provenance of high quality vein quartz of Sri Lanka is yet to be explained. Despite attempts made for reserve estimation, extensive studies have not been conducted to investigate the possible origin of principal vein quartz occurrences of Sri Lanka. Detailed mapping of these occurrences in southern part of Sri Lanka, along the Highland-Vijayan boundary suggests a pegmatitic origin, where quartz may have been separated from the magma solution at later stages. This explanation suggesting the presence of a root for each and every sporadic vein quartz occurrence is very unlikely when the lateral extent of the studied deposits is taken into consideration.

Detailed field studies on vein quartz deposits at Randeniya, Illukpelessa and Mahagama showed that those are laterally extensive for long distances along the general strike direction although the main occurrence is bulk in appearance. Cross-cutting field relationship of large vein quartz deposits is hardly visible and "pinch and swell" mode of occurrence is a common feature that is observed at many known major quartz veins. A common feature is their cap-like occurrence occupying the top of morphological highs. In many instances, vein quartz caps are rimmed by calc gneiss occurrences and a possible genetic relationship between the two lithologies is yet to be ascertained.

Mahagama resistivity analysis confirmed the cap like occurrence of the vein quartz deposit there and showed no substantial root-like features. The geophysical investigations conducted on the deposit could hardly confirm its "vein type" subsurface extension. This study and other previous studies on vein quartz lead to the conclusion that the subsurface extension of vein quartz is very limited and it demands a reliable model for reserve estimation of vein quartz occurrences.

Evaluation of Possible Cause of Low Resistivity Values in Karadiyana - Borupone Dump Site

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ABSTRACT

DC resistivity studies that were conducted at Karadiyana-Borupone dump site gave extraordinary low resistivity values that are lower than that of water-logged clay formations. Resistivity data that were collected in 1-D, 2-D and 3-D modes gave similar results that are mutually consistent with each other. The outcome of very low resistivity values at near surface depths of the dump site demands evaluation of possible cause of the low resistivity values at the site.

Keeping in-line with this set objective, 22 leachate samples were randomly collected from different locations at the dump site to determine the physico-chemical parameters pH, Electrical Conductivity (EC), Total Dissolved Solids (TDS), chloride, sulfate, nitrate, fluoride, magnesium, calcium, sodium, potassium and heavy metal contents (Cu, Zn, Ni, Pb, Cr, Fe and Mn), in order to identify the possible cause of low resistivity values. In addition, optical microscopic studies were carried-out to identify suspended matter of the leachate.

The correlation between low resistivity values and leachate was confirmed by physico-chemical analysis of leachate samples collected from the site and optical microscopic analysis confirmed the availability of clay mixed with partially decomposed waste material.

It is concluded that the presence of high concentration of different inorganic ions in leachate mixed with partially decomposed waste and clay materials are the agents for low resistivity values at the dump site. Particularly, high concentration of sodium and potassium contained in leachate could decrease the ER (Electrical resistivity) value at the dump site due to dispersion of clay particles.

**Importance of Geology of Road Cuttings -
A Case Study from Southern Expressway, Sri Lanka**

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ABSTRACT

During road construction practices in the hilly Sri Lankan Precambrian terrains, collapse of cut slopes due to unstable geological conditions is a common occurrence. This type of instability is triggered by intense precipitation in relatively short periods of time. Therefore, it is important that geologists play a significant role in engineering construction practices in the complex metamorphic terrain of Sri Lanka during preliminary reconnaissance studies and at the design level, in view of the fact that Sri Lankan metamorphic terrains have complex and non-continuous structures. Thus, special attention should be paid to the geology and structure of the cut slope, occurrence of old landslides, man's role in disturbing the geological conditions etc. This study is based on experience of the Southern Expressway is built along Precambrian rock successions of the Highland Complex composed of charnockite, charnockitic gneiss, migmatite and garnet biotite gneiss as major rock types.

To avert collapse of rocks or soils, efforts should be made to divert or cut off any percolations of rain water into the cut slope. The existing drainage network of the natural waterways should be strengthened by geotechnical structures such as cut off-, cascade-, side- and berm- drains and weep holes on retaining walls. Shotcreting of weak sectors such as highly fractured surfaces, cavity fillings, etc. should be done where necessary. Supply of unhindered smooth flow of water should be maintained to curtail infiltration and/or accumulation in the weathered, low strength rock/soil zones. Further, the newly cut faces should not be exposed to direct rainwater for long periods of time since thinly foliated highly weathered rock bands can absorb more water causing collapse. Grass-turfing is an effective method to protect cut slopes from erosion by rain water. Periodical monitoring of cut slopes is vital during and after highway construction.

Toxic Metal Release from Serpentine Soil in Simulated Environmental Conditions

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ABSTRACT

This study investigates the Cr, Ni and Mn release from serpentine soil in simulated environments in the presence of organic, inorganic acids and different ionic strength conditions. The fractionation and the bio-availability of these metals were also examined to identify their forms of release to the environment. Experiments were carried out over an acid concentration range of 0.05 to 10 mM using three organic (citric, acetic, oxalic) and inorganic (H₂SO₄, HNO₃, HCl) acids. The fractionation of metals in the soil samples was investigated using sequential leaching techniques, which identify the elements in different host fractions: exchangeable, carbonate bound, Fe-Mn oxide bound, organic matter bound, and residual. Bio-available fraction was observed using single extraction experiment with 0.01 M CaCl₂. Metal releasing rates increase in the order of nitric ≈ hydrochloric ≈ acetic < sulfuric < citric < oxalic acid. The maximum rate of release of Ni and Mn was observed in the presence of oxalic acid which was recorded as 5.84x 10⁻¹¹ and 2.56x 10⁻¹¹ mol m⁻²s⁻¹ respectively. However, Cr release is less compared to the other two metals. Nickel is released preferentially, relative to Mn and Cr in the presence of both organic and inorganic acids. Increase in ionic strength enhanced the quantity of heavy metal released from serpentine soil. However, there was no significant effect of the ionic strength on the metal release around pH range 8-9 which was in the region of the point of zero charge (8.57) of this soil. In the exchangeable fraction (readily available to plant uptake and groundwater), Ni (258 ± 9.20 mg/kg, 7.00%) was higher than Mn (49.4 ± 4.00 mg/kg, 7.87%) and Cr (<10 mg/kg, 1.00%). Nickel was the most bio-available metal compared to Mn and Cr, reported 168 ± 6.40 mg kg⁻¹ in the 0.01M CaCl₂ phase. The results from the sequential extractions pointed out that Mn is mainly associated with the reducible fraction (Fe-Mn oxide bound fraction) whereas nickel is found mainly in the residual fraction. Large fractions of Cr are found in organic matter and Fe-Mn bound form indicating that the oxidation-reduction conditions in the soil may favor the release of Cr to the environment. This suggests that there is a potential toxic metal release from serpentine soils to the environment if such simulated conditions (organic, inorganic acids, oxidation-reduction conditions) persist in the natural environment.
