Himalayan Knowledge Conclave

MoSTE / GoN

Institute of Science and Technology

2045

First Graduate Conference on Environment and Sustainable Development

March 29 and 30, 2015
Khumaltar, Lalitpur, Nepal

"ABSTRACTS"

Organized by
Tribhuvan University Institute of Science and Technology with the cooperation of Government of Nepal (MoSTE)

Initiative Partners:
TU-CDES, RHF, ISET-N

Supporters:
NAST, NTNC, TU-GGIC, MU-MICD, KU-NCHE, PU-SchEMS, YAE

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Abstracts

Organized by
Tribhuvan University Institute of Science and Technology with cooperation of
Ministry of Science, Technology and Environment, Government of Nepal

Initiative Partners
Central Department of Environmental Science, TU
Resources Himalaya Foundation
Institute of Social and Environmental Transition in Nepal

Suported by
Nepal Academy of Science and Technology
National Trust for Nature Conservation
Master in International Cooperation and Development, Mid-Western University
Golden Gate International College, Tribhuvan University
School of Environment Science and Environment, Pokhara University
National College for Higher Education, Kathmandu University
Youth Alliance for Environment

Conference at a Glance

Background

Nepali society needs creative thinkers to better understand the changing social, political, cultural and economic climate. In particular, young people need to play a definitive and creative role in sharing their ideas and findings among their peers and other groups within society. Graduates from Nepali universities must engage with each other and wider society to promote economic development, social welfare and environmental stewardship. The Central Development of Environment Science (TU-CDES), Resource Himalaya Foundation (RHF) and the Institute for Social and Environmental Transitions-Nepal (ISET-Nepal) have come together to create the Graduate Conference on Environment and Sustainable Development (GCESD). This conference will provide a platform for graduates to do just this.

The conference aims to bring together Post Masters level graduates to present their research and review each other's work. The conference will be held on 29th& 30th March 2015 and will be the first of its kind in Nepal. The organizers intend to promote the conference as a Himalayan Knowledge Conclave that will happen every year. The Government of Nepal and other organizations working in the field of environment and sustainable development back the conference. The conference aims to support participants to develop leadership skills although the expectation is that they will participate equally in the proceedings. The conference will also provide an opportunity for networking among thematic group members and experts.

Goal

Establish an interdisciplinary knowledge-sharing platform for young researchers, with a particular focus on environment, resource conservation, management, economic development and natural science.

Conference Theme for 2015

Seeking Harmonized Knowledge Pathways

Modality

An advisory board will guide the conference. A coordinating committee will support the board to fulfill management tasks and develop content for the conference. RHF will work as the conference secretariat. TU-CDES will coordinate scientific aspects of the conference and ISET-Nepal will lead the programming aspects. The Secretariat supported by conference secretary and associates will organize logistics and management.

Thematic Areas
* Agriculture/Livelihood
* Climate Change/Disaster Risk Management
* Energy and Water Resources
* Biodiversity Conservation and Natural Resources Management
* Green and Inclusive Development
* Pollution Reduction and Health

Participants

GCESD is open to all interested recent graduates and young researchers in the areas of environment, sustainable development and related disciplines mentioned above.

Advisory Board

* Er. Ganesh Shah, Former Minister, MoEST
* Prof. Dr. Pitamber Sharma, Former Vice Chair, NPC
* Mr. Govinda Gajurel, Member Secretary, NTNC

Coordinating Committee

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- Dr. Dinesh Raj Bhuju, Academician, NAST
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- Mr. Sanot Adhikari, President, Youth Alliance for Environment
- Er. Ajaya Mani Dixit, Executive Director, ISET-Nepal
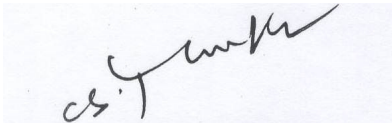- Prof. Dr. Sanjayanath Khanal, Kathmandu University

Message from Conference Chair

It is the privilege of Tribhuvan University - Institute of Science and Technology to organize the Graduate Conference on Environment and Sustainable Development (GCESD) on March 29 and 30, 2015 in Kathmandu, with the cooperation of Ministry of Science, Technology and Environment, Government of Nepal. The initiating partners of the Conference are: Central Department of Environmental Science–TU, Resources Himalaya Foundation and Institute for Social and Environmental Transition- Nepal. The Conference is backed by academic institutions, civil society and like-minded organizations working in the field of environment and sustainable development.

The GCESD aims to provide the fresh graduates and young researchers working on the issues of environment and sustainable development with a platform to share their findings and get linked with the experts. It envisions institutionalizing the platform as an annual event. In the first conference of GCESD, we are accommodating some 50 oral presentations including lead presentations by young researchers. The Conference also contains exhibition, poster and publication displays. I hope that the Conference will inspire our young graduates to know each other's' work and develop professional linkages.

On behalf of the organizing team, I extend my heart-felt thanks are to all institutions and individuals for their support and cooperation in convening the Conference.

Welcome to All!

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Chirika Shova Tamrakar
Dean, TU-IOST
Conference Chair, GCESD-2015

Contents

AGRICULTURE AND LIVELIHOOD

Climate Variability and Livelihood of the Rural Farmers in Chisapani, Ramechhap of Nepal

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Agriculture is the mainstay of livelihood of the people in rural areas of Nepal. Any perturbations in agriculture stemming from climatic and/or non-climatic factors can affect their livelihood significantly. Farmers keep exploring alternative practices in agriculture to adapt to increasing uncertainties and some of which can be scaled out to enhance resilience of the agricultural system. An exploratory study was done in one of the most vulnerable districts of Nepal, Ramechhap district. By selecting 91 farm households using purposive random sampling and by collecting information through semi-structured questionnaire along with key informant interviews and focus group discussions to assess the effects of local livelihood owing to climatic variability. Historical weather data of rainfall were analyzed to see the rainfall pattern and linked to agriculture production over time. Almost nine out of 10 farm families were marginal farmers and 60 percent of the households face food deficit half a year. Most of the respondents reported changes in climate and agriculture production practices. Historical rainfall data confirmed that the rainfall trend was declining by 13.77mm per year. The average rainfall of Manthali station is 1008mm, which is almost half of the national average. Since rain-fed farming predominates in the area, drought events have negatively affected agriculture and local livelihoods. Due to drought eighteen percent of the paddy land was converted to *Bari land*. Similarly, cold spells along with increasing foggy days aggravated the occurrence of pest and diseases affecting winter crops far more than what it used to be. Landraces of many crops had disappeared and new invasive species started appearing in the farmlands. Farmers had shifted from large animals to smaller ones as a coping strategy. Adoption of new crop varieties, crop rotation, rainwater harvesting and use of plastic tunnel in vegetable farming were the major new practices introduced in the area which have a greater potential for out- and up-scaling. However, strong institutional supports are required to build stakeholders (including farmers) capacity to experiment with adaptive strategies.

Keywords: Agriculture, climate change, drought, rainfall

Effect of Parity and Season on Performance of Transhumant Cattle ×Yak Hybrids Grazing Pastures in the Kanchenjunga Conservation Area, Nepal

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Hybridization of cattle (*Bos taurus*) with yaks (*Bos grunniens*) are the traditional practices used by herders across the Nepalese Himalayan Mountains. Cattle × yak hybrids (locally called Chauries) are one of the high mountain pasture dwellers, and utilize the pastures of different altitudes in different seasons/months, and are the one of the major livelihood contributors in the for the Himalayan herders. In Kanchenjunga Conservation Area (KCA) of Nepal, a traditional transhumant route was selected in order to learn the performance of three parity groups of milking hybrids in a pasture situated at 4100 m in July and September representing summer/rainy and late autumn/early winter season of grazing. Data was analyzed using mixed procedure of SAS (version 9.1) and mean differences obtained at 5% level of significance using Tukey's test. Body weight with using digital balance and milking performance (using lactoscan) were observed for two seasons. The initial body weight was recorded highest for 6th parity hybrids in September and daily weight gain mas rapid for the 4th and 6th parity hybrids in comparison to the younger groups (2nd parity). Parity had no influence on daily weight gain but effect of season on parity was significant in overall. Daily milk yield, ECM and fat content were significantly affected by season and parity and their interactions. Highest daily milk yield was obtained from 6th parity hybrids in July whilst there was similar daily milk yield in early winter. Milk fat content was highest at September for 4th parity hybrids due to advancing stage of lactation. Milk protein and lactose content were higher at July than at September as such due to advancing lactation and vegetation. The daily output of fat, protein and lactose were significantly affected by season, parity of milking hybrids and their interactions. In general, the hybrids above 4th parity could be promising for their higher daily milk and milk constituents and for persistent daily weight gain might be due to the better altitude adaptation than the younger parity. Moreover, a detailed pasture inventory and grazing behavior are needed to further confirm the findings of this experiment.

Keywords: Catttle, Yak, cattle x yak hybrids, transhumance, Himalayan Mountains

Energy and Economic Efficiency of Large Cardamom (Amomum subulatum Robx.) based Agroforestry System: A Case from Hangpang, Taplejung, Nepal

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Sustainability of agroforestry systems as sound agricultural practices and their potential for further development largely depend on energy use efficiency and economic benefits. Large cardamom based agroforestry system in mid hills of eastern Nepal was chosen for the study of energy balance and economic analysis. Energy and economic efficiency of Alnus Forest Cardamom Stand (AFCS) and Mixed Forest Cardamom Stand (MFCS) were analyzed. Similarly, component energy content of large cardamom crop and floor-litter of AFCS and MFCS were also determined. Inputs, mainly in the form of farm labour and firewood used for cardamom curing and outputs in the form of agronomic yield, firewood and fodder extractions from the agroforestry systems were estimated. Energy efficiency of AFCS was 2.50 ± 0.46 and of MFCS was 4.21 ± 0.93. Likewise economic efficiency of AFCS and MFCS was 7.62 ± 1.27 and 11.41 ± 1.42, respectively. Large cardamom crop components and floor-litter under the AFCS and MFCS systems did not show much difference in energy values ($p > 0.05$). It was found that MFCS have a higher energy and economic efficiency compared to AFCS however the difference were not statistically significant ($p > 0.05$). It was concluded that large cardamom based agroforestry system was efficient both energetically and economically yet reduction in inputs as firewood used in curing of cardamom capsules and deploying more energy and cash in weeding and post- harvest process will definitely help to improve energy productivity, energy efficiency and economic performance.

Keywords: Economic efficiency, energy efficiency, Large Cardamom, mid-hills

Morphodynamic Study of Channel Migration and Its Effect on Agriculture

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Agricultural land is widely believed to be affected from channel migration process, but few studies have quantified the effect on agricultural production through channel migration. Measured historical changes in a river channel centerline, combined with mapped changes in eroded agricultural land, provide an opportunity to test how channel migration rate affects the production of agricultural land. In this study, migration patterns from 1990 to 2014 for upper, central and downstream reaches of the Kandra river was analyzed, using channel planform, satellite images and hydro-meteorological data. Numerical model developed by Hasegawa, 1989 was also used to understand the channel migration characteristics. Channel migration process can be easily understood with the help of mathematical model even with simple model. These models help us to understand the geotechnical and flow characteristics of river channel along with its planform. Data of agricultural land loss was generated in ArcGIS 10.1 and agricultural productivity data was collected from District Agricultural Office, Kailali to analyze the effect on agricultural production through multiple regression analysis. A comparison of migration rates for approximately 25 years suggests that channel was significantly migrating with high erodability in downstream than upstream reaches of river. A comparison of river channel from various year shows the channel is migrating with various pattern (i.e. translation in upstream, rotation in midstream and extension in downstream). Impact on agriculture was seen significantly due to channel shifting. The majority of agricultural lands lost in the Kandra river area were due to bank cutting. Channel migration and its associated hazard such as erosion have significant effect in agricultural production. Although agricultural production of any area depends upon various factors such as irrigation, soil fertility, rainfall, etc. but productions near Meander river channel is largely affected by the channel migration process.

Keywords: Agriculture, GIS, linear migration model, river channel migration

Soil Nutrient Status of Agricultural Land in Deusa VDC, Solukhumbu, Nepal

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2 Central Department of Geology, Tribhuvan University, Kathmandu, Nepal

Soil nutrients play important role in nutrient availability, where organic matter is a major constituent among all to determine soil major nutrients that plant take. Most of the studies in Nepal involve in soil macro-nutrient analysis only focus in determination of soil nutrient plot-wise and not predicting overall area. Spatially, soil nutrient is best represented by interpolation method, when sufficient point data are present. The objectives of the study are i) to study N, P, K, OM and pH status in forest and agricultural lands of Deusa VDC, ii) to prepare soil macronutrient and carbon maps using model, and iii) to compare slope wise and altitude wise variation of N, P, K and OM in the study area. Descriptive and exploratory research is carried out using soil parameters as a major variable where 48 top-soil and 42 sub-soil random samples were collected from agricultural land and 13 top-soil and 8 sub-soil samples were collected from forest land using GIS random point. Agricultural land had strong acidic pH, whereas pH of forest soil was almost neutral. This shows that there is presence of parent material having acidic pH and due to natural process of maintenance there is nearly neutral pH in forest land. Increase in N, P, K and OM was seen in those plots with added organic manure. Average C:N ratio of agricultural land was less than that of forest soil. With increase in altitude, OM also increase. With increase in slope of tillage land and non-tillage land use shows less in all macronutrients and OM. From interpolation of N, P, K and OM, both land use type and soil depth, soil macronutrient content of overall study area were made. Interpolation map shows that soil macronutrient of southern part of study area was less than other part of study area. Nitrogen, P, K, OM and pH in different land uses show that nitrogen content in two different land use has no significant variation. Nutrient P, K, OM, and pH vary significantly in forest and agricultural land. From linear interpolation method, soil macronutrient in top-soil of forest land shows higher nutrient. Therefore farmers should be careful for land with higher slope. Higher C:N ratio was found in forest land than in agricultural land. To increase soil macronutrient of the soil calcium carbonate should be applied to balance acidic pH. Vegetation cover should be increased to reduce loss of soil erosion by intense rainfall.

Keywords: Fuzzy interpolation, descriptive, exploratory, C:N ratio, altitudinal variation

BIODIVERSITY CONSERVATION AND NATURAL RESOURCE MANAGEMENT

Abundance and Distribution of Small Mammals in Chitwan National Park, Nepal

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Small mammals play important roles in maintaining ecological phenomena but the attention has not been paid much for their study. We studied abundance and distribution pattern of small mammals (excluding bat) in three plots of riverine and sal forests in Chitwan National Park using different traps (Elliot, Pitfall and Camera) and direct field observations in December 2011 and May 2012. There was no significant difference in the trapping efficiency of three types of traps ($P>0.05$). We recorded 14 species of small mammals belonging to three orders and six families from a total survey effort of 1080 trap nights. The abundance of small mammals was higher in riverine forest than in sal forest but there was no significant difference ($P>0.05$) in their occurrence. Shannon Weiner Diversity Index was found to be high (0.70). The distribution pattern of small mammal was clumped. The study indicated that the micro habitats were important for the diversity of small mammals in Chitwan National Park.

Keywords: Small mammals, abundance and distribution, riverine, sal forest

Assessing Illegal Wildlife Trade in Araniko Highway, Nepal

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Wildlife trade is the biggest threat to biodiversity conservation. China is an important source of demand for wildlife products and harvesting from its neighboring Asian states via Araniko Highway (Kathmandu-Kodari) and other routes. Criminal groups have procured and dispatch wildlife products and they adjust organizational form to reduce the most significant transaction cost faced at each stage/point in the supply chain. Transport to the Chinese border is the tough job and local people have been used to reduce the cost and improve the success on transport wildlife products. Current study focused to analyze the status of illegal wildlife trade; trade routes in Araniko highway and groups of people involved in illegal wildlife trade. Key informant interviews, interview with ex-poacher/traders have been conducted in Sindhupalchowk, Dolakha, Kavrepalanchowk, Bhaktapur and Kathmandu. Among the total arrested individuals more than two third are the locals and never attended high school. The people of 18-28 years age groups were most active in the wildlife trade. The pattern of wildlife trade is shifting from mega celebrity species to least known and concerned species i.e. from tiger, asian elephant, and one-horned rhinoceros to pangolin, red panda, common leopard, musk deer, python and eurasian eagle owl. The poaching and trade of mega species is becoming hard for poacher in National Parks and Wildlife Reserves, poacher and trader are targeting the species which are out of protected areas. The illegal exploitation of wildlife has severe impacts on biodiversity and local indigenous communities involved in such activities are also suffering in long run. In the developing country like Nepal unemployment, illiteracy, poverty, resource scarcity has empirical relationship with poaching, illegal trade and habitat destruction of the wildlife. The success of CNP needs to extrapolate outside the National Park. Conservation programs must create visible incentives to local people if we are to save pangolins and other endangered species with the active participation of local community.

Keywords: Illegal wildlife trade, trader, poacher, enforcement

Distribution and Habitat Characteristics of Chinese Pangolin (*Manis pentadactyla* Linnaeus, 1758) in Nagarjun Forest of Shivapuri Nagarjun National Park, Nepal

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Pangolins belong to the least studied burrowing mammal whose information on distribution and ecology is still lacking in Nepal. Their distribution and habitat characteristics were studied in the Nagarjun forest of Shivapuri Nagarjun National Park using strip transects for indirect field signs and quadrats for vegetation analysis. Study recorded 235 burrows of pangolins which were not uniform in distribution. Burrows were mostly distributed in the habitat dominated by *Schima wallichii, Castonopsis tribuloides, Castonopsis indica* and *Betula alnoides* with canopy cover between 25-50% and in the elevation range between 1450-1550 m. They preferred brown soil and northwest aspect. Distribution of burrows was independent of different attributes: transects altitude, aspects, soil, vegetation and crown cover (p<0.05). Burrows dimension were significantly different in red and brown soil (p<0.05). Fresh burrows density was found to be 0.83 burrows per hectare.

Keywords: Burrows, strip transects, quadrats, vegetation, dimension

Earthworm Distribution in Different Land Use Types in Panchase Area

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The study was carried out with the aim of assessing earthworm distribution in various land use types. For this purpose, earthworms were sampled from different aspects, land use types, depth and altitude in October 2013 and June 2014 in Panchase area which was selected as site for piloting "Ecosystem based Adaptation in Mountain Ecosystem" program. In addition, soil sample was also taken to characterize the habitat preference of the earthworms as well as the effect of earthworms on soil quality. The highest earthworm density was found in forest followed by agriculture land and grassland in both the months. Majority of earthworms were found in top 15cm of soil. Life stage of earthworms: adults, sub-adults and juveniles were found in similar proportion in October while adults outnumbered the juveniles and sub-adults in June. However, higher population of juveniles followed by sub-adults and then adults were found in grassland in both months. Earthworm population density (no/m^2) was positively, strongly and significantly correlated to soil moisture and organic matter content (r > 0.5, P < 0.01). Similarly, biomass (g/m^2) was positively, strongly and significantly correlated to organic matter (r > 0.5, P < 0.01). The study also highlighted some ecosystem services provided by earthworms like decomposition of organic matter, soil aeration, infiltration and mineral nutrient availability. These services increase soil fertility that play important role in maintaining well-functioning and productive natural ecosystems like forests and grassland as well as advantageous in agro-ecosystem for increasing crop productivity. So, being an important component of an ecosystem, functioning of an earthworm can be important ecosystem based adaptation tool.

Keywords: Ash free dry mass, earthworm population density, ecosystem based adaptation

Feeding Ecology of Assamese Macaque (*Macaca assamensis*) in Nagarjun Forest of Shivapuri Nagarjun National Park, Nepal

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Assamese macaque (*Macaca assamensis*) of Nepal is designed as 'Nepal Population' which is less common primate species and is explored patchily in Nepal. This study is focused on feeding ecology of Assamese macaques in Nagarjun forest of Shivapuri Nargarjun National Park. Two troops of macaques were selected for the study on the basis of their feeding habit using Scan sampling and Ad-libitum sampling. Macaques were highly frugivorous and observed foraging on 37 plant species which include 22 families, 28 species of tree, 4 species of vine, 3 species of shrubs and 2 species of herbs. Majority of fruit came from *Castanopsis tribuloides, Syzygium cumini, Machilus duthiei* and *Choerospondias axillaris*. Also, the diet composition of two troops was significantly different (p< 0.001). Vegetation analysis and food preference of macaque shows that Nagarjun is good habitat for the macaques regarding food resource.

Keywords: Scan sampling, diet composition, frugivorous

Feeding Ecology of the Four-Horned *Antelope Tetracerus quadricornis* (De Blainville, 1816) in Bardia National Park, Nepal

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Quantifying diet is an important aspect of studying animals' ecology; without full understanding of what they eat, why they eat, where they eat, how it changes over time, species-specific management is nearly impossible. Diets composition of the four-horned antelope (*Tetracerus quadricornis*) was studied in Bardia National Park, Nepal during summer, monsoon and winter seasons of 2012-2013. Microhistologcal analysis was used to determine the diet. The four-horned antelope was found to be a mixed feeder feeding on trees (25.87%), shrubs (21.3%), forbs (18.2%), grasses (10.5%) and climbers (4.36%). *Metragyna parviflora*, *Bridelia retusa*, *Bambusa vulgare*, *Hymenodictyon orixense* and *Zizyphus mauritiana* were major tree species while *Barleria cristata*, *Pogostemon benghalensis*, *Achyranthus sps*, *Clerodendrum viscosum* were among shrubs. *Ageratum cristata* and *Blumea virens* were the main forbs while *Eulaliopsis binata* and *Imperata cylindrica* were the principal grass species. Climber *Trachelospermum lucidum* was consumed in small proportion. Grasses in monsoon were consumed distinctly in higher percentage (16.83%) than in other two seasons. There was significant difference in the frequency of consumption of functional plant categories in different seasons ($\chi2$= 94.160, d.f. = 10, p-value <0.001). Four-horned antelopes in Bardia National Park are concentrate feeders and browsers (Browse to grass ratio = 3.52) and adopt generalized feeding strategy (Niche breadth =0.646). Similar studies are to be conducted in other landscapes and with sympatric and potential competitor species to understand its dietary niche overlaps, degree of competition and how it manages to adjust itself with other super-abundant prey species.

Keywords: Browser, concentrate feeder, generalist, microhistological analysis

Forest Biomass in Panchase: A Middle Mountain Forest Area

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Owing to anthropogenic impacts and changing climate, forest ecosystem has been rapidly changing thus precise assessment of biomass changes and understanding of its causes stands fundamental to sustain resilience in forest ecosystem as well as forest dependent people. Vegetation structural parameters and above ground biomass were studied in Panchase forest along an altitudinal gradient of 1000 m in different aspects, along with the influence of edaphic factors on aboveground biomass. Dendroecological tool was used to assess annual mean radial growth of the common tree species. Mean DBH, tree species richness, sapling, seedling and tree abundance and canopy cover increased significantly along altitudinal gradient and was higher in northern compared to southern aspect. Species diversity and richness was found higher in southern aspect with reported past severe anthropogenic disturbances. Edaphic factors were found to have greater influence on aboveground biomass in northern aspect. *Neolitsea pallens* for the first time in Nepal was documented in dendrochronological studies and is recommended for further studies. The radial growth patterns of tree species could provide insights on improved assessment of the actual influence of environmental constraints on biomass production. Forest ecosystem-based adaptation could be achieved through integration of current estimates of biomass production, annual radial growth rates of common tree species as a baseline information and maintenance of diversified species through forest management strategy.

Keywords: Altitudinal gradient, ecosystem-based adaptation, resilience

Impact of *Lantana camara* on the Floral Diversity of Laxmi Community Forest, Morang, Nepal

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This study assessed an impact of *Lantana camara* invasion in Laxmi community forest of eastern Nepal. The field visit was carried out in July 2014 and stratified random sampling was adopted at three levels of invasion uninvaded, moderately invaded and highly invaded sites. A total of 19 species of trees, 18 herbaceous and 11 shrubs were found among these studied areas. Significant differences (p≤0.05) in soil pH, moisture, texture (sand, silt and clay), organic carbon, soil nitrogen, phosphorous and potassium were measured among the three levels of *L. camara* invasion. Local's attitudes towards *L. camara* invasion and its invasiveness were viewed through questionnaire survey. The Pearson's chi-square test suggested that most of them were aware of its invasion and invasiveness but less aware of climate regulation and carbon sequestration. There were a significant difference in soil pH and moisture. The heavily invaded sites showed the highest mean soil organic matter followed by uninvaded and moderately invaded sites. Similarly, the moderately invaded sites had the highest mean soil organic carbon followed by highly invaded and uninvaded sites. The heavily invaded sites had the highest mean soil nitrogen and phosphorous followed by the uninvaded and the moderately invaded sites. The highest soil potassium level was recorded in the uninvaded sites and the lowest in moderately invaded sites. Mean soil moisture value varied significantly among the three levels of *L. camara* invasion. Mean soil moisture was highest in uninvaded sites followed by the highly invaded sites and moderately invaded sites. This significant difference in soil pH and soil moisture may suggest that L. camara is altering soil properties, floral structure and composition in LCF. Hence, management of *L. camara* is urgently required in order to conserve floras and fauna in the community forest.

Key words: Carbon sequestration, detrended correspondence analysis, invasive alien species

Modelling of Metapopulation Dynamics and Distribution of *Varanus flavescens* in Nepal Tarai: Implications to Conservation

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Human presence within the Jagdishpur reservoir and associated wetlands has largely fragmented the wetland habitats. We attempt to model metapopulation dynamics of Golden monitor lizard (*Varanus flavescens*) using occupancy survey data of two consecutive years in 2012 and 2013. Satellite image was classified to categorize land cover patterns and recognition of landscape variables. Surveys to determine dynamic occupancy state of the species was performed in 40 grids; 1 sq km each, enclosing Jagadishpur Reservoir and associated wetlands and analyzed in Program PRESENCE. Impact of landscape variables on species distribution and other factors used as covariates. Available presence data were modeled for predicting potentially suitable habitat using Program MAXENT for entire Terai. Five major land cover types: forest, settlement areas, grassland, marshlands and bare lands were categorized. The results revealed a higher rate of recolonization probability over local extinction, patchy type of metapopulation. Estimated occupancy of Golden monitor lizard was negatively affected by distance to settlements while positive correlation existed between the state variable and distance to nearest water source. MAXENT model predicted entire Tarai and some river valleys as potential area. The study concluded unstable metapopulation existed as human disturbance increases. Identification and monitoring of other metapopulation of the species, providing better protection or extension of protected area networks, landscape level conservation and enlistment of the species in national Red Data List as endangered will help to conserve the species if implicated.

Keywords: Fragmentation, dynamic occupancy, MAXENT, Varanus flavescens

Nesting Preference of White-rumped Vultures (*Gyps bengalensis Gmelin*, 1788): A Case of Nawalparasi District

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The study was carried out in the Kawasoti VDC, Pithauli VDC and buffer zone of Chitwan National Park in Nawalparasi district in 2013. This study was focused on the assessment of nesting habitat characteristics of the White-rumped vultures, food requirements and its availability, carrying capacity of the Jatayu Restaurant and the perception of people towards vulture conservation and Jatayu Restaurant. The nesting habitat assessment of the White-rumped vulture suggested that *Bombax ceiba* was a preferred tree species for nest building since 19 nests were built on *Bombax ceiba* out of the 21 nests. It was found that the height of the tree was an important characteristic for nesting rather than its diameter. Similarly, the height of the tree was dependent on the distance from the forest edge. The nests were found to be randomly distributed along the forest edge as determined by using G-statistics. Likewise, the nests were found along the water sources and nearer to the human settlement and farmland which indicate that water is the vital component for the nesting site selection and they are tolerant to human disturbance. The change in the trend of cattle rearing practice has been a major reason for the food shortage for the vultures. The Jatayu Restaurant has been supplying the food for vultures but its supply insufficient. The study indicated that the carrying capacity of Jatayu Restaurant is maximum 92 vultures.

Keywords: Habitat, nesting preference, Jatayu Restaurant, carcass

Orchid Distribution along the Elevational Gradient in Panchase Protected Forest, Nepal

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The distribution of organisms across the surface of the earth is not uniform. In order to preserve the biodiversity of the earth it is essential to find out the reason behind their occurrence, causes that are threatening their existence. The research is specially focused on the mid-mountain (Panchase Protected Forest). The orchid diversity, distribution of orchids along elevational gradient, and the relationship between epiphytic orchids with host-trees having different rugosity, dbh and sunlight abundance were studied. The study has been carried out in two VDCs of Kaski district (Chapakot and Bhadaure Tamagi). Chapakot represents SW aspect (952 m to 2452 m) and Bhadaure represents NW aspect (1652 m to 2452 m). Belt transect method with quadrat (20 mx20 m) size at the interval of 100 m elevation was used to study the richness along elevational gradients. Anthropogenic disturbances were also observed. Altogether 16 plot were laid along SW (Transect I) whereas 9 plot along NW (Transect II). The characteristics of host-trees like dbh, rugosity with sunlight abundance were noted. The data were collected in monsoon and post monsoon. Altogether 61 orchid species (including 12 unidentified) were documented. The orchid species *Dendrobium gibsonii* which was not documented earlier from Panchase was also observed. In both seasons orchid richness and diversity were higher in SW compared to NW aspect. The differences might be due to aspects, as SW aspect receives high energy input than in NW. The result showed fluctuations in orchid richness with elevation along Transect I expected to be caused by the anthropogenic disturbances. Transect II showed humped shaped pattern caused due to the hard boundary effect. *Schima wallichii, Daphniphyllum himalense, Quercus semecarpifolia, Lyonia ovalifolia, Castonopsis indica* and *Rhododendron arboreum* are found as important host-trees. Orchids select trees with rugosity (medium to rough), larger dbh and sunlight abundance (rather calm to calm) as suitable host-tree.

Keywords: Anthropogenic disturbances, host-trees, Orchid richness, transect

Status and Distribution of Endemic, Rare and Endangered plant species of Panchase

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Documentation of the pattern of biodiversity and to identify the priority areas accurately for conservation studies is essential. Status of endemic or threatened species in particular area acts as an indicator for decision making process in developing conservation strategies. For effective conservation it is important to know what is being lost, why it is disappearing so quickly, what might be the cause and perhaps most important is what are the measures taken to protect and restore them. The present research was conducted with an objective of determining the status and distribution of endemic, rare and endangered plant species of Panchase. For the purpose of determining distribution of endemic, rare and endangered species vegetation analysis was carried out using square quadrats and the size of quadrat was determined using species area curve. The appropriate size of quadrat determined for tree was $20x20m^2$, for shrub was $5x5m^2$ and for herb was $1x1m^2$. Altogether 20 quadrats were laid for trees and shrubs whereas 80 quadrats were laid for herbs. Canopy coverage was determined using densitometer and basal area was determined using DBH tape. For the purpose of status assessment of plant species at local level the methods like field observation, households' socio-economic survey, key informant interview and focus group discussion were carried out. These methods also provide information related to demand of fuel wood and fodder, sources of energy use, types of species preferred for fuel wood and fodder. Altogether 218 species of plants belonging to 82 families and 60 orchid species were recorded from the study area. A total of 13 Himalayan endemic, 2 Nepalese endemic and 30 locally rare and endangered plant species were recorded in the study area. The total species richness peaked at an elevation of 1500m whereas endemic species and endangered species showed two peaks one smaller at an elevation of 1500m and another higher at an elevation between 2100-2200m. Habitat destruction along with over-exploitation were found to be the major threats to biodiversity followed by over grazing and introduction of alien species. Daphniphyllum himalense was found to be most dominant tree species followed by *Lyonia ovalifolia, Schima wallichi* and *Castonopsis indica*. The dominant shrub and herb species found were *Drepanostachyum falcatum* and *Eragrostis tennella* respectively. The Shannon Weiner diversity was found to be highest among herbaceous plant (3.44) and lowest among tree (2.86).

Keywords: Biodiversity, dominant, elevation, richness, threats

Tree Fern Distribution and Association in Panchase Mountain Forest, Nepal

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The research focused on distribution and ecology of threatened pteridophytic species tree fern (*Cyathea spinulosa* wall ex Hook) found in subtropical ecosystem of Panchase Protected Mountain Forest of Nepal. The objective of the study was to map the distribution status of tree ferns with habitat description, explain some morphological features of tree fern and determine the community characteristics of associated vegetation layer from Panchase area. Field research was conducted from April to December of 2014 with extensive survey. Purposeful sampling method was adopted on the basis of presence of tree ferns. Total of 74 circular quadrats (Sizes: 500 m^2, 25 m^2 and 1 m^2) were laid to collect information on tree ferns and associated vegetation (tree, shrub and herb). In each quadrat, tree fern number, geographic location of individual, slope, aspect, morphological and structural features of tree fern and associated dominant vegetation layer were analyzed through phytosociological approaches. The analysis was done through the laboratory analysis, Microsoft Excel, SPSS and Geographic Information System. Baseline map of tree fern in Panchase Protected Forest area was prepared with GPS locations of 429, and directly counted 768. Out of 9 VDCs of the area it was recorded from the different forest patches of Bhadaure Tamagi, Chapakot and Pumdi Bhumdi VDC of Kaski, Chitre and Arther Dadakharka VDC of Parbat and Wangsing Ddeurali VDC of Syangja district. Tree fern in Panchase were recorded from 902 m to 1692 m altitudinal range, preferred north and northeast aspect, slope of 18 to 27 degree, shady area with relatively high soil moisture and near of many natural water sources. No significant relation was found between the number of tree fern and altitudinal variation or different soil chemical parameters tested, except with Nitrogen content. Some morphological features of fronds were quantified and found the longest fronds of 4.35 m, maximum DBH of trunk is 104 cm and maximum height is 10.5 m. Association was mainly with *Schima wallichii, Castonopsis indica* and *Macaranga sp* in tree layer. Regeneration was recorded in only 56.75 % of the studied quadrats.

Keywords: Diversity, dominance, habitat, soil, structural features

CLIMATE CHANGE AND DISASTER RISK MANAGEMENT

Application of Multi-criteria Decision Analysis (MCDA) to Prioritize Climate Change Vulnerability of the Kathmandu Valley

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Climate change is a state of change of climate which is directly or indirectly attributed to human activity that alters the composition of the global atmosphere. This has resulted in the increase in dry periods, intense rainfall, floods, landslides, forest fires, glaciers retreat and Glacial Lake Outburst Flood (GLOF) threats. In order to address the vulnerability of Kathmandu valley to climate change impacts, the climate change vulnerability was prepared through Multi-Criteria Decision Analysis (MCDA) tools in this study. Study districts included were Kathmandu, Lalitpur and Bhaktapur. Climate change vulnerability was assessed as function of Exposure/risk, sensitivity and adaptive capacity. Indicators for vulnerability, exposure, sensitivity and adaptive capacity were selected through mean rating with five Likert's scale. Similarly weighing for these indicators was done by pair-wise comparison. MCDA was carried out by Definite 2.0 (Student version) whereas Vulnerability mapping was carried out by ArcView 10. In addition, ranking for study district was done by five Likert's scale and they are very low, low, moderate, high and very high. MCDA value for sensitivity for Kathmandu, Lalitpur and Bhaktapur were 0.62 (very low), 0.63 (very low) and 0.26 (Moderate) respectively. Similarly, MCDA value for exposure/risk for Kathmandu, Lalitpur and Bhaktapur were 0.26 (High), 0.73 (very low) and 0.55 (low) respectively. Moreover, MCDA value for adaptive capacity for Kathmandu, Lalitpur and Bhaktapur were 0.84 (very high), 0.44 (high) and 0.33 (moderate) respectively. Lastly, MCDA value for overall vulnerability for Kathmandu, Lalitpur and Bhaktapur were 0.56 (moderate), 0.58 (moderate) and 0.46 (moderate) respectively.

Keywords: Climate change, vulnerability, sensitivity, exposure/risk, adaptive capacity, MCDA, mapping

Climate Change Impact and Adaptation in Agriculture in Bardiya District of Nepal: A Case Study of Kalika VDC

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Climate change has become one of the greatest threats to livelihood initiatives. Indeed, several studied has been carried out associated with the impact of climate change in Himalayan region, but very limited studied are done in Terai. This study was conducted with primary aim to identify impacts of climate change in agriculture in Kalika VDC of Bardiya district, Nepal. The study examines the way local people perceive climate change and their adaptation strategies to climate change. Information was collected from both primary and secondary data sources. Primary information was collected through semi-structured and open-ended questionnaire of household survey, key informant survey and focus group discussion whereas climatic data analysis was done with the data obtained from Department of Hydrology and Meteorology (DHM). The result has clearly indicated that the study area has experienced changes over temperature and precipitation pattern. Result shows that most local people perceive climate change and respond to it, based on their own local knowledge and experiences. Erratic rainfall pattern, increased temperature, delayed monsoon, increased frequency and length of drought, decrease water sources are changes perceive by local people. In adapting to climate change, local people cultivate different varieties of crop and change planting time to adapt with changing condition. Further, local people are using various technologies such as construction of irrigation canals, use of treadle pump as adaptation strategies to cope up with climate change related risk. However, these adaptation measures are spontaneous and short-term. Well off farmers have well adjusted their farming practices to account for climate change impacts while the poor farmers are still vulnerable. Therefore, it is important to formulate appropriate technologies and adaptation strategies and strengthened community to better cope with increasing impact of climate change.

Keywords: Climate change, community, perception, adaptation, impact

Comparative Study of Carbon Stock in Different Forest Types of Panchase

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Carbon storage in soil and biomass plays an important role in reducing the rise of atmospheric Carbon dioxide (CO2). There are few studies with direct focus on estimating Carbon stocks both in the biomass and in the entire soil profile under different forest categories in the Nepalese forest. This study was carried out in different forest types of Panchase to find out the carbon stock in different vegetation types as well as to find out the role of vegetation in carbon stock. The inventory for estimating above and below ground biomass of forest was carried out using purposive sampling. Biomass was calculated using allometric model equation. Soil samples were taken from the centre of same vegetation plot from soil profile up to 15cm depth for surface soil and up to 30 cm for bottom soil at the interval of 15cm. Walkley and Black method were applied for measuring Soil Organic Carbon (SOC). Average biomass carbon in Alnus-Schima, Daphniphyllum and Quercus forest was found 121.16±36.18 ton/ha, 127.53±42.29 ton/ha and 277.69±35.88 ton/ha respectively. Average SOC in *Quercus, Daphniphyllum* and *Alnus-Schima* forest was found 106.92±11.09 ton/ha, 198.17±9.17 ton/ha and 141.39±14.86 ton/ha respectively. Similarly average SOC in above layer was found 84.32±4.55 ton/ha and 64.51±4.76 ton/ha was found in below layer. Total carbon stock was found higher in *Quercus* forest than *Alnus-Schima* and *Daphniphyllum* forest. The study found the variation (P<0.0) in carbon stock within forest types thus indicate that the forest types play an important role on total carbon sequestration.

Keywords: Biomass,CO2, carbon sequestration, SOC, Walkley and Black Method

Discharge Estimation of Langtang River Basin by Changing Temperature and Precipitation Using Snowmelt Runoff Model

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Evidences of climate change can be seen from rising temperatures, changing rainfall patterns, melting of glaciers and permafrost, increasing aridity, reduced water supplies and increase in the frequency of water-induced disasters. Nepal is vulnerable to climate change due to its fragile ecological systems and rugged geographical features with high elevations and steep slopes. This study shows the impact of potential warming on snowmelt and its effect on river discharge by using a glacio-hydrological model, Snowmelt Runoff Model (SRM) in snow and glacier fed Langtang river, located at Rasuwa district. The Langtang River basin covers an area of 353.85 km^2, having the lowest elevation from 3646 m a.s.l to the highest elevation of 7232 m a.s.l. The SRM is a degree-day based temperature index method. It uses hydro-meteorological data (precipitation, temperature and discharge) and daily snow covered data as input data. The model uses 2006 as a calibration year while 2007 as a validation year. The annual mean observed and computed discharge of Langtang river in 2006 is 5.38 m^3/s and 5.23 m^3/s, respectively. Similarly, in 2007, the annual mean observed and computed discharges are 5.24 m^3/s and 5.3 m^3/s. A test of SRM performed for the Langtang river, shows that coefficient of determination (R2) and volume difference (Dv) are very good, 0.88 and 2.79 %, respectively in calibration year (2006) whereas 0.67 and 2.35 %, respectively in validation year (2007). According to the model, when temperature is increased by 1°C, 2°C and 3°C, the discharge increases by 15.29%, 35.18% and 55% respectively. Similarly, reduction in precipitation and temperature (10%-1), (20%-2) and (30%-3) will decrease the discharge by 12.8%, 31.09% and 40.68% respectively. Therefore, the present simple model can be used to predict the estimation of river discharge more accurately even with sparse data. SRM is effective in remote and inaccessible high mountain watersheds, also works particularly well in the data sparse region to estimate daily river discharge.

Keywords: Hydrological model, climate change, discharge

Estimating Forest Biomass using Airborne LiDAR and Aerial Images Point Clouds

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Accurate assessment and monitoring of forest biomass is important for sustainable forest management. Various remote sensing (RS) techniques can be applied to estimate forest biomass. Airborne LiDAR data, in this respect, has proved to be a valuable tool, able to provide accurate estimates of above-ground biomass (AGB). Similarly, three-dimensional (3D) matching of digital aerial photographs provides a new prospective for AGB estimation which is low cost compared to LiDAR. This study aims to compare the photogrammetric 3D aerial point cloud and LiDAR to extract tree height and Crown Projection Area (CPA) and develop species-specific regression models for accurate estimation and mapping of carbon stock in Bois noir forest of Barcelonnette, France. LiDAR data was processed to obtain the canopy height model (CHM) by subtracting the digital terrain model (DTM) from digital surface model (DSM). 3D aerial point clouds were processed to generate CHM using subtraction of LiDAR DTM from aerial DSM since the terrain does not change abruptly but gradually. Tree crown delineation was done using a region growing approach in object based image analysis (OBIA). The carbon stock was calculated from field measured DBH and height using species-specific allometric equations and a standard conversion factor. For carbon stock estimation and mapping of the study area, species-wise multiple regression models were developed using segmented CPA and derived CHM from LiDAR and aerial point clouds and field measurements. The LiDAR derived tree height and the CHM derived from aerial point clouds were able to explain 81% and 66% of the field measured height variability respectively. Overall segmentation accuracy was 77% and 80% based on 1:1 correspondence for LiDAR and aerial image respectively. Species wise multiple regressions were able to explain 57%, 74%, 84% & 88% of variation in carbon estimation for *Pinusuncinata, Pinussylvestris, Fagussylvatica* and *Larix decidua* in the case of the aerial image and 54%, 57%, 71% & 72% of variation in the case of the LiDAR. A total of 54.18 tonne C ha-1 and 47.37 tonne C ha-1 AGB carbon stock was estimated using aerial images and LiDAR respectively. This study concludes that photogrammetric matching of digital aerial images is as promising a technique as LiDAR for estimating above ground carbon stock and the cost of forest sampling can be reduced with its application.

Keywords: Forest biomass/carbon, LiDAR, aerial images, object based image analysis

Gender Sensitive Flood Vulnerability Assessment of Dhansar Watershed, Central Nepal

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Natural disasters do not discriminate, but people do. Prevailing socio-economic conditions and disparities in society lead to differentiated outcomes, although the communities are demographically similar. Researchers have revealed that disasters tend to increase the female mortality, amplify the existing gender inequality, making bad situation worse for women. Nepal has patriarchal society where women had less access to basic needs, education, social rights and control over assets. Especially such is the condition among women of marginalized community. Tamang and Majhi are amongst marginalized communities of Nepal, who are also dominant inhabitants of the study area. The main aim of this study is to assess gender dimension of flood vulnerability in Dhansar watershed, Central Nepal. Originating from Chure and terminating in Bhabar, this major tributary of Lalbakaiya river holds four communities near its bank namely, Dhiyal, Arunbasti, Singaul and Simri, that are prominent to flood hazard. Assessment of flood hazard was conducted via participatory GPS based Flood Hazard Assessment method and revealed that 372 ha of watershed was hazardous area, most of where was our studied communities located. Community Based Vulnerability Assessment method, along with place-based indicators were used to determine socio- economic vulnerability which identified all four communities as highly vulnerable to flood hazard, with Arunbasti and Dhiyal being very high vulnerable. Reasons for higher female vulnerability was attributed to illiteracy, exhausting enrollment in productive, reproductive and community roles, less representation in decision making, lack of financial resources, control over assets, and flexibility of time. Furthermore, being a marginalized community, they are often impoverished on access of resources and their resilience was weakened as majority of them were deprived of knowledge on life saving skill- swimming. Ignorance in hand washing, water purification and lack of latrines compounded the problem. However, risk taking nature of men during flood period was found to increase their vulnerability as well.

Keywords: Bhabar, chure, exposure, foothills, flash flood, marginalized community

Hazard, Vulnerability & Risk Assessment of Landslide and Flood in the Siwalik Tarai region of Nepal: A case study of Banke Watershed, Central Nepal

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Landslide and flood are frequent geomorphic processes in the Siwalik hills Tarai region and these geomorphic processes are the major physical determinants of land degradation in the Siwalik hills Tarai region of the Nepal. The processes of landslide and flood hazards causing land degradation is appeared as the sources of vulnerability and risk to local inhabitants in the Siwalik hills Tarai since several decades. In this regard, this study mainly focused on mapping and assessment of landslide, flood and land degradation causing vulnerability and risk to local inhabitants of the Banke watershed which is a part of Siwalik Tarai region of Nepal. Remote sensing and Geographical Information System are used as the major tools for data building, extraction, manipulation and spatial analysis. In this study, bivariate modeling is used for landslide hazard susceptibility analysis in the Siwalik whereas geomorphic approach is used for flood hazard mapping and assessment in the Tarai region. The analysis of landslide hazard map and flood hazard map is mosaic into composite hazard and hazard classes are categorized into three different classes e.g. High, Medium and Low. The processes of land degradation and reclamation is examined and calculated with the aid of spatial analysis of different period of land use, land cover and river morphological, topographical layers. This study found that there is more dynamic of geomorphic process and seemed to be leading physical and social vulnerability caused to be risk to the local inhabitants and community daily life. The findings shows that slope gradient, aspect, drainage density, land use, land cover, NDVI (vegetation density) and curvature are appeared as the major controlling factors of landslide processes in the Siwalik hills whereas changing or dynamic river morphology, inundation and sites of fresh floods and flat land are appeared as the proxy indicators of flooding in Tarai region.

Keywords: Siwalik landslide, geomorphic hazard, GIS application

Impact of Climate on Rice Weed and Crop Productivity

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Rice (*Oryza sativa L.*) is important food crop in terms of feeding more than three billion people. The production of rice is influenced by various biotic and abiotic factors. Temperature and soil moisture are major constraint for the crop yield whereas in case of biotic factor weeds are the major factor for the yield loss. Present experiment was conducted to study the impact of temperature and soil moisture on rice weed and crop productivity from June to October 2014. The experiment on temperature impact on rice weed and crop productivity consists of three treatments and four replications of each. Temperature was recorded at six hour interval daily after rice transplantation. Experiment on soil moisture impact on rice weed and crop productivity consist of three treatments and three replications of each. Soil moisture was measured with the help of soil pH and moisture meter during experimental period. Weeds were counted three times for both temperature and soil moisture study. Grain yield from each replications were measured using electronic weighing machine. Straw yield at varied temperature was weighed. The Results showed that under elevated temperature to 2°C and 3°C weed density as well as crop productivity increases than at ambient condition. Maturity of grain was 10 and 7 days earlier at elevated temperature to 3°C and 2°C respectively. Result from soil moisture impact on rice weed and crop productivity showed that under moisture reduction there is increase in weed density and reduction in crop productivity comparing to ambient condition. Under similar condition of water depth, plant spacing, rice variety and soil nutrient rise in temperature up to 2°C is favorable for rice straw yield and crop productivity though weed density increase with elevated temperature. Reduction in soil moisture causes to increase in weed density resulting deficiency in crop productivity. Yield loss under elevated temperature and moisture is due to sterile floret.

Keywords: Elevated temperature, soil moisture, straw yield, weed density

Past Climate Reconstruction of Nepal Himalaya using Tsuga Dumosa (D. Don, Eichler) A Case From Api Nampa Area

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Nepal Himalaya lacks the long term instrumental recorded climatic data. These shortage can be fulfilled by the study of various natural archives, among them tree ring is an important one. This study was carried out to know growth response of tree ring with climate and to reconstruct past climate of western Nepal Himalaya by analyzing the ring width of Tsuga dumosa. For this study, 89 cores from 49 trees of T. dumosa from Api Nampa Conservation Area, western Nepal Himalaya were collected. For the core collection suitable trees were located at the elevations of 2700-2800 masl. Out of 89 cores only 77 cores were used for final analysis. A 356 - year (AD 1657-2013) long chronology was prepared. Response function analysis indicated that the ring width growth of T. dumosa had significant negative correlation with the temperature of pre-monsoon months, March, April and May but positive correlation with the precipitation of same pre-monsoon months. Using transfer function analysis 311 years (AD 1702-2013) long pre-monsoon temperature and precipitation were reconstructed. Reconstructed pre-monsoon temperature recognized several warming and cooling periods. Cooling period was from year AD 1721- 1740, 1751– 1765, 1840-1857, 1819-1830, 1882-1888 and 1912-1922. Warming period was detected on 1702-1720, 1741-1750, 1780-1788, 1800-1818 and 1922-1975. Reconstructed precipitation showed several high events and low events of precipitation. High precipitation period were on AD 1721-1740, 1751-1765, 1819-1830, 1840-1857 1882-1888 and 1912-1922. On the other hand low precipitation events were on AD 1702-1720, 1741-1750, 1780-1788, 1800-1818 and 1922-1975. Reconstruction also showed that the pre monsoon months are cooling and getting more precipitation since 1975. A 356 - year long tree ring chronology of T. dumosa indicated it as dendroclimatic potential species. The growth-climate relation indicated that the ring growth of T. dumosa is influenced by pre-monsoon climate. The pre-monsoon temperature reconstruction indicated not any consistent trend of warming and cooling periods. And the precipitation reconstruction indicated not any similar periods of high events and low events precipitation within three centuries.

Keywords: Dendroclimatology, instrumental, pre-monsoon, ring width

Spatial and Temporal Variation of Aerosol Optical Depth in the Hindu-Kush Himalayan Region

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Anthropogenic aerosol plays a significant role in the regional to global climate. In particular, due to its unique geophysical and climatic characteristics, Himalayas are considered much vulnerable to the impact of aerosol deposition and associated climate forcing. In this research we attempt to extend our understanding on the spatial and temporal variation of aerosol from 2000 to 2013. Further, we try to understand the impact of aerosol on cloud cover, precipitation and surface temperature over the Hindu-Kush Himalayan (HKH) region. Analysis of Goddard Earth Science Data for monthly Aerosol Optical Depth (AOD) measured at 550nm over the region 70E-100E and 25N-40N covering the entire Himalaya suggests significant spatial and temporal heterogeneity in the AOD over the study period. High AOD levels are observed in the Eastern Himalaya during winter, which gradually shifts towards Western Himalaya and reaches its peak during early June. Such spatial and temporal variation is consistent with the seasonal monsoon circulation pattern. Correlation analysis shows that the AOD is significantly correlated with total cloud cover (r=0.571, p<0.01) and precipitation (r=0.55, p<0.01), while the correlation between AOD and surface temperature is comparatively low (r=0.48). There exist a strong and significant positive correlation between surface temperature and total cloud cover (r=0.811, p<0.01) which indicates that the surface temperature is largely controlled by cloud cover or vice versa. Further, to study the relationship among aerosol, surface temperature and total cloud cover, the role of aerosol is removed and correlation between surface temperature and total cloud cover is calculated. We observed weakening relationship between cloud cover and surface temperature with correlation coefficient of 0.745. This suggests that the atmospheric aerosol plays an important role in the surface heating and cloud formation process, which in turn affects the regional precipitation pattern over the study area.

Keywords: AOD, HKH, cloud cover

Vulnerability Mapping for Climate Change Adaptation: A Case of Marginalized Community in Chure Hills of Nepal

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Climate change is fast pushing communities, particularly the most poor and marginalized, beyond their capacity to respond. Erratic rainfall patterns and changing seasons are upsetting agricultural cycles and many drought events are leaving many to struggle to feed their families. Therefore, it is very important to quantify the impacts in order to identify the adaptation options and thereby minimize the potential damage on major crops and commodities. This study was undertaken to map vulnerability of marginalized communities under climate change context. With the above objective in mind this study was based on the both primary and secondary sources of data. The primary information was collected using structured and semi-structured questionnaire from 78 households of marginal communities living in Gauribas village of Mahottari district along with key informant interviews and the survey was conducted in August, 2014. Vulnerability map was also prepared to observe the extent of risk of community living near Ratu River with the help of digital topographic map in Arc GIS9. Majority of the people were poor and marginal farmers (< 1ha land) in both the communities. Agriculture and livestock was the main source of livelihood. Communities were facing emergence of diseases and pests in their farmland and livestock. About 20% of the respondents in both communities faced food deficit as they were the people under poverty line. Most of the respondents reported changes in climate, agriculture production practices and water availability. Climate data particularly that of rainfall and temperature were analyzed to see the rainfall pattern and temperature trends. Analysis of temperature data revealed increment of mean annual temperature by 0.0140C per year, which verified the increase in number of warmer days. Similarly, rainfall data confirmed that the rainfall trend was declining by 24.01mm per year. The average rainfall of the Sindhuligadhi station was 2425mm, which is as per with the national average; however, the people were facing dry spells time and again. Community shifted from larger animals to smaller ones, adoption of new varieties of commercial vegetables, crop rotation, surface channels for irrigation, artificial ponds, wells and water tank for the storage of water were the major new practices introduced in the area which have a greater potential for out-and up-scaling. Bio-engineering have been applied near the bank of Ratu River to decrease the risks form flash floods and landslides events. However, strong institutional supports are required to build stakeholders and poor and under privileged community to experiment with adaptive strategies and practices.

Keywords: Agriculture, Gauribas, Mahottari, precipitation, temperature

Warehouse Location for Humanitarian Relief Distribution: A Case Study of Nepal

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The ability of a country to efficiently respond to disasters plays an important role in decreasing its impact on affected people. Presence of warehouses helps in improving the efficiency and effectiveness of the disaster response by pre-positioning inventory which reduces the overall delivery time of the relief items while overcoming failures arising in disaster response due to uncertainty in transport network right after the disaster. Vulnerable to earthquakes floods, landslides, windstorms, hailstorms, fires, and floods, Nepal is considered one of the world's natural disaster "hotspots". Owing to the eminent vulnerability of the country to disasters there exists very little to no preparedness in terms of prepositioning of inventories for disaster response. Hence, there is an acute need for determining the number and strategic location of facilities to efficiently distribute relief items. The objective of this research is to determine the optimal number and strategic location of warehouses using three different techniques and comparing the results thus obtained to validate their optimality. The thesis utilizes different solution techniques SITATION, SPREADSHEET and LINGO 15.0 to find a location problem solution based on the model formulation as an integer task. The mathematical model is described as "maximal covering location problem". The algorithm used to solve this problem includes Lagrangean relaxation and simplex algorithm with branch-and-bound applied to the relaxed integer program. The results obtained from the first technique, SITATION suggests establishment of twelve facilities in Baitadi, Doti, Jumla, Jajarkot, Banke, Dang, Syangja, Bhaktapur, Siraha, Taplejung, Terhathum and Jhapa in order to cover 100 percent of relief demands of 54 disaster prone districts.Preliminary results are encouraging but due to lack of real data for some input parameters the results obtained are still not optimal and needs more work to be done.

Keywords: Location problem, integer programming, linear solvers, maximum coverage

GREEN AND INCLUSIVE DEVELOPMENT

Economic Valuation of Harpan Khola Sub-watershed at Panchase Mountain Ecosystem, Nepal – A Willingness to Pay Mode of Payment

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A dynamic complex formed by the interaction of plants, animals, microorganism communities and environment is an ecosystem and the benefits people obtain from the ecosystem are referred as ecosystem services. The data were analyzed using the Logit Regression model for the economic valuation of Panchase forest area. The study shows that though the forest conservation has been the government priority, it is forest management which is of dire need. Willingness to Pay (WTP) mode of payment was considered for the research. Age of people, number of visits made by households' members, cost of loss incurred due to unmanaged forest expansion and distance from the nearest market are positively related to the WTP. Number of dependent family members, expenditure of households and assistance by NGOs and INGOs are negatively related to the WTP. The forest is a good with a negatively sloped demand curve with luring potential for mushroom.

Keywords: Willingness to pay, ecosystem services, contingent valuation method, cost benefit

How Much is Too Much? Economic Impact of Entry Fee in Langtang National Park

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About one quarter of Nepal's territory is covered by protected areas of different sizes and categories. Some of these protected areas are the growing destination of ecotourism in the form of trekking, mountaineering, wildlife viewing and cultural tourism. Langtang National Park (LNP) is one of the important tourism destinations for trekking and cultural experience, often complemented by mountaineering. Protected area management is a costly business and requires sufficient finance for the sustainable management of the park. Ecotourism can be a promising instrument to generate fund to finance protected area management in the form of 'Entry Fee' and tourism activities brings economic benefits to the local people as well. The aim of this study is to explore the visitors' willingness to pay (WTP) for park entrance fee, possibility to finance LNP management costs and associated economic impacts from tourism activities. Contingent Valuation and questionnaire survey method were applied for the analysis of the study. It is found that 70% of the total respondents' are willing to pay more than the current entry fee of US$ 30. Finding suggests that the average WTP for the park entrance fee was US$ 63.59 whereas the entrance fee of US$ 50 or 30? generates the maximum revenue of US$ 466,400 to the park. Estimated gross regional economic impact from the ecotourism and associated activities (including current entrance fee) generates at least US$ 4,825,408. Chi square test shows significant relationship between WTP and trip experience (satisfaction), education level, annual household income and Nepal as the prime tourism destination. Full recreational economic value of ecotourism is not captured in LNP. There is high prospect to finance the LNP through increased park entrance fee. However, certain preconditions and/or visitors' expectation has to be met before the fee can be raised in the future.

Keywords: Contingent valuation, willingness to pay, ecotourism, protected areas

Role of Organic Tea Farming in Green Economy

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Green economy is a newly emerged concept that includes three principle of sustainable development i.e. Ecology, Economy and Equity. Different approaches have been carried out through different parts of world. Among various approach organic farming is one. Tea is one of the lowest cost beverages taken by all group of people. The six districts of Nepal i.e. Jhapa, Illam, Terathum, Panchthar, Kaski, and Dhankuta are major tea producing districts. The present study is aimed to assess the three E's of green economy in organic tea farming in Fikkal VDC of Illam. Gorkha Tea Estate (GTE) is chosen for organic farming. But why? The soil sampling is taken done on the basis of altitudinal gradient. Non-shaded and shaded portion was chosen from organic farming whereas only non-shaded portion was chosen for inorganic farming. Questionnaire survey and key informant survey was done for economic and social analysis to the community and employees. pH, Electrical Conductivity, Moisture Content, Nitrogen (N), Potassium (K), Phosphorous (P) and Organic Matter (OM) of total 18 soil samples were determined. Average K and P of inorganic farm are greater than organic farm. Besides this OM, Moisture Content and N in organic farm is more than inorganic farm. Potassium is that nutrient which negatively correlated with the OM which could be one reason for more K in inorganic. Since organic soil is highly porous moisture content is more. Similarly benefit cost ratio of GTE is 4.1 and NSTP is 1.56. Although NSTP invest more as the input cost, its gross output is lesser than GTE. Organic tea is being sold with high price (for how much?) in the international market than inorganic which could be the reason for this. The community of GTE is more satisfied than the community of NSTP as GTE has been doing more social work such as cow distribution, biogas plantation etc. Dispute between factory and farmer is common in both factories due to the fluctuating price of tea leaf. Community of GTE is ready to pay more for economic service of factory than the community of NSTP. Disputes between community and factory should be minimized by having regular negotiation and discussion with farmers.

Keywords: Green economy, small tea producers, organic tea farming

POLUTION REDUCTION AND HEALTH

Assessment of Indoor Air Pollution and Associated Health Risks in Bhutanese Refugee Camp, Beldangi, Jhapa

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Indoor air pollution is hazardous problem in the world. Globally, indoor air pollution has responsible for approximately 1.6 million deaths every year. Nepal, a developing country that has highly depended on solid fuels for the energy sources, is being high risk of indoor air pollution. A study was conducted with an aim to assess the Particulate Matter (PM10) concentration with documenting associated health problems in Bhutanese Refugee camp, Beldangi, Jhapa, Nepal. Structured questionnaire survey was conducted randomly among 160 household which ensures 10% household of the study area which helped to know the existing condition of fuel users and health status of respondents. Onsite measurements of particulate matter (PM10) have been done by using APM 821 handy air sampler of cooking hour concentration in the kitchen. Result shows that PM10 concentration level during cooking hour of the briquette, firewood and LPG fuels are 942.06µg/m3, 2342.77 µg/m3and 155.29 µg/m3, respectively. In the study area, firewood has produced tremendous amount of pollution continuously until the last minute of cooking while as briquette produced vague smoke in the initial phase of burning and slowly diminish. Most of the respondents in the study area are suffering by the respiratory illness due to inhalation of hazardous pollutants. Mostly, the females are shown to be more responsible for cooking process. Therefore, they have seen longer exposure with indoor pollutants. Statistics shows that, person who has more exposure with PM10 concentration; those have more chances to suffer from different diseases causing by indoor air pollution.

Keywords: Energy, exposure level, fuels, improved cooking stove, PM10

Assessment of Indoor Air Pollution through Firewood Consumption Pattern: A Case Study of Ikudol VDC, Lalitpur

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The present study analyzed the assessment of indoor air pollution through firewood consumption pattern and its impacts on human health in Ikudol Village Development Committee, Lalitpur district. The assessment of indoor air pollution was analyzed through the fuel wood consumption pattern and monitoring of the indoor air pollutants (PM10, PM2.5 and CO). Absolute 100% dependency was found on the firewood for the main energy source including biogas (10%) and LPG (5%) as supplementary source. It also showed that about 84% used electricity along with kerosene (58%) and solar (26%) respectively whereas 16% used kerosene only as a source for lightening purpose. The average firewood consumption was found to be 478.3 kg/month/HH. The per capita firewood consumption was found to be nearly 3 kg/day/person. The total firewood consumption for the study area was found to be 2249.9 ton/year. The average time spent in kitchen was found to be 2.88 hr/day. The average concentration of PM10 and PM2.5 were found to be 62.45 µg/Nm3 and 31.22 µg/Nm3 respectively. Similarly, the average concentration of CO was found to be 53.67 ppm. Both particulate matters were found to be within the national standard whereas concentration of CO was found to exceed the national standard given by indoor air quality standard for average one hour during cooking time. It shows that the indoor air pollution in the rural household was poor and often related with the poor ventilation system. Mainly four health issues related with the respiratory illness was found namely as pneumonia (6%), asthma (24%), cough (10%) and eye itching and headache (18%). Female (29) and children (3) were found to be affected by respiratory illness. These may relate with solid biomass fuel burning often related with poor ventilation. The installation of the efficient ICS may be one of the options to improve the quality of life and quality of air in indoor environment.

Keywords: PM10, PM2.5, CO, National standard, cooking stove, respiratory illness

Industrial Noise Exposure and its Consequences in the Health of Workers: A Case of Dharan Industrial Estate

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Noise is often neglected subject and interferes human wellbeing and quality of environment. Industrial noise is burden at workplace which is very jarring and unbearable. Cross-sectional study was carried out in Dharan Industrial Estate (DIE) to measure the industry specific noise level, assess the provision of occupational health and safety and examine the prevalence of Noise Induced Hearing Loss (NIHL). Noise level was measured by SPL meter in 20 industries at 454 points in 3 different intervals where personal and area sampling was taken into consideration. 10 industries noise levels was recorded above the severe WHO guideline value 80dB(A). Workers were susceptible to NIHL due to loud noise as well as mechanical accident. Only 24.1% workers used personal safety devices at workplace so that status of occupational health and safety was found to be unsatisfactory. Also, the prevalence of NIHL was assessed with audiometric test among 104 employees where 76.9% and 23.1% were exposed and non- exposed group. Tinnitus was reported by 35.6%. Audiogram prevail the prevalence of NIHL among exposed and non-exposed group accounting 38.8% and 12.5 % respectively. The Odd ratio was found to be 9.255 and P-value=0.016 shows significant difference. Similarly, relationship of NIHL with age and duration of exposure was statistically significant. Prominently, NIHL prevailed in machining, welding and aluminum sections with range from mild to profound hearing loss. NIHL is remarkable problem at DIE. Longitudinal study including this type of cross sectional study should be carried out. To address the health and safety problem, hearing conservation programme enforcement should be implied.

Keywords: Audiogram, audiometric, dB(A), NIHL, SPL, tinnitus

Investigation on the Soil Parameters for their Corrosivity towards the Buried Pipelines in Bharatpur Municipality of Chitwan Valley, Nepal

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Soil parameters like organic matter, moisture content, pH, bulk resistivity, oxidation-reduction potential (ORP), chloride and sulfate ions are generally considered to be most affecting factors for the corrosion of the buried-galvanized steel and cast-iron pipes those are used to supply the drinking water from reservoirs to consumers house in Nepal. Estimation of these soil parameters can give an indication of the soil corrosive nature towards the buried-pipelines. In this context, the present research work was carried out to study soil corrosivity towards the buried-water supply pipelines in Bharatpur municipality area of Chitwan district of Nepal. Seven soil parameters of the collected thirty soil samples from one meter below the ground level of the study area were analyzed using ASTM standards and other relevant methods in Central Department of Chemistry, Kirtipur. Based on ASTM and NACE standardizations and compared with present results, it is concluded that most of the soil samples collected from Bharatpur municipality area are found to be less corrosive to mildly corrosive towards the water supply buried-galvanized steel and cast-iron pipes buried in the study areas. Based on the findings of the present research work, it can be advised to the related authorities and local people that a simple modification of the soils using cheapest non-conducting materials like gravel or sand around the buried-pipelines before burying them in the study areas is seems to be very beneficial and effective from the corrosion point of view to increase their life time for long times. Details of the results will be discussed during the presentation.

Keywords: Corrosion, galvanized steel, cast iron pipe, resistivity, chloride, sulfate

Life Cycle Assessment of Municipal Solid Waste Management System in Kathmandu Metropolitan City

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The study was focused on the life cycle assessment of the municipal solid waste management of Kathmandu Metropolitan City (KMC). One ton of waste was taken as a functional unit to compare different scenarios. Scenario 1: business as usual includes collection, transport and landfilling, Scenario 2: energy recovery with recycling and Scenario 3: conjunctive disposal system comprising of composting and landfilling. The primary and secondary data related with the scenarios were collected from the KMC, Environment Department and Solid Waste Management Section as well as the Solid Waste Management Technical Support Center and Ministry of Federal Affairs and Local Development. The life cycle inventory was developed that includes detail unit process and has quantified values of various resources and emissions. The Life cycle impact assessment was also done to quantify the impact level on the environment by the help of Integrated Waste Management Model. In the process of the life cycle assessment of the municipal solid waste management, the contribution of this process to environment was calculated as Global Warming Potential (GWP), Acidification Potential (AP), Eutrophication Potential (EP) and Fuel Energy Consumption (FEC). The results obtained from the environmental impacts quantification were compared which showed that the scenario 3 is more eco-friendly than scenario 1 and scenario 2. The result was fundamentally based on the environmental burden by the tones of the waste managed in landfill regardless of waste recycled and waste composted. Therefore, the GWP, AP, EP and FEC were calculated for the each scenario and compared in kg equivalents per tones of waste managed in landfill. The GWP for scenario 1 was approximately 3 times more than GWP for scenario 3, while the AP, EP and the FEC was almost same as GWP. The scenario 3 was found more eco-friendly than other scenarios. The comparison is made throughout the entire lifecycle that includes the waste from its cradle to grave. In accordance with the results, scenario 3 was found to be the option with minimum environmental impacts (less GWP, AP, EP) and cheap in case of fuel consumption cost. The result is influenced more due to higher composition of organic waste that can be composted and the GWP can be controlled by it. The final results obtain from this study can be applied for the integrated solid waste management system as an environmental tool.

Keywords: Life cycle inventory, global warming, acidification, eutrophication potential,

Wastewater Treatment by Phytoremediation in a Constructed Wetland

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An experiment was carried out to assess the efficiency of *Chrysopogon zizanioides* (Vetiver) and *Phragmites karka* (Common reed) in wastewater treatment. The experimental set up was made by constructing a green house cottage consisting of four wetlands separated by plastic lined earthen bunds and planted with Vetiver, Common reed, both (mixed) and none (control). The objectives were to determine the morphological (height, hedge, leaf color, decay and rebirth) in plants, physical (pH, temperature, conductivity, turbidity) chemical (BOD5, COD, NO3-N, TP, Chloride, CO2) and microbial (Total coliform) parameters of wastewater before and after treatment and to study their relation with soil nutrient change (percent organic matter, percent organic Carbon, percent Total Nitrogen and Average Phosphorus). The morphological data was taken by field observation. The physico-chemical parameters tests were done according to APHA-AWWA-WPCF, 2005 and General Experiments on Physiochemical parameters of Water, 2007. Saplings of Vetiver and Common reed were respectively 6cm and 32cm during plantation which after four months of plantation, reached the equal height of 156cm. Net increase in height for Vetiver was 225.8±9.66cm while that of Common reed was 7.35cm in six months with appearance yellow patches and drying of old leaves. Decay and rebirth was continuous in Common reed while Vetiver survived 100% though proper hedge development was not seen in the mixed plantation. Water samples were taken at interval of two weeks after three months of plantation and preserved in refrigerator at less than 4oC above freezing point within 10 hours of collection. The physio-chemico parameters results showed that on the sixth month the overall concentration of BOD5, COD, NO3- N, TP, Free CO2 and Chloride content in the effluent after treatment were reduced by 92.30%, 80.76%, 90.90%, 87.5%, 78.12%, 81.13% by *Chrysopogon zizanioides* pond 76.92%, 35.38%, 81.18%, 55%, 56.25%, 52.83% by *Phragmites karka* pond, 84.61%, 53.84%, 84.09%, 60%, 62.5%, 60.37% by the mixed pond and 53.84%, 28.12%, 30%, 32.5%, 28.12%, 26.41% by the control respectively at their outlets. Soil nutrients were also found to increase along with the plants growth and increased efficiency in wastewater treatment.

Keywords: Wastewater treatment physico-chemical and morphological parameters, nutrients

WATER RESOURCES AND ENERGY

Effects of Land Use Change on Soil Organic Carbon Stock in Sundarijal Catchment, Kathmandu, Nepal

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Land use change is a major source of carbon emission due to burning and decomposition of vegetation and declining soil organic carbon (SOC) contents. The SOC can act as both sink and source in response to changes in climate, land use, and atmospheric CO2 and it exhibits considerable variability both spatially and horizontally according to land use and vertically within the soil profile. Evaluation of SOC stock provides better guidelines for soil management and to make appropriate future land use/land management changes. The present study was carried out with the general objective to identify the effect of land use change effects on SOC stock in Sundarijal catchment. The present study is based on the stratified random sampling. SOC stock in forest soil was found to be 1807.72 ton/ha with mean value 60.26 ton/ha and in agricultural soil the value was found to be 460.47 ton/ha with mean value 15.33 ton/ha. The internal trading of land use area between the land uses during the 18 years period (1978-1996) indicated net gain of SOC stock by 6051.3 ton i.e. 15.57% of the original stock in the Sundarijal catchment. Similarly, land use change during 18 years period (1996-2014) showed net loss of SOC by 2455.56 ton i.e. 6.18% of the original stock. Land use/land cover has changed in positive direction in terms of forest conservation. Changes in land use and land cover impart important effect on soil organic carbon sinking; SOC has lost from the catchment when forest changed to other ecosystems, while reverse phenomenon has enhanced the SOC stock.

Keywords: Carbon, land use, stratified random sampling, forest soil, agricultural soil, carbon sink

Energy Consumption Scenario and Renewable Energy Alternatives in Madi Kalyanpur VDC, Chitwan, Nepal

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Energy consumption pattern and greenhouse gases emission are interrelated. The unsustainable use of biomass and commercial energy is one of the major sources of greenhouse gas emission. The alternative to kerosene for lighting is solar home system, which is one of the proven and potential renewable technologies for rural electrification. The present study aims to analyze the energy consumption scenario and greenhouse gases emission from energy consumption practices which was focused on household energy consumption. The general concept of people is that solar home system is more costly than kerosene due to its high installation cost. Thus, the present study analyzed the solar home system with focusing its viable option in environmental and economic prospects. Madi, Kalyanpur Village Development Committee (VDC) is far from access to grid electricity therefore, a typical VDC where almost all houses had solar home system was selected. Primary data was collected through household questionnaire survey, key informant interview and focus group discussion. Published and unpublished document were reviewed for secondary information. About 90% people of the study area used fuel wood as a source of energy for cooking, heating and making feed for animals along with liquefied petroleum gas (62%) and biogas (55%). All people used solar home system for the lighting purpose. The greenhouse gas emission with the current energy consumption pattern i.e. fuel wood and liquefied petroleum gas was 7.89 ton and 0.17 ton of CO2 equivalent annually/household respectively. Typically, 40 Wp solar home systems reduced the consumption of kerosene by 42 liter annually for lighting that displaced 0.11 ton of CO2 equivalent per household/year. The simple cost payback period for typically 40 Wp solar home system was found to be 9 years, 7 years and 2 years for without subsidy, with subsidy through AEPC and with subsidy through Indian Government respectively. The benefit-cost ratio was 3.1, 3.5 and 4.6 for without subsidy, with subsidy through AEPC and with subsidy through Indian Government respectively. The study concludes that solar home system is the better alternative energy for lighting as it reduces greenhouse gases and is economically beneficial.

Keywords: Cost payback period, greenhouse gases emission, solar home system, liquefied petroleum gas, biogas

Seasonal Trophic Characteristics in Beeshazar Lake

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Wetlands are among the most threatened ecosystems in Nepal. The excessive amounts of nutrient favor the growth of algae and weeds leading to eutrophication, one of the major problems in most wetlands. Beeshazar Lake, the one of the Ramsar sites, is no exception. The study was conducted with the major aim to determine seasonal variation of trophic status in the lake. The trophic status of the lake was determined based on simple productivity index (Wetzel, 2001) in terms of secchi depth and total phosphorus concentration. The secchi depth and total phosphorus concentration were determined through standard methods, UNEP and APHA. The lake was sampled at four sampling sites in monsoon (July, 2013) and winter (February, 2014). The average secchi depth in monsoon and winter was 1.17 m and 1.61 m, respectively, difference being insignificant ($p = 0.167$). The total phosphorus concentration however, decreased significantly from 0.195 mg/L in monsoon to 0.025 mg/L in winter ($p=0.001$). Results showed that the lake, in terms of secchi depth, was eutrophic in both seasons. In terms of total Phosphorus concentration, the lake was hyper-eutrophic in monsoon but meso- to eu-trophic in winter. The study concluded that the nutrient enriched during monsoon than in winter in Beeshazar Lake.

Keywords: Ramsar site, Secchi depth, total phosphorus, trophic state index, trophic status, nutrient

Seasonal Variation of Ice Melting on Varying Layers of Debris of Lirung Glacier, Langtang Valley, Nepal

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Glaciers in the Himalayan region are often covered by extensive debris cover in ablation areas, hence it is essential to assess the effect of debris on glacier ice melt. Seasonal melting of ice beneath different thicknesses of debris on Lirung Glacier in Langtang Valley, Nepal, is studied during three seasons of 2013–14. The melting rates of ice under 5cm debris thickness are 3.52, 0.09, and 0.85 cmd^{-1} during the monsoon, winter and pre-monsoon season, respectively. Maximum melting is observed in dirty ice (0.3cm debris thickness) and the rate decreases with the increase of debris thickness. The energy balance calculations on dirty ice and at 40 cm debris thickness show that the main energy source of ablation is net radiation. The positive degree-day factors for monsoon (2013), winter (2013) and pre-monsoon (2014) seasons are 4.64, 2.43 and 5.71 $mm^oC^{-1}d^{-1}$, respectively under the 5 cm debris thickness. Similarly, debris temperature profile shows higher amplitude near surface, which diffuses down with lower amplitude and increasing lag time. The major finding from this study is that the maximum melting occurs during the monsoon season than rest of the seasons.

Keywords: Himalayas, dirty ice, energy balance, debris thickness

The Water Footprint of Kathmandu Metropolitan City, Nepal

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The water footprint is consumption-based indicator of water use. It is defined as the total volume of both indirect and direct freshwater used for producing goods and services consumed by individuals or inhabitants of community. The present study has attempted to fill the lacuna of estimating water volume of both direct and indirect water use. The total volume of water calculated is based on the consumption pattern of different commodities by inhabitants of Kathmandu Metropolitan city using extended water footprint calculator. An average water footprint of individuals was found to be 1145.52 m3/yr and the total water footprint of Kathmandu Metropolitan City was appeared to be 1117.40 Mm3/yr. This comprised of indirect water footprint of 1070.82 Mm3/yr and direct water footprint of 46.59 Mm3/yr. The total water footprint obtained is equal to 2.27 times the annual flow of Bagmati River. In indirect water footprint, food water footprint appear to be 1055.60 Mm3/yr and industrial water use to be 15.22 Mm3/yr that is equal to 2.14 times and 0.03 times the annual flow respectively. While the direct water footprint appear to be 46.59 Mm3/yr which is 0.09 times the annual flow. Among the food grains, cereals consumption shared the highest contribution of 34.82% followed by meat with share of 32.62% in total water footprint. The daily per capita water use of inhabitants was 3138 liters which includes water use in food items (2965 liters), industry (43 liters) and domestic (131 liters). The daily per capita domestic water use was estimated to be 90 liters which seems to be more than supplement (41 liters) by the water operator and is already exceeding by 5 liters than expected improvement in water supplement (126 liters) in 2025 after accomplishment of Melamchi water project. It is expected to increase further with the current trend of rapid urbanization of Kathmandu Metropolitan City. The finding showed water footprint of individuals is directly related to food consumption behavior, life style and services used. Therefore, it is necessary to initiate water offsetting measures at individual level and water operator to find environmentally sustainable alternatives along with ongoing water project to fulfill demand.

Keywords: Consumption pattern, per capita direct/in-direct water use, domestic water use

Water Footprint of Beverage Industries of Nepal: A Case Study of Varun Beverages (Nepal) Private Limited

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Beverage industry is one of the water intensive industries where water is the key ingredient in all its products and huge amount of water is consumed and/or polluted in the production process. In the recent times, freshwater has become a scarce resource with its annual availability being limited by growing demand that manifolds into serious risks for beverage industries. Water footprint is an emerging concept that provides a comprehensive water accounting tool that promulgates water consumption and pollution of industries throughout the production and supply-chain. This study was carried out to estimate the total water footprint as well as water footprint components of Varun Beverages (Nepal) Private Limited (VBNPL) using the concept and methods given by Water Footprint Assessment Manual 2011. This study has included the water footprint accounting phase - the core of water footprint assessment. The estimation of water footprint values was based on the data of onsite abstraction and discharge (operational) as well as raw materials imported for production (supply-chain). The total water footprint of VBNPL was estimated to be 22.32 million m3 for the year 2013 and 2.45 million m3 for the month of August 2013 with an operational water footprint of 0.06 million m3/month and supply-chain water footprint of 2.39 million m3/month. Most of the water footprint of the industry came from supply-chain related to agricultural inputs while the operational water footprint attributed to a smaller portion. The operational water footprint was mostly grey while the supply-chain water footprint was mostly green. The spatial aspect of water footprint illuminated that the water consumption and pollution by the industry does not only occur in the locality of the factory production site. But, in fact, it also occurs in various parts of Nepal and India as a result of raw materials purchased by the industry for use in the production of products.

Keywords: Supply-chain, operational water footprint, water sustainability, pollution

OTHERS

Chemico-Mineralogical Analysis of Clays Deposited in Kamerotar Area of Bhaktapur, Nepal

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Clay mineral is one of the most important natural products formed by means of chemical & physical weathering, and hydrothermal processes. It is one of the major natural minerals of interest to industrialists and business entrepreneurs in the world, mainly in the fields of ceramic industry, pulp and paper industry, cement industry, petrochemical industry and agricultural industry, pollution control and so on. Hence, it is necessary to characterize the naturally deposited different types of clay minerals in Nepal and to investigate the possible potentialities of these minerals in details for various uses. The main objectives of this research work are to characterize the clay minerals (locally known as KAMERO MATO) deposited in Kamerotar area of Madhyapur Thimi municipality of Bhaktapur district Nepal and to study the mineralogy for their potentiality in different sectors or industries in Nepal. In the present study, the Kamerotar clay mineral was characterized using chemical, X-ray diffraction, Fourier transforms infrared spectroscopic and thermal analysis. Mineralogical analysis of the clay sample was carried out using rational and ionic formula determination methods. The clay sample consists mainly of vermiculite and muscovite type clay minerals in addition of feldspars and quartz as admixtures. Chemical compositions of the clay sample showed high amount of SiO_2 and low amount of Al_2O_3 indicating low amount of clay minerals. The clay sample contained considerable amounts of Fe_2O_3 and MgO which is unfavourable composition for the porcelain productions without modification and purification. The ionic formula determination method was successfully used to study the nature and degree of substitution of different cations in the naturally deposited clay minerals of Kamerotar area, Nepal and hence it becomes very fruitful to explore their industrial applications in different sectors like ceramics, environmental pollution control, petrochemical, paper and pulp so on industries in Nepal.

Keywords: Vermiculite, muscovite, feldspar, quartz, mineralogy, XRD

Study of Bioactivity, Antioxidant and Phytochemical Screening of plant parts of Centella asiatica, Zanthoxylum armatum and Impereta cylindrical from Baglung District of Nepal

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The hexane, methanol and aqueous extracts of leaves of Centella asiatica and Zanthoxylum armatum and roots of Impereta cylindrical from Damek VDC of Baglung District of Nepal were analyzed. The phytochemical screening of extract showed some secondary metabolites, which were also common in many plants while presence of compound varied species to species. All tree extracts showed greatest antimicrobial properties against E. coli and S. aureus. Methanol extract of C. asiatica showed greatest antimicrobial properties, which could be potential sources of new antimicrobial agents. All three plants revealed some antioxidant power in FRAP assay. Leaves extracts of Z. armatum showed highest antioxidant activity.

Keywords: Centella asiatica, Zanthoxylum armatum and Impereta cylindrical, phytochemical screening, antioxidant

Synthesis of Geopolymers from Demolished Brick Dust and their Characterization

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Rapid urbanization and construction of several permanent structures in developing countries impart huge amount of demolition wastes creating economical burdening as well as environmental pollution. These wastes are rich in SiO_2 and Al_2O_3, which can be used as a raw material for the preparation of geopolymer. Geopolymerization is a relatively new technology that transforms aluminosilicate materials into geopolymer, which involves a chemical reaction between solid aluminosilicate oxides and an alkaline activator solution at ambient or slightly elevated temperatures, yielding an amorphous to semi-crystalline polymeric structure with Si–O–Al and Si–O–Si bonds. The present study describes briefly about the potential of geopolymer technology towards green buildings and future sustainability with a reduced carbon footprint. Such geopolymer can be used as a building material which can reduce greenhouse gas emission as well as fulfill the depletion of natural resources. In this study, construction and demolition waste i.e., brick dust was selected. During the variation of sodium hydroxide, a concentration of 6 M was selected, the compressive strength of geopolymer was found to be 6.15 MPa. Further particle size was varied at constant alkali concentration of 6 M. Finally, variation of temperature was carried out at constant alkali concentration and particle size. The maximum compressive strength of the geopolymer thus synthesized was found to be 23.47 MPa.

Keywords: Alkaline activator, compressive strength, construction and demolition waste

Trend Analysis of Land Use / Land Cover Pattern Using GIS and RS in Eastern Churia Region

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Land use and land cover change in any region depend on various attribute such as biophysical condition, terrain, micro climate, carrying capacity, productivity, political scenario, anthropogenic activities, conservation practices and development planning. Land use land cover changes due to deforestation, forest degradation and soil erosion have been a major issue in the Churia region which is considered as "reservoir of water" for Tarai, "the green basket of the country" in Nepal. This research is carried out to understand the trend of land use and land cover change in eastern Churia region covering Sarlahi, Mahottari, Dhanusha, Siraha, Sindhuli and Udayapur districts in Nepal, with the aim to prepare time series maps of land use / land cover change. The study is particularly focused on the analysis of trade off of gain and loss of forest and ranking drivers of change. Drivers of change was identified and ranked from the qualitative data obtained from Focused Group Discussion (FGD) and key informant interview (KIS). The temporal series land use / land cover of eastern Churia region was studied using images from Landsat 5 for 2010, Landsat 7 ETM + for 2000, Landsat 2 MSS for 1980. For Image segmentation and Object Based Image Analysis (OBIA), machine learning Classification and Regression Tree (CART) process was applied. Landsat image spectral and textural variables were used along with two-phase stratified random sample points as training sets for the CART machine learning. Accuracy assessment and verification of result was done with test sets. Land use / land cover status in 1980, 2000 and 2010 were computed. For transition trend analysis, land use / land cover change maps were prepared. Drivers of change were ranked from qualitative data obtained from Focused Group Discussion (FGD) and Key Informant Survey (KIS). Within 30 years of time interval, forest area has increased by 8% from 63% in 1980 to 71% in 2000 and decreased by 19% from 71 % in 2000 to 52% in 2010. The overall result shows that drivers of change for land use / land cover in eastern Churia region are resettlement, illegal harvest of forest product, encroachment, overgrazing, high dependency on forest and forest product, forest fire, unsustainable harvesting practice, expansion of invasive species and infrastructure development.

Keywords: Land use, land cover, land use classification, land use change, drivers of change

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