An Environmental Research Abstract

Headlines Himalaya

May 15 – May 31 (2021) No. 651 - 652 Editorial Team: Arati Gurung and Nirmala Bohara

For the 651st – 652nd issues of Headlines Himalaya, we reviewed researches from three sources and selected nine researches from three countries. We selected three researches from Nepal and six researches from other Himalayan countries (India and Pakistan).

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Nepal-Himalaya

SEEING THE WOOD FOR THE TREES: CARBON STORAGE AND CONSERVATION IN TEMPERATE FORESTS OF THE HIMALAYAS

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Forest Ecology and Management 487: 119010

Forests have a prominent role to play in the success of the UN's Agenda 2030, thus actions to halt deforestation are high on the international sustainability agenda. As humans are altering the composition and extent of forest ecosystems, from local to global scales, we are also affecting the provisioning of forest ecosystem goods and services. We tested how measures of biodiversity, structural diversity, forest disturbances and environmental variables affect above ground tree carbon storage as an essential ecosystem service in differing legally protected forest ecosystems in the central Himalayas. This region is part of a biodiversity hotspot as well as a developing country where rural livelihoods are profoundly dependent on forest resources. We analysed drivers of above ground tree carbon in 530 plots, measuring a total of 6879 individual trees across six forests in three regions in legally protected and un-protected forest ecosystems in the Nepalese Himalayas. The aboveground tree carbon was markedly higher in protected forests (164 ± 8 t/ha) compared to in unprotected forests (114 ± 5 t/ha) but varied across regions. Biodiversity matrices were weakly correlated with above ground tree carbon content (hereafter called 'tree carbon') while the matrices of structural diversity were strongly correlated. Tree size inequalities, canopy cover, elevation, management, tree density, ground disturbance and woody species richness had effects on the tree carbon in bivariate regression models. However, in a multiple linear regression model matrices of structural diversity outweighed biodiversity matrices; tree size inequalities have the largest effect size on tree carbon, followed by elevation, management regime and tree richness. Tree size inequality, elevation and management regime show positive effects while tree richness has negative effect on tree carbon when accounting for the random effects of regions. Our analysis gives an evidence-base in support of forest management that retains tree size inequality, with particular emphasis on protecting large trees, as the best strategy to enhance above ground tree carbon storage and their co-benefits in temperate forests of the Himalayas.

Further reading: https://doi.org/10.1016/j.foreco.2021.119010

PROJECTED SHIFTS IN THE DISTRIBUTION RANGE OF ASIATIC BLACK BEAR (*URSUS THIBETANUS*) IN THE HINDU KUSH HIMALAYA DUE TO CLIMATE CHANGE

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Ecological Informatics 63: 101312

Climate change is one of the main threats to many vulnerable species, including the Asiatic black bear (*Ursus thibetnus*), due to disruption in biological and ethological responses, hibernation, reproduction, and intraspecific and interspecific interactions. To assess the current and future distribution of the Asiatic black bear in the Hindu Kush Himalaya (HKH), we used maximum entropy modeling (MaxEnt) with species presence data and bioclimatic (under two representative concentration pathways i.e., RCP4.5 and RCP8.5) and non-climatic variables. We identified current and future suitable habitats, climate refugia, increased suitable habitat and vulnerable habitat. Our model estimated that a 487,036 km^2 area of the HKH is currently suitable for the Asiatic black bear, and projected that 458,060 km^2 and 470,368 km^2 areas will be suitable under RCP4.5 and RCP8.5, respectively, by 2050. The maximum area (of the current suitable habitat) projected as climate refugia under RCP4.5 and RCP8.5 was 350,510 km^2 and 342,796 km^2, respectively. The model projected a shift in the bear's range towards higher elevations, primarily >3500 m under both RCPs with change an average elevation from 2697 m (under current scenario), to 2949 m (under RCP4.5) and 3021 m (under RCP8.5). Such changes may lead to scarcity of natural resources and increase the dependency of bears on human-related food, which will likely result in increased

human-bear conflicts and bear mortalities. The recommended implications, including climate refugia management by habitat corridors, establishment of and increased status for existing natural reserves, improved adaptive management capacity, and strengthening monitoring of bear populations could help to mitigate the intensity of the adverse impacts of climate change on the bear's population.

Further reading: https://doi.org/10.1016/j.ecoinf.2021.101312

CLIMATIC CHANGE AND ITS IMPACT ON TOMATO *(LYCOPERSICUM ESCULENTUM L.)* PRODUCTION IN PLAIN AREA OF NEPAL

Environmental Challenges 4: 100129

Roshan Bhandari, Nilhari Neupane, and Danda Pani Adhikari

The present study attempts to assess the tomato productivity trend, potential diseases impacting tomato farming and attitudes and practices of tomato cultivators under the light of changing climate in Lalbandi, Sarlahi, Nepal. Meteorological data of the Lalbandi station was analyzed; 89 households out of 248 tomato growers in Lalbandi were surveyed and five key Informant's Interviews as well as one Focus Group Discussion were conducted to understand the perception of tomato cultivators. In the area, average summer temperature over the last 30 years increased by 0.02°C per annum and maximum annual winter temperature rose by 0.01°C, while minimum winter temperature dropped by 0.02°C /year. Likewise, annual precipitation and monsoon precipitation declined by about 31.5 mm and 25.3 mm each year, respectively. Tomato plants were observed to have suffered from various diseases such as late blight, leaf curl, and black spot which could be attributed to change in climatic conditions. Despite the increment in number of diseases, productivity, however, has slightly increased since 2003 due to the excessive use of chemical pesticides. It is expected that plastic house technology, use of hybrid varieties of tomato and application of organic pesticides and fertilizers could significantly yield more tomato in Lalbandi area.

Further reading: https://doi.org/10.1016/j.envc.2021.100129

India -Himalaya

COMPROMISING SITUATION OF INDIA'S BIO-MEDICAL WASTE INCINERATION UNITS DURING PANDEMIC OUTBREAK OF COVID-19: ASSOCIATED ENVIRONMENTAL-HEALTH IMPACTS AND MITIGATION MEASURES

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Environmental Pollution 276: 116621

COVID-19 induced pandemic situations have put the bio-medical waste (BMW) management system, of the world, to test. Sudden influx, of COVID-infected patients, in health-care facilities, has increased the generation of yellow category BMW (Y-BMW) and put substantial burden on the BMW-incineration units of India. This study presents the compromising situation of the BMW-incineration units of India, in the wake of COVID-19 pandemic, from 21st March 2020 to 31st August 2020. This analysis revealed that on an average each COVID-infected patient in India generates approximately 3.41 kg/d of BMW and average proportion of Y-BMW in it is 50.44%. Further, it was observed that on 13th July 2020, the total Y-BMW, generated by both the normal and COVID-infected patients, fully utilized the BMW-incineration capacity of India. Also, it was made evident that, during the study period, BMW-incineration emitted several pollutants and their concentration was in the order: NO_x > CO > SO_x > PM > HCl > Cd > Pb > Hg > PCBs > Ni > Cr > Be > As. Subsequently, life time cancer risk assessment

depicted that with hazard quotient >10^{-6}, Cd may induce carcinogenic health impacts on both the adults and children of India. Therefore, to mitigate the environmental-health impacts associated with the incineration of BMW, evaluation of various options, viz., alternative technologies, substitution of raw materials and separate treatment of specific wastes, was also done. It is expected that the findings of this study may encourage the global auditory comprising scientific community and authorities to adopt alternate BMW-management strategies during the pandemic.

Further reading: https://doi.org/10.1016/j.envpol.2021.116621

A CRITICAL REVIEW OF FOREST BIOMASS ESTIMATION EQUATIONS IN INDIA

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Trees, Forests and People 5: 100098

Plant biomass is an integral part of the global carbon cycle and a renewable energy source that can deaccelerate the rising global temperature. India has 71 million ha (M ha) of land under forests represented by tropical to alpine ecosystems. Numerous direct and indirect species-specific and mixed-species equations have been used for biomass estimation in India. Biomass estimation equations that facilitate the prediction of aboveground biomass (AGB) stocks non-destructively across India are still lacking. Therefore, the objective of this review is to (i) assess the existing species-specific biomass estimation equations for trees, bamboos, palms, and bananas in India, (ii) assess and identify the most appropriate multi-species biomass estimation equations for AGB estimation across India, and (iii) define the critical research gaps in biomass estimation in India. The literature search found 85 species-specific and six multi-species AGB estimation equations reported from India. It was also found that a 50% of these equations were based on the power-law function using diameter at breast height (D) as the predictor variable. We carried out a multi-fold validation to compare the multi-species equation's compatibility by comparing the root mean square error (RMSE). The estimated RMSE values of the six reported multi-species equations showed that the following two equations could be effectively used for estimation of AGB: (i) lnAGB= 0.349+1.316 lnGBH and (ii) AGB= $(0.18D^{2.16}) \times 1.32$. These are adequate for predicting biomass of any woody species across a range of conditions in India.

For further reading: https://doi.org/10.1016/j.tfp.2021.100098

ECONOMIC SIGNIFICANCE OF WILD BIORESOURCES TO RURAL COMMUNITIES IN THE EASTERN HIMALAYAN STATE OF ASSAM, NOTRHEAST INDIA

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Trees, Forests and People 5: 100102

Wild bioresources are indispensable for the survival and sustenance of ethnic and rural communities, especially those of Northeast (NE) India which has a rich heritage of indigenous traditional knowledge on biodiversity and bioresources. This study investigates the trade of wild bioresources throughout the Eastern Himalayan state of Assam along with the socio-economic attributes of the communities involved in the trade system. Surveys and interviews were executed in local markets and village households. Interviews were carried out with vendors and consumers in 30 weekly markets, and with household heads in 550 households using open-ended structured

questionnaires. A systematic database on species diversity, distribution, use pattern, availability, local market economics and community details was assembled, from which standard values of commodities were computed to facilitate uniformity of market values. The study recorded 5 species of wild edible mushrooms, 158 species of wild plants and 11 species of animals available in local markets. Among these 78.7% are consumed as food, while 77 of the total species are medicinal. In some markets, products of species like *Amaurornis phoenicurus, Canarium strictum, Elaeocarpus ganitrus, Hystrix indica, Lentinus polychrous, L. squarrosulus, Ocimum basilicum, Piper longum* and *Termitomyces* sp., were sold at a high price of 6.5–65 USD/kg. It was observed that trading wild bioresources contributes 5–75% to the total income at a majority of the households. The present study highlights that wild bioresources are indeed significant for the subsistence of rural communities in Assam, with the potential of improving local economies and promoting community development. Through effective policies and conservation strategies, local communities should be encouraged and empowered to sustainably manage biodiversity and bioresources in the wake of climate change.

Further reading: https://doi.org/10.1016/j.tfp.2021.100102

AEROSOLS OPTICAL DEPTH AND ÅNGSTRÖM EXPONENT OVER DIFFERENT REGIONS IN GARHWAL HIMALAYA, INDIA

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Environmental Monitoring and Assessment 193: 324

Aerosol optical depth (AOD) and Ångström exponent (AE) are observed to be important parameters in understanding the status of ambient aerosol concentration over a particular location and depend not only upon the local but also on the large-scale dynamics of the atmosphere. The present article analyses the AOD and AE parameters retrieved with Moderate Resolution Imaging Spectrometer (MODIS) and Multi-angle Imaging Spectro-Radiometer (MISR) instruments onboard satellites, for the upper (Chamoli) and foothill (Dehradun) regions of Garhwal Himalaya in Uttarakhand, India, from 2006 to 2015. Aerosol properties are investigated at monthly, seasonal, and annual scales. The monthly mean values of MODIS-derived AOD and AE were observed to be 0.18 (± 0.14) and 1.05 (± 0.43) respectively over the Dehradun region. The seasonal maximums in AOD with MODIS and MISR were observed as 0.23 ± 0.06 and 0.29 ± 0.07 respectively in the pre-monsoon season, and the minimum values (0.099 ± 0.02) were observed in the post-monsoon season, over the Dehradun region. In contrast, in the Chamoli region, the maximum AOD (MODIS) was 0.21 ± 0.06 observed in the monsoon season and the minimum was 0.036 ± 0.007 in the post-monsoon season. Over a decade, the AE for Chamoli and Dehradun was found to vary from 0.07 to 0.17 and from 0.14 to 0.20 respectively. The median AE for Chamoli and Dehradun was found to be 1.49 and 1.47 respectively, marking the dominance of fine mode particles of anthropogenic origin. Observations show the presence of dust and polluted dust resulting from the long-range transport from the west. The comparison of AOD values from the two sensors shows a significant correlation (0.73) with slightly higher values from MISR over the year. The results obtained are important in understanding the climatic implications due to the atmospheric aerosols over the abovementioned Himalayan region of Uttarakhand, India.

Further reading: https://doi.org/10.1007/s10661-021-09048-4

INFLUENCE OF ALTITUDE ON DIVERSITY AND DISTRIBUTION PATTERN OF TREES IN HIMALAYAN TEMPERATE FORESTS OF CHURDHAR WILDLIFE SANCTUARY, INDIA

Usha Thakur, Narendra Singh Bisht, Munesh Kumar, and Amit Kumar

Water, Air, & Soil Pollution 232: 205

This study aimed to investigate the diversity and distribution pattern of tree in different altitudes in a protected area of Churdhar Wildlife Sanctuary (CWS), situated in Himachal Pradesh, Western Himalaya, India. CWS is one of the famous sanctuaries and rich in biodiversity. The tree species analysis was done with the stratified sampling technique by performing a random sampling using the quadrats method. The study area was divided into four different altitudes: (i) Chhogtali (CT; 1900–2200 masl), (ii) Churas (CH; 1900–2200 masl), (iii) Nohra 1 (NH1; 2800–3200 masl), and (iv) Nohra 2 (NH2; 2800–3200 masl). Among the studied sites, results revealed that tree species richness decreases with an increase in altitude. *Quercus leucotrichophora* was dominant in CT and CH sites, whereas *Q. semecarpifolia* was dominant in NH1 and *Abies spectabilis* in NH2 sites. *Picea smithiana reported to be dominant species in the studied sites*. Compared to CT and CH sites, the dominance-diversity (d-d) curve showed a decrease in species richness on HN1 and NH2 at higher altitudes, whereas tree total basal cover (TBC) increases with altitude. The maximum similarity was between CT and CH sites and reduced between CT and NH2 sites with higher altitudes. Almost all tree species exhibited contagious distribution patterns which are common in natural forests; however, a few species showed random distribution, and no species were found distributed regularly. This study provides fruitful information to the policy-makers, environmentalists, and foresters to understand species diversity and distribution with species composition and structure with altitude. Thus, conservation and sustainable management strategies of the forest could be design in better ways to conserve diversity on a regional and/or global scale.

Further reading: https://doi.org/10.1007/s11270-021-05162-8

Pakistan -Himalaya

GEOHAZARDS SUSCEPTIBILITY ASSESSMENT ALONG THE UPPER INDUS BASIN USING FOUR MACHINE LEARNING AND STASTISTICAL MODELS

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International journal of Geo-information 10: 315

The China–Pakistan Economic Corridor (CPEC) project passes through the Karakoram Highway in northern Pakistan, which is one of the most hazardous regions of the world. The most common hazards in this region are landslides and debris flows, which result in loss of life and severe infrastructure damage every year. This study assessed geohazards (landslides and debris flows) and developed susceptibility maps by considering four standalone machine-learning and statistical approaches, namely, Logistic Regression (LR), Shannon Entropy (SE), Weights-of-Evidence (WoE), and Frequency Ratio (FR) models. To this end, geohazard inventories were prepared using remote sensing techniques with field observations and historical hazard datasets. The spatial relationship of thirteen conditioning factors, namely, slope (degree), distance to faults, geology, elevation, distance to rivers, slope aspect, distance to road, annual mean rainfall, normalized difference vegetation index, profile curvature, stream power index, topographic wetness index, and land cover, with hazard distribution was analyzed. The results showed that faults, slope angles, elevation, lithology, land cover, and mean annual rainfall play a key role in controlling the spatial distribution of geohazards in the study area. The final susceptibility maps were validated against ground truth points and by plotting Area Under the Receiver Operating Characteristic (AUROC) curves. According to the AUROC curves, the success rates of the LR, WoE, FR, and SE models were 85.30%, 76.00, 74.60%, and 71.40%, and their prediction rates were 83.10%, 75.00%, 73.50%, and 70.10%, respectively; these values show higher performance of LR over the other three models. Furthermore, 11.19%, 9.24%, 10.18%, 39.14%, and 30.25%

of the areas corresponded to classes of very-high, high, moderate, low, and very-low susceptibility, respectively. The developed geohazard susceptibility map can be used by relevant government officials for the smooth implementation of the CPEC project at the regional scale.

Further reading: https://doi.org/10.3390/ijgi10050315