An Environmental Research Abstract

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For the 725th - 726th issues of Headlines Himalaya, we reviewed research papers from seven sources and selected 12 research papers from five countries. We selected three papers from Nepal and nine from other Himalayan Countries (India, China, Bhutan, and Pakistan).

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SPATIAL PATTERNS AND CLIMATIC DRIVERS OF PHYLOGENETIC STRUCTURE FOR FERNS ALONG THE LONGEST ELEVATIONAL GRADIENT IN THE WORLD

Hong Qian, Michael Kessler, and Yi Jin

Ecography 2022: e06516

Many biodiversity hotspots are located in montane regions, thus, understanding the underlying mechanisms driving species assembly along elevational gradients is of major interest in ecology and biogeography. Here, we assess spatial patterns and climatic drivers, and the effects of clade age, on patterns of phylogenetic structure of ferns along the world's longest elevational gradient in the central Himalaya. We used correlation and regression analyses to relate metrics of phylogenetic structure reflecting both shallow (tip-weighted) and deep (basal-weighted) evolutionary histories of ferns, and their two major groups reflecting different ages (polypods representing a young clade, all other ferns representing old clades), in fifty 100-m vertical bands to climatic factors representing different aspects of climatic conditions (mean climate, stressful climate and climate seasonality). Variation partitioning analysis was used to determine the relative importance of each group of climatic factors on phylogenetic structure. We find that the composition of fern assemblages along the Himalayan elevational gradient in Nepal shows strong signatures of evolutionary processes. In a simplified way, species-rich assemblages at mid-elevations are likely the result of recent radiations in combination with low extinction rates, whereas species-poor assemblages at low elevations are composed of numerous lineages with limited radiations, and those at high elevations of few lineages, also with limited signature of recent radiations. Variables related to temperature and climatic extremes tended to play a more important role than precipitation- and seasonality-related variables, respectively, in driving fern phylogenetic structure. Combining the results of ferns and angiosperms suggests that there are a few generally consistent evolutionary processes that apply to all plant groups (e.g. niche conservatism and environmental filtering), but that the specific outcomes of these processes vary with elevation, clade age and taxon.

For further reading: https://doi.org/10.1111/ecog.06516

WHAT MOTIVATES SMALLHOLDER FARMERS TO ADAPT TO CLIMATE CHANGE? INSIGHTS FROM SMALLHOLDER CROPPING IN FAR-WESTERN NEPAL

Prahlad Lamichhane, Kelly K Miller, Michalis Hadjikakou, and Brett A. Bryan

Anthropocene 40: 100355

Adaptation to climatic change in smallholder agriculture is pivotal to ensuring food security in many developing countries. Research into adaptation to climate change in smallholder agriculture has often used capital-based indicator frameworks, with only limited consideration of the cognitive dimensions influencing adaptation motivation. In this study, we interviewed 327 farmers in far-western Nepal and the responses were used in structural equation modelling to quantify determinants of adaptation motivation. Results indicate that farmers

with a higher level of adaptation appraisal are motivated to adapt, whereas the higher level of threat appraisal exhibited a weak influence. Social drivers such as incentives and subjective norms had a weak effect. Risk experience influenced adaptation motivation negatively. Adaptation cost was negatively related to the adaptation appraisal. Determinants of adaptation motivation varied across agroecosystems. These results suggest that effective adaptation policies must emphasise on the factors that positively contribute to adaptation motivation (e.g., adaptation efficacy) and target interventions that break down the barriers to adaptation (e.g., adaptation cost), while boosting trust and confidence in farmers to adaptation measures. Findings can inform adaptation policies in similar smallholder contexts of Asia/South Asia, while the research approach can be used to generate insights into farmers' adaptation motivation globally.

For further reading: https://doi.org/10.1016/j.ancene.2022.100355

SOIL RESPIRATION VARIATIONS IN TEMPERATE *RHODODENDRON* (*RHODODENDRON ARBOREUM*) FOREST OF ANNAPURNA CONSERVATION AREA (ACA) IN NEPAL

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International Journal of Forestry Research 2022: 1677084

Temperate forests are considered most fragile hence need to recognize their vulnerability owing to continuous climatic changes and anthropogenic activities. In this study, we assessed soil respiration (SR) by using the chamber method in a natural *Rhododendron* (*Rhododendron arboreum*) forest which is recognized as the world's largest forest type located at Annapurna Conservation Area in the temperate region of Nepal. We evaluated the consequences of multiple ecological parameters mainly climatic and biotic factors on SR variations during the month of October in 2016 and 2017. Our results confirmed that SR well corresponded with soil temperature (ST) variables represented with the highly significant ($p<0.05$) exponential curve ($y = 1.049e^{0.529x}$, 2016 and $y = 26.34e^{0.284x}$, 2017). And the variation in SR was mediated by a short-range (2-3°C) of ST difference in the month of October during autumn season. However, the effect of soil water content (SWC) on SR was scattered and the photosynthetic photon flux density (PPFD) stood weak to represent the SR variation. The seasonal trend of SR was compatible with the PPFD and litter input with having accountable temporal, diurnal, and interannual variations of SR, ST, SWC, and litterfall. The SR over the entire measurement period were averaged at 269.9 mg CO_2 $m^{-2}{\cdot}h^{-1}$ in 2016 and 295.1 mg CO_2 $m^{-2}{\cdot}h^{-1}$ in 2017. Our study manifested that temperate forests could store maximum soil carbon with limited emission through SR and become a larger sink of atmospheric carbon dioxide even though SR is very sensitive to environmental changes and interactively affected by multiple ecological factors. Thus, our finding is an appreciable measure for the temperate forest to understand the regional carbon balance and suggested temperate forests are valued to incorporate them in evaluating global carbon budget.

For further reading: https://doi.org/10.1155/2022/1677084

India-Himalaya

REJUVENATING IMPACT OF COVID-19 LOCKDOWN ON MAJOR ENVIRONMENTAL PARAMETERS: AN INDIAN PERSPECTIVE

Deepak Kumar Jha, Niti Yashvardhini, Samiksha, and Amit Kumar

Spatial Information Research 30: 1 - 13

The recent coronavirus outbreak caused severe impact on the life of people. Despite of several health and economic losses, COVID-19 pandemic induced lockdown proved to be a boon for the environment. This review highlights the positive impact of COVID-19 induced lockdown on the environment; enumerating its effect on air quality indices, water quality indices, wildlife and noise pollution, therefore, focusing on the brighter side of the effects of lockdown. Notably, in India, rivers like Ganga and Yamuna showed a drastic reduction in water pollutant levels. For the first time in a generation, the Himalayas were visible from various parts of India. The amount of waste generated also showed a decline during the lockdown, and wildlife was seen blooming. During the lockdown period temperature levels were also recorded low as compared to 2019 between March to June. Hence, this review emphasizes the beneficial impacts of lockdown on different pollution parameters as well as wildlife in India.

For further reading: https://doi.org/10.1007/s41324-022-00499-6

EFFECT OF GROUNDWATER TABLE FLUCTUATION ON SLOPE INSTABILITY: A COMPREHENSIVE 3D SIMULATION APPROACH FOR KOTROPI LANDSLIDE, INDIA

Soumya Darshan Panda, Saurabh Kumar, Sarada Prasad Pradhan, Jaspreet Singh, Abhishek Kralia , and Mahesh Thakur

Landslides 2022: 1 - 20

In the hilly terrain of the Indian Himalayas, prolonged severe rainfall and subsequent rise of the water table during the Indian monsoon season are the most prevalent prerequisites for the development of deep-seated landslides. The Kotropi landslide in the mountainous region of Himachal Pradesh represents such a suitable site; its location in the North-West (NW) Himalayas and varying depth of groundwater table (GWT) throughout the year along with several other geological factors resulted in the third reactivation of the slide on August 13th of 2017. To properly quantify and demonstrate the effect of GWT fluctuation on slope instability, this research proposes a comprehensive approach. It integrates the 3D model–building process of the entire slide with the simulation process of that model using FLAC 3D software. To determine the geometry of the slide and the depth of the GWT, a total station tacheometric survey and an electrical resistivity tomography (ERT) study were conducted respectively. When the model was simulated at different GWT depths of 15 m, 10 m, 5 m, and surface, the factor of safety (FoS) dropped from 1.21 to 0.86, indicating slope instability as GWT rises. The findings highlight the importance of groundwater fluctuation modeling in slope instability studies of deep-seated landslides. The simulated models show impending failure in the right flank, which was validated during a recent field visit in April 2022. This study provides useful insights for examining the failure mechanism of deep-seated landslides in the Himalayan terrain.

For further reading: https://doi.org/10.1007/s10346-022-01993-6

GEOSPATIAL MODELING TO ASSESS THE PAST AND FUTURE LAND USE-LAND COVER CHANGES IN THE BRAHMAPUTRA VALLEY, NE INDIA, FOR SUSTAINABLE LAND RESOURCE MANAGEMENT

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Environmental Science and Pollution Research 2022: 1 - 24

Satellite remote sensing and geographic information system (GIS) have revolutionalized the mapping, quantifying, and assessing the land surface processes, particularly analyzing the past and future land use-land cover (LULC) change patterns. Worldwide river basins have observed enormous changes in the land system dynamics as a result of anthropogenic factors such as population, urbanization, development, and agriculture. As is the scenario of various other river basins, the Brahmaputra basin, which falls in China, Bhutan, India, and Bangladesh, is also witnessing the same environmental issues. The present study has been conducted on the Brahmaputra Valley in Assam, India (a sub-basin of the larger Brahmaputra basin) and assessed its LULC changes using a maximum likelihood classification algorithm. The study also simulated the changing LULC pattern for the years 2030, 2040, and 2050 using the GIS-based cellular automata Markov model (CA-Markov) to understand the implications of the ongoing trends in the LULC change for future land system dynamics. The current rate of change of the LULC in the region was assessed using the 48 years of earth observation satellite data from 1973 to 2021. It was observed that from 1973 to 2021, the area under vegetation cover and water body decreased by 19.48 and 47.13%, respectively. In contrast, cultivated land, barren land, and built-up area increased by 7.60, 20.28, and 384.99%, respectively. It was found that the area covered by vegetation and water body has largely been transitioned to cultivated land and built-up classes. The research predicted that, by the end of 2050, the area covered by vegetation, cultivated land, and water would remain at 39.75, 32.31, and 4.91%, respectively, while the area covered by built-up areas will increase by up to 18.09%. Using the kappa index (ki) as an accuracy indicator of the simulated future LULCs, the predicted LULC of 2021 was validated against the observed LULC of 2021, and the very high ki observed validated the generated simulation LULC products. The research concludes that significant LULC changes are taking place in the study area with a decrease in vegetation cover and water body and an increase of area under built-up. Such trends will continue in the future and shall have disastrous environmental consequences unless necessary land resource management strategies are not implemented. The main factors responsible for the changing dynamics of LULC in the study area are urbanization, population growth, climate change, river bank erosion and sedimentation, and intensive agriculture. This study is aimed at providing the policy and decision-makers of the region with the necessary what-if scenarios for better decision-making. It shall also be useful in other countries of the Brahmaputra basin for transboundary integrated river basin management of the whole region.

For further reading: https://doi.org/10.1007/s11356-022-24248-2

IMPACT OF ENVIRONMENTAL GRADIENTS ON PHENOMETRICS OF MAJOR FOREST TYPES OF KUMAON REGION OF THE WESTERN HIMALAYA

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Forests 13: 1973

Understanding ecosystem functional behaviour and its response to climate change necessitates a detailed understanding of vegetation phenology. The present study investigates the effect of an elevational gradient, temperature, and precipitation on the start of the season (SOS) and end of the season (EOS), in major forest types of the Kumaon region of the western Himalaya. The analysis made use of the Normalised Difference Vegetation Index (NDVI) time series that was observed by the optical datasets between the years 2001 and 2019. The relationship between vegetation growth stages (phenophases) and climatic variables was investigated as an interannual variation, variation along the elevation, and variation with latitude. The SOS indicates a delayed trend along the elevational gradient (EG) till mid-latitude and shows an advancing pattern thereafter. The highest rate of change for the SOS and EOS is 3.3 and 2.9 days per year in grassland (GL). The lowest rate of temporal change for SOS is 0.9 days per year in mixed forests and for EOS it is 1.2 days per year in evergreen needle-leaf forests (ENF).

Similarly, the highest rate of change in SOS along the elevation gradient is 2.4 days/100 m in evergreen broadleaf forest (EBF) and the lowest is −0.7 days/100 m in savanna, and for EOS, the highest rate of change is 2.2 days/100 m in EBF and lowest is −0.9 days/100 m in GL. Winter warming and low winter precipitation push EOS days further. In the present study area, due to winter warming and summer dryness, despite a warming trend in spring season or springtime, onset of the vegetation growth cycle shows a delayed trend across the vegetation types. As vegetation phenology responds differently over heterogeneous mountain landscapes to climate change, a detailed local-level observational insight could improve our understanding of climate change mitigation and adaptation policies.

For further readings: https://doi.org/10.3390/f13121973

China Himalaya

GLACIAL LAKE OUTBURST FLOOD HAZARD UNDER CURRENT AND FUTURE CONDITIONS: WORST-CASE SCENARIOS IN A TRANSBOUNDARY HIMALAYAN BASIN

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Natural Hazards and Earth System Sciences 22: 3765 – 3785

Glacial lake outburst floods (GLOFs) are a major concern throughout High Mountain Asia, where societal impacts can extend far downstream. This is particularly true for transboundary Himalayan basins, where risks are expected to further increase as new lakes develop. Given the need for anticipatory approaches to disaster risk reduction, this study aims to demonstrate how the threat from a future lake can be feasibly assessed alongside that of worst-case scenarios from current lakes, as well as how this information is relevant for disaster risk management. We have focused on two previously identified dangerous lakes (Galongco and Jialongco), comparing the timing and magnitude of simulated worst-case outburst events from these lakes both in the Tibetan town of Nyalam and downstream at the border with Nepal. In addition, a future scenario has been assessed, whereby an avalanche-triggered GLOF was simulated for a potential large new lake forming upstream of Nyalam. Results show that large (>20×10^6 m^3) rock and/or ice avalanches could generate GLOF discharges at the border with Nepal that are more than 15 times larger than what has been observed previously or anticipated based on more gradual breach simulations. For all assessed lakes, warning times in Nyalam would be only 5–11 min and 30 min at the border. Recent remedial measures undertaken to lower the water level at Jialongco would have little influence on downstream impacts resulting from a very large-magnitude GLOF, particularly in Nyalam where there has been significant development of infrastructure directly within the high-intensity flood zone. Based on these findings, a comprehensive approach to disaster risk management is called for, combining early warning systems with effective land use zoning and programmes to build local response capacities. Such approaches would address the current drivers of GLOF risk in the basin while remaining robust in the face of worst-case, catastrophic outburst events that become more likely under a warming climate.

For further readings: https://doi.org/10.5194/nhess-22-3765-2022

RESPONSE OF SOIL MICROBIAL COMPOSITIONAL AND FUNCTIONAL HETEROGENEITY TO GRAZING EXCLUSION IN ALPINE SHRUB AND MEADOWS IN THE QINGHAI–TIBET PLATEAU

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Frontiers in Microbiology 13: 1038805

Soil microorganisms found in shrub-meadow ecosystems are highly heterogeneous and extremely sensitive to grazing, but changes in microbial compositional and functional heterogeneity during grazing exclusion (GE) have been largely overlooked compared to community diversity. We collected soil samples from heavily grazed plots (6.0 sheep/ha) and GE plots (matrix and patch areas in both), and used a combination of next-generation sequencing, vegetation features, and the associated soil property data to investigate the effect of GE on the composition and function of microbial communities (bacteria fungi, and archaea) in 0–10 cm soils. Regarding community composition, the proportions of species in bacteria, fungi, and archaea were 97.3, 2.3, and 0.4%, respectively. GE significantly affected the species diversity of fungi and archaea but not that of bacteria. GE decreased the heterogeneity of bacteria (2.9% in matrix and 6.2% in patch) and archaea (31.1% in matrix and 19.7% in patch) but increased that of fungi by 1.4% in patch. Regarding community function, enzyme diversity and heterogeneity were increased by 10.4 and 9.4%, respectively, in patch after 6 years of fencing, exemplifying a high level of microbial functional redundancy. The Kyoto Encyclopedia of Genes and Genome pathways—cell growth and death, translation, digestive system, and nucleotide metabolism—were functional biomarkers (linear discriminant analysis effect size method) in matrix-non-grazed plots, whereas lipid metabolism, xenobiotics biodegradation and metabolism, and metabolism of terpenoids and polyketides, cell motility, cancer: overview, endocrine system, and membrane transport were biomarkers in patch-non-grazed plots. Additionally, GE improved the capacity for fatty acid metabolism but decreased the abundance of methane-producing archaea by 42.9%. Redundancy analysis revealed that the factors that affected microbial composition the most were soil aggregates, soil moisture, and the number of plant species, whereas those that affected microbial function the most were soil available phosphorus, soil temperature, and shrub canopy diameter. Our results quantified soil microbial heterogeneity, emphasizing the different responses of the composition and function of bacteria, fungi, and archaea to GE in alpine shrubs and meadows.

For further reading: https://doi.org/10.3389/fmicb.2022.1038805

AN ETHNOBOTANICAL STUDY ON WILD PLANTS USED BY TIBETAN PEOPLE IN GYIRONG VALLEY, TIBET, CHINA

Chang-An Guo, Xiaoyong Ding, Huabin Hu, Yu Zhang, Huizhao Yang, and Yuhua Wang

Journal of Ethnobiology and Ethnomedicine 18: 67

Gyirong Valley known as the “Back Garden of the Himalayas” is located in the core area of the Everest National Nature Reserve. It is also one of the important ports from ancient Tibet to Kathmandu, Nepal, since ancient times. Over the years, the Tibetans of Gyirong had accumulated sufficient traditional knowledge about local plant resources. However, there is almost no comprehensive report available on ethnobotanical knowledge about the local people. The purposes of this study were to (1) conduct a comprehensive study of wild plants used by Tibetan people in Gyirong Valley and record the traditional knowledge associated with wild useful plants, (2) explore the influence of Tibetan traditional culture and economic development on the use of wild plants by local people, and (3) explore the characteristics of traditional knowledge about wild plants of Tibetans in Gyirong. Ethnobotanical data were documented through free listings, key informant interviews and semi-structured interviews during fieldwork. The culture importance index and the informant consensus factor index were used as quantitative indices. In total, 120 informants (61 women and 59 men) and 3333 use reports and 111 wild plant species belonging to 39 families and 81 genera were included. These use reports were then classified into 27 categories belonging to three major categories. The use category that contained the most plant species was edible plants

(62), followed by medicinal plants (32) and economic plants (22), and other uses (71). Plants with high CI included *Allium prattii, Neopicrorhiza scrophulariiflora, Gymnadenia orchidis, Rhododendron anthopogon and Fritillaria cirrhosa.* Thirty-six species of plants in the catalog of Gyirong and Yadong were the same, but only 17 species were the same in Gyirong and Burang. There were only 11 overlapping species between all the three regions. Tibetans of Gyirong have rich and unique knowledge about plant use, and wild edible and medicinal plants play an important role in the nutrition and health protection of local people. However, traditional knowledge is slowly being lost and is being hit by modern tourism. In the future, more attention needs to be paid to the important role of traditional knowledge in biodiversity conservation.

For further reading: http://dx.doi.org/10.1186/s13002-022-00565-1

Bhutan-Himalaya

OCCURRENCE OF FOLIICOLOUS FUNGUS ZYGOSPORIUM MONT. (ZYGOSPORIACEAE) FROM THE MIO-PLIOCENE OF EASTERN HIMALAYA

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Review of Palaeobotany and Palynology 309: 104803

Zygosporium Mont. (Zygosporiaceae, Xylariales, Sordariomycetes) is known to have saprophytic or parasitic relationship with various modern angiosperms. Fossil record of such an interaction is unknown till date. Here, we report in situ occurrence of asexual morphs of two fossil species of *Zygosporium* from the Neogene Siwalik sedimentary strata of eastern Himalaya for the first time. *Z. palaeotuberculatum* sp. nov. is found to be interacting with leaves cf. *Woodfordia* sp. Khan et al. (Lythraceae) and *Glochidion palaeogamblei* Khan and Bera (Euphorbiaceae) from the lower Siwalik strata of Darjeeling (middle Miocene to late Miocene) and middle Siwalik strata of Arunachal sub-Himalaya (Pliocene) respectively, whereas, *Z. miochinensis* sp. *nov*. is found on the leaf cuticle of *Terminalia panandhroensis* Lakhanpal and Guleria (Combretaceae) from the Formation II (Pliocene) strata of Bhutan. These fungal morphotypes possibly developed in a tropical evergreen to deciduous forest under warm, moist environmental condition in the eastern Himalaya during deposition.

For further reading: https://doi.org/10.1016/j.revpalbo.2022.104803

Pakistan- Himalaya

GIS-BASED ASSESSMENT OF SELECTIVE HEAVY METALS AND STABLE CARBON ISOTOPES IN GROUNDWATER OF ISLAMABAD AND RAWALPINDI, PAKISTAN

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Frontiers in Environmental Science 10: 1027323

This study applied a nuclear technique in conjunction with a classical monitoring tool to characterize the origin, fate, and behavior of metal pollutants in groundwater of Islamabad-Rawalpindi Metropolitans, which are also known as the “twin cities.” In total, 122 groundwater samples were collected and analyzed in accordance with standard methods. GIS and multivariate statistical analysis were employed for the ground water vulnerability assessment and source apportionment. The results of the aesthetic parameters indicated that the majority of groundwater sources were tested and were colorless, odorless and tasteless in the “twin cities.” In addition, the findings of this study indicated that the concentration of pH, phosphates, copper, manganese, and zinc were within the drinking water standards in the “twin cities” as stipulated by the World Health Organization (WHO) and Pakistan Standard and Quality Control Authority (PSQCA) at all sampling points in the study area. The groundwater quality was found unsuitable for consumption due to elevated levels of electrical conductivity and total dissolved solids at 9.83% and 4.09% of samples, respectively. The contents of arsenic and fluoride were well within the allowable range at almost all points except at one location. However, iron and lead contents were above permissible limits. A statistical analysis revealed that trace metals originated from both geogenic and anthropogenic sources such as enhanced rock-water interaction, over abstraction, evaporation enrichment, improper waste disposal, discarded batteries, cross contamination of water supply and sewerage lines, active recharge from Lie drain, and domestic, industrial, and agricultural effluents. The computed water quality index (WQI) based on heavy metals elucidated that groundwater quality was poor in most of the study area due to elevated electrical conductivity, total dissolved solids, lead, iron, arsenic, fluoride values. A highly depleted isotopic composition of ^{13}C provides clues about the aquifer’s vulnerability from miscellaneous sources such as domestic, urban, construction, and agricultural sites and the dissolution of carbonate minerals. This study clearly indicates that a rapidly growing population, unplanned urbanization, industrialization, improper waste disposal, over abstraction, and a lack of water abstraction policies are significantly contributing toward the impairment of groundwater quality in the study area. The study strongly emphasized the need to regulate ground water abstraction by improving water treatment and the supply system for the provision of safe water to the urban populace. These results will help in designing remedial strategies for improving water quality in the “twin cities”.

For further reading: http://dx.doi.org/10.3389/fenvs.2022.1027323