An Environmental Research Abstract

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For the 735th-736th issues of Headlines Himalaya, we reviewed research papers from five sources and selected 12 research papers from three countries (Nepal, India and Pakistan). We selected three papers from Nepal and nine from other Himalayan countries (India and Pakistan).

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CHARACTERIZATION OF FOREST ECOSYSTEMS IN THE CHURE (SIWALIK HILLS) LANDSCAPE OF NEPAL HIMALAYA AND THEIR CONSERVATION NEED

Yadav Uprety , Achyut Tiwari, Sangram Karki, Anil Chaudhary, Ram Kailash Prasad Yadav, Sushma Giri, Srijana Shrestha, Kiran Poudel, and Maheshwar Dhakal

Forests 14: 100

As a basic component of the forest ecosystem, the forest structure refers to the general distribution of plant species of different life forms and sizes. The characterization of forest structure is the key to understanding the vegetation history, present status, and future development trajectory of the forest ecosystems. The Chure region of Nepal covers about 12.78% of the country's land area and extends east to west along the southern foothills. This biologically rich but geologically fragile region is home to many species and provides many ecosystem services to millions of people. The Chure landscape is severely suffered from anthropogenic disturbances including logging, grazing, fuelwood collection, solid waste disposal, encroachment, forest fire, and excavation of sand, gravel, and boulders. In this study, we aim to characterize the forest ecosystem types outside the protected areas in the Chure region of Nepal and analyze the threat and vulnerability of the landscape from the biodiversity point of view. We sampled 62 sites to study the dominant vegetation type, regeneration status, and major threats to the forest ecosystems. A distribution map of the forest ecosystem types in Chure was prepared. We identified 14 forest ecosystem types in Chure including seven new ones. The newly reported forest ecosystems are *Hymenodictyon excelsum* Forest, *Syzygium cumini* Forest, *Terminalia anogeissiana* Forest, *Schima wallichii–Shorea robusta* Forest, *Pinus roxburghii– Shorea robusta* Forest, *Pinus roxburghii* Forest, and Bamboo thickets. We conclude that intensified human activities including forest encroachment and deforestation are mainly responsible for the ecological imbalance in the Chure region. We emphasize an in-depth analysis of biophysical linkage and immediate conservation efforts for the restoration of the Chure landscape in Nepal.

For further reading: https://doi.org/10.3390/f14010100

IMPACT OF CLIMATE CHANGE ON DISTRIBUTION OF COMMON LEOPARD (*PANTHERA PARDUS*) AND ITS IMPLICATION ON CONSERVATION AND CONFLICT IN NEPAL

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Heliyon 9: e12807

Climate change is projected to create alterations in species distributions over the planet. The common leopard (*Panthera pardus*) serves an important ecological function as a member of the big carnivore guild, but little is known about how climate change may affect their distribution. In this study, we use MaxEnt to simulate the geographic distributions by illustrating potential present and future ranges of common leopard by utilizing presence records alongside important topographic and bioclimatic variables based on two shared socioeconomic pathways (SSP2-4.5 and SSP5-8.5) scenarios. The goals of this study was to look into possible distribution ranges of

common leopards due to climate change, as well as explore the implications for conservation and potential conflict with humans. At present, 4% of Nepal was found to be highly suitable for common leopards, 43% suitable, 19% marginally suitable, and 34% unsuitable. A large portion of the climatically suitable habitat was confined to non-protected areas, and the majority of the highly suitable habitat was encompassed by forest land, followed by agricultural areas. Elevation, mean temperature of driest quarter, annual precipitation, and precipitation seasonality were the variables influencing habitat suitability for the common leopard. A significant increase in marginally suitable habitat was observed in the high mountain region, indicating a shift of habitat in upper elevation areas due to the effects of climate change. We recommend timely management of these potential habitats to expand the range of this vulnerable species. At the same time, a combination of expanding new habitats and poor management practices could escalate human-leopard conflict. Therefore, further study on the impact of climate change on the distribution of prey species and proper habitat management techniques should be prioritized to mitigate conflicts.

For further reading: https://doi.org/10.1016/j.heliyon.2023.e12807

LAND USE LAND COVER CHANGES IN THE MAJOR CITIES OF NEPAL FROM 1990 TO 2020

Praval Devkota, Sameer Dhakal, Sujata Shrestha, and Uttam Babu Shrestha

Environmental and Sustainability Indicators 17: 100227

Nepal—one of the most rapidly urbanizing countries in the world—has witnessed unplanned urbanization in recent decades. Nevertheless, spatial-temporal dynamics of land use land cover (LULC) in major cities of Nepal are not well understood. This study investigates LULC changes in the 12 rapidly urbanizing cities of Nepal from 1990 to 2020. Freely accessible Landsat images and Google Earth Engine (GEE), a cloud-based analysis platform were used to classify the city landscape into five major classes: vegetation, agriculture, barren, water body, and built-up using a random forest algorithm. Built-up areas have continuously increased in the Nepali cities mostly at expense of agricultural lands thus agriculture areas have decreased, and vegetation areas have followed mixed trends during each of the three decades. Biratnagar, Janakpur, Kathmandu, Nepalgunj, and Rajbiraj showed an overall increase in built-up areas at the expense of vegetation and agricultural lands while Bharatpur, Birendranagar, Dhangadhi, Ghorahi, Hetauda, Pokhara, and Tulsipur showed an overall decrease in agricultural areas with increased built-up areas and vegetation from 1990 to 2020. This study will assist the policymakers, city planners, and local governments to formulate sustainable urban development strategies and plans to prevent haphazard urban growth while preserving the city's agricultural lands to promote local food supply and green areas to ensure an uninhibited flow of ecosystem services in the cities.

For further reading: https://doi.org/10.1016/j.indic.2023.100227

India-Himalaya

KNOWLEDGE MINING FOR THE DIFFERENTIATION PATTERN WITH RESPECT TO THE PRODUCTIVITY AND TROPHIC STATUS OF SOME SELECTED LAKES OF WESTERN HIMALAYAS

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Frontiers in Environmental Science 11: 1009942

The present study deals with an account of the primary productivity and trophic status of Rewalsar, Kuntbhyog, and Prashar lakes of Western Himalayas. Seasonal variations in gross primary productivity (GPP) (g C m^{-2} day^{-1}), net primary productivity (NPP), respiration (R), and the NPP/R ratio have been studied and compared with hydrobiological factors. Among various factors, temperature, light, nutrients, and chlorophyll a were accountable for high productivity. Nygaard's trophic state indices were calculated. GPP showed a positive relationship with water temperature, penetration of light, nitrate, and with phosphate. The extensive range of the compound index observed in Rewalsar (12.00–20.00) and Kuntbhyog lakes (12.50–18.00) confirmed their eutrophic nature. Based on the trophic classification of waters and on the basis of productivity, Nygaard's trophic state indices, and richness of nutrients, Rewalsar and Kuntbhyog lakes could be categorized as eutrophic, whereas Prashar Lake, as oligo-eutrophic. Based on the presence, absence, frequency of appearance, and abundance of different organisms recorded during the present investigation, bioindicators of trophic status have been determined.

For further reading: https://doi.org/10.3389/fenvs.2023.1009942

FRONTAL CHANGES OF GANGOTRI GLACIER, GARHWAL HIMALAYA, BETWEEN 1935 AND 2022

Rakesh Bhambri, Kalachand Sain, Pritam Chand, Deepak Srivastava, Sameer K. Tiwari, and Jairam Singh Yadav

Journal of the Geological Society of India 99: 169-172

Gangotri Glacier is one of the most thoroughly investigated glaciers in the Indian Himalaya in terms of terminus monitoring. This study aims to update the frontal retreat of Gangotri Glacier between 1935 and 2022 using a large scale Geological Survey of India map, remote sensing images, and repeated photography. Gangotri Glacier's retreat rate varied significantly during the study period. This glacier receded by 1727 ± 51m (19.8 ± 0.2 m a^{-1}) between 1935 and 2022. The retreat of Gangotri Glacier decreased from 2001 to 2006 (7.0 ± 4.0 m a^{-1}) compared to the previous observation (1980–2001; 21.0 ± 1.2 m a^{-1}) but increased about three times between 2006 and 2017 (21.9 ± 1.9 m a^{-1}). Furthermore, from 2017 to 2022, the frontal retreat accelerated by about 1.5 times (33.8 ± 6.7 m a^{-1}) compared to the period between 2006 and 2017. The findings of the present study are consistent with ground based survey conducted by the Geological Survey of India.

For further reading: https://doi.org/10.1007/s12594-023-2283-3

ECOSYSTEM SERVICES AS SYSTEMIC ENABLERS FOR TRANSFORMATION IN THE HINDU KUSH HIMALAYA: AN ANALYTICAL SYNTHESIS

Purnamita Das gupta and Bandana Shakya

Regional Environmental Change 23: 39

Centre-staging ecosystem services within development paradigms can improve understanding on the flow of benefits from nature to human societies across time, scale and geographies, and trigger well-being-oriented societal and policy responses in the Hindu Kush Himalaya region. This region is amongst the world's most biodiverse, has high-value nature-society interactions, supports one-fourth of humanity and faces several developmental challenges. An assessment of the existing evidence establishes that substantial benefits and values can be gained by nurturing the relationship between ecosystems and socioeconomic systems. Mainstreaming ecosystem services in the development agenda helps address poverty and intersectionality, preserves culture and heritage, and enables holistic transformation in the region. The Nature Futures Framework of the IPBES is used to develop and apply an analytical framework for the region, in which ecosystem service-oriented action pathways

are considered to be relevant and feasible for attaining sustainability. Three pathways, labelled as Prevention, Restoration and Development innovation, incorporate strategies and actions that mainstream ecosystem services and uphold the multiple values placed on nature by society. Illustrations are used to demonstrate the significant potential for policy action in creating positive impacts on both nature and society with the adoption of a Nature Futures framing for the region. The region has the potential to demonstrate the operationalisation of an integrated framework for nurturing nature-people relationships, in the pursuit of transformative change as envisioned under the sustainable development agenda. Ecosystem services can enable such transformative change, acting as triggers for action that mainstream nature into developmental decision-making.

For further reading: https://doi.org/10.1007/s10113-022-02022-x

EVIDENCE OF STRUCTURAL SEGMENTATION OF THE UTTARAKHAND HIMALAYA AND ITS IMPLICATIONS FOR EARTHQUAKE HAZARD

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Scientific Reports 13: 2079

The earthquake hazard associated with the Main Himalayan Thrust (MHT) is a critical issue for India and its neighbouring countries in the north. We used data from a dense seismic network in Uttarakhand, India, to model the lateral variations in the depths of MHT (2–6% drop in V_s at 12–21 km depths), Moho (a sharp increase in V_s (by ~ 0.5–0.7 km/s) at 39–50 km depths) and lithosphere (a marked decrease in V_s (~ 1–3%) at 136–178 km depths), across the Himalayan collisional front. Our joint inversion of radial PRFs and group velocity dispersion data of Rayleigh waves detects three NNE trending transverse lithospheric blocks segmenting the lithosphere in Uttarakhand Himalaya, which spatially correlate well with the northward extension of the Delhi -Haridwar Indian basement ridge, an inferred tectonic boundary and great boundary fault, respectively. Our radial receiver function imaging detects highly deformed and segmented crustal and lithospheric structures associated with three mapped transverse lithospheric blocks, suggesting a reduction in rupture lengths of future earthquakes, thereby, reducing earthquake hazards in Uttarakhand.

For further reading: https://doi.org/10.1038/s41598-023-29432-z

GEOHERITAGE ASSESSMENT OF A HERMIT CAVE SYSTEM AT LAKHAMANDAL VALLEY, UPPER YAMUNA RIVER BASIN, NW HIMALAYA

Rahul Devrani, Rohit Kumar, Som Dutt, and Rongsenzulu Jamir

Geoheritage 15:30

The Himalayan orogeny is among the youngest mountain belts on the earth's surface. The dynamic landscape of the Himalaya accommodates plentiful eminent geological–geomorphological–heritage sites. The present study assesses a hermit cave system at Lakhamandal valley, located in the Yamuna River basin, Northwest Himalaya. The valley is filled with valley-fill deposits, including a hermit cave complex excavated by sages and local people of the valley. This hermit cave complex is extended between the different terrace levels, one or/and two-story structures carved in the quaternary sediments with a slight opening. Throughout history, the Lakhamandal valley has been located near a pilgrimage route famously known for its cultural and historical significance reflected in many historical texts of the Indian subcontinent. In the last few decades, the growing infrastructure in the valley has drawn local and international tourists leading to multiple unorganised excavations of the hermit caves in the region. To recognise such a remarkable geological and historical feature, we introduce the Lakhamandal valley

hermit cave complex geosite with a preliminary assessment with SWOT analysis augmenting with urgent concerns and recommendations further aiming at its validation for a geoheritage site.

Further reading: https://doi.org/10.1007/s12371-023-00799-9

BIOSTIMULANT ENHANCES GROWTH AND CORM PRODUCTION OF SAFFRON (*CROCUS SATIVUS* L.) IN NONTRADITIONAL AREAS OF NORTH WESTERN HIMALAYAS

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Frontiers in Plant Science 14: 1097682

The usage of seaweed extracts in cropping systems is gaining attention nowadays due to their distinct bioactive properties. This study aims to assess how saffron (*Crocus sativus* L.) corm production was affected by seaweed extract through different application modes. The study was conducted at the CSIR-Institute of Himalayan Bioresource Technology, Palampur, HP, India, during the autumn winter agricultural cycle. Five treatments using a combination of Kappaphycus and Sargassum seaweed extracts were replicated five times in a randomized block design. Treatments that were examined include T1: Control, T2: Corm dipping @ 5% seaweed extract, T3: Foliar spray @ 5% seaweed extract, T4: Drenching @ 5% seaweed extract, and T5: Corm dipping + foliar spray @ 5% seaweed extract. Seaweed extract, when applied to saffron plants (T5: Corm dipping + foliar spray @ 5% seaweed extract) resulted in significantly higher growth parameters along with the higher dry weight of stem, leaves, corms, and total roots per corm. Corm production, viz., the number of daughter corms and corm weight per m2 was significantly affected by seaweed extract application, with the maximum value recorded with treatment T5. Biochemical parameters chlorophyll, carotenoids, and photosynthetic rate were higher in T5, while nutrient concentration was lowest in this treatment. Seaweed extracts improved corm production, making it a feasible alternative to limiting the application of conventional fertilizers, attenuating the effects on the environment, and enhancing corm number and weight.

Further reading: https://doi.org/10.3389/fpls.2023.1097682

ELEVATION, ASPECT, AND HABITAT HETEROGENEITY DETERMINE PLANT DIVERSITY AND COMPOSITIONAL PATTERNS IN THE KASHMIR HIMALAYA

Zishan A. Wani, Vikram S. Negi, Jahangeer A. Bhat, K. V. Satish, Ashish Kumar, Sajid Khan, Rupesh Dhyani, Sazada Siddiqui, Rahmah N. Al-Qthanin, and Shreekar Pant

Frontiers in Forests and Global Change 6: 1019277

Elevational gradient, slope, and aspect offer a unique opportunity to explore the response of plant species under changing environmental conditions. The present study aimed to analyze the species diversity and distribution patterns with respect to altitude, aspect, and habitat types in the Kashmir Himalayas. Considering major aspects and habitats, a total of 123 representative sites were selected along the elevational gradients for the present study. The plant species composition of each selected site was studied by organized sampling following the standard ecological methods. During the present study, a total of 361 vascular plant species belonging to 71 families and 214 genera were identified in the study area. At the lower altitudes, the southern aspect and drier habitats showed the highest diversity. Moreover, a significant amount of compositional dissimilarity was observed between the studied aspects, habitats, and elevation belts and was mainly due to species turnover rather than the nestedness component. Further, among the studied variables, altitude was the most important contributing variable, explaining the greatest variation in the species composition. The paired effects of altitude and habitat explained the maximum variation in plant species composition. It may be concluded that floristic diversity should be studied not only with reference to elevational gradients but should also include aspects and habitats. The

current study will act as a reference in this direction. A similar study must be replicated in other parts of the Himalayan region in the future to improve our understanding of the distribution and preferences of plant species in mountainous zones. This, in turn, will be immensely helpful in the conservation and sustainable utilization of resources in these ecologically fragile regions.

Further reading: https://doi.org/10.3389/ffgc.2023.1019277

PLANT-BENEFICIAL *BACILLUS*, *PSEUDOMONAS*, AND *STAPHYLOCOCCUS* SPP. FROM KUMAON HIMALAYAS AND THEIR DROUGHT TOLERANCE RESPONSE

Diksha Sati, Veni Pande, and Mukesh Samant

Frontiers in Sustainable Food Systems 7: 1085223

Plant growth-promoting rhizobacteria (PGPR) have been shown to augment plant responses against drought and other abiotic stresses. In the present study, we isolated 27 bacteria from the rhizosphere of various plants cultivated in the Kumaon Himalayas., and to measure their abiotic stress tolerance, these 27 isolates were subjected to variations in pH, temperature, and drought. All 27 isolates were also screened for various plant growth-promoting traits. Among these, the four isolates RR1, ASC1, AFS3, and NG4 demonstrated various plant growth promotion activities including the synthesis of indole-3-acetic acid (IAA), siderophores, ammonia, and 1-aminocyclopropane-1-carboxylic acid (ACC) deaminase production, and concomitantly high tolerance to abiotic stresses. Moreover, 16S rRNA sequencing of these four isolates validated their identities as *Bacillus, Pseudomonas*, and *Staphylococcus* sp. Finally, to assess the in-vivo drought tolerance potential of these four isolates, a pot-trial experiment was undertaken in wheat cultivar VL-892. The results demonstrated that inoculating wheat plants with these four PGPR isolates greatly improved plant growth under drought circumstances by increasing root and shoot length and both fresh and dry weight of root and shoot. This study endeavors to discover the biochemical and molecular diversity of cultivable PGPR in six remotely located districts of Uttarakhand. In conclusion, the drought-tolerant PGPR strains described in this study are plant-beneficial and can effectively mobilize nutrients under drought conditions. Consequently, they could be used as bioinoculants to alleviate drought stress in wheat plants, in a sustainable manner. To the best of our knowledge, this is the first report of exploring the diversity and characterization of PGPR from the Kumaon Himalayas and their drought evaluation.

Further reading: https://doi.org/10.3389/fsufs.2023.1085223

Pakistan-Himalaya

ANALYSIS OF THE RELATIONSHIP AMONG LAND SURFACE TEMPERATURE (LST), LAND USE LAND COVER (LULC), AND NORMALIZED DIFFERENCE VEGETATION INDEX (NDVI) WITH TOPOGRAPHIC ELEMENTS IN THE LOWER HIMALAYAN REGION

Waheed Ullah, Khalid Ahmad, Siddique Ullah, Adnan Ahmad Tahir, Muhammad Faisal Javed, Abdul Nazir, Arshad Mehmood Abbasi, Mubashir Aziz, and Abdullah Mohamed

Heliyon 9: e13322

Land Surface Temperature (LST) affects exchange of energy between earth surface and atmosphere which is important for studying environmental changes. However, research on the relationship between LST, Land Use Land Cover (LULC), and Normalized Difference Vegetation Index (NDVI) with topographic elements in the lower Himalayan region has not been done. Therefore, the present study explored the relationship between LST and

NDVI, and LULC types with topographic elements in the lower Himalayan region of Pakistan. The study area was divided into North-South, West-East, North-West to South-East and North-East to South-East directions using ArcMap 3D analysis. The current study used Landsat 8 (OLI/TIRS) data from May 2021 for LULC and LST analysis in the study area. The LST data was obtained from the thermal band of Landsat 8 (TIRS), while the LULC of the study areas was classified using the Maximum Likelihood Classification (MLC) method utilizing Landsat 8 (OLI) data. TIRS collects data for two narrow spectral bands (B10 and B11) with spectral wavelength of 10.6 µm–12.51 µm in the thermal region formerly covered by one wide spectral band (B6) on Landsat 4–7. With 12-bit data products, TIRS data is available in radiometric, geometric, and terrain-corrected file format. The effect of elevation on LST was assessed using LST and elevation data obtained from the USGS website. The LST across LULC types with sunny and shady slopes was analyzed to assess the influence of slope directions. The relationship of LST with elevation and NDVI was examined using correlation analysis. The results indicated that LST decreased from North-South and South-East, while increasing from North-East and South-West directions. The correlation coefficient between LST and elevation was negative, with an R-value of − 0.51. The NDVI findings with elevation showed that NDVI increases with an increase in elevation. Zonal analysis of LST for different LULC types showed that built-up and bare soil had the highest mean LST, which was 35.76 ◦C and 28.08 ◦C, respectively, followed by agriculture, vegetation, and water bodies. The mean LST difference between sunny and shady slopes was 1.02 ◦C. The correlation between NDVI and LST was negative for all LULC types except the water body. This study findings can be used to ensure sustainable urban development and minimize urban heat island effects by providing effective guidelines for urban planners, policymakers, and respective authorities in the Lower Himalayan region. The current thermal remote sensing findings can be used to model energy fluxes and surface processes in the study area.

Further reading: https://doi.org/10.1016/j.heliyon.2023.e13322