

# Headlines Himalaya

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Editorial Team: Anju Kumari Dhakal and Kiran Gosai

For the 659<sup>th</sup> – 660<sup>th</sup> issues of Headlines Himalaya, we reviewed researches from 10 sources and selected 26 researches from five countries. We selected 11 researches from Nepal and 15 researches from other Himalayan countries (India, China, Bhutan and Pakistan).

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**COVID-19 LOCKDOWN AND THE FORESTRY SECTOR: INSIGHT FROM GANDAKI PROVINCE OF NEPAL**

Hari Krishna Laudari, Shiva Pariyar, and Tek Maraseni

Almost all countries have imposed large-scale mobility restrictions (or lockdown) to stop the spreading of the novel coronavirus (COVID-19). The mobility restriction has disrupted all types of business; causing a devastating impact on countries' economies; and pushing millions of people into extreme poverty. Scientists have been assessing the impact of COVID-19 lockdown on various fronts but there is limited scholarship in the forestry sector. We navigated the impact of COVID-19 lockdown on the forestry sector by taking Gandaki Province (21,974 km<sup>2</sup>) of Nepal as a case. Employing semi-structured interviews ( $n = 62$ ) with all ten stakeholder groups, literature review and media analysis, our study revealed that the COVID-19 lockdown suspended all types of forestry and ecotourism businesses; obstructed research and monitoring activities; halted capacity development and extension services; impacted forest development work; and increased incidences of illegal logging and poaching and trafficking of wildlife. Because of the complete shutdown of businesses, the forestry sector of Gandaki province lost 9.6 million USD and 3.2 million man-days of employment during the lockdown period. The economic cost of the lockdown was 1.73 million USD for NTFPs traders, 1.26 million USD for ecotourism entrepreneurs, 0.55 million USD for the community forest user groups and 0.24 million USD for the smallholder or private forest owner. We suggested four post-COVID recovery pathways, including sustainable forest management, nature-based tourism, improvement of forest products value chain and community-based natural resource management to bounce back from the loss. As the current pandemic is most likely to derail the Sustainable Development Pathways of several countries, including Nepal and necessitates the need for an immediate response, the finding and recommendation of our study may inform decision-makers to reimagine post-pandemic recovery and leverage sustainable development.

Further reading: <https://doi.org/10.1016/j.forpol.2021.102556>

#### **MAPPING HABITAT SUITABILITY FOR ASIATIC BLACK BEAR AND RED PANDA IN MAKALU BARUN NATIONAL PARK OF NEPAL FROM MAXENT AND GARP MODELS**

Huiyi Su, Manjit Bista, and Mingshi Li

*Scientific Reports* 11: 14135

Habitat evaluation is essential for managing wildlife populations and formulating conservation policies. With the rise of innovative powerful statistical techniques in partnership with Remote Sensing, GIS and GPS techniques, spatially explicit species distribution modeling (SDM) has rapidly grown in conservation biology. These models can help us to study habitat suitability at the scale of the species range, and are particularly useful for examining the overlapping habitat between sympatric species. Species presence points collected through field GPS observations, in conjunction with 13 different topographic, vegetation related, anthropogenic, and bioclimatic variables, as well as a land cover map with seven classification categories created by support vector machine (SVM) were used to implement Maxent and GARP ecological niche models. With the resulting ecological niche models, the suitable habitat for asiatic black bear (*Ursus thibetanus*) and red panda (*Ailurus fulgens*) in Nepal Makalu Barun National Park (MKNP) was predicted. All of the predictor variables were extracted from freely available remote sensing and publicly shared government data resources. The modeled results were validated by using an independent dataset. Analysis of the regularized training gain showed that the three most important environmental variables for habitat suitability were distance to settlement, elevation, and mean annual temperature. The habitat suitability modeling accuracy, characterized by the mean area under curve, was moderate for both species when GARP was used (0.791 for black bear and 0.786 for red panda), but was moderate for black bear (0.857), and high for red panda (0.920) when Maxent was used. The suitable habitat estimated by Maxent for black bear and red panda was 716 km<sup>2</sup> and

343 km<sup>2</sup> respectively, while the suitable area determined by GARP was 1074 km<sup>2</sup> and 714 km<sup>2</sup> respectively. Maxent predicted that the overlapping area was 83% of the red panda habitat and 40% of the black bear habitat, while GARP estimated 88% of the red panda habitat and 58% of the black bear habitat overlapped. The results of land cover exhibited that barren land covered the highest percentage of area in MBNP (36.0%) followed by forest (32.6%). Of the suitable habitat, both models indicated forest as the most preferred land cover for both species (63.7% for black bear and 61.6% for red panda from Maxent; 59.9% black bear and 58.8% for red panda from GARP). Maxent outperformed GARP in terms of habitat suitability modeling. The black bear showed higher habitat selectivity than red panda. We suggest that proper management should be given to the overlapping habitats in the buffer zone. For remote and inaccessible regions, the proposed methods are promising tools for wildlife management and conservation, deserving further popularization.

For further reading: <https://doi.org/10.1038/s41598-021-93540-x>

### **CONTRIBUTION OF ECOSYSTEM SERVICES TO RURAL LIVELIHOODS IN A CHANGING LANDSCAPE: A CASE STUDY FROM THE EASTERN HIMALAYA**

Nakul Chettri, Kamal Aryal, Sanjan Thapa, Kabir Uddin, Pratikshya Kandel, and Seema Karki

*Land Use Policy* 109: 105643

Ecosystem services (ES), or tangible and intangible goods and services from nature, are an integral part of the rural economy in Nepal. However, there is limited recognition of their contribution to human wellbeing. To understand the linkages between local people and ES, an integrated assessment based on the Millennium Ecosystem Assessment framework was undertaken in Rautamai Rural Municipality of Udayapur District, Eastern Nepal. The study applied three broad approaches and multiple tools. This included a set of participatory tools (10 focus group discussions and 36 key informant interviews), followed by a household survey (439 households), and complemented by geospatial tools. The study identified three major ecosystems, namely forest ecosystems, agro-ecosystems, and freshwater ecosystems on which over 75% households were dependent for their livelihood. Collectively, these ecosystems provide 27 provisioning services, 14 regulating, 6 cultural, and 4 supporting services. Among the three ecosystems, the forest ecosystem provides the maximum number of services (40%). However, about 69% households depend on agro-ecosystems as their primary source of livelihoods. There have been subtle changes in land use over the last 18 years, which has had notable impacts on the flow of ecosystem services, and it reflected in people's perceptions. The study highlights the importance of ecosystem services and the implications of land use change on the flow of these services and wellbeing of people in rural Nepal. The findings of this study will be instrumental for land use planning and incentive-based conservation being planned by Nepal aimed at building socio-ecological resilience.

Further reading: <https://doi.org/10.1016/j.landusepol.2021.105643>

### **EPIPHYTIC ORCHID DIVERSITY ALONG AN ALTITUDINAL GRADIENT IN CENTRAL NEPAL**

Binu Timsina, Pavel Kindlmann, Sajan Subedi, Subhash Khatri, and Maan B. Rokaya

*Plants* 10: 1381

Epiphytic orchids are common in subtropical forests, but little is known about the factors that determine their diversity. We surveyed two sites (north-facing Phulchowki and south-facing Shivapuri hills), in the sub-tropical

forest in the Kathmandu valley, central Nepal. Along five transects per site, spanning an altitudinal gradient of 1525–2606 m a.s.l., we recorded all epiphytic orchids and the host species on which they were growing. The data were analyzed using a generalized linear model (GLM) and redundancy analysis (RDA). Species richness significantly decreased with increasing altitude and was higher in larger hosts and in places with high temperature. Species composition was affected by altitude, distance from the forest edge, host type, and precipitation. This study indicates that the most important factors affecting epiphytic orchid diversity was altitude, even if other factors were associated with patterns in composition. The low-altitude habitats with high species diversity are the best places for epiphytic orchids in this region. The altitudinal species richness and patterns in composition revealed by this study provide a baseline for further studies on epiphytic orchids.

Further reading: <https://doi.org/10.3390/plants10071381>

### **CLIMATE CHANGE ADAPTATION FOR MANAGING NON-TIMBER FOREST PRODUCTS IN THE NEPALESE HIMALAYA**

Lila Jung Gurung, Kelly K. Miller, Susanna Venn, and Brett A. Bryan

*Science of the Total Environment* 796: 148853

Non-timber forest products (NTFPs) contribute to the well-being of mountain communities in many ways but their availability is being impacted by climate change. Policy and programs to enhance adaptation can alleviate these impacts, but to be effective they require an understanding of mountain community perceptions of climate change impacts on NTFPs and the perceived barriers to climate change adaptation. Here, we explored mountain communities' adaptation responses to the perceived impacts of climate change on NTFPs and people's barriers to adaptation using a structured questionnaire delivered as a field-based survey of 278 forest-dependent households from the Upper Madi Watershed of Nepal. We present a quantitative graphical exploration of the results to provide a simple overview of climate change impacts of NTFPs and local adaptation. The most common adaptation practices adopted by the mountain communities in the study area include the self-regulation of over-collection of NTFPs, alternative income generating activities, improved stoves, agroforestry, and sourcing alternative tools and materials. However, adaptation options to deal with increased invasive plant species and pest insect outbreaks appear to be challenging despite having the highest perceived impact on NTFPs. Adaptation practices are constrained by several factors such as the lack of predictability of extreme events and climate-related hazards, lack of technical knowledge, fatalistic beliefs and perceived lack of agency, and limited government support. Our results can inform policies and programs required for addressing the impacts of climate change on mountain communities in Nepal and other developing nations.

Further reading: <https://doi.org/10.1016/j.scitotenv.2021.148853>

### **ADOPTION OF GOOD AGRICULTURAL PRACTICE TO INCREASE YIELD AND PROFIT OF GINGER FARMING NEPAL**

Rudra Baral, Bishnu Prasad Kafle, Dinesh Pandey, Jiban Shrestha, and DooHong Min

*Journal of Horticultural Research* 29: 55-66

Ginger (*Zingiber officinale*) is one of the major high-value cash crops in Nepal. Low yield, conventional farming, and limited access to production resources such as improved cultivars, production technologies, and extension services are the existing problems of Nepali ginger farmers. In this study, we conducted community based-participatory research in Ilam district, Nepal, in 2015–2017. This research aimed to explore the appropriate ginger farming

technology considering yield, income, and environment. We compared the effect of four different ginger production technologies on ginger yield and net farm income that include: i) traditional practice with mother rhizome harvest, ii) traditional practice without mother rhizome harvest, iii) good agricultural practice (GAP) with mother rhizome harvest, and iv) GAP without mother rhizome harvest. The experiment was conducted in a randomized complete block design with five replications. The yield of ginger under GAP and without mother rhizome harvest was observed  $17.9 \text{ t}\cdot\text{ha}^{-1}$ , which was 39.8% higher than the farmers' existing practices and 45.5% higher than the national average. The cost of production was almost the same in all treatments; however, the GAP with mother rhizome-harvested treatment gave the highest benefit–cost ratio (1.5) along with the maximum net farm income ( $\$2072.6\cdot\text{ha}^{-1}\cdot\text{year}^{-1}$ ). Thus, we suggest ginger producers adopting GAP rules to obtain a higher yield and harvesting mother rhizomes earlier for obtaining maximum profit. The GAP rules will additionally protect the environment. This study also suggests policymakers and related stakeholders promoting GAP as a sustainable production technology in agriculture-based countries like Nepal.

Further reading: <https://doi.org/10.2478/johr-2021-0009>

### **CONSERVATION EFFORTS OF ASIAN WILD WATER BUFFALO**

Pramod Kumar Kherwar and Ajaya Bhattarai

*Journal of Buffalo Science* 10: 52-60

Asian Wild Water Buffalo with the scientific name *Bubalus bubalis arnee* is recorded as an imperiled species in the International Union for Conservation of Nature (IUCN's) Red List of Threatened Species wetland-subordinate. More number Wild Water Buffalo in Nepal are found at the KoshiTappu Wildlife Reserve (KTWR), situated on the floodplain of the Koshi River in Province 1. This species is in danger because of a high anthropogenic pressing factor going from natural surroundings weakening to hybridization with homegrown Buffalo. Various preservation and work mediations have been attempted to shield the biodiversity, especially the wild buffalo populace in the KTWR. The people group-based supportable administration approach profiting both protection and work of neighborhood individuals is important to guarantee the drawn-out preservation of the species. But it is not happening, so the Government of Nepal translocated 18 Wild Water Buffaloes to Chitwan National Park, and the environment is not suitable for them. There is the possibility to translocate Wild Water Buffaloes in the Babai flood plain of Bardia National Park for conservation.

Further reading: <https://doi.org/10.6000/1927-520X.2021.10.08>

### **NUDGING ADOPTION OF ELECTRIC VEHICLES: EVIDENCE FROM AN INFORMATION BASED INTERVENTION IN NEPAL**

Massimo Filippini, Nilkanth Kumar, and Suchita Srinivasan

*Transportation Research Part D: Transport and Environment* 97: 102951

Addressing hazardous levels of air pollution in densely populated cities in emerging countries requires concerted efforts to reduce fossil fuel use in the transport sector, such as through greater use of electric motorcycles. However, their adoption has been limited due to several market failures and behavioral anomalies. In this study, we collect novel data on more than 2,000 potential motorcycle buyers in Kathmandu, Nepal. Using randomization, we evaluate the effects of informational nudges on their stated choice to buy an electric motorcycle. We find

evidence to suggest that our interventions play a role in determining the stated preference of respondents. Furthermore, results also hint at the importance of gender, health status and education in determining the effectiveness of these nudges. Implications of this study relate to policy choice in cities in developing countries, where fuel-inefficient vehicles are used widely, and the negative externalities due to air pollution are stark.

Further reading: <https://doi.org/10.1016/j.trd.2021.102951>

#### **EVALUATION OF AIR POLLUTION TOLERANCE INDEX (APTI) OF PLANTS GROWING ALONGSIDE INNER RING ROAD OF KATHMANDU, NEPAL**

Sabina Timilsina, Sudarshana Shakya, Sujan Chaudhary, Gyanu Thapa Magar, and Nabin Narayan Munankarmi

*International Journal of Environmental Studies* 78: 1946346

The air quality of the Kathmandu valley is highly degraded by pollution from motor vehicles. Planting green vegetation along roadsides has been shown to reduce air pollutants. Different leaf parameters like pH, relative water content, chlorophyll content, and ascorbic acid content, that comprise the Air pollution tolerance index (APTI), were used to test the susceptibility of plants to air pollution. APTI values of  $\leq 11$ , 12–16, and  $\geq 17$  categorised the plant species under sensitive, moderate, and tolerant species, respectively. In the present study, all the plant species had APTI less than 11. The highest APTI value was for *Mangifera indica* (10.62) and the lowest for *Buddleia asiatica* (6.92). Therefore, based on the findings of the present study, planting trees with high APTI value alongside the roads may help reduce air pollution as these trees are resistant to high pollution levels.

Further reading: <https://doi.org/10.1080/00207233.2021.1946346>

#### **SEGMENTING WILDLIFE VALUE ORIENTATIONS TO MITIGATE HUMAN-WILDLIFE CONFLICT FOR ECOTOURISM DEVELOPMENT IN PROTECTED AREAS**

Birendra KC, Jihye (Ellie) Min, and Cristopher Serenari

*Tourism and Planning and Development* 18: 1947889

Ecotourism is increasingly being adopted to improve the livelihoods of local communities and fulfill conservation goals. Many critical actors, including but not limited to governments and conservation organizations, believe that for ecotourism to be successful, local communities must appreciate and support wildlife conservation activities. Without evidence that communities' value systems are oriented in a manner that aligns with the authorities' sustainable development and wildlife conservation ideologies, strategies for how to achieve the most benefits for the most people will be based on anecdotes and assumptions. This study investigated residents' value orientation towards wildlife in the context of Bardia National Park (BNP), Nepal. We surveyed residents from eight buffer zone communities surrounding BNP with a human-wildlife conflict ( $n = 871$ ). Our findings revealed four distinct clusters of resident WVOs, creating challenges for BNP ecotourism development. Socio-demographic and resource management factors also play critical roles in shaping the sustainable development of BNP ecotourism.

Further reading: <https://doi.org/10.1080/21568316.2021.1947889>

#### **ATMOSPHERIC PARTICLE-BOUND MERCURY IN THE NORTHERN INDO-GANGETIC PLAIN REGION: INSIGHTS INTO SOURCES FROM MERCURY ISOTOPE ANALYSIS AND INFLUENCING FACTORS**

Junming Guo, Lekhendra Tripathy, Shichang Kang, Qiangong Zhang, Jie Huang, Chhatra Mani Sharma, Pengfei Chen, Rukumesh Paudyal, and Dipesh Rupakehti

*Geoscience Frontiers* 13: 101274

Lumbini is a world heritage site located in the southern plains region of Nepal, and is regarded as a potential site for evaluating transboundary air pollution due to its proximity to the border with India. In this study, 82 aerosol samples were collected between April 2013 and July 2014 to investigate the levels of particulate-bound mercury (PBM) and the corresponding seasonality, sources, and influencing factors. The PBM concentration in total suspended particulate (TSP) matter ranged from  $6.8 \text{ pg m}^{-3}$  to  $351.7 \text{ pg m}^{-3}$  (mean of  $99.7 \pm 92.6 \text{ pg m}^{-3}$ ), which exceeded the ranges reported for remote and rural sites worldwide. The Hg content (PBM/TSP) ranged from  $68.2 \text{ ng g}^{-1}$  to  $1744.8 \text{ ng g}^{-1}$  (mean of  $446.9 \pm 312.7 \text{ ng g}^{-1}$ ), indicating anthropogenic enrichment. The PBM levels were higher in the dry season (i.e., winter and the pre-monsoon period) than in the wet season (i.e., the monsoon period). In addition, the  $\delta^{202}\text{Hg}$  signature indicated that waste/coal burning and traffic were the major sources of Hg in Lumbini during the pre-monsoon period. Meanwhile, precipitation occurring during photochemical processes in the atmosphere may have been responsible for the observed  $\Delta^{199}\text{Hg}$  values in the aerosol samples obtained during the monsoon period. The PBM concentration was influenced mostly by the resuspension of polluted dust during dry periods and crop residue burning during the post-monsoon period. The estimated PBM deposition flux at Lumbini was  $15.7 \text{ } \mu\text{g m}^{-2} \text{ yr}^{-1}$ . This study provides a reference dataset of atmospheric PBM over a year, which can be useful for understanding the geochemical cycling of Hg in this region of limited data.

Further reading: <https://doi.org/10.1016/j.gsf.2021.101274>

## India-Himalaya

### FOREST FIRE HAZARDS VULNERABILITY AND RISK ASSESSMENT IN SIRMAUR DISTRICT FOREST OF HIMACHAL PRADESH (INDIA): A GEOSPATIAL APPROACH

Jagpal Singh Tomar, Nikola Kranjčić, Bojan Đurin, Shruti Kanga, and Suraj Kumar Singh

*International Journal of Geo-Information* 10: 447

The Himachal Pradesh district's biggest natural disaster is the forest fire. Forest fire threat evaluation, model construction, and forest management using geographic information system techniques will be important in this proposed report. A simulation was conducted to evaluate the driving forces of fires and their movement, and a hybrid strategy for wildfire control and geostatistics was developed to evaluate the impact on forests. The various methods we included herein are those based on information, such as knowledge-based AHP-crisp for figuring out forest-fire risk, using such variables as forest type, topography, land-use and land cover, geology, geomorphology, settlement, drainage, and road. The models for forest-fire ignition, progression, and action are built on various spatial scales, which are three-dimensional layers. To create a forest fire risk model using three different methods, a study was made to find out how much could be lost in a certain amount of time using three samples. Precedent fire mapping validation was used to produce the risk maps, and ground truths were used to verify them. The accuracy was highest in the form of using "knowledge base" methods, and the predictive value was lowest in the

use of an analytic hierarchy process or AHP (crisp). Half of the area, about 53.92%, was in the low-risk to no-risk zones. Very-high- to high-risk zones cover about 24.66% of the area of the Sirmaur district. The middle to northwest regions are in very-high- to high-risk zones for forest fires. These effects have been studied for forest fire suppression and management. Management, planning, and abatement steps for the future were offered as suitable solutions

For further reading: <https://doi.org/10.3390/ijgi10070447>

### **FOOD, FIELDS AND FORAGE: A SOCIO-ECOLOGICAL ACCOUNT OF CULTURAL TRANSITIONS AMONG THE GADDIS OF HIMACHAL PRADESH IN INDIA**

Aayushi Malhotra, Sailaja Nandigama, and Kumar Sankar Bhattacharya

*Heliyon* 7: e07569

Traditional food systems of many ethnic communities in India directly depend on their symbiotic relationship with the surrounding natural resources and the local socio-ecological and cultural dynamics. However, in the light of development activities resulting in drastic socio-ecological changes, these communities are oftentimes found stranded with over-simplified and unsustainable food systems. Using an ethnographic methodology, we present the case of Gaddis – an agro-pastoral community of Himachal Pradesh in India. In this paper, we documented the on-going trade-offs in traditional livelihoods of the Gaddis and their land use patterns that cause a significant transition in the traditional food systems. Based on our observations, we argue that mapping the shifting political ecology of resources enables a better understanding of transitioning food systems and the consequent eco-cultural changes. While doing so, we emphasize the need for revisiting the existing praxis of tribal development in India with an urgent focus on holistic socio-ecological approaches.

Further reading: <https://doi.org/10.1016/j.heliyon.2021.e07569>

### **BIOMASS, CARBON STOCK AND SOIL PHYSICOCHEMICAL PROPERTIES IN PLANTATION OF EAST SIANG DISTRICT, ARUNACHAL PRADESH, INDIA**

Hobby Dabi, Reetashree Bordoloi, Biswajit Das, Ashish Paul, Om Praksh Tripathi, and Bhanu Prakash Mishra

*Environmental Challenges* 4: 100191

The present study emphasizes the biomass and carbon sequestration potential of plantations in the East Siang district of Arunachal Pradesh, India. The integrated approach of geospatial technology along with field inventory based data was used in spatial modelling of biomass and carbon sequestration potentials of selected plantations. The stand density was recorded highest (1320 individuals ha<sup>-1</sup>) in *Areca catechu* (AC) plantation followed by *Citrus sinensis* (CS) 1240 individuals ha<sup>-1</sup> and lowest (620 individuals ha<sup>-1</sup>) in *Hevea brasiliensis* (HB) plantation. The basal area was recorded maximum in HB plantation and minimum in CS plantation. The above ground biomass (AGB) was recorded for the plantations AC, CS, HB were 51.42 t/ha, 18.84 t/ha, and 60.74 t/ha, respectively. Total biomass carbon was found to be highest in the plantation of HB (43.10 t/ha) followed by AC (36.48 t/ha) and (13.37 t/ha) in CS plantation. Total soil carbon was recorded highest in AC (61.76 t/ha) followed by HB (46.73 t/ha) and CS (29.27 t/ha). The highest total carbon storage in various plantation parts (tree above and below ground, deadwood and litter, soil) was found greater in AC plantation (67.82 t/ha) followed by HB plantation (66.91 t/ha)

and CS plantation (28.50 t/ha). Spatial AGB density was modelled using satellite data derived vegetation indices and GIS techniques. Among the vegetation indices used, SAVI resulted better relationship with the AGB hence was used for modelling carbon stock for the study area. The predicted average biomass in the study area was computed as 56.32 t/ha. However, the predicted biomass was 65.86 t/ha, 73.26 t/ha and 29.86 t/ha for the CS, HB and AC plantations, respectively. The present study reveals that HB plantation possessed the greater potential of carbon capture followed by AC and CS plantations and the girth of trees plays an important role in biomass accumulation.

Further reading: <https://doi.org/10.1016/j.envc.2021.100191>

### **TREE DIVERSITY AND BIOMASS CARBON STOCK ALONG AN ALTITUDINAL GRADIENT IN OLD-GROWTH SECONDARY SEMI-EVERGREEN FORESTS IN NORTH EAST INDIA**

Panna Chandra Nath, Abed Ahmed, Jitnu Kumar Bania, Koushik Majumdar, Arun Jyoti Nath, and Ashesh Kumar Das

*Tropical Ecology* 62: 1-10

Forest structure and composition change are driven by complex interactions among local site factors, past site history, and region-specific socio-demographic factors. Previous studies suggest the structural, functional, taxonomic, and carbon storage potential of vegetation increases during succession. However, information on these attributes along an altitudinal gradient from the North East India is lacking for the old growth secondary forests. Therefore, the present study investigates (i) tree diversity and biomass carbon storage, and (ii) dominating and carbon important tree species, along an altitudinal gradient (30–700 m) in the tropical semi-evergreen forests of southern Assam. Random quadrats of 0.1 ha were laid over selected elevation gradient of secondary forest to evaluate tree diversity, density, basal area, and biomass carbon stock. Shannon–wiener index increases from 2.88 (at 30 m) to 3.33 (at 700 m) indicating an increase in species diversity with elevation. The stand density ranges from 920–1630 stems ha<sup>-1</sup> and reciprocally related to the altitude. *Palaquium polyanthum*, *Dysoxylum binectariferum*, and *Maniltoa polyandra* were the most dominant species at 30 m, 300 m and 700 m, respectively. Biomass carbon stock decreases with the increase in altitude and ranges from 71.20 to 77.47 Mg ha<sup>-1</sup>. *Palaquium polyanthum*, *Sterculia* sp. and *Syzygium cumini* were the most carbon important species at 30 m, 300 m and 700 m, respectively. Present study suggests conservation and management of old-growth secondary forests have carbon storage and regional climate benefits. Management of such secondary forests can also enhance the resiliency of forest ecosystems to nature conservancy.

Further reading: <https://doi.org/10.1007/s42965-021-00185-y>

### **HEAVY METAL TOLERANCE OF BACTERIAL ISOLATES ASSOCIATED WITH OVERBURDEN STRATA OF AN OPENCAST COAL MINE OF ASSAM (INDIA)**

Khomdram Niren Singh and Diganta Narzary

*Environmental Science and Pollution Research* 28: 1-16

Coal overburden strata (OBS) vary in thickness, geochemical composition, and physical properties from stratum to stratum. Here, we enumerated the cultivable bacterial diversity and their distribution in different OBS taken from the opencast mining of Tikok colliery, Assam. The pH of the coal OBS ranged from 2.46 to 7.93, but 73% of the OBS

was acidic. The OBS samples were mostly of shale types except for a few that were sandstone, mudstone, and red soil. The bacterial CFUs per gram OBS samples were highly diverse ranging from 52 to  $57.4 \times 10^4$ . A total of 79 bacterial pure culture isolates belonging to 19 genera, 12 family, and 3 phyla (Actinobacteria, Firmicutes, and Proteobacteria) were recovered in nutrient agar plates. Firmicutes appeared dominant over the others. All the isolates were screened for heavy metal tolerance in broth culture augmented with five different metals ( $\text{Ni}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Cr}^{6+}$ ,  $\text{As}^{3+}$ , and  $\text{Cd}^{2+}$ ) separately. The number of isolates that showed tolerance was 95% for  $\text{Cr}^{6+}$ , 69.6% for  $\text{Ni}^{2+}$ , 50.6% each for  $\text{As}^{3+}$  and  $\text{Cu}^{2+}$ , and 7.6% for  $\text{Cd}^{2+}$ . The bacterial isolates with high metal tolerance, i.e., 5 to 12 mM could be promising for bioremediation of  $\text{Ni}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Cr}^{6+}$ , and  $\text{As}^{3+}$  from the sites contaminated with these heavy metals.

Further reading: <https://doi.org/10.1007/s11356-021-15153-1>

## **UNDERSTANDING HYDROGEOMORPHIC AND CLIMATIC CONTROLS ON SOIL EROSION AND SEDIMENT DYNAMICS IN LARGE HIMALAYAN BASINS**

Somil Swarnkar, Shivam Tripathi, and Rajiv Sinha

*Science of the Total Environment* 795: 148972

The Himalayan basins are characterised by severe soil erosion rates and several basins are among the largest sediment dispersal systems in the world. Unsustainable agricultural activities increase the soil erosion rates and influence the overall hydro-geomorphic regime of river basins. Consequently, the water holding capacity of soil reduces, which enhances the flood risk in the lowland regions. In addition, excessive sediment flux severely affects the reservoir capacity in the mountainous regions, thus amplifying the flood hazard in the upland regions. Here, we have analysed two large and hydro-geomorphically diverse Himalayan River basins, namely, the Ganga Basin (GBA) from source to Allahabad in northern India and the Kosi Basin (KB) draining through Nepal and north Bihar plains in eastern India. Based on RULSE and region-specific SDR modelling framework, which includes model calibration, validation and uncertainty assessment, we demonstrate that spatial variation in rainfall, hydrogeomorphic conditions, the presence of hydraulic structures, and large-scale agricultural activities influence the overall pattern of sediment production and transport in these two large river basins. Total soil erosion in GBA and KB are estimated to be  $\sim 404 \times 10^6$  t/y and  $\sim 724 \times 10^6$  t/y respectively, a large part of which comes from the mountainous regions in both basins. Sediment yield at the mountain exits of the GBA and KB are computed as  $14.1 \times 10^6$  t/y and  $86.4 \times 10^6$  t/y respectively, which work out to be  $\sim 5\%$  and  $\sim 15\%$  of total soil erosion from the respective contributing areas of the KB and GBA respectively. Similarly, sediment yields at outlets in the alluvial plains are estimated to be  $32.2 \times 10^6$  t/y and  $37.3 \times 10^6$  t/y in the GBA and the KB, respectively suggesting that a large part of sediments are accommodated in the alluvial plains of KB. These results have significant implications for sediment management in the Himalayan River basins.

Further reading: <https://doi.org/10.1016/j.scitotenv.2021.148972>

**China Himalaya**

## **INTEGRATING MULTIPLE INDICES OF GEOBIODIVERSITY REVEALS A SERIES OF REGIONAL SPECIES-RICH AREAS WORTHY OF CONSERVATION IN THE REGION OF THE QINGHAI-TIBET PLATEAU**

Haibin Yu, David C. Deane, Yili Zhang, Shicheng Li, Shenyu Miao, Guowen Xie, Xue Yin, and Adrien Favre

*Biological Conservation* 261: 109238

While there is a general understanding of broadscale patterns of the region of the Qinghai-Tibet Plateau (QTP)'s biodiversity, this is largely reliant upon knowledge of species richness. Less known is the correlation between species richness and other measures of biodiversity, and how this correlation varies among different types of taxa. Using county-level seed plant data for the QTP region, we identified and compared regional species-rich areas, using six indices quantifying taxonomic, endemic and phylogenetic diversity for distinct plant types (trees, shrubs, herbs, endemic/non-endemic, alpine/non-alpine/non-alpine-endemic plants). We modelled diversity for each index and plant types using predictors of contemporary climate, topography and historical factors. We found a high congruence between species richness and phylogenetic diversity, which showed a consistent gradient from high values in the southeast to low values in the northwest. We confirm that this known pattern was largely associated with contemporary climatic and topographic predictors. There was a similarly high congruence of species-rich areas among plant types, except for alpine species. Strikingly, we identified species-rich areas which were previously unrecognized. Their identification largely derives from a low congruence between general patterns and patterns predicted by corrected weighted endemism. Nine of these species-rich areas are located where coverage in nature reserves is absent or inadequate, highlighting clear conservation gaps in the regional conservation strategy. Our study is the first to compare taxonomic, endemic and phylogenetic diversity for different plant types in the QTP region. Thus, it provides the essential bases for designing strategies for local to regional biodiversity conservation.

Further reading: <https://doi.org/10.1016/j.biocon.2021.109238>

## **LONG-TERM DYNAMICS OF NITROGEN FLOW IN A TYPICAL AGRICULTURAL AND PASTORAL REGION ON THE QINGHAI-TIBET PLATEAU AND ITS OPTIMIZATION STRATEGY**

Fangfang Wang, Shiliang Liu, Yixuan Liu, Yongxiu Sun, Lu Yu, Qingbo Wang, Yuhong Dong, and Robert Beazley

*Environmental Pollution* 288: 117684

Nitrogen (N) plays a central role in livestock development and food production in agricultural and pastoral regions, while its flow and loss can affect environmental quality, biodiversity and human health. A comprehensive understanding of the sources, patterns and drivers of N flow helps to alleviate its negative effects and promote sustainable management. We developed a county-scale N flow model to quantitatively analyze the N use efficiency (NUE), N losses and their driving forces in the food production and consumption system (FCPS) on the Qinghai-Tibet Plateau (QTP). More sustainable N utilization was further investigated through scenario analyses. Our results revealed that N fluxes doubled from 1998 to 2018 to maintain the growing demands for human food production and consumption in Ledu County, which was related to the increasing N losses to the atmosphere and water environment. The surging N fluxes greatly changed the N distribution pattern, resulting in a relatively low NUE (mean value: 29.41%) in the crop-production subsystem (CPS) and a relatively high NUE (mean value: 23.50%) in the livestock-breeding subsystem (LBS). The CPS contributed the most to the N losses. The urban population, animal-derived consumption, crop planting structure, imported fodder and N fertilizer application level were closely associated with N losses. The scenario analysis indicated that combined reasonable changes in planting

structure, precision animal feeding, fertilizer management, diets and conversion of cropland into pasture could reduce N losses in 2030 to 5%–61% of Business as usual level. Our results highlighted the strong anthropogenic impact on the N flow of food production and consumption and suggested a sustainable N flow management strategy to harmonize the relationship between N flow and anthropogenically driven factors on the QTP.

Further reading: <https://doi.org/10.1016/j.envpol.2021.117684>

### **CARBON STORAGE OF THE FOREST AND ITS SPATIAL PATTERN IN TIBET, CHINA**

Long-yu Jia, Gen-xu Wang, Ji Luo, Fei Ran, Wei Li, Jun Zhou, Dan-li Yang, Wen-bo Shi, Qian Xu, Kun Zhu, and Yang Yang

*Journal of Mountain Science* 18: 1748-1761

The raising concentration of atmospheric CO<sub>2</sub> resulted in global warming. The forest ecosystem in Tibet played an irreplaceable role in maintaining global carbon balance and mitigating climate change for its abundant original forest resources with powerful action of carbon sink. In the present study, the samples of soil and vegetation were collected at a total of 137 sites from 2001 to 2018 in Tibet. Based on the field survey of Tibet's forest resources and 8<sup>th</sup> forest inventory data, we estimated the carbon storage and carbon density of forest vegetation (tree layer, shrub, grass, litter and dead wood) and soil (0–50 cm) in Tibet. Geostatistical methods combined with Kriging spatial interpolation and Moran's I were applied to reveal their spatial distribution patterns and variation characteristics. The carbon density of forest vegetation and soil in Tibet were 74.57 t ha<sup>-1</sup> and 96.24 t ha<sup>-1</sup>, respectively. The carbon storage of forest vegetation and soil in Tibet were 344.35 Tg C and 440.53 Tg C, respectively. Carbon density of fir (*Abies* forest) was 144.80 t ha<sup>-1</sup> with the highest value among all the forest types. Carbon storage of spruce (*Picea* forest) was the highest with 99.09 Tg C compared with other forest types. The carbon density of fir forest and spruce forest both increased with the rising temperature and precipitation. Temperature was the main influential factor. The spatial distribution of carbon density of forest vegetation, soil, and ecosystem in Tibet generally showed declining trends from western Tibet to eastern Tibet. Our results facilitated the understanding of the carbon sequestration role of forest ecosystem in the Tibet. It also implied that as the carbon storage potential of Tibet's forests are expected to increase, these forests are likely to serve as huge carbon sinks in the current era of global warming and climate change.

Further reading: <https://doi.org/10.1007/s11629-020-6520-6>

### **LONG-TERM ECOLOGICAL EFFECTS OF TWO ARTIFICIAL FORESTS ON SOIL PROPERTIES AND QUALITY IN THE EASTERN QINGHAI-TIBET PLATEAU**

Yuejun He, Xiuru Han, Xueping Wang, Lingqing Wang, and Tao Liang

*Science of the Total Environment* 796: 148986

Afforestation is an essential process of ecological restoration, landscape reconstruction, and environmental improvement. While large-scale plantations have restored the fragile ecosystems of the Qinghai-Tibet Plateau, they have also changed local soil characteristics. A 30-year-old typical planted forest on the eastern Qinghai-Tibet Plateau was selected to determine the long-term ecological effects of artificial forests on the soil in this study. Physicochemical soil characteristics at varying soil depths and relative soil parameters, such as element stoichiometry and growing stock, were quantified on the different plantations. This soil quality

information was used to construct an MDS-SQI Model. Our findings revealed that soil TN, TK, TP, and AP content was higher than pre-afforestation baseline values, while SOC and pH values were lower. Amounts of soil nutrients SOC, TN, TP, TK, AP, and AK, were positively correlated in the artificial forests. The ratio of soil C/N was higher and ratios C/P and N/P were lower in poplar than the Chinese pine plantation. The soil quality index values calculated from the MDS model were 0.31 and 0.40 for poplar and Chinese pine plantations in the top 30 cm and 0.55 and 0.46 in the 100 cm depth, respectively, which indicated that the two plantations had low-quality soil. LiDAR satellite imagery was used to estimate a growing stock of 7723 m<sup>3</sup> and 435 m<sup>3</sup> in the poplar and Chinese pine plantations. The results suggest that the artificial forest improves soil properties overall but that different stand forests have discrete effects on the soil environment.

Further reading: <https://doi.org/10.1016/j.scitotenv.2021.148986>

### **CHANGES IN PLANT DEBRIS AND CARBON STOCKS ACROSS A SUBALPINE FOREST SUCCESSIONAL SERIES**

Zihui Wang, Lianjun ZHao, Yi Bai, Fei Li, Jianfeng Hou, Xuqing Li, Yurui Jiang, Yuyue Deng, Bingqian Zheng and Wanqin Yang

*Forest Ecosystems* 8: 40

As a structurally and functionally important component in forest ecosystems, plant debris plays a crucial role in the global carbon cycle. Although it is well known that plant debris stocks vary greatly with tree species composition, forest type, forest origin, and stand age, simultaneous investigation on the changes in woody and non-woody debris biomass and their carbon stock with forest succession has not been reported. Therefore, woody and non-woody debris and carbon stocks were investigated across a subalpine forest successional gradient in Wanglang National Nature Reserve on the eastern Qinghai-Tibet Plateau. Plant debris ranged from 25.19 to 82.89 Mg·ha<sup>-1</sup> and showed a global increasing tendency across the subalpine forest successional series except for decreasing at the S4 successional stage. Accordingly, the ratios of woody to non-woody debris stocks ranged from 26.58 to 208.89, and the highest and lowest ratios of woody to non-woody debris stocks were respectively observed in mid-successional coniferous forest and shrub forest, implying that woody debris dominates the plant debris. In particular, the ratios of coarse to fine woody debris stocks varied greatly with the successional stage, and the highest and lowest ratios were found in later and earlier successional subalpine forests, respectively. Furthermore, the woody debris stock varied greatly with diameter size, and larger diameter woody debris dominated the plant debris. Correspondingly, the carbon stock of plant debris ranged from 10.30 to 38.87 Mg·ha<sup>-1</sup> across the successional series, and the highest and lowest values were observed in the mid-coniferous stage and shrub forest stage, respectively. Most importantly, the carbon stored in coarse woody debris in later successional forests was four times higher than in earlier successional forests. The stock and role of woody debris, particularly coarse woody debris, varied greatly with the forest successional stage and dominated the carbon cycle in the subalpine forest ecosystem. Thus, preserving coarse woody debris is a critical strategy for sustainable forest management.

Further reading: <https://doi.org/10.1186/s40663-021-00320-0>

### **SCENARIOS OF POTENTIAL VEGETATION DISTRIBUTION IN THE DIFFERENT GRADIENT ZONES OF QINGHAI-TIBET PLATEAU UNDER FUTURE CLIMATE CHANGE**

Zemeng Fan and Xuyang Bai

The spatial distribution of potential vegetation types in Qinghai-Tibet Plateau presents a significant vertical zonation. Explicating the vertical differences of potential vegetation distribution under future climate change in Qinghai-Tibet Plateau is an important issue for understanding the response of terrestrial ecosystem to climate change. Based on the observed climate data in 1981–2010 (T0), the scenario data of RCP 2.6, RCP 4.5 and RCP 8.5 released by CMIP5 in 2011–2040 (T1), 2041–2070 (T2) and 2071–2100 (T3), and the digital elevation model (DEM) data, the Holdridge life zone (HLZ) model has been improved to simulate the scenarios of potential vegetation distribution in the different gradient zones of Qinghai-Tibet plateau. The shift model of mean center has been improved to calculate the shift direction and distance of mean center in the potential vegetation types. The ecological diversity index was introduced to compute the ecological diversity change of potential vegetation. The simulated results show that there are 17 potential vegetation types in Qinghai-Tibet Plateau. Wet tundra, high-cold moist forest and nival are the major potential vegetation types and cover 56.26% of the total area of Qinghai-Tibet Plateau. Under the three scenarios, the nival would have the largest decreased area that would be decreased by  $3.340 \times 10^4$  km<sup>2</sup> per decade, and the high-cold wet forest would have the greatest increased area that would be increased by  $3.340 \times 10^4$  km<sup>2</sup> on average per decade from T0 to T3. The potential vegetation types distributed in the alpine zone would show the fastest change ratio (11.32% per decade) and that in low mountain and other zone would show the slowest change ratio (7.54% per decade) on average. The ecological diversity and patch connectivity of potential vegetation would be decreased by 0.108% and 0.290% per decade on average from T0 to T3. In general, the potential vegetation types distributed in the high elevation area generally have a higher sensitivity to climate change in Qinghai-Tibet plateau in the future.

Further reading: <https://doi.org/10.1016/j.scitotenv.2021.148918>

## Bhutan-Himalaya

### COMMUNITY PERCEPTION OF ECOSYSTEM SERVICES FROM COMMERCIALY MANAGED FORESTS IN BHUTAN

Jigme Wangchuk, Kinley Choden, Robin R. Sears, Himlal Baral, Dawa Yoezer, Kelly Tobden Dorji Tamang, Thinley Choden, Norbu Wangdi, Shacha Dorji, Dorji Dukpa, Kaka Tshering, Cheten Thinley, and Tashi Dhendup

*Ecosystem Services* 50: 101335

Given the direct dependence rural communities have on forests, understanding ecosystem services can empower communities and align stakeholders to define priorities and objectives for the sustainable management of forest resources. In this qualitative study on the forest ecosystem services in Bhutan, we assessed community awareness and perceptions of local forest ecosystem services, identified their top priorities, and evaluated how they have changed over time. The study focused on state reserve forest areas designated for commercial timber production, formally known as forest management units (FMU). We held focus group discussions separately with women and men associated with five FMUs in the central belt of the country. Participants identified 45 ecosystem services, with soil productivity, freshwater, timber, fresh air, construction stone, carbon sequestration, spiritual value, pollination, and local weather regulation comprising the most highly valued services critical to local livelihood and well-being. Participants felt that forest ecosystem services have been generally declining over the past decade in the FMUs and identified a need for forest restoration activities to improve their delivery. We recommend that state forest entities conduct an awareness campaign to empower communities with the conceptual framework

and globally recognized concepts to advocate for their needs related to forests. We also recommend that biophysical and economic studies be conducted in these areas to seek evidence for causal linkages between natural resource use and the status of ecosystem services. This study contributes to a growing literature on ecosystem services in Bhutan and provides a basis for future studies to understand how management activities can impact the delivery of critical services.

For further reading: <https://doi.org/10.1016/j.ecoser.2021.101335>

## Pakistan- Himalaya

### ROLE OF BENEFICIAL MICROBES WITH NITROGEN AND PHOSPHOROUS LEVELS ON CANOLA PRODUCTIVITY

Hazratullah, A. Muhammad, M. Alam, I. Ahmad, and A. Jalal

*Brazilian Journal of Biology* 82: 227703

A research was conducted to evaluate the impact of various nitrogen and phosphorus levels along with beneficial microbes to enhance canola productivity. The research was carried out at Agronomy Research Farm, The University of Agriculture Peshawar in winter 2016-2017. The experiment was conducted in randomized complete block factorial design. The study was comprised of three factors including nitrogen (60, 120 and 180 kg ha<sup>-1</sup>), phosphorous (70, 100 and 130 kg ha<sup>-1</sup>) and beneficial microbes (with and without BM). A control treatment with no N, P and BM was also kept for comparison. Application of beneficial microbes significantly increased pods plant, seed pod, seed filling duration, 1000 seed weight, biological yield and seed yield as compared to control plots. Nitrogen applied at the rate of 180 kg ha<sup>-1</sup> increased pods plant<sup>-1</sup>, seed pod, seed filling duration, seed weight, biological yield and seed yield. Maximum pods plant<sup>-1</sup>, seed pod, early seed filling, heavier seed weight, biological yield, seed yield, and harvest index were observed in plots treated with 130 kg.ha<sup>-1</sup> phosphorous. As comparison, the combine treated plots have more pods plant<sup>-1</sup>, seeds pod<sup>-1</sup>, seed filling duration, heaviest seeds, biological yield, seed yield and harvest index as compared to control plots. It is concluded that application of beneficial microbes with N and P at the rate of 180 kg ha<sup>-1</sup> and 130 kg ha<sup>-1</sup>, respectively, increased yield and its attributes for canola.

For further reading: <https://doi.org/10.1590/1519-6984.227703>

### PHENOLOGY, GROWTH, YIELD AND NITROGEN UPTAKE OF WHEAT IN RESPONSE TO NITROGEN, POTASSIUM AND THEIR APPLICATION METHODS

Asad Ali Khan, Inamullah Khan, Muhammad Faheem Jan, Waqas Liaqat, Asim Muhammad, Shahenshah K., and Shazma Anwar

*Pakistan Journal of Scientific and Industrial Research Series B: Biological Sciences* 64: 142-159

Application of macronutrients in less amount along with improper application method(s) are the major factors for low yield. Experiments were designed with the objectives to determine the optimum rate of nitrogen (N) and potassium (K) along with suitable application method to minimize nutrients losses. The experimental site was New Developmental Farm of the University of Agriculture Peshawar and experiments were conducted for two consecutive years *i.e.* 2010-11 and 2011-12. After analysis, the results indicated that both N and K significantly

affected days to phenology (anthesis and maturity). Days to phenology increased linearly with increase in rate of N and K and more days to phenology were recorded when both were at their highest rates. Similarly plant height, leaf area/tiller, flag leaf area, leaf area index, leaf area duration, grain yield, N uptake by grains and straw were increased with increasing level of N and K and attained maximum value when N and K was applied at the rate of 180 and 90 Kg/ha, respectively. Nutrients application method significantly affected plant height, leaf area/tiller, flag leaf area, grain yield and N uptake by straw and grains with maximum values for these traits were recorded when nutrients (N and K) were applied in such a combination that 15% nutrients were supplied through foliar and 85% through soil application. Application methods had a non-significant effect on days to phenology, leaf area index and leaf area duration. It is concluded from the results that application of N and K at the rate of 180 and 90 Kg/ha respectively in such a way that 15% is applied through foliar spray and 85% through soil application improved growth, yield and N uptake of wheat crop under the semi-arid climate.

Further reading: <https://doi.org/10.52763/PJSIR.BIOL.SCI.64.2.2021.142.159>

## Highlight of the Issue

### WORLD CELEBRATES TIGER DAY

This year's Global Tiger Day was celebrated worldwide on July 29 to raise awareness about tiger conservation. Tiger has been a flagship species for conservation in the range countries. Declining tiger population globally forced the 13 range countries in 2010 to set a goal of doubling the population by 2022. In South East Asian region, the tiger population is still decreasing and is completely extinct from Cambodia, Laos, and Vietnam in the last 25 years. However, Nepal is the first country who is reaching the target of doubling the tiger population in the country. To evaluate the achievement of this doubling tiger population, Russia will be organizing the Global Tiger summit on September 2022. Protection of tiger and its habitat through research and trans-boundary collaboration help to save the species in the natural habitat.

Further Reading:

[www.bbc.com/news/in-pictures-58012200?fbclid=IwAR2sWDj4nOjad30aNGGC97rz4tKFmJ2N3mJUBqsY33vG2xlxWGFZwGiRQOc](http://www.bbc.com/news/in-pictures-58012200?fbclid=IwAR2sWDj4nOjad30aNGGC97rz4tKFmJ2N3mJUBqsY33vG2xlxWGFZwGiRQOc)

<https://www.news18.com/news/india/international-tiger-day-india-saw-over-300-big-cat-deaths-since-2018-with-poaching-still-a-cause-of-worry-4023281.html>