An Environmental Research Abstract

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For the 599- 600th issues of Headlines Himalaya, we reviewed journal articles from five sources and selected sixteenresearches from five countries. We selected threeresearches from Nepal and nineresearches from other Himalayan countries (India, China, and Bhutan).

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SPATIO-TEMPORAL DYNAMICS OF LANDSLIDES IN THE SEDIMENTARY TERRAIN: A CASE OF SIWALIK ZONE OF BABAI WATERSHED, NEPAL

Bharat Prasad Bhandari and SubodhDhakal

SN Applied Sciences 2: 1-17

Topographical, geological and hydrological attributes of mountainous region play significant role for landslide occurrence. In this study, the spatial and temporal behaviors of landslides in the Siwalik zone of Babai watershed are evaluated on the basis of topographical, geological and hydrological attributes. For this work, polygon based landslide spatial inventory and spatio-temporal inventory from the years 2010 to 2019 were prepared by using Santeniel-2, USGS and temporal series of Google earth images. Further analysis of landslides including the numbers, area and other geometrical parameters were carried out using Q-GIS. The geological map prepared by the Department of Mines and Geology of Nepal government was referred and validated from the field. The precipitation data was obtained from department of hydrology and meteorology, Government of Nepal. The state of activity of landslides was evaluated in different geological formations in temporal basis. The result shows that the landslides in study area are highly dynamic in nature showing reactivation, expansion and even self - stabilization in some parts. The new and active landslides are identified every year in every geological formation since a decade. It is also found that the hanging wall of the thrust zone is more sensitive for the distribution of medium to large scale landslides. The total annual rainfall shows positive correlation with the landslide frequency. The study will be useful for the researchers and policy makers to understand landslide mechanics and to manage the safe settlements in the area.

For further reading: https://doi.org/10.1007/s42452-020-2628-0

THE DIET OF THE STRIPED HYENA IN NEPAL'S LOWLAND REGIONS

Shivish Bhandari, Craig Morley, AchyutAryal, and UttamBabu Shrestha

*Ecology and Evolution*10: 7953-7962

Striped hyenas (*Hyaenahyaena*) are extremely rare in Nepal, and only a few people have studied them in their natural forest and grassland habitat. Their rarity is due to anthropogenic pressures such as hunting, habitat modification, being killed on roads, and depletion of their natural prey. Here, we studied the feeding ecology of

hyenas in lowland, Nepal. We employed an opportunistic sampling to collect hyena scats in a range of habitats and the line transect sampling to identify the prey of the hyena in the study site. We collected 68 hyena scats between 2015 and 2018. Most of the hyena scat (39.7%) was found in the Churia Hill forest followed by riverbed (26.4%), mixed forest (14.7%), Sal (*Shorearobusta*)-dominated forest (11.7%), and grassland area (7.3%). We found eleven mammalian prey species, plants, and some unidentified items in the hyena scats. The frequency of occurrence and relative biomass of the medium-sized wild boar (*Susscrofa*) were higher than other smaller prey species such as hare (*Lepusnigricollis*) and rhesus macaque (*Macacamulatta*). Similarly, the proportion of large prey species such as nilgai (*Boselaphustragocamelus*) in the hyena diet was lower compared with wild boar, hares, and rhesus macaques indicating medium-sized wild boar is the most preferred prey species. Livestock contributed 17.3% of the total dietary biomass. Domesticated species such as goats, sheep, cows, and even dogs were found in the diet of hyenas. Predation of livestock by hyenas could cause conflict, especially if this ongoing issue continues in the future. Rather, more conservation effort is required in lowland areas of Nepal to protect the hyenas' natural prey species, particularly in wildlife habitats to reduce the lure of taking domestic livestock. Similarly, conservation education at the local level and active involvement of government authorities in the conservation of this species might be helpful to mitigate human–hyena conflict in the human-dominated landscape.

For further reading: https://doi.org/10.1002/ece3.6223

SENSITIVITY OF SOURCE APPORTIONMENT PREDICTED BY A BAYESIAN TRACER MIXING MODEL TO THEINCLUSION OF A SEDIMENT CONNECTIVITY INDEX AS AN INFORMATIVE PRIOR: ILLUSTRATION USING THE KHARKA CATCHMENT (NEPAL)

Hari Ram Upadhayaya, SushilLamichhane, Roshan Man Bajracharya, WimCornelis, Adrian L. Collins, and Pascal Boeckx

Science of The Total Environment 713: 136703

Long-chain saturated fatty acid (LCSFA) isotopic composition in tandem with Bayesian isotope mixing models (BIMM) can provide insight into land use-based sediment sources in catchment systems. Apportioning sediment sources robustly, however, requires careful consideration of how additional factors including topography, surface cover and land use practices interact to influence contributions from individual sources. Prior knowledge can be used in BIMM; however, the full capacity of this functionality has not been thoroughly exploited yet in conjunction with sediment fingerprinting. In response, we propose an approach for applying a state-of-the-art BIMM incorporating a sediment connectivity index (SCI) as an informative prior for sediment source apportionment in a highly hydrodynamic catchment in Nepal. A library of LCSFA carbon isotopic composition was constructed for surface soils collected from mixed forest, upland and lowland terraces in the Kharka micro-catchment. $\delta^{13}C$ values of LCSFA of time-integrated suspended bulk (<2 mm) sediment were depleted by 4‰ compared to the fine (<0.063 mm) sediment fraction. Conventional source apportionment for fine sediment samples without the SCI informative prior suggested that 66% of the sediment is derived from forest soils followed by lowland (19%) and upland (15%) terraces. Incorporation of the SCI as an informative prior in BIMM, however, modified the original source apportionment estimates to 90%, 9% and 1% respectively. The lower contributions from agricultural terraces are explained by landscape complexity comprising small levelled terraces that reduce hillslope-to-channel sediment connectivity. This study demonstrates the sensitivity of BIMM posterior distributions to incorporation of an informative prior based on a SCI. Inclusion of SCI linked to land use and management can provide a more physically-grounded approach to estimating sediment source contributions from biogeochemical tracers, and

critically one which generates results better reflecting what makes good environmental sense in the context of land management and visual evidence of sediment mobilisation and delivery.

For further reading: https://doi.org/10.1016/j.scitotenv.2020.136703

China Himalaya

THE PLATEAU PIKA HAS MULTIPLE BENEFITS FOR ALPINE GRASSLAND ECOSYSTEM IN QINGHAI-TIBET PLATEAU

Xinquan Zhao, Liang Zhao, TianweiXu, and ShixiaoXu

Ecosystem Health and Sustanability 6: 1750973

The plateau pika (*Ochotonacurzoniae*) has been engaged in pest control for many years based on the logic that the plateau pika is responsible for alpine grassland degradation and competes with livestock for forage resources. However, the plateau pika is an important species which has multiple benefits in Qinghai-Tibetan plateau, as it (i) makes burrows that are the primary homes for lizards and a variety of small birds; (ii) creates microhabitat disturbance that promotes the increase of plant species richness; (iii) serves as the principal prey for almost all of the plateau predator species; and (iv) contributes positively to the dynamic equilibrium of alpine ecosystems.

For further reading: https://doi.org/10.1080/20964129.2020.1750973

HOUSEHOLD AIR POLLUTION AND PERSONAL EXPOSURE FROM BURNING FIREWOOD AND YAK DUNG IN SUMMER IN THE EASTERN TIBETAN PLATEAU

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*Environmental Pollution*263: 114531

This study assessed the sources, magnitudes, and chemical compositions of household air pollution (HAP) and personal exposure in traditional Tibetan households. We measured 24-h personal exposures to $PM_{2.5}$ and kitchen area black carbon (BC) concentrations, using MicroPEMs and microAeths, respectively. Particulate polycyclic aromatic hydrocarbon (PAH) and inorganic element concentrations were quantified via post analyses of a subset of MicroPEM sample filters. Household surveys regarding participant demographics, cookstove usage, household fuel, cooking behaviors, and lifestyles were collected. The results reaffirm that burning firewood and yak dung, mainly for cooking, leads to high $PM_{2.5}$ and BC exposures. The geometric mean concentration (95% confidence interval, CI) was 74.3 (53.6, 103) $\mu g/m^3$ for $PM_{2.5}$ and the arithmetic mean ± standard deviation (SD) concentration was 4.90 ± 5.01 $\mu g/m^3$ for BC and 292 ± 364 ng/m^3 for 15 identified PAHs, respectively. The arithmetic mean ± SD of mass concentrations of 24 detected elements ranged from 0.76 ± 0.91 ng/m^3 (Co) to 1.31 ± 1.35 $\mu g/m^3$ (Si). Our statistical analyses further illustrated that the high concentrations of $PM_{2.5}$, BC, and most PAHs and metals, are significantly associated with nomadic village, poorer stove/chimney conditions and yak dung burning. The results from this study show that substantial HAP exposure is prevalent in Tibetan households and requires immediate actions to mitigate potential negative environmental health impacts. The observational data also revealed the possibility of other important sources (e.g. traffic and garbage burning) that have contributed to personal exposures. These findings improve our understanding of HAP exposure and potential health risks in Tibetan communities and will help inform strategies for reducing HAP in Tibetan households and beyond.

For further reading: https://doi.org/10.1016/j.envpol.2020.114531

INDICATION OF PRIMARY BIOGENIC CONTRIBUTION TO BRC OVER A HIGH ALTITUDE LOCATION IN THE SOUTHEASTERN TIBET

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*Atmospheric Environment*231: 117462

To investigate the characteristics of primary biogenic organic aerosol (PBOA) and correlations with brown carbon (BrC) light absorption in the southeastern Tibetan Plateau (TP), the total suspended particle (TSP) samples were collected at a high altitude site (Lulang) from November 2015 to November 2016. The seasonal variations of PBOA tracers (including arabitol, mannitol, and glucose) were obtained. Elevated arabitol, mannitol and glucose concentrations were observed in monsoon (54, 10 and 18 times higher than in winter, respectively), largely due to the intensive contributions of seasonal biological origin. The highest percentages of fungal-spore-derived organic carbon (OC) and plant-debris OC were obtained in monsoon season with 23.4% and 4.0%, respectively. The results indicated that monsoon PBOA can be the contributor to BrCchromophores in the southeastern Tibetan Plateau. Further studies are needed to investigate the relation between PBOA components and BrC light absorption properties.

For further reading: https://doi.org/10.1016/j.atmosenv.2020.117462

PROFILE DISTRIBUTIONS OF SOIL ORGANIC CARBON FRACTIONS IN A PERMAFROST REGION OF THE QINGHAI–TIBET PLATEAU

Zi-Qiang Yuan, Hui-Jun Jin, Qing-Feng Wang, Qing-Bai Wu,Guo-Yu Li, Xiao-Ying Jin, andQiang Ma

Permafrost and Periglacial Processes

Adequate characterization of soil organic carbon (SOC) fractions is essential to elucidate carbon dynamics in permafrost-affected ecosystems. SOC and its fractions were investigated across alpine ecosystems, including alpine swamp meadows (ASM), alpine meadows (AM) and alpine steppes (AS), in permafrost regions on the Qinghai–Tibet Plateau (QTP), southwest China. The density separation method was used to separate the SOC into light- and heavy-fraction organic carbon (LFOC and HFOC, respectively). Permafrost soils in the ASM had higher SOC, LFOC, and HFOC contents than in the AM. LFOC and HFOC contents were significantly correlated, but both were more closely related to SOC than to each other. On the ecological gradient from ASM to AS, the thickness of surficial organic horizons decreased while the thickness of mineral materials increased. SOC in the organic horizon and permafrost had high mineralization probability. At soil depths of 0–200 cm in ASM, AM, and AS, the SOC stocks were 123, 71, and 25 kg m^{-2}; LFOC stocks were 70, 49, and 12 kg m^{-2}; and HFOC stocks were 58, 37, and 15 kg m^{-2}, respectively. These results show that SOC fractions vary with vegetation type and active layer thickness, thus making SOC sensitive to changes in environmental conditions. Therefore, the decomposition of SOC in permafrost-affected soils of the QTP could be accelerated over a degrading permafrost and under a warming climate.

For further reading: https://doi.org/10.1002/ppp.2055

SPATIOTEMPORAL CHARACTERISTICS OF HYDROTHERMAL PROCESSES OF THE ACTIVE LAYER ON THE CENTRAL AND NORTHERN QINGHAI–TIBET PLATEAU

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Science of The Total Environment 712: 136392

The spatial and temporal variations of the seasonal freeze–thaw cycles are important in understanding the ecological and hydrological processes and biogeochemical cycle associated with permafrost degradation caused by climate change, although observational data on the soil hydrothermal dynamics within the active layer of the permafrost region at the central and northern Qinghai–Tibet Plateau (QTP) are extremely scarce. In this study, soil temperature and moisture date from 11 observational sites along the Qinghai–Tibet Highway from 2010 to 2014 were used to analyze the freeze-thaw cycles of the active layer. The results revealed that mean annual ground surface temperature (MAGST) and mean annual temperature at the top of permafrost (TTOP) were the most closely related to the onset dates of soil freezing and thawing. The onset dates of soil freezing from bottom to top did not occur earlier than those from top to bottom. The differences between the onset dates of the two freezing directions and the proportion of bottom-up freezing depth increased with decreasing TTOP. The unfrozen water content of the cooling process was always higher than that of the warming process during the freezing stage. The hysteresis effect of the unfrozen water content could also be observed in the field experiment, and the maximum hysteresis levels occurred at their corresponding soil freezing points. Soil organic matter and soil moisture associated with vegetation cover are essential for water-heat exchanges between atmosphere and permafrost beneath active layer. We suggest that a better protected plant ecosystem, helps preserving the underlying permafrost on the Qinghai–Tibet Plateau.

For further reading: https://doi.org/10.1016/j.scitotenv.2019.136392

THE EFFECT OF DESERTIFICATION ON FROZEN SOIL ON THE QINGHAI-TIBET PLATEAU

LuyangWang, Qingbai Wu, and Guanli Jiang

Science of The Total Environment 711: 134640

Under the influences of climate change and human activities, desertification has become widespread on the Qinghai-Tibet Plateau (QTP). However, the effect of desertification on frozen soil is still debated. Here, soil temperatures are observed through 14 boreholes at Honglianghe River Basin on the QTP to study the relationship between desertification and frozen soil. The results showed soil temperatures change with the thickness of sand cover. With increasing sand thickness, maximum soil temperatures at shallow depths (0.05–6.00 m) increase by 0.25–1.57 °C, but minimum temperatures decrease by 0.21–1.49 °C, on average. Temperatures at deep depth (≥6.00 m) exhibit a rising trend that temperatures increase by 0.01–0.05 °C on average with each increment of 10 cm in sand thickness. Furthermore, aeolian sand enhances seasonal thawing processes, resulting in an increase of 7.70–9.50 cm in active layer thickness with each increment of 10 cm in sand thickness. Meanwhile, aeolian sand weakens seasonal freezing processes, resulting in a decrease of 1.07–13.00 cm in seasonal freezing depth with each increment of 10 cm in sand thickness. Moisture contents of aeolian sand and vegetation coverages on the sand cover surface influence energy state and thermal regime of frozen soil. Annual heat budgets of soil under aeolian sand increase from −57.97 MJ m^{-2} to −26.28 MJ m^{-2} as water content of sand layer decreases from 13.42% to 3.61%. Annual range of ground temperatures of soil at shallow depths (0.05–1.60 m) increase by 2.19–6.17 °C

on average as vegetation coverage increases from 5% to 20%. Due to the effects of aeolian sand on frozen soil, desertification accelerates, and can even cause, the degradation of frozen soil on the QTP. Our study provides an important reference for future research about the interaction between desertification and frozen soil in other regions.

For further reading: https://doi.org/10.1016/j.scitotenv.2019.134640

Bhutan-Himalaya

SPATIAL LANDSLIDE RISK ASSESSMENT AT PHUENTSHOLING, BHUTAN

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Geosciences 10: 131

Landslides are one of the most destructive and most recurring natural calamities in the Himalayan region. Their occurrence leads to immense damage to infrastructure and loss of land, human lives, and livestock. One of the most affected regions is the Bhutan Himalayas, where the majority of the landslides are rainfall-induced. The present study aims to determine the hazard and risk associated with rainfall-induced landslides for the Phuentsholing region located in the southwestern part of the Bhutan Himalayas. The work involves developing a landslide risk map using hazard and vulnerability maps utilizing landslide records from 2004 to 2014. The landslide hazard map was generated by determining spatial and temporal probabilities for the study region. The spatial probability was computed by analyzing the landslide contributing factors like geology, slope, elevation, rainfall, and vegetation based on comprehensive field study and expertise about the area. The contributing factors were divided into various classes and the percentage of landslide occurrence under each class was calculated to understand its contributing significance. Thereafter, a weighted linear combination approach was used in a GIS environment to develop the spatial probability map which was multiplied with temporal probabilities based on regional rainfall thresholds already determined for the region. Consequently, vulnerability assessment was conducted using key elements at risk (population, land use/land cover, proximity to road, proximity to stream) and the weights were provided based on expert judgment and comprehensive field study. Finally, risk was determined and the various regions in the study area were categorized as high, medium, and low risk. Such a study is necessary for low-economic countries like Bhutan which suffers from unavailability of extensive data and research. The study is conducted for a specific region but can be extended to other areas around the investigated area. The tool can serve as an indicator for the civil authorities to analyze the risk posed by landslides due to the rapid infrastructure development in the region.

For further reading: https://doi.org/10.3390/geosciences10040131

MID-CRUSTAL RAMPING OF THE MAIN HIMALAYAN THRUST IN NEPAL TO BHUTAN HIMALAYA: NEW INSIGHTS FROM ANALOGUE AND NUMERICAL EXPERIMENTS

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*Tectonophysics*782-783: 228425

The mid-crustal ramp on the Main Himalayan Thrust (MHT) in the Lesser Himalaya Sequence (LHS) is the most critical geometrical asperity to trigger major seismic events in the Himalaya, including the 2015 *Mw* 7.8 Gorkha, Nepal earthquake. However, it is still not well understood what caused the MHT to ramp up at laterally varying locations in central to eastern Himalaya during the southward propagation of the Himalayan tectonic wedge. Based on laboratory and numerical model experiments, approximated to the central (Nepal) and eastern (Bhutan) Himalayan geological settings, we show that the coal-bearing Gondwana horizon in the stratigraphic sequence has played a crucial role in producing the mid-crustal ramp on the MHT. During the southward propagation of the Himalayan wedge, the mechanically weak Gondwana sequence resulted in strain localization at its northern edge, and it eventually caused the MHT to ramp from a depth of >20 km to ~6–7 km. Combining our experimental and field observations with the geophysical sections, we interpret that a strike-wise non-uniform occurrence of the Gondwana horizon is responsible for the MHT to ramp at different locations, separated by N-S trending natural barriers, like tear faults. The weak-zone model also explains the rock uplift versus erosion pattern recorded in central Nepal. The ramp-induced surface uplift rates, calculated from our model, are in good agreement with those reported from central Nepal ($U^* \sim 0.28$, normalized to the convergent rate).

For further reading: https://doi.org/10.1016/j.tecto.2020.228425

CLIMATE CHANGE EFFECTS ON WILDFIRE HAZARDS IN THE WILDLAND-URBAN-INTERFACE – BLUE PINE FORESTS OF BHUTAN

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Forest Ecology and Management 461: 117927

Increased wildfire activity in the Himalayan Mountains due to climate change may place rural livelihoods at risk, yet potential climate change effects on forest fires in this region are poorly investigated. Here we use Bhutan's blue pine (Pinuswallichiana) ecosystems to study the sensitivity of fire behavior to climatic changes. Wildland fires are one of the biggest threats to forest resources in Bhutan; blue pine ecosystems, in particular, are of high concern because of their importance for rural livelihoods and relatively high frequency of forest fires. Due to the geographical and socioeconomic characteristics of Bhutan, the region is highly sensitive to climate change. We investigated fire hazards in the wildland-urban-interface (WUI) of two valleys in Bhutan (Thimphu and Jakar), where human settlements and infrastructure are surrounded by blue pine forests. We applied FlamMap, a spatially-explicit wildfire simulation model, to simulate fire behavior under four climate scenarios. As indicators of fire behavior, we used flame length, rate of spread, crown fire activity, burn probability, and fire size. With the simulation outcomes we constructed a fire hazard map showing the hotspots of forest fire susceptibility. FlamMap predicts a two-fold increase in fire hazards in the WUI for both study areas owing to climatic changes. The capital city of Thimphu has, on average, greater fire hazards than Jakar, though fire hazards are spatially variable within both study areas. Our study contributes to the understanding of and ability to predict forest fire hazards in Himalayan blue pine ecosystems. The findings will help to more precisely allocate fire management resources in the WUI, plan suburban development to minimize fire risk to livelihoods, and adapt forest management in the face of climate change.

For further reading: https://doi.org/10.1016/j.foreco.2020.117927