An Environmental Research Abstract

Headlines Himalaya

March 1 - March 15 (2021) No. 641-642 Editorial Team: Lila Paudel and Bimal Sharma

For the 641st - 642nd issues of Headlines Himalaya, we reviewed journal articles from four sources and selected 12 researches from five countries. We selected one research from Nepal and 11 researches from other Himalayan countries (India, China, Bhutan and Pakistan).

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FEASIBILITY OF REINTRODUCING GRASSLAND MEGAHERBIVORES, THE GREATER ONE-HORNED RHINOCEROS, AND SWAMP BUFFALO WITHIN THEIR HISTORIC GLOBAL RANGE

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Scientific Reports 11: 4469

Reintroduction of endangered species is an effective and increasingly important conservation strategy once threats have been addressed. The greater one-horned rhinoceros and swamp buffalo have declined through historic hunting and habitat loss. We identify and evaluate available habitat across their historic range (India, Nepal, and Bhutan) for reintroducing viable populations. We used Species Distribution Models in Maxent to identify potential habitats and evaluated model-identified sites through field visits, interviews of wildlife managers, literature, and population-habitat viability analysis. We prioritize sites based on size, quality, protection, management effectiveness, biotic pressures, and potential of conflict with communities. Our results suggest that populations greater than 50 for rhinoceros and 100 for buffalo were less susceptible to extinction, and could withstand some poaching, especially if supplemented or managed as a metapopulation. We note some reluctance by managers to reintroduce rhinoceros due to high costs associated with subsequent protection. Our analysis subsequently prioritised Corbett and Valmiki, for rhino reintroduction and transboundary complexes of Chitwan-Parsa-Valmiki and Dudhwa-Pilibhit-Shuklaphanta-Bardia for buffalo reintroductions. Establishing new safety-nets and supplementing existing populations of these megaherbivores would ensure their continued survival and harness their beneficial effect on ecosystems and conspecifics like pygmy hog, hispid hare, swamp deer, hog deer, and Bengal florican.

Further reading: https://doi.org/10.1038/s41598-021-83174-4

India-Himalaya

GHARIAL NESTING IN A RESERVOIR IS LIMITED BY REDUCED RIVER FLOW AND BY INCREASED BANK VEGETATION

Gaurav Vashistha, Ninad Avinash Mungi, Jeffrey W. Lang, Vivek Ranjan, Parag Madhukar Dhakate, Faiyaz Ahmad Khudsar, and David Kothamasi

Scientific Reports 11: 4805

The gharial (*Gavialis gangeticus* Gmelin) is a fish-eating specialist crocodylian, endemic to south Asia, and critically endangered in its few remaining wild localities. A secondary gharial population resides in riverine-reservoir habitat adjacent to the Nepal border, within the Katerniaghat Wildlife Sanctuary (KWS), and nests along a 10 km riverbank of the Girwa River. A natural channel shift in the mainstream Karnali River (upstream in Nepal) has reduced seasonal flow in the Girwa stretch where gharials nest, coincident with a gradual loss of nest sites, which in turn was related to an overall shift to woody vegetation at these sites. To understand how these changes in riparian vegetation on riverbanks were related to gharial nesting, we sampled vegetation at these sites from 2017 to 2019, and derived an Enhanced Vegetation Index (EVI) from LANDSAT 8 satellite data to quantify riverside vegetation from 1988 through 2019. We found that sampled sites transitioned to woody cover, the number of nesting sites declined, and the numbers of nests were reduced by > 40%. At these sites, after the channel shift, woody vegetation replaced open sites that predominated prior to the channel shift. Our findings indicate that the lack of open riverbanks and the increase in woody vegetation at potential nesting sites threatens the reproductive success of the KWS gharial population. This population persists today in a regulated river ecosystem, and nests in an altered riparian habitat which appears to be increasingly unsuitable for the continued successful recruitment of breeding adults. This second-ranking, critically endangered remnant population may have incurred an "extinction debt" by living in a reservoir that will lead to its eventual extirpation.

Further reading: https://doi.org/10.1038/s41598-021-84143-7

ACTIVE THRUST INDUCED REALIGNMENT OF RECENT NEAR-SURFACE STRESSES IN THE DARJEELING-SIKKIM HIMALAYAS: REASONS AND IMPLICATIONS

Dip Das, Jyotirmoy Mallik, Shreeja Das, Tanwita Deb, Ayanangshu Das, and Krishanu Bandyopadhyay

Journal of Structural Geology 145: 104311

This paper presents a study where Fracture Induced Electromagnetic Radiation (FEMR) technique has been used to decipher the direction of recent near-surface stresses along the near surface segments of the major thrusts of the Darjeeling-Sikkim Himalaya, India. Slip Tendency analysis on the same thrust system was carried out where the sensitivity of the mutual angle between thrust strike and stress azimuth was tested. A major realignment of the regional surface stress was observed in specific areas of the Darjeeling-Sikkim Himalaya which perhaps indicate enhanced localized neotectonic activities. An attempt was made to test spatial correlation between landslide locations and areas with enhanced tectonic activity as predicted by the FEMR technique. We conclude that the newly practiced FEMR technique can be a fruitful shallow activity indicator of critically stressed fault systems which could cause shallow earthquakes and landslides.

Further reading: https://doi.org/10.1016/j.jsg.2021.104311

China Himalaya

NON-TARGET METABOLOMICS REVEALED THE DIFFERENCES BETWEEN *Rh. tanguticum* PLANTS GROWING UNDER CANOPY AND OPEN HABITATS

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BMC Plant Biology 21: 119

Rheum tanguticum (Rh. tanguticum) is an important traditional Chinese medicine plant, "Dahuang", which contains productive metabolites and occupies wide habitats on the Qinghai-Tibet plateau. Plants occupying wide habitats usually vary in phenotypes such as in morphology and metabolism, thereby developing into different ecotypes. Under canopy and open habitats are a pair of dissimilar habitats which possess *Rh. tanguticum* plants. However, few studies have focused on the effect of habitats on *Rh. tanguticum* growth, particularly combining morphological and metabolic changes. This study focused on *Rh. tanguticum* plants growing in under canopy and open habitats where morphology and metabolism changes were quantified using non-target metabolism methods. The obtained results indicated that the two dissimilar habitats led to *Rh. tanguticum* developing into two distinct ecotypes where the morphology and metabolism were simultaneously changed. Under canopy habitats bred morphologically smaller *Rh. tanguticum* plants which had a higher level of metabolites (22 out of 31) which included five flavonoids, four isoflavonoids, and three anthracenes. On the other hand, the open habitats produced morphologically larger *Rh. tanguticum* plants having a higher level of metabolites (9 out of 31) including four flavonoids. 6 of the 31 metabolites were predicted to have effect targets, include 4 represent for under canopy habitats and 2 for open habitats. Totally, 208 targets were connected, among which 42 were communal targets for both under canopy and open habitats represent compounds, and 100 and 66 were unique targets for under canopy superior compounds and open habitats superior compounds, respectively. In addition, aloe-emodin, emodin, chrysophanol, physcion, sennoside A and sennoside B were all more accumulated in under canopy habitats, and among which aloe-emodin, emodin, chrysophanol and physcion were significantly higher in under canopy habitats. This study determined that *Rh. tanguticum* growing in under canopy and in open habitats developed into two distinct ecotypes with morphological and metabolic differences. Results of network pharmacology study have indicated that "Dahuang" coming from different habitats, such as under canopy and open habitats, are different in effect targets and thus may have different medicinal use. According to target metabolomics, under canopy habitats may grow better "Dahuang".

Further reading: https://doi.org/10.1186/s12870-021-02897-8

DYNAMICS AND FLUXES OF DISSOLVED CARBON UNDER SHORT-TERM CLIMATE VARIABILITIES IN HEADWATERS OF THE CHANGJIANG RIVER, DRAINING THE QINGHAI-TIBET PLATEAU

Jun Zhong, Si-Liang Li, Xuetao Zhu, Jing Liu, Sen Xu, Sheng Xu, and Cong-Qiang Liu

Journal of Hydrology 596: 126128

Carbon-climate feedback is sensitive in the Qinghai-Tibet Plateau. A series of temporal measurements from Jinsha River and Yalong River, in conjunction with flow information, were used to study the carbon dynamics and predict future carbon fluxes under ongoing climate change. DIC and DOC concentrations showed considerable temporal variations, with low DIC and high DOC concentrations in the high-flow season, and vice versa. DIC and DOC concentrations had negative and positive relationships with runoff changes, respectively, showing the hydro-biogeochemical controls on carbon dynamics. With the increase of runoff, the accelerated chemical weathering and the high carbonate buffering capacity should be responsible for the chemostatic behaviors of DIC. Meanwhile, warm weather would enhance organic carbon degradation, and also thicken the active layer of permafrost in the source area, both of which would produce DOC. In addition, organic carbon degradation in the high-flow season would produce DIC with ^{13}C-depleted values. $\delta^{13}C_{DIC}$ also had significant temporal variations, synchronous with runoff changes (i.e., light values under high runoff conditions), supporting that biological carbon plays an important role in carbon dynamics during the warm season. Based on the clear positive correlations between carbon fluxes and runoff, we predicted that the sensitivities of DOC fluxes to temperature changes are 12.2%/°C and 8.3%/°C for the Jinsha River and Yalong River, respectively. The sensitivities of DIC fluxes to temperature

changes are much lower, which are 5.5%/°C and 6.1%/°C for the Jinsha River and Yalong River, respectively. This study sheds lights on the alpine riverine carbon cycling based on runoff-shifting concentration-isotope (*q-C-I*) relationships in the Qinghai-Tibet Plateau, which has implications on the understanding of climate forcing on carbon fluxes in alpine areas.

Further reading: https://doi.org/10.1016/j.jhydrol.2021.126128

LATE QUATERNARY STEADY DEFORMATION OF THE MINLE FAULT IN THE NORTH QILIAN SHAN, NE TIBET

Qingri Liu, Youli Li, Jianguo Xiong, Huiping Zhang, Weipeng Ge, Xudong Zhao, Feipeng Huang, Xiu Hu, Yuezhi Zhong, and Weilin Xin

Tectonophysics 807: 228775

The Qilian Shan, located in the northeastern Tibetan Plateau, has been continuously extending to the foreland since the late Cenozoic, resulting in the deformation of the Hexi Corridor Basins. Five terraces of the Hongshui River are faulted in the southern Zhangye Basin, a sub-basin of the Hexi Corridor, documenting the tectonic history of the Minle Fault since the late Quaternary. In this study, a high precision digital elevation model (DEM) generated by unmanned aerial vehicle (UAV) photogrammetry is used to obtain the cumulative vertical offset of each terrace. And the abandonment ages of terraces are dated by AMS ^{14}C dating. The results show that the Minle Fault has produced an almost constant shortening rate of 0.95 ± 0.30 mm/a since 42.3 ± 0.5 ka, and has been active throughout the Holocene. The shortening rate of the Minle Fault could represent the deformation rate in the south margin of the Zhangye Basin. Geological and geodetic data indicate the shortening rates of the Zhangye Basin are steady in 10^4 and 10-year timescales. The deformation rate of the north Qilian fault-fold system (NQF) has not changed significantly since the late Quaternary and may be consistent with that in the 10^6-year timescale, although further studies are needed.

Further reading: https://doi.org/10.1016/j.tecto.2021.228775

MICRO-SCALE FRAGMENTATION OF THE ALPINE MEADOW LANDSCAPE ON THE QINGHAI-TIBET PLATEAU UNDER EXTERNAL DISTURBANCES

Jiexia Li, Xilai Li, Jay Gao, Kazhaocairang, Geliang Ma, and Xuezhong Qi

CATENA 201: 105220

Detailed characterization of alpine meadow ecosystems using spatial metrics is important to understand the underlying processes of meadow degradation and to inform its proper management. The change in the fragmentation of the alpine meadow on the Qinghai-Tibet Plateau during 2018–2019 was studied in relation to plateau pika (*Ochotona* curzoniae) population and simulated grazing both independently and interactively. For the first time this study has quantified their effect on the changes in the spatial metrics of bare and healthy meadow patches with the assistance of multi-temporal UAV images in ArcGIS. The spatial index reflecting the fragmentation degree of landscape caused by external disturbances was obtained via spatial analysis in the Fragstats 4.2 software. The results showed that the impact of pika on landscape fragmentation was higher than that of simulated grazing, so pikas populaton should be controlled within the manageable level. The influence of each disturbance on the degree of fragmentation was the highest in high density pika and severe mowing plot, followed by the plots of medium density pika, the control treatments, high density pika, other three interactive effect groups, moderate mowing and severe mowing. In the interactive effect, at the same mowing intensity, landscape fragmentation increased with pika population. At the same pika population, landscape fragmentation increased

with mowing intensity. The correlation coefficient between the change in pika burrows and area of bare patches is 0.538, and the proportion of bare patches to the landscape is 0.541. This study provides a reference for studying the feasibility of grassland fragmentation monitoring in the future and the landscape stability of the alpine meadow.

Further reading: https://doi.org/10.1016/j.catena.2021.105220

Bhutan-Himalaya

VULNERABILITY OF MAMMAL COMMUNITIES TO THE COMBINED IMPACTS OF ANTHROPIC LAND-USE AND CLIMATE CHANGE IN THE HIMALAYAN CONSERVATION LANDSCAPE OF BHUTAN

Ugyen Penjor, Sonam Wangdi, Tandin Tandin, and David W. Macdonald

Ecological Indicators 121: 107085

Human land-use and climate change drive biodiversity loss, precipitating the extinction crisis. The fragility of the Himalayas makes species in this landscape vulnerable to land-use and climate change. We aim to quantify the response of terrestrial mammal community to land-use and climate scenarios in the Bhutan Himalaya. Using large-scale camera-trap dataset, we examine the effects of anthropic land-use and climate variables on the terrestrial mammal assemblage using Bayesian multi-species occupancy model. Most of the terrestrial mammals in our sample displayed a strong negative relationship with anthropic land-use variables (agriculture, roads and settlement). Further, the occurrence of most species decreased with likely projections for climate variables, illustrating threats to conservation if the current trend in global warming continues. Notably, we found that biodiversity conservation in this landscape can be achieved by protecting extensive forest cover. Our findings emphasize the importance of reconciling land-use management and mammal conservation in the face of climate change and provide vital information which can be used to optimize future conservation and development plans.

Further reading: https://doi.org/10.1016/j.ecolind.2020.107085

AN ESTIMATION OF PROBABLE SEISMIC HAZARD IN THE ACTIVE DEFORMATION FRONT OF THE HIMALAYAN ARC

Basab Mukhopadhyay

Journal of Earth System Science 130: 43

In this study, the strain rate (SR) in grid-nodes in and around Himalaya that was computed from 1252 GPS station data, is also used. The earthquake catalogue of Himalaya between 1225 and 2017 is compiled. The active tectonic front of the Himalaya is subdivided into 14 zones between MFT and MCT, where MHT is locked. For each zone, magnitude-completeness (M_c), 'a' and 'b' values, geodetic moment rate (Mgd), seismic moment rate (Msm), moment ratio (Mgd/Msm) are calculated. It is observed that the moment ratio is <1 in zone 1 (Kashmir), 3 (Kangra), 5 (Almora), 6 (Central-gap 1), 8 (Pokhra–Kathmandu), 9 (Everest), 11 (W Bhutan), 12 (E Bhutan), 13 (Arunachal) and 14 (Eastern Syntaxis). These zones show good agreement between geodetic and seismic moment rates, and are vulnerable to large earthquakes (M_w 8.15–8.95) in the distant future. Presently, zone 2 (Kishtwar), 4 (Nahan), 7 (Central-Gap 2), and 10 (Sikkim) are vulnerable as they show moderate-low b-values, high moment ratio (>1), and long seismic hiatus for large earthquakes. Moreover, zones 2, 4, 10, 12, and 13 have un-ruptured patches of MHT and have the capacity to spawn M_w 6.75–7.95 earthquake at any point of time. The rupture generated in

these zones will transgress the zone boundaries and terminate in the sub-surface Precambrian ridge systems continuing from Peninsular India below Himalaya.

Further reading: https://doi.org/10.1007/s12040-020-01544-4

Pakistan- Himalaya

THE SIGNIFICANCE OF UPPER JURASSIC FELSIC VOLCANIC ROCKS WITHIN THE INCIPIENT, INTRAOCEANIC DRAS ARC, LADAKH, NW HIMALAYA

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Gondwana Research 90: 199-219

The Dras Arc is an island arc terrane located along the Indus Suture within the Ladakh Himalaya. To the north it is juxtaposed against the Eurasian Ladakh Batholith and to the south it is thrust over the Lamayuru Complex and Indian passive margin. Establishing the timing of inception and final collision of the Dras Arc is imperative to reconstructions of the Neotethyan Ocean and timing of arc-continent collisions, prior to the terminal India-Asia continental collision. We describe and date felsic tuffs and adakitic felsic volcanic rock interbedded within the dominantly basaltic-andesitic Dras volcanic complex. These felsic volcanic units yield Upper Jurassic zircon U–Pb ages of 160 ± 3 and 156 ± 1 Ma respectively, making these the oldest reported units within the Dras Arc. We also report zircon U–Pb geochronologic and whole rock geochemical results for the Kargil Intrusive Suite which intrudes the volcanic complex. Previous ages for the intrusives have been reproduced (102 ± 2 Ma and 101 ± 2 Ma), and a second, much younger phase (80 ± 1 Ma) has been identified as one of the youngest igneous phases within the Dras Arc. The presence of felsic, adakitic volcanism early in the evolution of the Dras Arc is consistent with the adolescent stages of island arc systems, in which dehydration melting of underplated arc or subducted oceanic crust generates small volumes of felsic magmas. Thus, the intraoceanic Dras Arc initiated in the Neotethyan Ocean during the Upper Jurassic, much earlier than previously reported, and possibly was active right up to collision during the late Palaeocene between 60 and 50 Ma. It is likely that the Dras Arc developed together with the Spongtang Ophiolite-Spong Arc complex and the intraoceanic Zedong terrane of Tibet, before first colliding and accreting onto the passive margin of India, prior to the terminal continental collision.

Further reading: https://doi.org/10.1016/j.gr.2020.11.007

SPATIAL DISTRIBUTION AND PROVENANCE OF HEAVY METAL CONTAMINATION IN THE SEDIMENTS OF THE INDUS RIVER AND ITS TRIBUTARIES, NORTH PAKISTAN: EVALUATION OF POLLUTION AND POTENTIAL RISKS

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Environmental Technology and Innovation 21: 101184

This study investigated heavy metal concentrations in sediment for the quantification of pollution and potential ecological risks of the Indus River and its tributaries. River sediments were sampled across the five major geological sections: the Kohistan batholith, Chilas complex, Kamila amphibolites, Jijal complex, and Indian plate. The heavy metal concentrations of the sediment samples were determined by atomic absorption spectrometry (Perkin Elmer, AAS-PEA-700). Results showed that the highest concentration of 36 300 mg/kg was observed for Fe in the Jijal complex and the lowest of 1.07 mg/kg for Cd in the Kohistan batholith. Heavy metal concentrations

were used to quantify the geospatial distribution of pollution. The contamination factor values revealed that heavy metal exhibited moderate contamination, except for Cr and Cd, which showed considerable contamination levels in the Jijal complex and Indian plate, respectively. The pollution load index revealed that the sediments in the study area were contaminated with heavy metal. Ecological risk index (ERI) values indicate a low risk (ERI <150) to the exposed aquatic environment. Statistical and geospatial analyses showed that the heavy metal contamination of sediments was higher in the Jijal complex and Indian plate owing to natural and anthropogenic activities.

Further reading: https://doi.org/10.1016/j.eti.2020.101184

DISENTANGLING THE DETERMINANTS OF LITTER DECOMPOSITION AMONG INVADED AND UNINVADED HABITATS: A FIELD EXPERIMENT FROM THE KASHMIR HIMALAYA

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Acta Oecologica 110: 103708

Litter decomposition, a key biogeochemical cycling process regulating carbon and other nutrient balances, is driven by several factors including vegetation composition, litter quality and local environmental conditions. However, the relative role of these drivers on decomposition process in the context of plant invasions has been little investigated, particularly in the Himalaya. In this study, we investigated the effect of plant invasion, litter quality and altitude on decomposition rate at multiple sites along an elevational gradient in Kashmir Himalaya. We used the standard litterbag incubation experiment to compare decomposition rates among the plots with- and without global plant invader *Leucanthemum vulgare*, using both standard (cellulosic filter papers) and local (pine needles) litter types. Our results show that invasion had a significant effect on decomposition rates of both the litter types with relatively higher decomposability in case of invaded plots than the uninvaded ones. Litter quality was the predominant factor in controlling the decomposition rate as evidenced from much higher decomposability (about eight times) of filter papers as compared to pine needles. Also, altitude had a significantly negative effect on decomposition rate of both the litter types, possibly through the influence on abiotic conditions (temperature and precipitation in particular). Our results highlight that, although multiple factors are affecting the litter decomposition at the regional scale, the litter quality exerted the stronger influence. Our study suggests that invasive *L. vulgare* by altering the litter decomposition rates could greatly influence the cycling of nutrients in the invaded landscapes.

Further reading: https://doi.org/10.1016/j.actao.2021.103708