An Environmental Research Abstract

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For the 633rd – 634th issues of Headlines Himalaya, we reviewed journal articles from four sources and selected eight researches from three countries. We selected two researches from Nepal and six researches from other Himalayan countries (India, and China).

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ECOLOGICAL RESPONSES TO FLOW VARIATION INFORM RIVER DOLPHIN CONSERVATION

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Scientific Reports 10: 22348

Many environmental flow (e-flow) studies and applications have predominantly used state—(i.e., at a single time point) and rate—(i.e., temporal change) based demographic characteristics of species representing lower trophic levels (e.g., fish communities) to build flow-ecology relationships, rather than using a process that incorporates population dynamics. Recent studies have revealed the importance of incorporating data on species traits when building flow-ecology relationships. The effects of flow on keystone megafauna species (i.e., body mass ≥ 30 kg) reverberate through entire food webs; however, the relationships between flow and these species are not well understood, limiting the scope of the relationships used in flow management. Here, we fill this gap by incorporating the habitat selection traits at different flows of a freshwater apex predator, Ganges River dolphin (GRD, *Platanista gangetica gangetica*), which plays a significant role in maintaining the structure, functions and integrity of the aquatic ecosystem. Using temporally and spatially measured GRD habitat selection traits, we quantified flow-ecology responses in the Karnali River of Nepal during the low-flow season when habitat was heavily reduced and water demand was highest. We define ecological responses as suitable habitat templates with enough usable surface area to support GRD fitness by improving reproduction and survival. We measured the available and occupied habitats to develop flow-ecology responses. Variation in flow resulted in substantial differences in the ecological response across time and space, suggesting that aquatic species adjusted in a variety of habitats to support their life histories and maintain viable populations. The limited availability of suitable habitats combined with uninformed water regulations by humans likely places GRDs under severe physiological stress during low-water seasons (i.e., January–April), suggesting that reduced flows contribute to the process of endangering and extirpating highly sensitive endemic aquatic biodiversity. Our study reveals that ad hoc or experience-based flow management is no longer tenable to maintain the integrity and functionality of aquatic ecosystems. We stress that quantifying the flow-ecology relationships of foundational species, particularly mega fauna, in response to flow variation is crucial for monitoring the effects of water alterations and determining the minimum flows needed for maintaining healthy and functional freshwater ecosystems in the Anthropocene.

For further reading: https://doi.org/10.1038/s41598-020-79532-3

RING WIDTHS OF RHODODENDRON SHRUBS REVEAL A PERSISTENT WINTER WARMING IN THE CENTRAL HIMALAYA

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Dendrochronologia 65: 125799

Himalayan Mountains provide unique opportunities for the extension of shrub-ring based dendroclimatology beyond the upper tree limit. However, little is known about limiting climate factors of shrub growth under harsh environmental conditions. We established a new ring-width chronology of a Himalayan shrub rhododendron (*Rhododendron campanulatum* D. Don) at the upper Krummholz treeline in the Mt. Gaurishankar massif, central Himalaya, Nepal. Bootstrapped correlation analysis showed positive relationships between radial growth and

temperatures of all months from previous November to current October. Correlations were the highest with winter (December-February) minimum temperature ($r = 0.781$, $p < 0.001$), indicating that radial growth of *R. campanulatum* is strongly sensitive to winter minimum temperature. The linear regression model explained 61 % of the actual winter minimum temperature variance during the calibration period 1960–2013. Periods of low and high minimum winter temperatures in the central Himalaya were consistent with cool and warm episodes found by other regional winter temperature reconstructions from the Himalayas and the Tibetan Plateau. Spatial correlation analysis with land surface temperatures revealed the spatial representativeness of our reconstruction for a larger geographical territory over the Himalayas and the Tibetan Plateau. Furthermore, winter temperature in the central Himalaya is teleconnected with the December-February India-Burma trough. The persistent increasing winter temperature in recent decades in the central Himalaya coincides with continental-scale warming. Alpine vegetation in humid regions of the Himalayas may benefit from winter warming via an earlier start and extension of the growing season, as long as moisture availability is sufficient.

For further reading: https://doi.org/10.1016/j.dendro.2020.125799

India-Himalaya

TREE SPECIES COMPOSITION AND DIVERSITY IN MONTANE FORESTS OF GARHWAL HIMALAYA IN RELATION TO ENVIRONMENTAL AND SOIL PROPERTIES

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Journal of Mountain Science 17: 3097-3111

The montane forests of Garhwal Himalaya were investigated for tree species composition and diversity in relation to environmental and edaphic variables. A stratified random sampling approach was adopted to collect the field data from each forest. A total of 39 tree species belonging to 31 genera and 23 families were recorded from the sampling area (6 forest stands × 10 plots in each). Lauraceae with 5 species was the largest family while *Quercus* (4 species) emerged as the largest genus. Species-area curve (asymptote) predicted more species than the observed number of species. Cluster analysis has shown that the two *Abies pindrow* dominant forest stands had the highest similarity in tree species composition. The tree stem density ranged from 540–1170 ha^{-1}, basal area 23.01–55.94 m2 ha^{-1}, Shannon-Wiener diversity index 1.69–2.49, evenness index 0.42–0.74, beta diversity 0.40–0.82 and similarity index 0.17–0.54 in the six studied forests. Two-way indicator species analysis (TWINSPAN) identified four distinct tree communities in the study area with *Daphniphyllum himalayense*, *Abies pindrow*, *Quercus oblongata*, and *Pinus roxburghii* as indicator species of corresponding communities. Canonical correspondence analysis (CCA) ascertained the TWINSPAN results and revealed the relation of tree species with environmental and edaphic variables. The phytosociological attributes of tree species varied from one forest stand to another; however, the tree species richness, density, and diversity peaked at intermediate elevation on the north aspect. Findings reveal that tree composition and diversity in the montane forests of Garhwal Himalaya are influenced by both environmental (elevation and slope aspect) and soil variables (texture, water holding capacity, moisture content, available N, exchangeable P, and pH). This study will help in understanding the forest distribution across the western Himalaya, guiding the conservationists and policymakers in carrying out conservation-related management activities, designing the long-term monitoring studies and assessing the effects of on-going and future climate change and disturbances.

For further reading: https://doi.org/10.1007/s11629-019-5761-8

GLACIER CHANGE AND GLACIER RUNOFF VARIATION IN THE HIMALAYAN BASPA RIVER BASIN

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Journal of Hydrology 593: 125918

Monitoring the changes in glaciers and their impact on melt runoff is significant to assess the availability of water resources in the Himalayan basins. In this study, the spatial processes in Hydrology (SPHY) model has been incorporated with variable degree-day factors coupled with temperature index model in the Baspa river basin, a major tributary of Satluj River, located in Western Himalaya. The temporal glacier maps derived from the LANDSAT satellite sensors and Moderate Resolution Imaging Spectroradiometer (MODIS) derived snow covered area (SCA) maps have been used to compute the snow and glacier melt runoff separately. The SCA maps generated through the model were found comparable to the MODIS derived SCA maps for the years 2010 and 2018. Model simulation results showed that SPHY based computed flow at the outlet i.e. Sangla gauge was found satisfactory when compared to the observed flow and R^2 computed > 0.7. The contribution from Glacier melt has been found to be reduced from 18 to 12% while Snow melt contribution increased from 58 to 64% from 2000 to 2018. On the basis of analysis of the 17 watersheds (i.e. dominated by snow and glaciers) out of 30 watersheds created in the basin, the flow from Glacier melt in glacier dominated watersheds is increasing while in other watersheds it is reducing due to reduced glacier cover. On an average, Glacier melt has decreased 14% and 44%, Snow melt increased 24 and 42% and Rain flow (rainfall induced runoff) 31 and 40% for the year 2011 to 2018 with respect to the year 2003 from these 17 watersheds. As per SPHY, corresponding to glacier map of the year 2000, the glacier ice volume has been computed around 13.41 km^3, while for the glacier map of 2018, it has been reduced around 10.99 km^3.

For further reading: doi.org/10.1016/j.jhydrol.2020.125918

China Himalaya

PLANNING PRIORITY CONSERVATION AREAS FOR BIODIVERSITY UNDER CLIMATE CHANGE IN TOPOGRAPHICALLY COMPLEX AREAS: A CASE STUDY IN SICHUAN PROVINCE, CHINA

Yafeng Lu, Pei Xu , Qinwen Li, Yukuan Wang, and Cheng Wu

PLoS ONE 15: e0243425

Identifying priority conservation areas plays a significant role in conserving biodiversity under climate change, but uncertainties create challenges for conservation planning. To reduce uncertainties in the conservation planning framework, we developed an adaptation index to assess the effect of topographic complexity on species adaptation to climate change, which was incorporated into the conservation framework as conservation costs. Meanwhile, the species distributions were predicted by the Maxent model, and the priority conservation areas were optimized during different periods in Sichuan province by the Marxan model. Our results showed that the effect of topographic complexity was critical for species adaptation, but the adaptation index decreased with the temperature increase. Based on the conservation targets and costs, the distributions of priority conservation areas

were mainly concentrated in mountainous areas around the Sichuan Basin where may be robust to the adaptation to climate change. In the future, the distributions of priority conservation areas had no evident changes, accounting for about 26% and 28% of the study areas. Moreover, most species habitats could be conserved in terms of conservation targets in these priority conservation areas. Therefore, our approach could achieve biodiversity conservation goals and be highly practical. More importantly, quantifying the effect of topography also is critical for options for planning conservation areas in response to climate change.

For further reading: https://doi.org/10.1371/journal.pone.0243425

DE NOVO ASSEMBLY, ANNOTATION, MARKER DISCOVERY, AND GENETIC DIVERSITY OF THE *STIPA BREVIFLORA* GRISEB. (POACEAE) RESPONSE TO GRAZING

Dongqing Yan, Jing Ren, Jiamei Liu, Yu Ding, and Jianming Niu

PLoS ONE 15: e0244222

Grassland is one of the most widely-distributed ecosystems on Earth and provides a variety of ecosystem services. Grasslands, however, currently suffer from severe degradation induced by human activities, overgrazing pressure and climate change. In the present study, we explored the transcriptome response of *Stipa breviflora*, a dominant species in the desert steppe, to grazing through transcriptome sequencing, the development of simple sequence repeat (SSR) markers, and analysis of genetic diversity. *De novo* assembly produced 111,018 unigenes, of which 88,164 (79.41%) unigenes were annotated. A total of 686 unigenes showed significantly different expression under grazing, including 304 and 382 that were up-regulated and down regulated, respectively. These differentially expressed genes (DEGs) were significantly enriched in the "alpha-linolenic acid metabolism" and "plant-pathogen interaction" pathways. Based on transcriptome sequencing data, we developed eight SSR molecular markers and investigated the genetic diversity of *S. breviflora* in grazed and ungrazed sites. We found that a relatively high level of *S. breviflora* genetic diversity occurred under grazing. The findings of genes that improve resistance to grazing are helpful for the restoration, conservation, and management of desert steppe.

For further reading: https://doi.org/10.1371/journal.pone.0244222

A STUDY ON INTER ANNUAL CHANGE FEATURES OF SOIL SALINITY OF COTTON FIELD WITH DRIP IRRIGATION UNDER MULCH IN SOUTHERN XINJIANG

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PLoS ONE 15: e0244404

The drip irrigation under mulch has become one of significant supporting technologies for cotton industry development in Xinjiang, and has shown the good economic and ecological benefits. With the rapid development of society and economy in Southern Xinjiang, the conventional mode of large-quota winter and spring irrigation, salt leaching and alkali decreasing is difficult to support sustainable development of land and water resources in Southern Xinjiang. This study tries to adjust soil moisture and salt content regulation mode of massive water salt leaching and drip irrigation under mulch in the non-growing period of cotton field in Southern Xinjiang, explores interannual soil salinity change features of drip irrigation cotton field without winter and spring irrigation, and provides experimental basis for drip irrigation technology under mulch which can reduce and exempt cotton irrigation in winter and spring. According to ET0, the dual-factor complete combination experiment involving 3

irrigating water quotas (I1, I2, I3) and 2 irrigation times (T12, T16) was designed, and 6 treatments were involved in total(I1T12,I2T12,I3T12,I1T16,I2T16 and I3T16). The investigation results of four-year (2012–2015) field positioning experiment showed that, under the condition of "germination under drip irrigation" without winter and spring irrigation, increasing irrigation quota and irrigation times could lower 0-100cm soil salinity accumulation, but the soil salinity accumulation degree was 40-100cm, and less than 0-30cm. In the seedling stage, bud stage, blossom and boll-forming stage, and boll opening stage, the average salinity of 0-100cm soil increased by 39.81%, 31.91%, 26.85% and 29.47%, respectively. Increasing irrigation quota and irrigation times could ease interannual soil salinity accumulation degree of cotton field with drip irrigation under mulch, without winter and spring irrigation. 0-100cm soil salinity before sowing was related to the irrigation quota of cotton in the growing stage of the last year. The larger the irrigation quota was, the smaller the soil salinity before sowing would be. The accumulation amount of soil salinity at the end of growing stage under different treatments was lower than that before sowing. The drip irrigation of cotton under mulch in the growing stage could effectively regulate soil salinity distribution and space-time migration process in the growing stage of cotton. Compared with the beginning of 2012, 0-100cm average soil salinity under 3 irrigation quotas (I1, I2, I3) was 33.66%, 5.60% and 1.24%, respectively. Salt accumulating rates under 12 irrigations and 16 irrigations were 20.66% and 6.33%, respectively. The soil had the risk of salinization when the "germination under drip irrigation" without winter and spring irrigation was used. Such results can provide the reference for prevention and treatment of soil moisture and salt content of cotton field with drip irrigation under mulch in the arid region.

For further reading: https://doi.org/10.1371/journal.pone.0244404

THE FATE OF *MECONOPSIS* SPECIES IN THE TIBETO-HIMALAYAN REGION UNDER FUTURE CLIMATE CHANGE

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Ecology and Evolution 11: 887-899

High-mountain areas such as the Tibeto-Himalayan region (THR) host cold-adapted biota expected to be sensitive to anthropogenic climate change. *Meconopsis* is a representative endangered genus confined to alpine meadow or subnival habitats in the THR. We used climate-niche factor analysis to study the vulnerability of ten *Meconopsis* species to climate change, comparing current climate (representative of 1960–1990) to future climate scenarios (2070: average 2061–2080). For these ten *Meconopsis* species, we then identified potential future climate refugia and determined optimal routes for each species to disperse to the proposed refugia. Our results indicate that for the ten *Meconopsis* species, the regions with low vulnerability to climate change in the THR are the central Qinghai-Tibet Plateau, the Hengduan Mountains (HDM), the eastern Himalayas, and the West Qinlin Mountain (WQL), and can be considered potential future climate refugia. Under future climate change, we found for the ten *Meconopsis* species potential dispersal routes to three of the four identified refugia: the HDM, the eastern Himalayas, and the WQL. Our results suggest that past refugia on the THR will also be the future climate refugia for the ten *Meconopsis* species, and these species may potentially persist in multiple future climate refugia, likely reducing risks from climate change. Furthermore, climate change may affect the threat ranking of Red Listed Species for *Meconopsis* species, as Least Concern species were estimated to become more vulnerable to climate change than the only Near Threatened species.

For further reading: https://doi.org/10.1002/ece3.7096