An Environmental Research Abstract

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For the 705th - 706th issues of Headlines Himalaya, we reviewed researches from six sources and selected 11 researches from five countries. We selected two researches from Nepal and nine researches from other Himalayan Countries (India, China, Bhutan, and Pakistan).

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Nepal-Himalaya

$PM_{2.5}$ POLLUTION LEVELS AND CHEMICAL COMPONENTS AT TEAHOUSES ALONG THE POON HILL TREK IN NEPAL

James D. Johnston, John D. Beard, M. Lelinneth B. Novilla, Frank X. Weber, and Ryan T. Chartier

Atmosphere 13: 1018

Unhealthy levels of fine particulate matter ($PM_{2.5}$) from the local burning of solid fuels, and from regional transport of pollutants, remain a major public health problem in the Himalayan foothill villages in Nepal. Teahouses (i.e., mountain lodges) along popular hiking trails in the lower Himalayas commonly use wood as the primary energy source for heating; however, little is known about teahouse air quality. The purpose of this study was to characterize the levels and chemical constituents of indoor and ambient $PM_{2.5}$ at three villages along the Poon Hill circuit trek in the Annapurna Conservation Area in Nepal. A convenience sample of five $PM_{2.5}$ measurements was collected with portable MicroPEM V.3.2A exposure monitors. Filters were analyzed for black and brown carbon using integrating sphere optical transmittance and 33 elemental constituents using energy-dispersive X-ray fluorescence. Median indoor $PM_{2.5}$ over the sampling period was 41.3 $\mu g/m^3$, whereas median ambient $PM_{2.5}$ over the sampling period was 34.7 $\mu g/m^3$. Chemical species associated with wood smoke, such as potassium (GM = 0.88 $\mu g/m^3$), predominated. High indoor and ambient $PM_{2.5}$ levels may pose a significant occupational health risk to teahouse workers, who may experience chronic exposures during trekking seasons. Our findings warrant additional research to characterize teahouse air pollution exposures more fully and to evaluate intervention measures.

For Further Reading: https://doi.org/10.3390/atmos13071018

TRADITIONAL STONE WATER SPOUTS STATUS AND ITS PRACTICAL SIGNIFICANCE IN URBANIZING KATHMANDU VALLEY, NEPAL - A REVIEW

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Environmental Challenges 8: 100573

The speedy unplanned urbanization in the Kathmandu Valley is creating an increasing demand for water. In 2021, the water demand was 470 MLD (million liters per day), and the supply was 106 MLD during the wet season and 80 MLD during the dry season. In such scarce conditions, traditional stone spouts have the potential to fulfill water demands of certain populations. However, these spouts themselves are degrading due to extensive pumping of groundwater, unstoppable constructions, and contamination from sewage, septic tanks, and industrial waste. This review paper essentially focuses on the status of stone spouts in the Kathmandu Valley in terms of quantity and quality. It also explores the reasons that affected the quantity and quality of spout water and its impact upon communities that depend on spout water. In 2019, the Kathmandu Water Supply Development Board (KVWSMB) identified 573 spouts in the Valley, out of which 224 were functional at the time of survey and 94 were completely lost. These functional spouts were the primary source of drinking water for low-income households and had total

discharge of 2.4 MLD. Spout water is perceived as “clean” drinking water but it is easily contaminated due to being mostly supplied by shallow groundwater. The observed samples exceeded WHO standards (sometimes national standards too) for total coliform, *E-coli* and nitrate, and the quality was heavily affected during monsoon. This indicates potential impacts on community health if not treated properly. These culturally significant spouts are to be conserved for sustainable water supply. Policy interventions regarding haphazard constructions, over-extraction of groundwater, waste and sewage management, source protections, renovation, and restorations can help to protect these traditional structures and fulfill water needs.

For Further Reading: https://doi.org/10.1016/j.envc.2022.100573

India-Himalaya

LIVELIHOOD VULNERABILITY ASSESSMENT AND CLIMATE CHANGE PERCEPTION ANALYSIS IN ARUNACHAL PRADESH, INDIA

Sufia Rehman, Adani Azhoni, and Pooja H. Chabbi

GeoJournal 87: 1 - 21

Climate change induced frequent disasters pose severe threats to agro-based rural livelihoods. Perceptions of risks play a critical role in planning and averting disasters. Lack of analytical documentation concerning how vulnerable communities perceive climate risks is a barrier to address and avert disasters with potential for maladaptation. This study utilized a combination of qualitative and quantitative method to examine the livelihood vulnerability – adopting the IPCC’s livelihood vulnerability index (LVI) – and perception of households concerning climate change impacts on their livelihood in Arunachal Pradesh, the largest northeastern state of India, facing severe challenges induced by climate change. A total 450 households from 18 villages located in the districts of Arunachal Pradesh were surveyed during October, 2021 for retrieving the ground complexities in the region. Decrease in yields, frequent landslides & floods, livestock losses and unpredictable weather condition were perceived by the sampled households. The LVI analysis indicated that households in Arzoo, Perum, Pekong and Amliang villages are particularly vulnerable, requiring priority for reducing the vulnerability and increasing coping capacity of the communities. Correlation analysis indicated that climate variability, natural disaster, health, food and social components attributed to livelihood vulnerability in the study area. Alternative livelihoods, enhancing preparedness to disasters, inclusion of women in workforce, sustainable livelihood practices and government assistance are some of the suggestions made to enhance the adaptation of local communities in a sustainable way.

For Further Reading: https://doi.org/10.1007/s10708-022-10703-7

MOVING FROM COEXISTENCE TO CONFLICT: A POLITICAL ECOLOGY PERSPECTIVE ON HUMAN-RHESUS MACAQUE CONFLICT IN HIMACHAL PRADESH, INDIA

Radha Gopalan and Sindhu Radhakrishna

Human Ecology 50: 463 - 476

Human-wildlife conflicts are typically treated as emergent dilemmas related to wildlife management and anthropogenic encroachment into forest land. However, conflict events are rarely discrete, localized phenomena

with direct cause-effect relationships, and a better understanding of how historic changes in social and cultural practices and politico-economic decisions impact human-nature relationships would lend greater insights into the development and unfolding of conflict events. We employ a political ecology framework to investigate the case of human-Rhesus macaque conflict in Himachal Pradesh, northern India, to show that human-rhesus macaque interactions originate in structural changes in the region's socio-economic systems because of global and national economic policies that have shaped the ecological stability of the region. Our analysis highlights that human-wildlife conflict needs to be examined as a complex interplay of multiple competing factors ranging in scale from the global to the local. It is therefore imperative that any strategy to mitigate human-wildlife conflict must account for the socio-ecological-economic stability of the region wherein the interaction occurs rather than merely addressing the visible cause of the conflict event.

For Further Reading: https://doi.org/10.1007/s10745-022-00331-7

China-Himalaya

A PERCEPTION OF THE NEXUS "RESISTANCE, RECOVERY, RESILIENCE" OF VEGETATIONS RESPONDED TO EXTREME PRECIPITATION PULSES IN ARID AND SEMI-ARID REGIONS: A CASE STUDY OF THE QILIAN MOUNTAINS NATURE RESERVE, CHINA

Shouguo Zhang, Jianjun Zhang, Sen Liang and Shidong Liu, and Yan Zhou

Science of The Total Environment 843: 157105

Unprecedented pulses of extreme precipitation due to climate change are causing significant stresses and impacts on regional and even global ecosystems. However, the relationship of vegetation response to this disturbance is unclear, such as phase characteristics, extent, timing, and degree. We summarize the nexus between vegetation resistance, recovery, and resilience under three stages of extreme precipitation pulses: duration, lagging, and post-disturbance, and then construct a pragmatic scheme to quantify and validate this complex relationship based on precipitation and Normalized Difference Vegetation Index (NDVI) data for the Qilian Mountains Nature Reserve (QMNR) from 2000 to 2020. The results show that the four extreme precipitation pulses were spring 2010 (118.98 mm), summer 2007 (312.25 mm), autumn 2010 (109.74 mm), and winter 2018 (6.84 mm). Extreme precipitations had a significant effect on vegetation in at least 98.5 % of the area, and there was also a two-month time lag effect. Specifically, the percentage of negative vegetation resistance in the face of four seasons of extreme precipitation pulses was 18.3 %, 2.0 %, 15.4 %, and 21.7 %, respectively, compared to negative recovery rates of 4.8 %, 11.9 %, 17.8 % and 10.2 % respectively, resilience was even more severe, with 20.1 %, 10.9 %, 16.1 % and 16.3 % of vegetation failing to rebound to normal levels within two months. The negative resistance, negative recovery, and weak resilience of vegetation under short-term extreme precipitation pulses are approximately 4.8, 3.7, and 5.3 times more fierce than long-term vegetation degradation. A total of 62 % of the four seasonal areas of severe negative resistance, severe negative recovery, and weak resilience were located in areas of moderate and significant steepness, which confirms that extreme precipitation pulses cause serious degradation of vegetation. Response of vegetation under extreme precipitation pulses is perceived, quantified, and validated in this study, which is essential for addressing climate change.

For Further Reading: https://doi.org/10.1016/j.scitotenv.2022.157105

IMPACT OF GLOBAL WARMING ON REGIONAL CYCLING OF MERCURY AND PERSISTENT ORGANIC POLLUTANTS ON THE TIBETAN PLATEAU: CURRENT PROGRESS AND FUTURE PROSPECTS

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Environmental Science Processes and Impacts 24: 35770617

Global warming profoundly affects not only mountainous and polar environments, but also the global and regional cycling of pollutants. Mercury (Hg) and persistent organic pollutants (POPs) have global transport capacity and are regulated by the Minamata Convention and Stockholm Convention, respectively. Since the beginning of this century, understanding of the origin and fate of Hg and POPs on the Tibetan Plateau (TP, also known as the third pole) has been deepening. In this paper, the existing literature is reviewed to comprehensively understand the atmospheric transport, atmospheric deposition, cumulative transformation and accumulation of Hg and POPs on the TP region under the background of global warming. The biogeochemical cycle of both Hg and POPs has the following environmental characteristics: (1) the Indian summer monsoon and westerly winds carry Hg and POPs inland to the TP; (2) the cold trapping effect causes Hg and POPs to be deposited on the TP by dry and wet deposition, making glaciers, permafrost, and snow the key sinks of Hg and POPs; (3) Hg and POPs can subsequently be released due to the melting of glaciers and permafrost; (4) bioaccumulation and biomagnification of Hg and POPs have been examined in the aquatic food chain; (5) ice cores and lake cores preserve the impacts of both regional emissions and glacial melting on Hg and POP migration. This implies that comprehensive models will be needed to evaluate the fate and toxicity of Hg and POPs on larger spatial and longer temporal scales to forecast their projected tendencies under diverse climate scenarios. Future policies and regulations should address the disrupted repercussions of inclusive CC such as weather extremes, floods and storms, and soil sustainable desertification on the fate of Hg and POPs. The present findings advocate the strengthening of the cross-national programs aimed at the elimination of Hg and POPs in polar (Arctic, Antarctic and TP) and certain mountainous (the Himalaya, Rocky Mountains, and Alps) ecosystems for better understanding the impacts of global warming on the accumulation of Hg/POPs in cold and remote areas.

For Further Reading: https://doi.org/10.1039/d1em00550b

NITROGEN LOADINGS AFFECT TROPHIC STRUCTURE IN STREAM FOOD WEBS ON THE TIBETAN PLATEAU, CHINA

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Science of the Total Environment 844: 157018

Anthropogenic activities, such as agricultural and industrial development, have increased nutrient inputs into waterways, which affect trophic interactions and the flow of energy through food webs in the aquatic ecosystems. However, the responses of food web structure and function to specific anthropogenic stressors in the alpine stream systems remain unclear. Here, we studied the stream food webs in the Lhasa River on the Tibetan Plateau, China. We measured the isotopic ratios ($\delta^{13}C$ and $\delta^{15}N$) of macroinvertebrate and fish functional feeding groups (FFGs) and their basal resources in the streams. Dietary contributions of basal resources to consumers and food web metrics including trophic length, diversity, and redundancy were used to quantify changes in stream food webs in response to anthropogenic disturbance. Dietary analysis showed that allochthonous resources contributed more than autochthonous resources to macroinvertebrate primary consumers regardless of the disturbance intensity in the adjacent land areas. Anthropogenic activities increased the $\delta^{15}N$ values in epilithic algae and isotopic variation in basal resources and fish but reduced the trophic length and redundancy (i.e., fewer species or

taxon at each trophic level) in food webs. Additionally, the total nitrogen concentration in waters was the most important environmental variable affecting trophic diversity and redundancy. Therefore, the reduction of nitrogen inputs into streams is critical for sustainable river management and biodiversity conservation in the streams on the Tibetan Plateau.

For Further Reading: https://doi.org/10.1016/j.scitotenv.2022.157018

THE EFFECTS OF ECOLOGICAL PUBLIC WELFARE JOBS ON THE USAGE OF CLEAN ENERGY BY FARMERS: EVIDENCE FROM TIBET AREAS-CHINA

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Agriculture 12: 900

In several rural areas of China, ecological public welfare work is an effective way to improve farmers' social participation. This job does not only increase farmers' income but also greatly improves their enthusiasm for ecological environment protection. Under the goal of carbon neutrality in peak carbon dioxide (CO_2) emissions, it is necessary to explore the impact of ecological public welfare jobs on the usage of Clean Energy (CE) in rural areas. Based on the data of 1100 farmers from Tibet areas in China, this paper applied the Ordered Probit model to explore the impact of ecological public welfare jobs on farmers' use of CE. The results are as follows: (1) Holding ecological public welfare jobs can raise farmers' willingness to use CE; (2) Holding ecological public welfare jobs can also promote farmers' use of CE by enhancing their ecological environment cognition and influencing their social behavior; (3) The impact of ecological public welfare work on CE use has regional and income heterogeneities. Firstly, this effect is smaller in mixed pastoral-farming areas than in agricultural and pastoral areas. Secondly, this effect is more obvious in low-income groups. Our study provided several policies aimed at improving rural and environmental development.

For Further Reading: https://doi.org/10.3390/agriculture12070900

Bhutan-Himalaya

DISTRICT FLOOD VULNERABILITY ASSESSMENT USING ANALYTIC HIERARCHY PROCESS (AHP) WITH HISTORICAL FLOOD EVENTS IN BHUTAN

Karma Tempa

PLoS ONE 17(6): e0270467

Flood hazards are common in Bhutan as a result of torrential rainfall. Historical flooding events also point to flooding during the main monsoon season of the year, which has had a huge impact in many parts of the country. To account for climate change patterns in flood hazards in Bhutan, 116 historical flood events between 1968 and 2020 for 20 districts were retrieved and reviewed. The preliminary review revealed that the frequency of flood occurrence has increased by three times in recent years. In this study, seven flood vulnerability (FV) indicators were considered. Five are the attributes of historical floods, classified into a number of incidents for flood events,

fatalities, affected population, and infrastructure damages including economic losses. Additionally, the highest annual rainfall and existence of a flood map were other two indicators considered. Using historical data, flood hazard and impact zonation were performed. The analytic hierarchy process (AHP) method was employed to derive a multi-criteria decision model. This resulted in priority ranking of the seven FV indicators, broadly classified into social, physical/economic, and environmental. Thereafter, an indicator-based weighted method was used to develop the district flood vulnerability index (DFVI) map of Bhutan. The DFVI map should help researchers understand the flood vulnerability scenarios in Bhutan and use these to mediate flood hazard and risk management. According to the study, FVI is very high in Chhukha, Punakha, Sarpang, and Trashigang districts, and the index ranges between 0.75 to 1.0.

For Further Reading: https://doi.org/10.1371/journal.pone.0270467

Pakistan- Himalaya

ANALYSIS OF PROVISIONING ECOSYSTEM SERVICES AND PERCEPTIONS OF CLIMATE CHANGE FOR INDIGENOUS COMMUNITIES IN THE WESTERN HIMALAYAN GUREZ VALLEY, PAKISTAN

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Ecosystem Services 56: 101453

Climate change is a significant threat to people living in mountainous regions. It is essential to understand how montane communities currently depend especially on the provisioning ecosystem services (ES) and the ways in which climate change will impact these services, so that people can develop relevant adaptation strategies. The ES in the Gurez Valley, in the Western Himalayas of Pakistan, provide a unique opportunity to explore these questions. This understudied area is increasingly exposed not only to climate change but also to the overexploitation of resources. Hence, this study aimed to (a) identify and value provisioning ES in the region; (b) delineate indigenous communities' reliance on ES based on valuation; and (c) measure the perceptions of indigenous communities of the impact of climate change on the ES in Gurez Valley. Semi-structured interviews and focus group discussions were used to classify the provisioning ES by using the 'Common International Classification on Ecosystem Services' (CICES) table and applying the 'Total Economic Valuation (TEV)' Framework. Results indicate that the indigenous communities are highly dependent on ES, worth 6730 ± 520 USD/Household (HH)/yr, and perceive climate change as a looming threat to water, crops, and rearing livestock ESS in the Gurez Valley. The total economic value of the provisioning ES is 3.1 times higher than a household's average income. Medicinal plant collection is a significant source of revenue in the Valley for some households, i.e., worth 766 ± 134.8 USD/HH/yr. The benefits of the sustainable use of ES and of climate change adaptation and mitigation, are culturally, economically, and ecologically substantial for the Western Himalayans.

For Further Reading: https://doi.org/10.1016/j.ecoser.2022.101453

BIOMONITORING OF MERCURY IN WATER, SEDIMENTS, AND FISH (BROWN AND RAINBOW TROUT) FROM REMOTE ALPINE LAKES LOCATED IN THE HIMALAYAS, PAKISTAN

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Environmental Science and Pollution Research 29: 1-16

Mercury (Hg) contamination of aquatic ecological units and subsequent bioaccumulation are major environmental problems of international scope. Moreover, the biogeochemistry of Hg in the remote alpine lakes aquatic ecosystem in the Himalayas remains largely unexplored. The current study investigated Hg concentrations in different environmental compartments such as water, fish, and sediments in the remote alpine lakes (RALs) including Glacial-fed Lake, Ice melting-fed Lake, and Rain-fed Lake in northern areas of Pakistan. The mean concentration of Hg in Rain-fed Lake water was (1.07 μg L^{-1}), Ice melting-fed Lake (1.16 μg L^{-1}), and Glacial-fed Lake (1.95 μg L^{-1}). For fish muscle tissues, mean concentration of Hg was 1.02 mg kg^{-1} in the Rain-fed Lake, and 1.2 mg kg^{-1} for the Ice melting-fed Lake, and 1.51 mg kg^{-1} in the Glacial-fed Lake. Meanwhile, 0.27 mg kg^{-1} was observed for sediments in the Rain-fed Lake, 0.33 mg kg^{-1} for the Ice melting-fed Lake, and 0.38 mg kg^{-1} for the Glacial-fed Lake, respectively. Chronic daily intake (CDI) and potential health quotient (PHQ) for water showed high health risk in Glacial-fed Lake and low in Rain-fed Lake (PHQ < 1). The target hazard quotient (THQ) values for both the Brown and Rainbow trout in all the studied lakes water were less than 1, indicating no health risk. Furthermore, the Hg level showed high level of contamination in the sediments of all the studied lakes (190 ≤ RI < 380). Overall, Glacial-fed Lake water was more polluted with Hg, as compared to Rain-fed Lake and Ice melting-fed Lake. In the light of the abovementioned results, further research work is urgently needed to shed light on the biological and geochemical monitoring of Hg in arid high-altitude ecosystems along with source identification, mercury speciation, and other potential pollutants.

For Further Reading: https://doi.org/10.1007/s11356-022-21340-5