MoChWo

MOUNTAINS IN THE CHANGING WORLD

5th INTERNATIONAL CONFERENCE ON MOUNTAINS IN THE CHANGING WOLRD

08-09 OCTOBER, 2020
KATHMANDU, NEPAL

Conference Program | Book of Abstracts

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The 5ᵗʰ International Conference on Mountains in the Changing World

October 8-9, 2020
Virtual Conference, Kathmandu, Nepal

Program Schedule

October 08, 2020 || DAY ONE

08:00–08:30	**Registration (Join ZOOM)**

Inaugural Session	**[Room: Sagarmatha]**
08:30–09:00	Welcome and Program Highlights [**Room: Sagarmatha**]
	Dr. Hemu Kharel Kafle, Convener *Kathmandu Institute of Applied Sciences, Kathmandu, Nepal*
09:00–10:20	Keynote Talks
Keynote Theme	**Mountain Resources and Livelihood: Path to Sustainable Development [OR-KN-1]**
Chair	Dr. Madan Lal Shrestha *Academician, Nepal Academy of Science and Technology*
09:00–09:40	**Keynote**: Remote sensing for vegetation monitoring, disaster damage assessment, and mineralogical mapping (OR-KN-1 -498-KEYNOTE)
	Yasushi Yamaguchi *Graduate School of Environmental Studies, Nagoya University, Japan*
09:40– 10:20	**Keynote**: Biodiversity conservation and ecosystem services for sustainable development in the Hindu Kush Himalaya (OR-KN-1 -499-KEYNOTE)
	Eklabya Sharma *International Centre for Integrated Mountain Development, Nepal*

10:20–10:30	Break

Technical Sessions

10:30–12:00	**Symposium: Food Security Poverty and Livelihood in a Post-COVID Era [OR-FS-1] [Room: Sagarmatha]**
Chair	Er. Dipak Gyawali *Nepal Academy of Science and Technology*
10:30–11:00	**Invited:** Hazards to food security: The significance of grain reserves (OR -FS -1 -500)
	Hendrik J. Bruins *Ben-Gurion University of the Negev, Israel*
11:00–11:30	**Invited:** GEOGLAM Asia-RiCE activity (OR -FS -1 -501)
	Shincihi Sobue, *GEOGLAM, Global Agriculture Monitoring, JAXA, Japan*
11:30–11:45	Current scenario of crop yield and national food security in Nepal (OR -FS -1-600)
	Yurishya Upadhyay and Hemu Kafle[2] *Center for Water and Atmospheric Research, Kathmandu Institute of Applied Sciences, Nepal*
11:45- 12:00	Drought indices and their relation to paddy production in Kailali district, Nepal (OR-FS-1-601)
	Hridesh Sharma, Kushal Poudel *Caritas Nepal*

10:30–12:00   **Symposium: Frontiers in Quantitative Ecology and Conservation [OR-QE-1]**
                      [Room: Annapurna]

Chair   Dr. Khem Bhattarai
                 Himalayan Resource and Development Center, Nepal

10:30–11:00   **Invited:** How to sustainably use a natural capital in peril – the case of insects as food and
                 feed (OR -QE -1 -502)

                 Olga M. C. C. Ameixa
                 University of Aveiro, Portugal

11:00–11:15   Diversity and regeneration pattern of tree species along the elevational gradient in
                 Chandragiri Hill, Central Nepal (OR -QE -1 -602)

                 Ram S Dani, Chitra B. Baniya
                 Central Department of Botany, Tribhuvan University, Nepal

11:15–11:30   Species composition of insect pollinators in different habitats of Shivapuri Nagarjun national
                 park, Nepal (OR -QE -1 -603)

                 Urmila Dyola[1], Chitra B. Baniya[2], Puspa Raj Acharya[3], Kumar Sapkota[1]
                 [1]Central Department of Zoology, Tribhuvan University, Nepal
                 [2]Central Department of Botany, Tribhuvan University, Nepal
                 [3]Mid-Western University, Nepal

11:30- 11:45   Lichen diversity in Khaptad national park, Western Nepal (OR-QE-1-604)

                 Alina Shrestha, Chitra B. Baniya
                 Central Department of Botany, Tribhuvan University, Nepal

11:40- 12:00   Lichens of Nepal: A synopsis (OR-QE-1-605)

                 Pooja Bhatt, Chitra B. Baniya
                 Central Department of Botany, Tribhuvan University, Nepal

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12:00–12:10   Break

12:10–13:40   **Symposium: Food Security Poverty and Livelihood in a Post-COVID Era**
                     [OR-FS-2][Room: Sagarmatha]

Chair: Prof. Dr. Kalyani Mishra Tripathi
                 Acting Dean Faculty of Agriculture, Agriculture and Forestry University (AFU)

12:10–12:40   **Invited:** Title: Improving Food Safety in Agriculture and Food Systems: A Strategic Policy
                 Pathway for 2030 in South Asia (OR -FS -2 -503)

                 Rudra Bahadur Shrestha,
                 SAARC Agriculture Center, Dhaka, Bangladesh.

12:40–13:10   **Invited:** Linking soil health to food security: Implications for subsistence to sustainable
                 agriculture (OR -FS -2 -504)

                 Rajan Ghimire,
                 New Mexico State University, Agricultural Science Center, Clovis, NM

13:10–13:40   **Invited:** Insects: An alternative source of food and feed in future? (OR -FS -2 -505)

                 Prabhat Khanal,
                 Faculty of Biosciences and Aquaculture, Nord University, Norway

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12:10–13:55   **Symposium: Frontiers in Quantitative Ecology and Conservation**
[OR-QE-2][[Room: Annapurna]

Chair   Dr. Maan Bahadur Rokaya

Institute of Botany, Czech Academy of Sciences, Průhonice, Czech Republic

12:10–12:25   Altitudinal patterns of vascular plant life forms in Arghakhanchi district, West Nepal (OR -QE -2 -606)

Baburam Nepali[1], Chitra B. Baniya[1], John Skarvit[2]
[1]*Central Department of Botany, Tribhuvan University, Nepal*
[2]*NLH, Bergen, Norway*

12:25–12:40   Distribution of soil organic carbon and its relation to forest types (OR -QE -2 -607)

Pramila K. Gachhadar[1], Chitra B. Baniya[1], T. N. Mandal[2]
[1]*Central Department of Botany, Tribhuvan University, Nepal*
[2]*PG Campus, Biratnagar, Nepal*

12:40–12:55   Pattern of primary succession along the glacier foreland Bhimthang, Manang, Nepal (OR -QE -2-608)

Benup Adhikari, Chitra B. Baniya
Central Department of Botany, Tribhuvan University, Nepal

12:55- 13:10   Habitat preference and seasonal diversity of birds in Koshi Tappu wildlife reserve, Nepal (OR-QE-2-609)

Bikram Ghimire[1], Chitra B. Baniya[1], Ishan Gautam[2]
[1]*Central Department of Botany, Tribhuvan University, Nepal*
[2]*Natural History Museum, Kathmandu, Nepal*

13:10- 13:25   Habitat preference of four-horned antelope in Banke national park, Nepal (OR-QE-2-610)

Sangam Acharya[1], Chitra B. Baniya[1], Tej. B. Thapa[2]
[1]*Central Department of Botany, Tribhuvan University, Nepal*
[2]*Central Department of Zoology, Tribhuvan University, Nepal*

13:25- 13:40   Altitudinal distribution of aquatic macrophytes in Eastern Nepal (OR-QE-2-611)

Eliza Acharya Siwakoti, Chitra B. Baniya
Central Department of Botany, Tribhuvan University, Nepal

13:40- 13:55   Soil properties and retreating status of Bhimthang glacier, Manang, Central Nepal (OR-QE-2-612)

Mahendra Gahatraj, Chitra B. Baniya
Central Department of Botany, Tribhuvan University, Nepal

13:55–14:40   Extended Break

14:40–16:10   **Symposium: Air Pollution: Exploring its impact and mitigation methods**
[OR-AP-1] [Room: Sagarmatha]

Chair   Prof. Dr. Rejina Maskey,
Central Department of Environmental Science, TU, Nepal

14:40- 15:10   **Invited:** Air pollution problems at altitudes Himalaya (APPA-Himalaya): Current scientific understanding and future prospects (OR -AP -1 -506)

Maheshowr Rupakheti,
Institute for Advanced Sustainable Studies, Germany

15:10- 15:40	**Invited***:* Nuclear technology and its application to particulate pollution characterization (OR -AP -1 -507)

Muhayatun Santoso,
National Nuclear Agency (BATAN), Indonesia

15:40-16:10	**Invited:** Facts learned from COVID-19 lockdown: Which pollution sector is affected the most? (OR -AP -1 -508)

Pradeep Khatri,
Tohoku University, Japan

14:40–16:40	**Symposium: Nature and livelihoods: Leveraging social systems for sustainability among the mountain people [OR-HE-1] [Room: Annapurna]**

Chair	Prof. Ram Bahadur Chhetri
	Central Department of Anthropology, TU

14:40- 15:10	**Invited:** Resources, livelihoods, and sustainable development: Experiences in remote regions of the Arctic (OR -HE -1- 509)

Henry Huntington
Huntington Consulting, Eagle River, AK, USA

15:10- 15:25	Adaptation to a changing environment in the Peruvian Andes (OR -HE -1 -613)

Christine Jurt[1], Luis Vicuña[2]
[1]*Berne University of Applied Sciences, Department of Agriculture, Forestry and Food Sciences, Switzerland*; [2]*University of Zurich, Department of Geography, Switzerland*

15:25-15:40	Rice and its multiple identities: An anti-essential political ecology of paddy cultivation in Nepal (OR -HE -1 -614)

Damodar Tripathi
Department of Anthropology, TU, Kathmandu, Nepal

15:40-15:55	Climate change impact to Hayu community and indigenous adaptation strategy: A case study from Wadipakha village Ramechhap, Nepal (OR -HE -1 -615)

Anita Shrestha[1], Shyam Krishna Shrestha[2]
[1] *Kathmandu Forestry College*; [2] *The Resource Nepal*

15:55-16:10	Livelihood and adaptation in Nepal Himalaya: A case study from Humla *(OR -HE -1 -616)*

Binod Pokharel
Central Department of Anthropology, Tribhuvan University, Nepal

16:10-16:25	Thiti as an Institution for Sustainable management of the environment in the Himalaya (OR -HE -1 -617)

Jiban Mani Poudel
Central Department of Anthropology, Tribhuvan University, Nepal

16:25-16:40	Changing livelihood strategies in the Mountain (OR -HE -1 -618)

Prashanta K. Chhetri
Central Department of Anthropology, Tribhuvan University, Nepal

16:10 −16:20	**Break**

16:20–18:05   **Symposium: Air Pollution: Exploring its impact and mitigation Methods**
                      [OR-AP-2] [Room: Sagarmatha]
Chair

                      Prof. Dr. Nanda Bikram Adhikari
                      Department of Electronics and Computer Engineering, Pulchowk Campus, Nepal

16:20–16:50   **Invited:** From mountains to valleys: A forensic approach to deciphering the impact of air
                      pollution on environmental quality in New-Zealand (OR-AP-2-510)

                             Perry Davy,
                             Air Particulates Laboratories (inc XRF Lab) at GNS Science, New Zealand

16:50- 17:20   **Invited***:* Impact of local urban processes and long-range transport of air pollution on the air
                      quality of Kathmandu Valley (OR -AP -2 -511)

                             Kundan Shrestha,
                             Department of Environmental Science and Engineering, KU, Nepal

17:20- 17: 50   **Invited**: Discernable role of dust in the spatial heterogeneity of observed snowmelt over
                      Himalayas (OR-AP-2-512)

                             Chandan Sarangi,
                             Department of Civil Engineering, Indian Institute of Technology, Madras, India

17:50-18:05   Collection Efficiency of Low volume Samplers and Filter papers in air quality monitoring
                      (OR-AP-2-619)

                             Jasmita Khadgi, Hemu Kafle,
                             Center for Water and Atmospheric Research, Kathmandu Institute of Applied Sciences, Nepal

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October 09, 2020 || DAY TWO

08:00 –08:30   Registration (Join ZOOM)

08:30 –10:00   Symposium: Women scientist and their role in the post pandemic socio-economic
                    development (OR -WS- 1) [Room: Sagarmatha]

Chair: Dr. Hemu Kharel Kafle
                    President, OWSD-Nepal Chapter

Speakers: Dr. Sunila Rai, Professor,
                    Department of Aquatic Resources, Agriculture and Forestry University, Nepal (OR-WS-1-517

                    Prof. Hasin Anupama Azhari, Professor & Chairman, Dept of Medical Physics and Biomedical
                    Engineering (MPBME), Bangladesh (OR-WS-1-513)

                    Dr. Atya Kapley, Senior Principal Scientist, AcSIR Faculty, Head, Director's Research Cell
                    CSIR-NEERI, Nagpur, India (OR-WS-1-514)

                    Dr. Chenfang Liu,
                    Professor, School of Advanced Agriculture Sciences, Peking University, China (OR-WS-1-515)

                    Ms Kausi Timsina, Bhutan

8:30 – 10:00	**Symposium: Ecosystem Conservation and Development [OR -EC -1] [Room: Annapurna]**

Chair:	Prof. Dr. Chitra B. Baniya *Central Department of Botany, Tribhuvan Univeristy, Nepal*
08:30- 09:00	**Invited:** Strategic tourism impact management in the Chittagong Hill tracts, Bangladesh (OR -EC -1 -519) Mashura Shammi *Department of Environmental Sciences, Jahangirnagar University, Bangladesh*
09:00- 09:30	**Invited:** Natural resource conservation and people's participation in Karnali Pradesh, Nepal (OR -EC -1 -520) Kabi Prasad Pokharel *Central Department of Geography, TU, Nepal*
9:30- 09:45	Estimation of fine biomass and its contribution to carbon stocks in the Sundarbans Mangrove forest, Bangladesh (OR -EC -1 -620) Md Kamaruzzaman, Rifat Rahaman Hredoy Mail Bangladesh
09:45- 10:00	The struggle of forest conservation with development interaction in Nepal: A critical appraisal (OR -EC -1 -621) Shradha Khanal, *Kathmandu School of Law, Nepal*

10:00 –10:10	Tea/Coffee Break

10:10–11:40	**Symposium: Women scientist and their role in the post pandemic socio-economic development (OR -WS- 2) [Room: Sagarmatha]**

Chair	Dr. Anjana Singh, *Nepal Academy of Science and Technology, Lalitpur, Nepal*
Panelist:	Dr. Pasang Dolma Sherpa, Executive Director, Center for Indigenous Peoples' Research and PanelistP Development (CIPRED) (OR-WS-1-516) Mrs. Bhawani Rana, President FNCCI Prof. Jennifer Thomson, President, Organization for Women in Science for the Developing World, Italy Pakistan Srilanka

11:40 –12:20	**Poster Session (PO-PO-1) [Room: Annapurna]**

12:20 –13:20	Extended Break

13:20 –14:50	**Symposium: Hydro-meteorological disasters: Causes, effects and mitigation measures (OR-HMD-1) [Room: Sagarmatha]**
Chair:	Prof. Dr. Deepak Aryal, *Central Department of Hydrology and Meteorology, TU, Nepal*
13:20 –13:50	**Invited:** Importance of landslide early warning system for the sustainable risk-reduction in the Nepal Himalaya (OR -HMD -1 -521)
	Basanta Raj Adhikari Institute of Engineering, Tribhuvan University, Nepal
13:50 –14:20	**Invited:** Need assessment of storm water management guidelines in Nepal (OR -HMD -1- 522)
	Keshav Basnet and Achyut Bhandari, *Pashchimanchal Campus, Institute of Engineering, TU, Nepal*
14:20-14:35	Technology for disaster resilience: Low cost weather station (OR-HMD -1 -622)
	Shrayan Khatiwada and Hemu Kafle *Center for Water and Atmospheric Research, KIAS, Nepal*
14:35-14:50	Catchment scale analysis of the impact of urbanization in the rainfall-runoff-inundation scenario of Kathmandu Valley (OR -HMD -1 -623)
	Saroj Karki, Rocky Talchabhadel, Suchana Acharya and Rajaram Prajapati Nepal
14:50 –15:00	Break
15:00-16:30	**Symposium: Hydro-Meteorological Disasters: Causes, Effects and Mitigation Measures (OR-HMD-2) [ZOOM: Sagarmatha room]**
Chair:	Dr. Rijan Bhakta Kayastha, *Department of Environmental Science and Engineering, Kathmandu University, Nepal*
15:00 –15:30	**Invited:** Can numerical model be utilized to simulate the extreme events in Nepal? (OR -HMD -2 -523)
	Binod Pokharel *Utah State University, USA*
15:30 –15:45	Numerical simulation of Bara-Parsa tornado using weather research and forecasting model (OR -HMD -2 -624)
	Ganesh Kafle, Netrajit Khadk, Dibas Shrestha, Deepak Aryal, Binod Dawadi *Central Department of Hydrology Meteorology, TU, Nepal*
15:45 –16:00	Simulation of extreme rainfall event in Nepal using weather research and forecasting Model (OR -HMD -2 -625)
	Rojan Lamichhane, Dibas Shrestha, Netra Jit Khadka, Deepak Aryal, Binod Dawadi *Central Department of Hydrology Meteorology, TU, Nepal*
16:00-16:30	**Invited:** Envisioning a decision support system using physical data (OR -HMD -2 -524)
	Nabin Malakar, *Department of Earth, Environment, and Physics, Worcester State University, USA*
16:30-17:00	**Closing Session [ZOOM: Sagarmatha room]**

11:40 –12:20	**Poster Session (PO-PO-1) [Room: Annapurna]**
Chair	Dr. Madhu Sudan Kayastha
	School of Engineering, Pokhara University, Nepal

Monitoring of air pollution in and near a natural museum in Srilanka (PO-PO -700)

Nirosha Lakmali Handagiripathira,
 Atomic Energy Board, Srilanka

Characterizing hydroclimatic variability in the mountainous catchment Nepal (PO-PO -701)

Rupesh Baniya, Jeeban Panthi, Piyush Dahal. Rocky Talchabhadel, Sanjib Sharma, Ganesh R. Ghimire, Binod Parajuli
Institute of Engineering, Pulchowk Campus, Nepal

Study on streamflow alteration across Nepal before and after 2000 (PO-PO-702)

Rocky Talchabhadel, Saroj Karki, Mahendra B. Baniya
Disaster Prevention Research Institute, Kyoto University, Japan

ORGANIZING COMMITTEE

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Society for Conservation Biology Nepal
Organization of Women Scientist in Nepal (OWSN), Nepal
Organization of the Women Scientist for the Developing World (OWSD), Italy
RCA Regional Office, South Korea
Asia Pacific Network for Global Change Research, Japan

ABSTRACTS

KEYNOTE: **Remote sensing for vegetation monitoring, disaster damage assessment, and mineralogical mapping** (OR -KN -1- KEYNOTE)

Yasushi Yamaguchi
Nagoya University, Japan

Remote sensing is defined as the non-contact recording of information from the ultraviolet, visible, infrared, and microwave regions of the electromagnetic spectrum by means of instruments such as scanners and camera located on mobile plat forms, such as aircraft or spacecraft, and is a powerful tool for a variety of scientific and practical applications. This presentation showcases typical examples of remote sensing applications that will help assess and monitor mountain resources and livelihood. Several indices have been developed to monitor vegetation by combining spectral features derived from multispectral remote sensing data, e.g. Normalized Difference Vegetation Index (NDVI). We studied the global vegetation change by using NDVI and its relation to climate parameters; temperature and precipitation. Drought can be monitored by other indices such as Vegetation Dryness Index (VDI) and Drought Severity Index (DSI). We confirmed that DSI gave us a promising result in monitoring a severe drought occurred from 2009 to 2010 in southwestern China and are applying it for drought monitoring in the south Asian countries. Remote sensing is also an important tool for rapid damage assessment of natural disasters such as landslide, flood, glacier lake outburst flood (GLOF), and forest fire. Mineralogical mapping is another important area of multispectral and hyperspectral remote sensing, based upon the characteristic spectral features of some rocks and minerals in the visible, near-infrared and short-wave-infrared regions. We developed a technique to combine information derived from the multispectral ASTER data and Digital Elevation Model (DEM).

INVITED: **Hazards to food security: The significance of grain reserves** (OR -FS -1 -500-INVITED)

Prof. Emeritus Hendrik J. Bruins
Ben-Gurion University of the Negev, Israel

The food system must be regarded as a critical infrastructure, from farmers to consumers, via sowing, growing, harvesting, storage, transportation, processing, packaging, and marketing. Various hazards may endanger the food system, including droughts and floods, pandemics, economic and political crises, revolution and war. Since ancient times, cereal grains and pulses (legumes), which can be stored dry for a long period, have been the most important part of our daily food. Most countries were basically self-sufficient in food grain production until the first half of the twentieth century. However, today more than 100 nations are permanently dependent on food imports to have enough food for their citizens. Less than 10 countries produce food grains significantly beyond their own internal requirements. Significant food reserves do not exist in the world, while the volume of food grains available on the world market is limited. Severe droughts in China and India, the two most populous countries in the world, as well as other hazards, may cause large global grain yield reductions at some time in the future. Then the global demand for food imports may rise far beyond the amount of food grains available for sale. Very steep price rises and food shortages may lead to large-scale famine. Even financial reserves do not guarantee food grain imports! Therefore, contingency planning is needed to establish significant food grain reserves in each country. Moreover, the local farming sector should be stimulated and safeguarded.

INVITED: **GEOGLAM Asia-RiCE activity** (OR -FS -1-501-INVITED)

Dr. Shinchi Sobue
GeoGlam, Jaxa, Japan

The Asia-RiCE (http://www.asia-rice.org) has been organized to enhance rice production estimates through the use of Earth observation satellites data, and seeks to ensure that Asian rice crops are appropriately represented within GEO Global Agriculture Monitoring (GEOGLAM) to support FAO Agriculture Market Information System (FAO-AMIS). Asia-RiCE is composed of national teams that are actively contributing to the Crop Monitor for AMIS and developing technical demonstrations of rice crop monitoring activities. Using GCOM-W, GPM, MODIS, Himawari and other

satellites, JAXA provides agro-met information such as soil moisture, rainfall, drought index, LST, NDVI, etc. to Asia to support monthly rice crop outlook in cooperation with ASEAN food security information project (AFSIS) to provide monthly rice crop outlook information to FAO AMIS through GEOGLAM.

This paper reports this GEOGLAM Asia-RiCE activity.

Current scenario of crop yield and national food security in Nepal (OR-FS-1-600)

Yurisha Upadhyaya, Hemu Kafle
Kathmandu Institute of Applied Sciences

This study reviewed on general overview of crop yield and food security status of Nepal. The increasing rate of population growth, their increasing demand of food requirements and the decreasing limited productive agricultural lands, has raised a concern towards national food security status, even though the interim constitution of Nepal has mentioned "food sovereignty as a fundamental right in its constituents". Although agriculture contributes to 25.29% of the nation's GDP, and 65.6% of national employment by domination of small and marginal holders, the impact of food scarcity is most severe on rural population and particular livelihoods of the far west (62%) and mid-west (72%). Hence, the issue of food security lies in priority. Since cereal crops are major staple food crops in terms of their productivity, they play significant roles in addressing food security issues in Nepal. In recent years, there have been fluctuations in production and demand situations due to various reasons. Thus, this research aims to analyze the dynamics of cereal crops production i.e. production status, causes of low production and discusses the strategies to mitigate food insecurity situation in Nepal by reviewing various literature as well as actual data from Ministry of Agriculture and Livestock Development (MoALD), Government of Nepal, Food and Agricultural Organization (FAO), World Food Programme (WFP) and statistical reports.

Drought indices and their relation to paddy production in Bardiya district Nepal (OR-FS-1-601)

Hridesh Sharma and Kushal Poudel
Caritas Nepal

Drought is a major concern of the rain-fed farming system, especially in the Terai region of the country which is predominantly occupied by rice based farming systems. Thus a study was conducted to identify/explore the relation of drought indices with paddy production in Kailali District of Nepal. For this, two drought indices namely, agriculture standardized precipitation index (aSPI) and modified reconnaissance drought index (RDIe) were purposively selected. Paddy productivity data and climate data (rainfall and temperature) of paddy growing season (PGS) (June-November) of the last 31 years (1986-2016) were taken for this analysis. FAO effective precipitation was used for the calculation of aSPI while FAO effective precipitation and Hargreaves method of PET (Potential Evapotranspiration) were used for the calculation of RDIe. To correlate drought indices with paddy productivity, standardized yield residuals series (SYRS) were used. For calculating SYRS, paddy productivity was firstly de-trended, normalized and standardized. The result of correlation analysis showed that there is a negative significant relationship between SYRS and both drought indices for August month i.e. (August-aSPI and August-RDIe) of PGS. This suggests that, month of August is an important period for paddy production in terms of drought indices Kailali and proper field monitoring to check soil moisture during the period is suggested. In comparison with two drought indices as pre strength of relationship with SYRS, aSPI can be referred over RDIe to understand the effect of drought in paddy production in similar locations.

Keywords: Drought index, modified reconnaissance drought index (RDIe), Paddy Growing season (PGS), Paddy yield

INVITED: **How to sustainably use a natural capital in peril: The case of insects as food and feed** (OR -QE -1 - 502-INVITED)

Olga M. C. C. Ameixa
University of Aveiro, Portugall

Biodiversity underpins the functioning of ecosystems, which provide a wide range of ecosystem services, including the provision of food and feed and for this reason, the accelerated rate of species loss can compromise food security. In recent years, insects have made the headlines due to the call for attention on the global decline of bees and other pollinators – both natural and managed, particularly in North America and Europe. Besides pollination, insects play important roles in food security delivering ecological services like biological control or serving as food and feed due to their nutritional composition on protein, fat, minerals and vitamins. In comparison to conventional livestock, insects have higher feed conversion efficiencies, lower water and land requirements, and lower greenhouse gas emissions. However, they are currently one of the most threatened taxa, facing significant challenges mainly due to habitat loss and fragmentation, pollution, invasive species, climate change and overharvesting. In addition, since most insects consumed are currently collected in the wild, an increase in their consumption will lead to overexploitation of wild species. As research shows potential biotechnological uses of insects, simultaneously, ecological studies show their declines. Biodiversity loss and global food security are currently two major challenges of our time and finding synergies between can contribute to enhanced sustainable development.

Diversity and regeneration pattern of tree species along the elevational gradient in Chandragiri hill, central Nepal (OR -QE -1 -602)

Ram S Dani, Chitra B. Baniya
Central Department of Botany, Tribhuvan University, Nepal

We examined the pattern of tree regeneration of forests along elevational gradients in Chandragiri Hill, Central Nepal. Vegetation data was collected from 110 sample plots from 10 elevational bands of 100 m ranging from 1365 m asl to 2450 m asl using a stratified random sampling technique during the years 2019 and 2020. Circumference at breast height (CBH) was used to broadly categorized plant life form into trees (C > 31.5cm), sapling (C = 10.5 – 31.4cm) and seedlings (C<10.5cm). CBH was measured at 1.37m height for trees and at 10 cm above the ground for seedlings. A total 45 tree species belonging to 38 genera and 22 families were recorded in the present study. Species richness at the study varied from 12 to 25. The tree density varied between 188 to 563 individuals per hectare whereas the total basal area ranged between 19.05 to 68.38 m^2 per hectare. The proportion of tree (0.68%), sapling (7.4%) and seedling (92%) in all elevational ranges. Findings of species richness, Shannon-Weiner Index, Simpson's index and IVI indicated a good regeneration status of forest in all elevational ranges.

Species composition of insect pollinators in different habitats of Shivapuri Nagarjun national park, Nepal (OR -QE -1 -603)

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Pollinating insects have particular environment requirements, and these pollinators likely to respond differently in different habitat types. National Parks provide important habitats for insect pollinators. However, habitat variation and disturbance within park can affect these pollinators in complex way. Three groups of flower pollinators; butterfly (Lepidoptera), bees (Hymenoptera) and hoverflies (Diptera) from four habitat types; forest trail, open trail, trails of buffer zone and grassland, present at different elevations of Shivapuri-Nagarjun National Park, Nepal were studied.The pollinators were trapped and netted from five different sites where five transects of 100m were set up at three elevations. A total of 166 species of insect pollinators were recorded. Butterfly representing the highest species (49%), followed by bees (30%) and the lowest by hoverfly (21%). The survey of the pollinators showed that the pollinators were strongly influenced by open trail and buffer zone. Open trail and buffer zone with a well-covered

herb and shrub with a higher flower index had high abundance of pollinators compared to grass land and forest trail.Survey also detected a strong negative effect of elevation on pollinator community as the herb and shrub layer decreased along the elevation gradient. It was concluded that herb and shrub layer of open trail and buffer zone can play important role in conserving the pollinator community.

Lichen diversity in Khaptad national park, western Nepal (OR-QE-1-604)

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This study aims to enumerate the lichen species found in the pristine area of Khaptad National Park, Western Nepal along with the altitudinal gradient and host plant species. Sampling plots were laid at the elevation levels between 2200 m to 3200 m asl in the different forest found in the study area. Detrended Correspondence Analysis (DCA) and Canonical Correspondence Analysis (CCA) was performed to analyze the species-environment composition. A total of 47 species belonging to 29 genera and14 families were recorded. DCA eigenvalue of 0.72 and the first axis length of 8.01 SD units showed complete species turnover and high beta diversity along the altitude and habitats in the study site. The CCA model test showed that the constrained could explain only about 13 % of total variance whereas rest was explained by other unknown environmental variables. Total lichen species showed increasing response with the altitude. Furthermore, the number of lichens seemed to be more on the Quercus at the lower altitude may be due to its rough bark and water retention capacity. At the higher altitude, high moisture aided in the higher number of lichens in the *Abies*, *Picea* forests. Slope and aspects showed no significant influence on the lichens. We concluded that the altitude and host affect the distribution of the lichens.

Lichens of Nepal: A synopsis (OR-QE-1-605)

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Lichens are composed of fungal and algal partner, adapted to survive in almost every possible terrestrial habitat and exhibit intriguing variation in miniature among terrestrial autotrophs. This study attempted to review previous works performed at different intervals of time on lichens of Nepal as well as to highlight their distribution pattern of different life forms, preferred substratum and effects of land use and canopy openness on species richness based on previous published literature. Lichenological research was primarily initiated by western lichenologists. Most of works were seem to be concentrated on Central and Eastern Nepal. A total of 842 species of lichenized-fungi, distributed in wide range of elevation (150m to 7400m) have been recorded from the country. *Carbonea vorticosa* in Nepalese Himalaya at 7400m was the world's highest reported lichen and *Heterodermia pseudospeciosa* represented one of the lichens occurring at the lowest elevation ranges in Nepal (150–2100m). *Leparia squamatica* and two new species *Leptogium sphaerosporum* and *Hypogymnia* sp. collected from Nepal were recently recorded as new to Asia and Science respectively. Total lichen species richness, species richness of all three-growth form, endemic lichen all shows unimodal relationship with elevation whereas saxicolous and terricolous lichen shows bimodal pattern with elevation. Crustose lichen peaked at highest elevation (4100m- 4200m) while foliose lichen had maximum richness at 2400m-2500m and fruticose lichen peaked at 3200m. Cyanolichen exhibited maximum richness at lower altitude (2900-3000m) while Chlorolichen exhibited maximum richness at 3300-3500m. Foliose lichen diversity and abundance (in terms of frequency) increases from the fringes of the forest to the core. Total species richness, corticolous lichen richness, both cyanolichens and green algal lichens showed a gradual decline with increasing canopy openness; in contrast, saxicolous lichen richness had a positive trend with increasing canopy openness. Land use having primary forest harbor highest diversity of foliose growth forms. Highest numbers of corticolous species were recorded from natural forests. Though the lichen diversity increased from outer fringes of the forest to the core, it was found constrained by phorophyte determinants (stand age, aspect, and bark properties) and change in land uses types. Highest numbers of corticolous lichens were harbored by temperate broad leaved and coniferous trees.

INVITED: **Improving Food Safety in Agriculture and Food Systems: A Strategic Policy Pathway for 2030 in South Asia** (OR -FS -2 -503-INVITED)

Dr. Rudra Bahadur Shrestha,
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Food safety is the enduring and intertwining issue in the world, particularly in the least developed and developing economies. The concern of food safety is being increasing rapidly because of its sensitivity on food trade, food security, food contamination and public health risk. This paper has been prepared to analyse the scenario, challenges and opportunities of food safety, and recommend policy measures to improve the food safety in South Asia using secondary data source and literature review. The assurance of comprehensive food safety is associated with the complete food chain— starts from the use of inputs to the plate; thus, appropriate and hygiene handling of the agriculture and the food production process is crucial to ensure safe, healthy, and hygiene intake of foods by the consumers. Proper dissemination, adoption and utilization of available research-based technologies, knowledge and information tools could enhance food safety from the primary production sources to the consumers' tables. Furthermore, for the South Asian countries, there is a need of harmonization and modernization of policies, laws and food standards according to the global food safety standards, such as Codex, Food and Drug administration (FDA) and European Union (EU) standard to establish a robust food safety management system in South Asia.

INVITED: **Linking soil health to food security: Implications for subsistence to sustainable agriculture** (OR -FS -2 -504-INVITED)

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Securing food for a growing population and improving environmental quality will continue to be a challenge for the 21st century. About 60 percent of the agroecosystems have either been degraded or used unsustainably to increase food, forage, fiber, and energy production for the growing population. The occurrence of extreme climatic events has exacerbated the challenges in sustainable crop production, food security, and agroecosystem resilience. The main goal of my research is to evaluate the role of conservation practices, including reduced-tillage management, crop residue recycling, crop rotations diversification, integrated nutrient management, manure and compost applications, and crop-livestock integration on the economic and environmental efficiency of cropping systems. We demonstrated that management practices that enhanced soil health through increased soil organic matter (SOM), nutrient cycling, and microbial activity, and improved nutrient and water use efficiency while reducing nitrogen (N) leaching and greenhouse gas emissions sustained crop production and net farm profitability. Reducing tillage and cover cropping increased microbial abundance by 31-84%, doubled microbial activity, increased soil C by 18-20%, and maintained net positive ecosystem carbon balance. Integrating livestock with crop production increased microbial community size in grasslands by approximately 42%, and enzyme activities in croplands by more than 95% compared to ungrazed grasslands and croplands, respectively. Conservation systems have the potential to improve soil health and support sustainable crop production through an increase in SOM and microbial community responses related to nutrient cycling.

Keywords: conservation agriculture, nutrient cycling, soil organic matter, sustainable food systems

Altitudinal patterns of vascular plant life forms in Arghakhanchi district, west Nepal (OR -QE -2 -606)

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The species richness is strongly related to quantitative vegetative parameters of species in any area. To find out the altitudinal pattern of quantitative parameters (density, frequency and coverage) of vascular life forms in Arghakhanchi district west Nepal, data was collected by applying 184 quadrats of 10 X 10 m^2 sized at 3-4 sites per 100 m elevation band at 2 aspects of landscapes (200-2300m alt) in study area. The collected plant samples were enumerated and

estimated the species richness and vegetative characters of each lifeform (herb, shrub, saplings, tree, fern, climber). The hypothesis of this research is the life forms also follow the similar pattern against altitude as species richness. The result of species richness and vegetative parameters was regressed against altitude by applying generalized linear model (GLM). The density followed the significant unimodal pattern against altitude in herb, fern and shrub but linear in climber, trees and saplings. The significant unimodal ($R^2 > 0.71$) structure of frequency was found in all life forms. Among the life forms, only coverage of herb showed the significant unimodal pattern. It can be concluded that species richness pattern of all life forms is not equally applied in their altitudinal pattern of quantitative vegetative parameters.

Distribution of soil organic carbon and its relation to forest types (OR -QE -2 -607)

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Carbon stocks in soil vary substantially across the globe depending on the type of forest, their location, and soil depth. We applied meta-analysis to 76 relevant published data with no restriction of published date, country and journals but impacted journals. The aim of this review was to study the distribution of soil organic carbon stocks and its relation to forest types. We found variation in soil organic carbon stocks among the different forests globally, in the hierarchy of AF < TF < SF < AfMF < MF < SAF < TeF < BF, ranging from 65.21 t/ha to 206.6 t/ha. Continent wise, the SOC stock value ranges from 64.63 t/ha to 183.69 t/ha in Africa and 53.03 t/ha to 206.6 t/ha in Asia. Similarly, the value of SOC stocks ranges from 75.20 t/ha to 124.18 t/ha, 115 t/ha to 136.99 t/ha and 55.88 t/ha to 101 t/ha in Europe, North America and South America respectively. In conclusion, the value of SOC stocks vary at various forest types might be due to various factors such as, soil depth, environmental factors, climatic factors, disturbances, altitudes etc.

Pattern of primary succession along the glacier foreland Bhimthang, Manang, Nepal (OR -QE -2-608)

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Glacier forelands are considered as natural laboratories to study vegetation change. Retreating glacier or the glacier foreland expose new habitat which was previously locked under ice for thousands of years and becomes suitable to microbes and plant for colonization. Glaciations and de-glaciations influenced greatly by changing in temperature and snow fall and can serve as an excellent indicator of increasing global temperature. These areas are suitable sites to study colonization pattern and soil development process during primary succession. This work was attempted to understand the trend of pattern of succession along the spatio-temporal gradient on Bhimtang Glacier foreland, Manang, Central Nepal. The study site was divided into 5 horizontal transects, T1, T2, T3, T4 and T5 respectively parallel to the glacier foreland. Each transect, representing a particular geological time period and stage of the soil development. The first and the youngest transect was laid around 20 m away from the top. Altogether, 25 plots with a 2×2 m square plot subdividing into 4, 1×1 m square sub plot were laid down. Each plot was placed at 30-meter interval along each anterior- posterior transect of single chronosequence. Distance in between two transects was 50m. Total breadth of each full cross section was 200m.The variables were estimated from each plot such as transect, plot, altitude, aspect, slope, vegetation cover, rock cover, open space and relative radiation index (RRI). A total number of 77 plant species under 66 genera and 40 families were identified from the study area. Among them, 89% of total plant species identified were angiosperms, 8% were gymnosperm and 3% were Pteridophytes. Out of 69 angiosperms, 55 species were dicots whereas 14 species were monocots. Species richness showed a decreasing pattern with distance further away from the glacier terminus which further justified the converging patterns of the primary succession.

Habitat preference and seasonal diversity of birds in Koshi Tappu wildlife reserve, Nepal (OR-QE-2-609)

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Bird Migration is a regular movement either annual or seasonal of at least a part of the population from its breeding place to inbreeding place either for obtained food and shelter or to pass the unfavorable climate and again its return to the same breeding ground for breeding and resting. The Research was carried out on Koshi Tappu Wildlife Reserve (KTWR) extends between 86°55'-87°05'E longitude and 26°34'- 26°45'N latitudes, covering 17500 ha core area and 17300 ha buffer zone. The objective of the study was to determine the seasonal and overall bird diversity rich areas of Koshi Tappu region. *Saccharum* sp and *Typha* sp were the dominant vegetation covering 80% of the KTWR area. The climatic condition of this area was tropical monsoonal type and experienced three distinct season's summer, rainy and winter. One hundred and ninety-two birds were recorded altogether. Among them seven habitats were found preferred. 65 species were identified as wetland species followed by 57 woodland and 48 grassland species. Due to shrubland and bareland number of species was least i.e. 12 and 10 respectively. Eight environmental factors were studied in KTWR. Among these eight grassland and canopy were found to be highly significance. Birds migrate from areas of low or decreasing resources to areas of high or increasing resources basically sought for food and nesting locations. Among the 192 recorded birds 44 were found to be winter migratory i.e. (23%) and 18 were summer migratory (10%). Calculation of Shannon Wiener Species Diversity indicates that winter birds got the diversity index of 1.36. This value of index was maximum influenced by *Upupa epops* (10.52%) followed by *Anthus godlewskii* with 10.42 %. Bird's species was increasing gradually every year but the bird's number was decreasing. The decline in the bird species was due to various human activities, increasing urbanization and exploitation of the habitats. Overall, this study revealed that wetland; grassland and woodland were the best habitats preferred sites. In general, birds migrate to KTWR during winter in huge counts in comparison to summer to avoid declining food stuff and increasing cold in the (winter) southern region of the globe.

Habitat preference of four-horned antelope in Banke national park, Nepal (OR-QE-2-610)

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The four-horned antelope (*Tetracerus quadricornis* Blainville, 1816), endemic to India and Nepal is one of the least studied species. Estimates suggest that Fewer than 10,000 FHA remain in the wild (IUCN SSC Antelope Specialist Group, 2017). In Nepal Four-horned Antelope (FHA) has been recorded from Banke, Bardia, Chitwan, Parsa and Dang district. Habitat Preference of FHA in core zone of Banke National Park was carried during summer season in May 2018. The core zone of BaNP was classified into 4 major categories namely Grassland, Hill forest, Mixed forest, and Sal forest. A grid of 2 km × 2 km was overlaid on the classified map of BaNP core zone. Of those grids, 25% of grids were selected randomly using random numbers so that every land cover/habitat type were included. By taking one transect of length 2 Km in each selected grid line transect sampling was performed. The habitat preference was examined by recording direct observation (visual encounter) and signs (pellets and foot marks) of four-horned antelope through the line transect method. A chi-square test for goodness of fit was used to test whether the use of different habitats were statistically significant or not by using R core team 2016.The relationship among environmental variables such as water, canopy, altitude, anthropogenic activities, settlements, Fire, invasive species etc. with presence of FHA was determined by using Redundancy Analysis (RDA) through vegan package in R (Oksanen *et al.,* 2018).The result showed that Hill forest (HP= 29.8 %) was most preferred habitat followed by Sal forest (HP= 26.5 %) and Grassland (HP= 23.8%). Mixed forest was least preferred (HP=19.9 %). The use of Grassland ($\chi2 = 0.1$, df = 1, p > 0.05), Mix forest ($\chi2 = 0.2$, df = 1, p-value > 0.05), Sal forest ($\chi2= 0.05$, df = 1, p-value > 0.05), Hill forest ($\chi2= 0$, df = 1, p-value > 0.05) were not significant. This study clearly found that presence of FHA increased with an increase in altitude. This animal also seemed to prefer semi-open canopy and has intermediate water needs. Also, it showed some positive relation with the areas that went through fire in that season. Two invasive species *Lantana camara* and *Ageratum houstonianum* were noted close to the pellets of FHA but they were not covering understory.

Furthermore, the animal seemed avoiding areas of anthropogenic activities. Overall, the study revealed that hill forest was the most preferred habitat by FHA.

Altitudinal distribution of aquatic macrophytes in Eastern Nepal (OR-QE-2-611)

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Macrophytes constitute an important component of aquatic ecosystem while lakes play a key role in sustainable development of wetland biodiversity. Although many works are done on inventory of lakes, scientific study on distribution of aquatic macrophytes in response to altitudinal gradients has been poorly explored. Different macrophytes may have different responses to altitudinal gradients and consequent habitat, climate and water quality. Therefore, the present study is focused on the altitudinal distribution of aquatic macrophytes in the lakes of Eastern Nepal ranging from tropical to subalpine region. Quantitative techniques will be applied to sample macrophytes in aquatic and semi-aquatic habitats of different lakes along altitudes. Nutrient analysis of some macrophytes will be done along the altitudinal gradient. Physico-chemical analysis of water will be carried out throughout the gradient to determine their variation along altitudinal gradient as well as their influence on growth of macrophytes.

Keywords: Macrophytes, altitudinal gradient, distribution, nutrient analysis, physicochemical analysis

Soil properties and retreating status of Bhimthang glacier, Manang, Central Nepal (OR-QE-2-612)

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Glacier forelands are considered as unique type of field laboratories and are sensitive and 'high-confident' indicators of climate change. This present work is attempted to study the variation in content of soil properties along a spatio-temporal gradient along Bhimthang glacier foreland, Manang, Central Nepal. Five transects, representing a particular geological time period and stage of soil development were laid on the south-west aspect of foreland. The perpendicular distance between two transects was 50 m each. Along each transect, 12 quadrats of 2 m $\times$ 2 m each were laid down at an interval of 30 m. A total of 14 variables were analyzed in this research. Soil depth showed strong positive correlation with T1 and negative correlation with soil pH. Soil depth didn't show any significant relationship with soil nutrients (N, P, K and SOC). Soil pH didn't show increase in content with increasing distance away from glacier. Soil bulk density showed moderately positive correlation with altitude and T1 whereas showed strong negative correlation with N, P, RRI, SOC and T5. Out of tested soil nutrients, N, P, K and SOC showed significant correlation with T5 and showed increase in content with increasing distance away from glacier terminus. Rock cover didn't explain significant correlation with other variables except with RRI and vegetation cover with which it showed positive and strong correlation. Vegetation cover was positively significant to increase distance from glacier terminus and had negative correlation with open space. Land sat imagery and sentinel data showed that glacier region in Bhimthang is continuously retreating since 1988 till now (2018). Glacier foreland represents a unique platform for research on study chrono sequential changes in ecosystems and soil development pattern during primary succession.

INVITED: **Air pollution problems at altitudes - Himalaya (APPA-Himalaya): Current scientific understanding and future prospect** (OR -AP -1 -506)

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The Himalayan-Tibetan Plateau (HTP) mountain region, the region with highest altitudes in the world, is still one of the least studied regions in the world in terms of atmospheric changes within and upwinds of the region and their impacts on many ecosystems of global importance and a large population in the region that are vulnerable to regional and global changes. This sensitive region is closely located downwind of heavily polluted Indo-Gangetic Plain (IGP). The interlinkages between radiatively active air pollutants such as aerosol particles and climate change in the region are not yet fully understood, and thus their quantification is still subject to large uncertainties. In this presentation, current understanding of the extent of particulate pollution at high altitudes, their sources and processes and mechanisms of their transport to the HKHT region, and potential impacts will be discussed. The future prospect of advancing scientific understanding of atmospheric aerosols –climate change interactions at this high-altitude region will also be presented briefly.

INVITED: **Nuclear technology and its application to particulate pollution characterization** (OR -AP -1 -507)

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National Nuclear Agency (BATAN), Indonesia

Urbanization and industrial growth are the main causes of air pollution which is a serious threat to human health. To design an appropriate air quality management requires the identification of sources of air pollution quantitatively. The selective and sensitive nuclear analysis technique (NATs) is a very suitable method for multi-elemental characterization of air particulates. This method has been applied to assess air quality in 17 urban areas in Indonesia including Java, Sumatra, Kalimantan, Sulawesi, Maluku, and Papua Islands. Particle samples in the PM2.5 and PM2.5-10 ranges have been collected using Gent stacked filter units, once a week for 24 hrs. since 2014. More than 7000 samples have been collected. The results showed that the majority of PM2.5 annual concentrations in 7 sites on the islands of Java as Indonesia's most populous island had exceeded Indonesia's annual standard (15 µg/m3), whereas in general PM10 was lower than the daily standard (150 µg/m3). The average BC fraction at PM2.5 ranged from 15 to 26%. The distribution of the concentrations of the main elements in PM2.5 varied widely from one site to another. The results obtained show that for sites around the industrial area the level of lead and several other heavy metals at PM2.5 was significantly higher (tens of times) compared to other sites. The chemical composition obtained from this research can then be used to identify source apportionment. Ambient air quality during volcanic eruptions and forest fires will also be discussed comprehensively. The results obtained from this study provide very important information as an early warning and scientific research-based references to avoid greater financial losses and human health impacts. Better solutions and appropriate actions should be taken into this matter.

Keywords: nuclear analytical techniques, PM2.5, BC, Indonesia

INVITED: **Facts learned from COVID-19 lockdown: Which pollution sector is affected the most?** (OR -AP -1-508)

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Despite awareness towards clean energy (e.g., solar, wind powers) production, dirty energies (e.g., fossil fuel burnings) still dominate total power consumption, generating several harmful air pollutants that are known to have manifold impacts on Earth's climate and human society. The COVID-19 pandemic, which unwillingly forced most of the countries to put restrictions on human activities, provided an opportunity to view the human made impact on the atmosphere from a new horizon. Taking this opportunity, this study analyzed air pollution concentrations of aerosols and trace gases over highly polluted countries of Asia (China, India, and Thailand) during lockdown, pre-lockdown,

and post-lockdown periods of 2020 and similar periods of previous years. Though Thailand saw an increase in air pollution despite lockdown, which was likely due to effects of forest fires, China and India saw reduction in air pollution during lockdown, but immediate rebound after lockdown. Air pollution (aerosol, SO_2, NO_2, and CO) related data were obtained from satellite observations (MODIS and Tropomi) and reanalysis (MERRA-2), whereas energy consumption and traffic congestion related data were obtained from various sources. A detailed study focusing China indicated reduction of air pollutants and energy consumption mainly in industrial and power sectors without any significant change in household sector, suggesting less effectiveness of lockdown for air pollution reduction of household sector. This study provides important clues for policy making to cope with the air pollution problem of developing countries, where dirty energies are heavily used.

INVITED: **Resources, livelihoods, and sustainable development: Experiences in remote regions of the Arctic** (OR -HE -1- 509)

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The Arctic, like high mountain areas, has Indigenous cultures and remote communities, which are experiencing rapid environmental, social, and economic change. This presentation will review the history of the North American Arctic from the early 1800s to the present. At the beginning of this period, Indigenous communities were largely practicing traditional ways of life, developed over millennia. When explorers and traders began to arrive from outside the region, much changed. New economic opportunities, such as fur trapping, provided access to new materials, tools, and ideas. Overhunting also reduced populations of some animal species, leading to hardship in hunting communities. Government agencies and missionaries opened schools and introduced further new ideas, including attempts to eradicate Indigenous languages, alter traditional economic systems, and more. Resource development shifted from exploiting fish and animal populations to the extraction of minerals and petroleum. These activities provide employment and revenue, but continue to alter patterns of employment and environmental conditions. The term "sustainable development" is commonly heard in the Arctic, as elsewhere in the world, but Arctic regions are at the far end of global supply chains. Resource extraction economies are at the mercy of global markets and prices. Government spending and policies are a major influence on Arctic economic health. As history shows, economic stability is temporary or elusive. Flexibility and adaptability are necessary. Long-term planning should account for major changes and surprises, rather than an expectation of continuity. Similarities and differences between the Arctic and high mountain areas may provide fertile ground for comparisons and sharing of experiences for mutual benefit.

Keywords: Arctic, livelihoods, resources, sustainable development, change

Adaptation to a changing environment in the Peruvian Andes (OR -HE -1 -613)

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Climate change impacts are assessed by both, natural as well as social scientists. The need of bringing together results from the natural sciences and the social sciences for understanding changes will be illustrated by the case of the lake 513 in the Peruvian Andes. After an incident in 2010, a multi-level risk management structure had been intended bringing the system based on an intensive scientific cooperation between Peruvian and Swiss scientists into function and led it become an example for other communities facing glacier risks. Nevertheless, in 2016 the early warning system was destructed by local people. Its destruction brings up many questions that are relevant for adaptation and research projects in the future. The analysis of this case is based on three months of anthropological fieldwork in the local communities of the Chucchún catchment during and after the installation of the early warning system. Methods like participant observation, semi-structured interviews, focus groups, transect walks, social mapping among others have been used. For our analysis we focus on negotiations and encounters of the different actors during the project but also in the past and what is expected in the future. Such encounters reflect the risk networks that underlie the actors' risk discourses including social, cultural, political and environmental risks. These analyzed risk networks - going

beyond the Glacier Lake Outburst (GLOF) risk of the lake 513 - bring visible and invisible risks into discussion that are crucial for what has occurred.

Rice and its multiple identities: An anti-essential political ecology of paddy cultivation in Nepal (OR -HE -1 - 614)

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This paper focuses on three different identities of rice: mythological/religious, socio-cultural and techno-political prevalent in almost all paddy farming communities in Nepal. It examines specific discursive practices that constitute rice and paddy cultivation, articulation of farm actors and their power relations, and overall implications of this discursive relation on the production of identity and subjectivity of rice and paddy farmers in each of the domain. For that, it analyzes the selected corpus of the statement taken from a comprehensive compendium on Rice Sciences and Technology (RST) in Nepal related to each of the selected domains. This paper is based on anti-essentialist political ecology framework. The finding reveals that the modern techno-political discourse of rice/paddy cultivation is emerging as the dominant one with its specific implications on the representation of rice as a discursive techno-scientific 'entity' and repositioning farmers as the mere followers of the prescriptions and orders channeled from the 'top' technical and political authorities.

Keywords: rice/paddy cultivation, identity, subjectivity, anti-essentialism, mountain farmers

Climate change impact to Hayu community and indigenous adaptation strategy: A case study from Wadipakha village Ramechhap, Nepal (OR -HE -1 -615)

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Hayu, an indigenous ethnic group reside in Ramechhap district of Nepal, has been suffering from climate change impact. Therefore, this study aims to explore the impact of climate change on the Hayu community in particular their traditional and existing adaptation strategies, and also examine the awareness of climate change. This study was based on 20 households whereas information was gathered from semi-structured interviews, focused group discussion, observation, and key informant interviews. Besides, secondary sources were used. This study shows that the livelihood of the Hayu community has been adversely affected by climate change over the last 10 years and more. Climate change has been forcing to low productivity of land, increase in drought, the emergence of pests and diseases, changes in the agriculture calendar, increase in invasive species, and rapid spoiling of grain and vegetables that ultimately been leading to challenges in food security to the community. However, they are not passive to adjust to the uncertainty created by climate change. They have been practicing traditional adaptation measures like protection plants, conservation of water sources, rotation of agriculture crops, organic farming practices, storage of food grains, storage of grass and forage, use of thatch roof house, white and red soil painting house, working at morning and evening in hot month, drinking of local fermented rice (as local liquor) and trans-humane cattle grazing system to combat climate change with less knowledge or without knowledge in this regard. However, these practices have a scientific ground, they have not been adopting these practices based on sufficient information. Since religion, rituals, and occupation of the Hayu community have been supporting climate change resilience and maintaining the environmental balance, it is necessary that traditional knowledge should be integrated and/or adjusted with the scientific knowledge of climate change adaptation and policy should reform to aware about it at the local level.

Keywords: Hayu, climate change, traditional knowledge, and Adaptation

Livelihood and adaptation in Nepal Himalaya: A case study from Humla (OR -HE -1 -616)

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This paper examines the changing adaptive strategies of the Lama people of Humla, the west northern border of Nepal. I argue that the adaptive process of the community is not only determined by the geographical locations, state policy and political upheavals in the trans-border countries also shape and reshape the adaptive mechanism of the community. Traditionally, trans-human, polyandry and trans-border trade were the major mode of livelihood. Restriction on long-distance trade between Nepal and Tibet declined due to political reasons in 1960. Because of this reason the Lama people shift their salt- grain trade from Tibet and Nepal to Salt-goat trade from Indian Border to Nepali Hill villages. Their traditional mode of adaptation transferred marriage institution i.e. polyandry. Polyandry was one of the high-value institutions which was supported by trans-human, trade and agriculture. They were perpetuated by long-distance trade of salt, wool and sheep. The Lama community develops an alternative adaptive strategy when the changes occur in the political economy of the country and the region.

Key words: Adaptation, Lama, polyandry, trans-human, trans-border trade

Thiti as an institution for sustainable management of the environment in the Himalaya (OR -HE -1 -617)

Jiban Mani Poudel
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Himalayan communities still have traditional ecological knowledge with a strong social mechanism for the management of resources to live in a harsh environment. This paper mainly discusses two thematic issues; how the Himalayan people optimize the use of limited resources to thrive in a harsh environment, and what the key socio-cultural factors that help them to survive in the rugged environment sustainably. The paper was based on nine months ethnographic study from 2012-2018 among Gurung agro-pastoral communities in Nhāson Valley of Manang. We conclude that *thiti* is a socio-cultural institution to Himalayan dwellers that controls the behavior of the people in a society; the source of the awareness and recognition of the fragile resources for living in rugged terrain; means of defining rights on resources. In the Himalayan region, indigenous ecological knowledge does not work in isolation; it is intertwined with a socio-cultural institution that unfolds in a social context.

Keywords: *thiti*, Himalaya, environment, sustainable, resource management

Changing livelihood strategies in the Mountain (OR -HE -1 -618)

Prashanta K. Chhetri
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This is a study on the changing livelihood strategies of the people in lower Manang, which lies on the northern side of Annapurna Himal. In this paper, I talk about the changes and continuities in the livelihood strategies of the people over the last few decades. This paper draws on a fieldwork carried out in 2014. Data were collected through interviews, observations and group discussions. Subsistence based rotational agriculture, transhumant livestock management and salt-grain trade were the traditional ways of livelihood; this has gradually shifted due to the availability of various income sources like the introduction of tourism or the collection and trade of herbal plants like *yarsagumba* and *satuwa*. The locals have opened shops and home-stay facilities catering to the needs of the flow of tourists, especially over the last two decades and more when Manang opened for outsiders. More recently, climate change is adversely affected Himalayan environment including increased in size of glacier lakes in the past few decades because of ongoing glacial melt. This tangible effect of glacial retreat caused by climate change has implications for the livelihood of the people of Manang.

INVITED: **From mountains to valleys: A forensic approach to deciphering the impact of air pollution on environmental quality in New-Zealand** (OR-AP-2-510-INVITED)

Perry Davy
Air Particulates Laboratories (inc XRF Lab) at GNS Science New Zealand

New Zealand is a mountainous country in an isolated oceanic location. However, air pollution events do occur due to local emission sources and the occasional incursion of long-range transboundary advection of airborne particulate matter. We present research investigating the composition and concentration of both the local and transboundary sources of air pollution and their impact on our urban valleys and mountainous environments. Specifically we show that long-range transport of dust-storm and wild-fire events from Australia can impact across the country including mountainous regions while our urban valleys are subject to the pressures of anthropogenic combustion sources associated with residential space heating and motor vehicle emissions. Natural oceanic sources provide a ubiquitous background to airborne particulate matter concentrations.

INVITED: **Impact of local urban processes and long-range transport of air pollution on the air quality of Kathmandu valley** (OR -AP -2 -511-INVITED)

Kundan Shrestha
Department of Environmental Science and Engineering, Kathmandu University, Nepal

Kathmandu Valley is urbanizing haphazardly and its air quality is degrading due to several problems linked with urbanization, such as Urban Heat Island effect and land-use changes, and also due to transboundary transport of air pollutants. The comprehensive modeling assessment confirms the impact of urban changes on the air quality of Kathmandu Valley. WRF-Chem modeling with urban canopy effects was primarily used for the research and the sparse air quality measurements in the valley were supplemented with the use of portable air quality sensors. The air pollutants such as $PM_{2.5}$, PM_{10} and ozone, and aerosol optical depth were simulated and then validated. The contribution of the transboundary transport of air pollutants to the air quality of Kathmandu Valley was also estimated with the particular focus on wildfire emissions. Thus, the impact of local urban processes and long-range transport on ozone and particulate matter in Kathmandu Valley will be presented in the conference.

INVITED: **Discernable role of dust in the spatial heterogeneity of observed snowmelt over Himalayas** (OR-AP-2-512-INVITED)

Chandan Sarangi
Department of Civil Engineering, Indian Institute of Technology, Madras, India

High-mountain Asia (HMA) is commonly known as the third pole of Earth, however, the snow cover and glacier mass is reducing at an unprecedented rate in recent decades. While climate change has been believed to be the primary reason for these reducing trends, light-absorbing particles (LAPs), mainly dust and black carbon, can also significantly impact the heterogeneity in snowmelt and regional water availability within HMA. In this talk, I will discuss the significance of dust deposition on snow albedo reduction and snowmelt over the Himalayas. Westerly-driven, long-range transportation of dust particles via elevated aerosol layers (EALs) is a persistent phenomenon during spring and summer over the Indian subcontinent. During the snow accumulation season EALs transport ~100-1000 µg/m3 of dust to the snow-covered slopes of the Himalayas. Using unique satellite estimates of snow albedo changes due to these impurities, I will demonstrate a robust physical association between the EALs and aerosol-induced snow darkening over the Himalayas. Further, results from fully coupled chemistry Weather Research and Forecasting (WRF-Chem) regional model simulations will also be discussed to reinforce the satellite observations. Results reveal that LAPs can induce high magnitudes of snow albedo reduction (4 %–8 %) in pre-monsoon seasons, which eventually leads to a snow-mediated radiative forcing of 30–50 W m-2 at the surface. Consequently, the western Himalayas hold the most vulnerable glaciers and mountain snowpack to LAP impacts within HMA. More interestingly, a distinct

elevational signature is found in dust- and black carbon-induced snow darkening over Himalayas in both observations and simulations. Specifically, the influence of dust on snow darkening is greater than that of black carbon above 4000 m. Thus, these findings suggest a discernable role of dust in the spatial heterogeneity of observed snowmelt and snowline trends over HMA and implicate an increasing contribution of dust to snowmelt as the snow line rises under future warming.

Collection Efficiency of Low volume Samplers and Filter papers in air quality monitoring

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Kathmandu Institute of Applied Science, Bagdol, Lalitpur, Nepal

There are plethora of the instruments and filter papers available for monitoring air quality depending upon wide range of characteristics. In this study, we analyzed the efficiency of particle collection (PM_{10} and $PM_{2.5}$) of two low volume samplers (Combined sampler GTI-241 and Gent Sampler) and three filter papers (Micro Glass Fibre, Teflon and Nucleopore).The instrument was operated in same flow rate of 16-17 litre per minute for 24-hours at residential area of Kathmandu. We checked the performance by switching the filter papers among the instruments and studied the instrumental design for collection of particles. We found the high discrepancy in collection of PM_{10} and $PM_{2.5}$ between GENT and combined sampler. Gent sampler and Nucleopore filter paper undermined the PM concentration whereas combined sampler was well aligned with the concentration of reference monitoring station. With the restriction of well-equipped laboratories in Nepal, combined sampler was found to be more applicable in monitoring air quality.

Keywords: Air samplers, Efficiency, Filter Papers, Particulate Matter,

INVITED: Strategic tourism impact management in the Chittagong hill tracts, Bangladesh (OR -EC -1 -519)

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[2]*Tourism & Hospitality Management, Faculty of Business Studies, University of Dhaka*

The Chittagong hill tracts (CHT) region are within the Chattogram division in the South-East part of Bangladesh, bordering India, and Myanmar. CHT covers 50% of the forest resources of Bangladesh, along with 0.67 million hectares of hilly land. One of the significant reservoirs of natural resources and a land of indigenous diversity, there are 34% different tribal communities dwell here. Due to the natural beauty and rich heritage of the indigenous community, CHT is visited by 25-30 lac tourists every year. Every fountain falls and streams in the CHT forest region is home to a highly biodiverse ecosystem: protected forests or wildlife sanctuaries. Moreover, these streams are the primary source of potable drinking water, domestic use, and irrigation for local communities. There are many governmental run resorts. Private entrepreneurs have also developed different hotels, motels, and resorts to support the local tourism industry devoid of proper environmental impact assessment (EIA), waste and wastewater management. Unaware of tourism activities in pristine areas have created substantial loads of solid wastes. The impact of the tourist industry has been deteriorating ecosystems, natural resources such as water, biodiversity, and polluting the local environment of the indigenous community. Considering the scenarios mentioned above, it is high time to manage the tourism activities in CHT strategically focusing on ecotourism and strategic environmental assessment (SEA) to mitigate environmental impacts.

Keywords: environmental impact assessment (EIA), natural resource, strategic environmental assessment (SEA), tourism, waste management

INVITED: Natural resource conservation and people's participation in Karnali Pradesh, Nepal (OR -EC -1 -520-INVITED)

Kabi Prasad Pokharel
Central Department of Geography, Tribhuvan University, Nepal

Karnali Pradesh i.e. province no 6 of federal Nepal is a treasure house of a wide range of biological resources, cultural heritage and diverse natural landscapes. Diversity and uniqueness have made the region one of the most important tourist destinations and biodiversity hotspots in Nepal. The Province has protected areas with global significance also. The people of Karnali Pradesh are on the way to improve their quality of life by conservation and utilization of available natural and cultural resources through their active involvement in development planning and implementation. However, Pradesh's existing socio-economic scenario and environmental situation demand an integrated development initiation which integrates the environment, economic, social and cultural spectrum of the area for better understanding the dynamics of these four pillars of sustainable development with pragmatic solutions.

Participatory natural resources management efforts could be an effective development model to address the aspirations and sustainability in mountain areas. This development model could play an important role in identifying resources, defining development priorities, adapting technologies and implementing practices. Further, the participatory approach can encourage locals to participate in their resources conservation, utilization and management for improving livelihood in a sustainable way. In this context, the main focus of the paper is to identify the current situation of the level of the natural resource management, assess the influential factors of people's participation in the natural resources management, analyze the strengths and weakness of people's participation in term of conservation, and sustainable use of natural resources in the Karnali Pradesh. The issues discussed in this paper clearly indicate that there is an urgent need to promote the community participation on environment and development for the proper links between population, development, technological implication and institutional strengths, using a micro level conservation and development model that suits local environments. The paper suggests that both central and local governments adopting people-public-private- partnership (p4) have to join hands with an effort to improve infrastructure, productivity of economic activities, tourism development and management of settlements in order to promote the quality of human life with ecological stability in the province.

Estimation of fine biomass and its contribution to carbon stocks in the Sundarbans Mangrove forest, Bangladesh (OR -EC -1 -620)

Md Kamruzzaman, Rifat Rahaman Hredoy Mail
Bangladesh

Fine roots are the fundamental pathway for both water and nutrient uptake by plants and also play a vital role in the carbon dynamics of forest ecosystems. The article presents the first estimates of fine root biomass and its contribution to carbon stocks of the world's largest continuous patch of mangrove forests, namely Sundarbans Reserve Forest (SRF), Bangladesh. This study was conducted over three year from March 2016 to February 2019. Attempts were made to quantify above and belowground biomass carbon, fine root biomass and their contribution in total biomass carbon. The study was conducted in two different sites of the SRF. We established two plots (20 m x 20 m) in each site and the area of the four plots was1600 m^2 sample. To evaluate the fine root biomass, a sequential coring method was used. The total Aboveground biomass carbon (AGBC) ranged from 10.7~209.3 Mg ha^{-1} and the total Belowground biomass carbon (BGBC) of the studied area ranged from 6.7~72.4 Mg ha^{-1}, respectively. Overall mean fine root biomass carbon including necromass was 1.31 Mg ha^{-1} in the study area. Fine root biomass carbon showed a significant correlation with tree density and basal area. Although fine roots are contributing less in total below ground biomass carbon because of its low structural content and it also has a very short life span. Fine roots may contribute more in heterotrophic respiration and nutrient recycling because of its rapid decomposition rate and thus it has undeniable values in the below ground carbon pool.

The struggle of forest conservation with development interaction in Nepal: A critical appraisal (OR -EC -1 -621)

Shradha Khanal
Kathmandu School of Law, Nepal

Deforestation is a multifaceted problem in Nepal. Deforestation elevates severe climate change effects, endangerment of biodiversity and wildlife, and causes environmental injustice against people belonging to forest communities in Nepal. The dual factors in escalation of widespread deforestation are a larger portion of unmonitored illegal forest activities such as illegal logging and negligent environmental impact assessment during development projects in Nepal. According to the National Biodiversity Strategy and Action Plan (2014-2020), Nepal holds 39.4% of forest area, a total of 110 ecosystems and currently 23.23% of Nepal's land falls under protected areas making it one of the largest in Asia. The Environment Protection Act-2053, Community Forest Directives-1994, IEE/EIA Review Guidelines for Forestry Sector-2060, National Parks and Wildlife Conservation Act-2029 and in addition to that, many other programs like Hariyo Ban Program, Rastrapati Chure Conservation Program, Community Forest Development Program were introduced to reduce friction in balancing the right to development and right to environment. This paper asserts that despite numerous attempts, weak law enforcement, and lack of governmental institutions in federal structure for resource management and chronic corrupt tendencies in forest conservation are not helping the state to achieve intergenerational equity. The paper proposes that environmental justice approach helps Nepal to fight legal discrimination, inequality and achieve sustainable development. This paper tries to answer whether strengthening of legal mechanisms will help in effective forest conservation in Nepal?

Keywords: Deforestation, Environmental Justice, Environmental Impact assessment, Sustainable development

INVITED: **Importance of landslide early warning system for the sustainable risk-reduction in the Nepal himalaya** (OR -HMD -1 -521-INVITED)

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Nepal Himalaya is one of the seismically active mountain belts in the world with several kilometers of relief and very prone to catastrophic mass failure. The collision between Indian and Eurasian plates resulted in numerous tectonic faults and highly deformed rocks which are responsible for triggering many earthquakes of different scales. High grade of rock weathering and subsequent torrential rainfall are directly related to increasing the numerous geo-hazard problems i.e., landslides, debris flow, and floods, etc. The M_w 7.8 Gorkha Earthquake-2015 has ruptured a 150-km long section of the Himalayan décollement and triggered more than 19332 co-seismic landslides in central Nepal. These landslides are carrying large volumes of sediment to the rivers and deposited in valleys and foothills of the Himalaya. Several catastrophic valley infill are quite interesting in the Himalayas and urgently needed for gauging and predicting the recovery times of seismically perturbed mountain landscapes. In this context, an outstanding research on Pokhara valley has suggested that this valley was formed due to catastrophic events in ~100, 1255 and 1344 C.E based on radiocarbon dates from peat beds, plant microfossils and humic silt in fine grained tributary sediment. Moreover, mountain slopes are unstable due to recurring earthquakes and intense rainfalls. e.g., a high-intensity rainstorm (540 mm in 24 hours) in July 1993 hit the central Nepal and 52 houses were destroyed and 62 persons were killed by a debris flow and deposited 5.1 million m^3 sediment volume in the Kulekhani Reservoir

Gorkha Earthquake-2015 has shattered rock mass forming cracks and these phenomena can represent a major part of the overall disaster with an impact that can last for years before restoring to background condition. These landslides can be done with the help of both structural and non-structural measures to reduce the impact of geo-hazard in this region. The research on community based landslide risk reduction has clearly shown that small scale intervention can be a fruitful solution for low-income countries like Nepal, however, structural measures are not always sufficiently effective due to terrain and unpredictable geological as well as meteorological conditions. In such conditions, non-structural measures such as Landslide Early Warning Systems (LEWS) are piloted by increasing community awareness and monitoring systems. Based on landslide susceptibility map, topography and need of the community, LEWS system has been piloted in one of the major landslides triggered by earthquake in the Nepal Himalaya to understand the surface dynamics and relations between rainfalls with surface movement. The locally developed Flash Flood Early Warning System will be useful for prediction of flood and can significantly reduce the destruction of life and property.

INVITED: **Need assessment of storm water management guidelines in Nepal** (OR -HMD -1-522- INVITED)

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Recently, the Environmental Protection Act 2076 has been implemented in Nepal which made provision be formulated by the provincial government and implemented to the community level through local government. Till date, not any regulation has been formulated primarily for the management of stormwater in Nepal. Although the highest annual rainfall of the country is observed in Gandaki province, the rainfall pattern differs in each province. Hence, the rules and regulations for environmental protection should preferably be drafted at the provincial level.

This research is intended to analyze the need of such guidelines to be incorporated for environmental protection at federal level. Many researchers around the world have discussed the necessity of management approaches which comes with the start of urbanization. It is due to the change in coefficient of runoff and change in the rate of infiltration due to land use/land cover, which finally alters the overall hydrological cycle of the surrounding. Pokhara is considered as the ideal region for study as the city receives enormous amounts of precipitation every monsoon season. Here, different perspectives have been analyzed on the basis of social need, qualitative approach and quantitative approach to justify the need of stormwater management guidelines in Gandaki province. With the numerous newspaper reports on lack of proper storm water drainage infrastructure system in Pokhara, this problem has now been a buzz creating issue in the public eye. Many past researches have pointed out the fact that the capacity of the drainage system in the Pokhara valley is not sufficient. Similarly, studies have shown that quality of discharge water in different outfalls in the city don't meet the standards for pollution control issued and being implemented in different developing and developed countries in the world. Lack of such a regulatory framework has been a key problem that has created hindrance in coordination and design of public physical infrastructures for many urban planners, architects, engineers and the administrators in the time being.

The research also discusses the practices and basic principles adopted by different countries in the world and its applicability in Nepal. While studying about the practices of different countries, their level of development and urban planning policy were also studied that helps for further clarification of the principle in terms of Nepal. After the detailed study of all the parameters required, this study has concluded the major points to be considered for storm water management guidelines to be drafted under the umbrella act of environmental protection act. As no any design procedures has been formulated in Nepal to estimate the storm water runoff and its safe discharge to the natural water bodies in the urban environment, the study has also stepped further to document the major steps for estimating the storm runoff and designing a storm water drainage that can be manipulated, changed or modified by the planners as per their requirement in different scenarios.

Keywords: Disaster risk management; Drainage Design; Flooding; Flood control; Flood management.

Catchment scale analysis of the impact of urbanization in the rainfall-runoff-inundation scenario of Kathmandu valley (OR -HMD -1 -623)

Saroj Karki, Rocky Talchabhadel, Suchana Acharya, Rajaram Prajapati
Nepal

Urban Inundation has emerged as a serious problem in recent years in different cities of Nepal. The frequent inundation in Kathmandu valley even with normal rainfall has raised a serious question over our land use and river management practices. With the rapid increase of population, the urban spheres of the Kathmandu valley is expanding hastily. Rapid conversion of permeable areas into impermeable concrete floors is thought to have accelerated both the quantity and timing of runoff into the river channels. Furthermore, urbanization has exaggerated the river encroachment practices while disregarding the hydraulic and hydrologic principles in designing river management works also attributes to the valley's inundation problem. In order to precisely plan the mitigation actions and policies, it is imperative to apprehend the inundation mechanisms and its response to the conversion of permeable areas into the impermeable ones. In the current study, we tried to investigate the rainfall-runoff-inundation characteristics and hence analyze the impact of urbanization on the spatio-temporal behavior of inundation. A catchment scale landscape

evolution model (CAESAR-LISFLOOD) is applied to the Kathmandu valley watershed with outlet at Khokana. We incorporated the effect of urbanization (built-up area) into the simulation by modifying the manning's roughness coefficient for two different land use scenarios. Preliminary simulation has demonstrated a reasonable match with the real field cases in terms of both the critical locations and the magnitude of inundation. Further improvement in the model output including the calibration and validation is underway.

INVITED: **Can numerical model be utilized to simulate the extreme events in Nepal?**(OR -HMD -2 -523-INVITED)

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Global temperature is rising and extreme weather is becoming more frequently around the world. Climate change has already strengthened extreme events that include the strongest tropical cyclone in Indian Ocean, massive fires from Australia to Western United States, and extreme drought, precipitation and floods over many parts of the world are recent examples. Nepal has witnessed the impact of extreme weather including drought and floods and more recently the extreme wind. First ever recorded tornado occurred in South-Central Nepal at the end of March 2019 that killed 30 people and injured more than 1000 people in Bara and Parsa districts. High resolution numerical model is simulated focusing on two extreme events that occurred around the same area. First case is the recent extreme wind event from 2019 and second case is the extreme precipitation and flash flood from the end of 20th century that occurred in July 1993. More than 500 mm rainfall occurred within 24-hour on 19-20 July generating the flash flood in Bagmati River and many tributaries, damaging the Bagmati Barrage, Kulekhani hydropower, and east-west highway. Both observation and model simulation captured mesoscale features of these extreme events however the model is unable to simulate the convective storms' right location as they occurred for a short duration of time over a small area. This presentation will focus on the strength and weakness of the numerical model that can be utilized for the forecasting and to study the genesis of extreme events.

Numerical simulation of Bara-Parsa tornado using weather research and forecasting model (OR -HMD -2 -624)

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Higher instability in the atmosphere during the pre-monsoon season (March-May) favors the development of severe storms and tornadoes in South Asia that has huge impact on life and property within the short span of time. Isolated or the supercells storms are accompanied by heavy rain, lightening thunder, surface wind squalls and down-bursts. Tornadic severe storms have been documented and studied worldwide. It is relatively new in-context of Nepal. The study focuses on the severe tornadic event that occurred in the evening of 31th March 2019 in the southern foothills of Central Nepal (Bara and Parsa districts) using Numerical Model. The Weather Research and Forecasting (WRF) model v.4.0.3 has been used with the domain resolution of 3 and 1 km. The physics scheme used in the present study are Morrision for Microphysics, Yonsei University (YSU) for PBL processes, Rapid Radiative Transfer Model (RRTM) for long-wave radiation and Dudhia scheme for shortwave radiation.

 Several thermodynamic stability indices including K Index, Total Totals Index (TTI), Convective Available Potential Energy (CAPE), Convective Inhibition (CIN) and Showalter Index are analyzed as indicator of the atmospheric stability. Meteorological parameters are extracted for nearby Rampur, Jagannathpur and Telgai to represent the study area Chitwan, Parsa and Bara districts, respectively. The CAPE value was greater than 2950 J /kg in Rampur Station at around 1100 UTC and on Jagannathpur and Telgai was greater than 3000 J/kg around 1200 UTC. Higher value of positive buoyancy area modulates the speed of the updrafts and results in the explosive thunderstorm development. The maximum value of K – index was 30.81 observed at Sakhuwa during 1330 UTC. The TTI value for Jagannathpur and Telgai stations were greater than 57^0C from 1230 to 1430 UTC, representing very unstable environment for longer time period. The showalter index was signifying the unstable environment with the value of -5 during the time of occurrence of the event. These higher values of CAPE, TTI, KI and lower value of Showalter index indicates strong convective phenomenon and the chances of scattered thunder cells. Pressure minima and surface temperature maxima was found at the time of occurrence of storm. Pressure drop was about 5 hPa along the path of tornado. The critical

value of Energy Helicity Index was 3.1 in Jagannathpur signifying the possibility of tornado. Model simulation shows that the storm has initiated around 1200 – 1230 UTC in Bara and Parsa region. The model was able to simulate the features of storm. Prediction of various stability indices were good and their higher values signifies the unstable environment suitable for the storm.

Keywords: WRF, CAPE, thunder cells, wind squalls, tornado

Simulation of extreme rainfall event in Nepal using weather research and forecasting model (OR -HMD -2 - 625)

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Central Department of Hydrology Meteorology, TU, Nepal

Massive floods and landslides triggered by extreme rainfall caused 25 people dead and 2065 household displaced in Central and Eastern Nepal (Province 1, 2, and Bagmati) during 11-13 July 2019. Two-day precipitation recorded over some stations in the eastern region is more than 500 mm with a maximum 24-hour rainfall (436.1 mm) at Tulsi station on July 12. To minimize the impact of such extreme rainfall events in the complex topography and scanty gauge network of Nepal, reliable prediction with numerical model is helpful. In the present study, this extreme rainfall is simulated using Weaterh Research and Forecasting Advanced Research WRF (WRF-ARW). The Weather Research and Forecasting model with a horizontal resolution of 27, 9 and 3 km is used in this study. Sensitivity studies using six microphysics schemes have been carried out to predict this extreme rainfall event and to find an optimal scheme for the study region. The results from the model are compared with available surface observation and with the satellite (IMERG) data. By considering the better performing microphysics scheme as a reference, large scale characteristics and meso-scale dynamics are investigated. Results shows, Morrison scheme, followed by the Lin scheme is generally able to capture the event, although the exact location and intensity vary. IMERG product is also able to capture the event. The moisture for this event is mainly from the Arabian Sea and a high amount of atmospheric moisture over the target region and adjoining areas. The two systems; northward movement of the monsoonal trough toward the Himalayan region at a lower level and southward extension of the westerly trough toward the Indian plain are the key indicator for this extreme event.

Keywords: WRF, extreme rainfall, Microphysics, Monsoon

Monitoring of air pollution in and near a natural museum in Srilanka (PO-PO -700)

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The assessment of effects of indoor pollutants on cultural heritage artefacts in museums is a major and growing concern in the scientific community. Studying the effects due to airborne particulate matter and gaseous pollutants in museums in tropical climates in the south Asian region is limited, especially in Sri Lanka. Sri Lanka is one of the richest countries in Asia, when considering its cultural heritage. Outdoor particulate matter, PM2.5, PM10, and black carbon, as well as indoor gases were measured near and inside the Kandy National Museum, Sri Lanka. Indoor gases, SO_2, NO, NO_2, NO_x and O_3, were sampled using 36 passive diffusion tubes exposed for 4 weeks in galleries and display cabinets in the museum. The gas concentrations were determined by ion chromatography. Coarse and fine particulate matters (PM) were collected (25 pairs) using a GENT stacked filter unit sampler at an outdoor location on the premises of Kandy National Museum from February to July 2015. Black carbon (BC) in these filters was determined by reflectance and masses of PM2.5 and PM10 were determined using a microbalance. The indoor gases pollutant concentrations in the museum were very low except for O_3. Average PM2.5, PM10, and BC concentrations were 12.0, 28.0, and 5.0 g/m3, respectively.

Keywords: indoor gases, cultural heritage, particulate matter, gaseous pollutants

Characterizing Hydroclimatic Variability in the Mountainous Catchment Nepal (PO-PO -701)

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Institute of Engineering, Pulchowk Campus, Nepal

Sound understanding of catchment hydroclimatic variability is critical for informed decision-making in water resource management. Observations and physical arguments suggest that the changing climate modifies rainfall, temperature and streamflow in several mountainous catchments in Nepal. We analyze the spatiotemporal variability and trend of rainfall, temperature and streamflow from a time series of available hydrological and meteorological stations in a mountainous catchment. Specifically, we choose the Tila basin in Western Nepal where several critical infrastructure projects (e.g., hydropower, irrigation and reservoir) are under the development phase. Tila basin is undergoing changes in climate, hydrology and land use, which in turn, influences agriculture and water resource projects. We apply the non-parametric Mann-Kendall test and Sen's Slope approach to determine nature and magnitude of change in trend across monthly, seasonal and annual scales. We also compute hydroclimatic extremes such as consecutive dry and wet days, which is vital for effective management of agricultural and irrigation systems. Our results provide insights on hydroclimatic variability, and are of practical importance for better planning, management and adaptation to climate change.

Study on Streamflow Alteration Across Nepal Before and After 2000 (PO-PO-702)

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This study presents a picture of streamflow alteration in major hydrologic stations across Nepal over the period of 1986-2015 attributed before and after 2000. We select 27 high-quality hydrologic monitoring stations maintained by the Department of Hydrology and Meteorology (DHM), Government of Nepal distributed across the country. The selected stations represent a wide range of basin size, from ~308 to ~54100 km^2. We compare the flow duration curves (FDCs) for two periods, T1: 1986-1999 and T2: 2000-2015. The study quantifies the changes of different streamflow indices including minimum, maximum, average daily streamflow, different percentiles and top 10, 20 and 50 maximum daily streamflow. Many studies reported that the climate (such as temperature and precipitation) showed an abrupt alteration during the late 90s in the central Himalayas. Here, the current study explores whether similar effects are observed in streamflow of the Himalayan catchments. The results of the study show a mixed pattern of positive and negative changes for different streamflow indices. However, about 60% of analyzed station (i.e. 17 out of 27) showed positive deviation of maximum daily streamflow meaning more extremes were observed in the latter period of time compared to the former period. Seven stations revealed > +20% shift in maximum daily streamflow from period T1 to T2. Overall, about 10% of increment could be found on time-sliced averaged maximum daily discharge between two periods. Most importantly, the inter- and intra- annual variation of extreme streamflow show a clear tendency of elevated peak streamflow recurrently over time.