Contents

Oral Programme

Tuesday 24 June 2014	
09.00	**Welcome**
11.30	**Student presentation from Leh School**
11.45	**A life in Ladakh** Professor (ambassador) Phunchok Stobdan, Institute for Defence Studies and Analyses
12.30	**Lunch and posters**
14.00	**Mountaineering in the Himalaya** Ang Rita Sherpa, Mountain Institute, Kathmandu, Nepal
Session theme: The geological framework of the Himalaya	
14.30	**Geochemical and isotopic constraints on magmatic rocks – some constraints on collision based on new SHRIMP data** Professor Talat Ahmed, University of Kashmir
15.15	**Short subject presentations and panel discussion** ***Moderators: Director, Geology & Mining, Jammu & Kashmir State & Director, Geological Survey of India*** **Structural framework of the Himalayas with emphasis on balanced cross sections** Professor Dilip Mukhopadhyay, IIT Roorkee **Sedimentology** Professor S. K. Tandon, Delhi University **Petrogenesis and economic potential of the Early Permian Panjal Traps, Kashmir, India** Mr Greg Shellnut, National Taiwan Normal University **Precambrian** Professor D. M. Banerjee, Delhi University
16.00	**Tea and posters**
16.40	**Short subject presentations continued & panel discussion**
18.00	**Close of day**

Wednesday 25 June 2014	
Session theme: Climate, Landscape Evolution & Environment	
09.00	**Climate** Professor Harjeet Singh, JNU, New Delhi
09.30	**Earth surface processes and landscape evolution in the Himalaya** Professor Lewis Owen, Cincinnati University
10.00	**Landscape & Vegetation** Dr P. P. Dhyani, GB Pant Institute of Himalayan Development
10.30	**Tea and posters**
11.10	**Short subject presentations and panel discussion** ***Moderator: Commissioner of Forests and Environment, Jammu & Kashmir State*** **Biodiversity, species patterns, habitat relationships and land use status of high altitude rangelands and their interfaces in upper Bhaderwah valley (north-western Himalayas), Jammu and Kashmir, India** Dr Neeraj Sharma, Institute of Mountain Environment, University of Jammu **Conservation & Development Challenges in the Himalaya** Dr Sejal Worah, WWF-India **Empowering Ladakhi Women** Thinlas Chorol, Ladakhi Women's Travel Company
12.50	**Lunch and posters**
Session theme: Sustainable Resources	
14.00	**Water and Sanitation** HRH Prince El Hassan Bin Talal, Chair of UN Secretary General's Advisory Board on Water and Sanitation
14.30	**Water Resilience to Climate Change and Human Development** Dr Mohammad Shamsudduha, IRDR-UCL
15.00	**Engineering challenges for development in mountainous areas** Dr Gareth Hearn, Hearn Geoserve Ltd
15.30	**Tea and posters**
16.10	**Short subject presentations & panel discussion** ***Moderator: Commissioner Planning/PHE, Jammu & Kashmir State*** **Markets, Institutions & Regulatory Regimes for a Market for Water in Rural North West India** Professor Dipankar Sengupta, University of Jammu **Agriculture and Food Production** Professor Tej Partap Singh, SKUAST **Geothermal Energy-Tapping the Heat from Below** Professor Joe Moore, EGI University of Utah **Social Aspects** Professor Lobzang Tsewang/Professor Chewang Norphal, Ladakh
18.00	**Close of day**

Thursday 26 June 2014	
Session theme: Natural Hazards and Risks	
08.30	**Earthquake Hazard in Himalayan Region: How to Mitigate?** Professor Harsh Gupta, Geological Society of India
09.00	**Active Deformation and Seismic Hazard in the India-Asia collision zone** Dr Tim Wright, Leeds University
09.30	**Short subject presentations and panel discussion** ***Moderator: Commissioner Revenue, Jammu & Kashmir State*** **Seismic Hazard Assessment in India: Current status and future plans** Dr B. K. Bansal, Indian Ministry of Earth Sciences **tbc** Professor T. N. Singh, IIT Mumbai **Traversing Disciplinary Borders: Greening Social Development through Interdisciplinary Approaches – Lessons for the Himalayas?** Professor Lena Dominelli, Durham University **The role of science and scientists in earthquake risk reduction** Dr Susanne Sargeant, British Geological Survey
10.30	**Tea and posters**
11.10	**Subject presentations continued and panel discussion**
12.30	**Lunch and posters**
Session theme: Tourism Opportunities and Challenges – (Mountain, Heritage, Cultural and Sensitive Environments) ***Chairs: Commissioner Tourism, Jammu & Kashmir State; Professor Parikshat Singh Manhas, University of Jammu & Mr Rattan Kotwal, former Commonwealth Tourism Advisor & Deputy Director General Tourism Government of India***	
14.00	**A Sustainable Mystic Avenue to Wellness in Himalayan regions: Linking ecological and economic concerns** Professor Parikshat Singh Manhas, University of Jammu **Marketing the Mountains** Mr Rattan Kotwal, Consultant, former Commonwealth Tourism Advisor & Deputy Director General Tourism Government of India **Tourism Impacts of Anthropogenic Geomorphologic Changes Caused by Environmental Disasters in the Carpathian Mountains and Basin** Professor David Lorant, Szent István University & Jean Monnet Professor, European Commission **The Great Himalaya Trail** Mr Samir Thappa, Silver Mountain School of Hotel Management **Himalayan Resources: Opportunities & Challenges. A Preliminary Study if Resources Usage & Expected Environmental Impact in Neelum Valley** Dr Mohsin Shakil, Azad Jammu Kashmir Medical College

Session theme: Tourism Opportunities and Challenges – (Mountain, Heritage, Cultural and Sensitive Environments)	
	Conceptualising Carbon Footprint and Offset Measures for Rural Tourism Destinations Professor Vikneswaran Nair, Taylor's University, Malaysia **Developing Sustainable Tourism in AJK: Opportunities and Challenges** Dr Shaheen Akhtar, Research & Policy Analyst **Issues in Preservation of Cultural Heritage in recently mapped area of Neelum Valley (Valley of Kishen Ganga) in lower Himalayan Range** Ms Rukhsana Khan, University of AJK, India
15.30	**Tea and posters**
16.10	**Short subject presentations & panel discussion** ***Moderators: Dr Ahmed Shamsul Huda, Ghulam Ishaq Khan Institute of Science & Technology; Dr Imtiaz Hussain, University of Poonch; Jonathan Cohen, Conciliations Resources; Tahir Aziz, Conciliations Resources; Ameya Kilara, Conciliations Resource & Professor Phil Meredith, UCL*** **Killing The Goose The Lays The Golden Eggs: The Impacts of Eagle Feeding Activities on Kilim River Basin, Langkawi, Malaysia** Professor Badaruddin Mohamed, Universiti Sains Malaysia
18.00	**Closing ceremony, conference dinner & cultural programme**

Poster Programme

Seabuckthorn- next generation eco friendly crop for the fragile Himalayan ecosystem Amjad Ali, Govt. Degree College Kargil
Fossil Elephants of the North-West Himalaya Jonathan Craig, Eni
Foundations: D.N. Wadia and his links with the Geology Department at the University of Jammu. Beth Craig-Geen, Guildford High School
Reviewing and visualising natural hazard interactions to inform hazard mitigation and management priorities in the Himalaya Joel Gill, King's College London
Unconventional and Conventional Petroleum Systems in the NW Himalayan Frontal Fold-Thrust Belt, Riasi, India Naveen Hakhoo, University of Jammu
Outline of Temperature Structures in Himalayan Collisional Zone: A Review Ismail Hossain, University of Rajshadi
Recent Geological Hazard in Leh – A timely warning Sumeet Khullar, University of Jammu
From Fossil Fuel to Manual Energy: *The Windup Girl* Ambish Malik, University of Jammu
Wind Energy Development in India: with special reference to Maharashtra State Sunil Narwade**,** Dr. Babasaheb Ambedkar Marathwada University
Studies on the analysis of cold arid soils of Lamayuru (moonland), Ladakh and its mycodiversity. Skarma Nonzom, University of Jammu
Climate change - Health of human and natural systems in Himalaya Stéphanie Piffeteau, Instiute of Environmental Sciences, Geneva
Fluctuating shorelines of Pangonng Tso Lake during Holocene Hari Singh Saini, Geological Survey of India
Geographer Planner's Role towards Sustainable and Safer Tourism Oppuritunities Gurpreet Singh Sandhu, HRA International
Earthquakes without Frontiers: A Partnership for Increasing Resilence to Seismic Hazard in the Continents (2012-2017) Susanne Sargeant, British Geological Survey

Poster Programme (continued)

Composition, distribution, diversity, indigenous uses and conservation status of threatened medicinal and aromatic plants of upper Bhaderwah valley, Jammu and Kashmir, India Neeraj Sharma, Institute of Mountain Environment
Thoreau and Aesthetics of nature Sundus Quyoom Sheikh, University of Jammu
Hydrocarbon Potential of Lower Palaeozoic Tethys Himalaya, India Hareshwar Sinha, Vinoba Bhave University
Tourism Influx: Environment, Socio-Economic and Cultural Dynamics of Ladakh Region Chhering Tandup, University of Jammu

ORAL PRESENTIATONS (Programme order)

Mountaineering in the Himalaya

Ang Rita Sherpa

Mountain Institute, Kathmandu

Each year more than 36,000 tourists, a number approximately ten times the local population, visit the Khumbu region of Sagarmatha National Park as trekkers and mountaineers. These visitors bring with them more than 80,000 people as back up staff, adding to the large total population. Mountaineers and trekkers come to enjoy spectacular mountain scenery, diverse and unique flora and fauna, as well as the Sherpa culture unique to this remote area. While representing an important economic opportunity for these communities, they also place a heavy burden on the ecology of the region as well as disruptive influences on the local culture.

Tourism has greatly benefited the Sherpas of Khumbu by providing them with the opportunity to work as guides and porters. Many Sherpa of Khumbu work exclusively for mountain expeditions, a prestigious and well paying occupation. By providing locals with these jobs, their standard of living is often improved.

Despite widespread improvements in the villagers' living conditions, there is still great disparity in the distribution of tourism's benefits among various socio-economic groups of the region. The benefits of trekking-based tourism are not distributed equally throughout the park and many areas remain culturally and economically isolated and underdeveloped.

To mitigate these issues the Mountain Institute (TMI) began implementing programs to ensure sustainable management of tourism in the area by introducing an innovative form of tourism known as Community-Based Tourism (CBT). TMI helped to establish a project called "Sacred Sites Trail to Khumbu" in the Khumbu region of Nepal, bringing trekkers to less visited villages in the area. This article will provide an outline of the growth of tourism and highlight the economic opportunities which the project aims to address, the principles on which it is based, and some of its achievements.

Geochemical and isotopic constraints on magmatic rocks- some constraints on collision based on new SHRIMP data

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The Indus-Tsangpo Suture Zone (ITSZ) is considered to represent collision zone between the Indian and Eurasian plates, preserving parts of the Neo-Tethyan Ocean. This collision event is considered to be marked by (1) transition from marine to continental sedimentation in the ITSZ, (2) termination of I-Type granite magmatism in the Trans-Himalayan Gangdese Batholith, (3) initiation and emplacement of S-Type anatectic granitoids and migmatites and (4) the development of south-verging thrust and folds in the Tibetan–Tethys and Indus–Tsangpo Suture Zone. I-type granite in a subduction zone is expected to follow calc-alkaline trend and S-type granite magmatism is expected to have formed in a thickened crustal environment because of accumulation of radioactive minerals and extensional environment. Geochemical and isotopic (Sr and Nd) data for the magmatic rocks of the Indus and Shyok sutures reveal important contrasts. The volcanic rocks of the Indus and Shyok suture zones are sub-alkaline basalt, basaltic-andesite, andesite and rhyolite.

The Indus suture rocks have nearly flat to slightly depleted light rare earth and large ion lithophile element (LREE-LILE) characteristics, with strong negative anomalies for the high field strength element (HFSE: Nb, P and Ti). These incompatible elemental characteristics indicate that they probably represent intra-oceanic island arc setting. Shyok suture rocks, on the other hand, have enriched LREE and LILE respectively and depleted HFSE trace element characteristics. They probably represent ocean-continent island arc system.

In addition to the arc component, the Indus suture contain the Zildat ophiolitic mélange with dominant OIB characteristics as evidenced by highly enriched Nb (60 to 130 ppm) and strongly negative values for fSm/Nd (-0.4147 to -0.4676) relative to CHUR. However, these rocks have positive epsilon Ndt=110 Ma of about +3 and +4, like many OIBs, indicating their derivation form isotopically depleted sources that got elementally enriched prior to melting. A minor component of this mélange is characterized by depleted LILE-LREE, highly positive epsilon Ndt=110 Ma of about +9 and initial Sr of 0.70466 to 0.70666, seen in many N-MORBs. The arc component, represented by the Nidar ophiolitic complex, have higher abundances of the LREE-LILE with respect to N-MORB and positive epsilon Ndt=110 Ma of about +8 and +9, similar to Zildat mélange. Initial Sr values for Nidar gabbros vary between 0.70422 and 0.70546 indicating absence of continental crustal component.

Shyok volcanics and Nubra ophiolitic volcanics of the Shyok suture zone have epsilon Ndt=110 Ma of about +5 to -2, fSm/Nd of -0.2553 to -0.2921 and initial Sr values of 0.70376 to 0.70471. Elemental and isotopic characteristics for the rocks of the Shyok suture zone indicate involvement of juvenile crustal component in their genesis.

Thus, the geochemical and isotopic data from Indus and Shyok suture indicate that the Neo-Tethyan ocean in this region was represented by contrasting tectonic scenarios ranging from dominantly OIB to minor MORB on the one hand and from ocean-ocean to ocean-continent arc system on the other.

Most of the workers suggest that collision occurred between 50 to 45Ma, when magmatism changed from I-Type to S-Type granitic magmatism. Our new U-Pb zircon data indicate that switch from I-type to S-Type granitic magmatism occurred much later between 31 Ma and 18Ma. It is suggested that the collision was not a single event but a series of collision- accretion that occurred from 70 Ma to 30 Ma.

We also present new U-Pb data on detrital zircon from Tangtse gorge of the Karakorum Range that indicates presence of Gondwanic elements considerably north of the Himalayan Range. This opens a debate “Where does India end and Eurasia begin”?

Structural framework of the Himalayas with emphasis on balanced cross sections

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The arcuate Himalayan Mountain belt extends for about 2400 km from Nanga Parbat (8126 m) in the west to Namche Barwa (7756 m) in the east with variable width of about 230-320 km. The northern and southern limits are marked by the depressed topography of the Indus-Tsangpo valleys and the very low and nearly flat topography of the Indo-Gangetic alluvial plain, respectively. This mountain belt is a manifestation of the still-continuing continent-continent collision between the northern Eurasian plate and the northward moving southern Indian plate (e.g. Dewey and Bird 1970; Powell and Conaghan 1973; Le Fort 1975; Molnar and Tapponnier 1975, 1978; Bird 1978). Klootwijk et al. (1992) suggested that the initial contact between the two continents occurred in the Kohistan-Ladakh area in the northwestern Himalayas by the Cretaceous/Early-Tertiary time (*ca*. 65 Ma). The zone of collision then migrated southeastward and the suturing was completed by about 55 Ma. The Indus-Tsangpo Suture Zone (ITSZ) marks the site of the collision. India's northward movement slowed down from pre-collision rate of about 18-19.5 cm/year to a post-collision rate of about 4-5 cm/year or less (Powell and Conaghan 1973; Molnar and Tapponnier 1975; Patriarch and Achache 1984; Molnar 1987; Besse and Courtillot 1988). A reasonable estimate of the total post-collision crustal shortening between the stable parts of the Eurasian and Indian plates is of the order of about 2500-3000 km (Besse and Courtillot 1988). The total crustal shortening has been partitioned into three parts: along a detachment, block rotation and sideways extrusion along large-scale strike-slip faults in the Eurasian plate north of ITSZ (Molnar and Tapponnier 1975), and within the Himalayan orogenic segment south of the ITSZ. The continued collision and crustal shortening have resulted in the overthrusting of the frontal part of the Indian continent back on to itself along a gently dipping detachment (Seeber *et al*. 1981). The overthrusting led to doubling of the thickness of the continental crust to about 70-80 km under Tibet. A part of the shortening within the Himalayan orogenic segment expresses itself by a number of thrusts that have sliced up the Himalayan rock sequences to form a crustal stacking wedge (Mattauer 1986). Three of these thrusts, viz., the Main Frontal Thrust (MFT), the Main Boundary Thrust (MBT) and the Main Central Thrust (MCT), are regionally important (Fig. 1.2; Gansser 1964; Le Fort 1975; Valdiya 1980). The South Tibet Detachment System (STDS; Burchfiel and Royden 1985), occurring north of the MCT, is a system of gentle northerly dipping normal faults that are supposedly reactivated thrusts. The MFT, MBT and MCT are supposedly splays from a basal detachment (Fig. 1.2b). The five tectonic surfaces separate four longitudinally continuous lithotectonic zones (Fig. 1.2a; Gansser 1964; Le Fort 1975). From north to south they are: (1) High Himalaya Sedimentary Zone (HHSZ) composed of a continuous sequence of low-grade metamorphic and sedimentary rocks ranging in age from Neo-Proterozoic to Cretaceous. These rocks were deposited on the leading edge of the northerly moving Indian plate. Structurally it is a complex zone and in Spiti valley these rocks show buckle folds affecting multi-layered sequence and associated structures. (2) High Himalaya Crystalline Zone (HHCZ) that occupies the area between the STDS and the MCT. The rocks of the HHCZ are the most highly deformed and metamorphosed rocks in the Himalayan orogenic belt. It represents the leading edge of the

Precambrian Indian crust, reactivated and remobilized during the Tertiary Himalayan orogeny. This zone is variably referred to as the Central Cystallines, the Jutogh/Vaikrita Groups, the

Tibetan Slab, Darjeeling gneiss, and others in different sectors (3) Lesser Himalaya Zone (LHZ) consisting of lower Proterozoic to lower Palaeozoic sedimentary and very low-grade metamorphic rocks lying between the MCT and the MBT. The determinations of definitive age relations and lateral correlations in the LHZ are difficult and uncertain due to lack of fossils, paucity of exposures in many areas and later structural complications. (4) Sub-Himalaya Zone (SHZ) consisting of Tertiary sedimentary rock sequences represents the "Himalayan foreland belt".

Detailed structural geometry and evolution within the broad tectonic framework of the Himalayas as outlined above is still sketchy. Earlier workers treated the different lithotectonic zones as separate entities separated from each other by kind of boundary faults. Raiverman *et al*. (1994) show profuse development of flower structures, especially at the core of anticlines, which are associated with the wrench faults at depth. However, the presence of large-scale strike-slip or wrench faults has not been definitively documented from this Himalayan foreland as yet. A number of studies have been undertaken in the last two decades to understand the structural evolution using the techniques of cross section balancing. Schelling and Arita (1991) and Schelling (1992) showed that the LHZ and SHZ are amenable to section balancing techniques. They also demonstrate the presence of antiformal stack in the LHZ and Imbricate fan in the SHZ. The prominent feature in two balanced cross sections of Srivastava and Mitra (1994) is a buried duplex in the Lesser Himalaya Zone. The sole thrust of the duplex in both the sections is the basal detachment. The Lesser Himalaya units are made up of a far-travelled sedimentary thrust sheet, the basal thrust of which serves as the roof thrust of the buried duplex. Our work (Mukhopadhyay and Mishra 1999, 2004, 2005; Mishra and Mukhopadhyay 2002, 2012) in the Kangra re-entrant and Nahan salient in the frontal fold-thrust belt of the Himachal Himalayas shows that the geometry of faults and fault-related folds increases in complexity from foreland towards hinterland. At the frontal part, rather simple structural geometry with widely-spaced thrusts and simple fault-related folds are characteristic features. Further upsection, the structural geometry becomes more complex with linked thrusts define thrust systems whose geometries vary spatially. The structural set up towards the hangingwall of the MBT is extremely complex. Low ramp spacing, folded thrust trajectories, interference of axial surfaces and breached horses are the characteristic features in this area. The structural geometry in this sector is described as stacked up horses. A model best describing the structural evolution is the one in which a foreland propagating, in-sequence thrusting event was followed by out-of-sequence thrusting in an approximately break-back style. During the out-of-sequence movement, some of the ramps formed during in-sequence thrusting were repeatedly reactivated leading to very complex structural geometries. The duplex structures with variable geometry and out-of-sequence thrusts firmly established in these studies from NW Himalayas have been replicated through cross section balancing from other parts of Himalayas, for example from Nepal Himalayas (e.g., Decelles *et al*. 1998), Sikkim (e.g., Mitra *et al*. 2010) and Bhutan Himalayas (e.g., McQuire *et al*. 2008). A balanced cross section across all the lithotectonic zones have been construted by Web *et al.* (2011). Some of their postulates need to be rigorously tested.

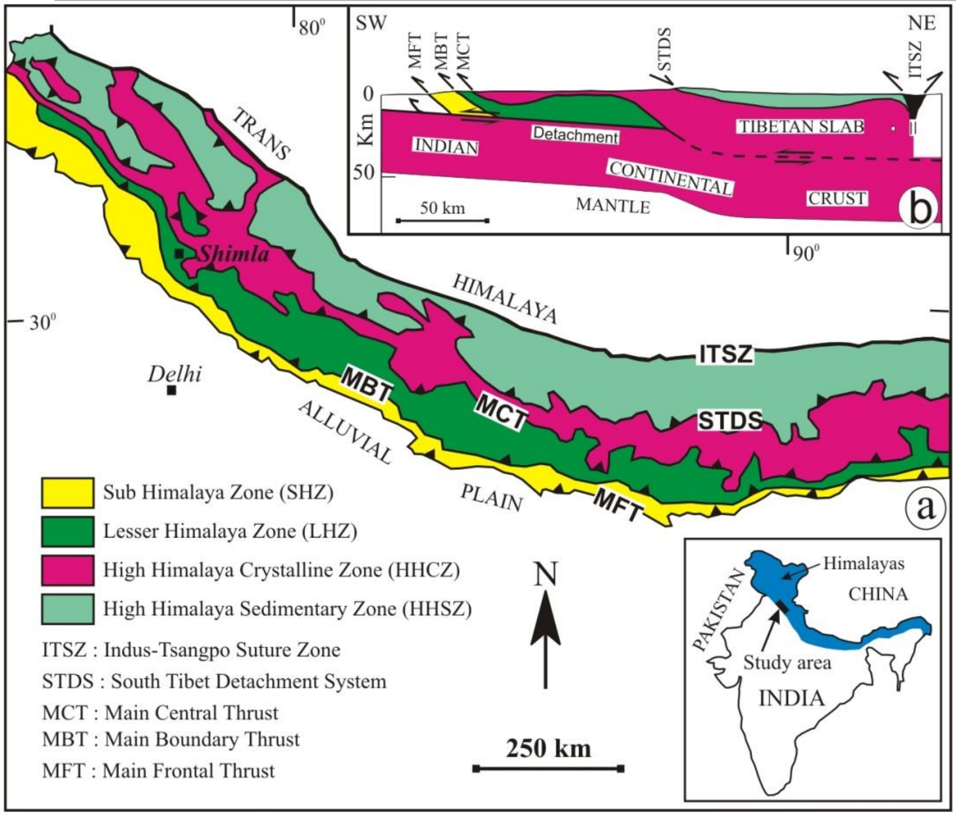

Figure 1. (a) Simplified geological map of Himalayas showing five tectonic surfaces and four lithotectonic zones. (b) Generalized NE-SW cross sectionacross the Himalayas showing that the MCT, MBT and MFT are splay faults from a gently dipping detachment along which the Indian plate is underthrusting below the Himalayas and Tibet. (after Mishra and Mukhopadhyay 2012).

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Petrogenesis and economic potential of the Early Permian Panjal Traps, Kashmir, India

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The Panjal Traps of northern India are the volcanic remnants of continental rifting which led to the Early Permian formation of the Neotethys Ocean and the development of the ribbon-like continent Cimmeria. Samples collected from the eastern side of the Kashmir Valley are chemically similar to mildly alkaline to tholeiitic, within-plate flood basalts. The variable TiO_2 contents (i.e. $TiO_2 \approx 0.6$ to 3.2 wt%) and Mg# (i.e. Mg# = 30 to 69), La/Yb_N values (i.e. La/Yb_N = 1.8 to 6.0) and $\varepsilon Nd_{(T)}$ values (i.e. $\varepsilon Nd_{(T)}$ = -5 to +1.3) along with partial melt modeling indicates that the basalts were derived from a lithospheric mantle spinel peridotite source that was enriched (i.e. EMII). In contrast, samples collected from the western side of the Kashmir Valley are more primitive in composition and show evidence for clinopyroxene fractionation. Although their TiO_2 (i.e. TiO_2 = 0.7 to 1.5 wt%) compositions and La/Yb_N values (i.e. La/Yb_N = 0.9 to 5.1) are similar to the eastern side, the western samples have much higher Mg# (Mg# = 50 to 77) values and $\varepsilon Nd_{(T)}$ values (i.e. $\varepsilon Nd_{(T)}$ = -0.1 to +4.5) suggesting they were derived by slightly higher amount of partial melting and from a more depleted spinel peridotite source. The changing bulk composition of the basalts from more enriched OIB-like on the eastern side to more depleted MORB-like compositions on the western side is indicative of the changing nature of the Panjal rift from a nascent continental setting to one that is transiting to a mature ocean basin. The platinum group element (PGE) contents of the Panjal Traps are relatively depleted for nearly all samples and suggest that they experienced early segregation of sulfide melt during ascent. Furthermore the PGEs indicate that the sub-Panjal lithospheric mantle is heterogeneous in terms of sulfur in order to produce the relatively PGE-rich magmas at lower degrees of melting. It is possible that the intrusive facies of the Panjal Trap might contain PGE mineralization or that PGE-rich sulfides may exist somewhere in the Panjal magmatic system.

Earth surface processes and landscape evolution in the Himalaya

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The Himalaya is one of the most dynamically active tectonic and geomorphic regions on our planet, and it is the most glaciated mountain area outside of the polar realms. The high mountains and deep valleys are a consequence of the continued collision of the Indian and Eurasian continental plates, rapid uplift and intense denudation by glacial, fluvial, landsliding, aeolian and weathering processes. The region provides one of the best natural laboratories in which to examine the nature and dynamics of landscape development within active mountain belts. As such, many new tectonic–climatic–geomorphic theories and models have emerged and/or have been greatly influenced as a consequence of the study of the region and the quest to understand its geomorphic development. These include models of the interactions between tectonics, climate and surface processes, notably, the influence of climate on surface uplift by denudational unloading; the limiting of topography by glaciation (the glacial buzz-saw model); localized uplift at syntaxes by enhanced fluvial and glacial erosion that, in turn, weaken the lithosphere, enhancing surface uplift and exhumation (the tectonic aneurysm model); climate-driven out-of-sequence thrusting and crustal channel flow; glacial damming leading to differential erosion and uplift; paraglaciation; and the influence of extreme events such as earthquakes, landslides, and floods as major formative processes. The development of new technologies, including satellite remote sensing and global positioning systems, and analytical methods such as numerical dating is now allowing these theories and models to be tested and will inevitably lead to new paradigms.

The study of tectonic, geomorphic and climatic-hydrological processes, and landscape evolution in the Himalaya is becoming increasingly relevant as the world advances into a time of rapid human-induced climatic and environmental change. The landscapes of the Himalaya are among the most sensitive to these encroaching changes. Understanding these nature of these changes is essential for the well being of the vast populations who live within and bordering the region. The economies of these regions are mostly agriculture based and are thus sensitive to variations in the glacial and hydrological systems that provide much of the water to these regions. Defining and predicting landscape change and changes in the frequency and magnitude of surface processes is challenging because of the complexity and diversity of Himalayan-Tibetan environments. Nevertheless, insights from studies of present and past processes and landscapes provide a framework for addressing future change. Of particular importance is the need to define both spatially and temporally: i) the nature of glacier oscillations; ii) hydrological changes; iii) the magnitude and frequency of flooding, including rainfall-induced and glacial lake outbursts; iv) rates of erosion and sedimentation; v) the nature of landsliding; and vi) seismic and associated geomorphic hazard such as earthquake-triggered landslides. Continued research in these and allied areas will aid in geomorphic and tectonic hazard mitigation and sustainable development in the coming years.

Biodiversity, species patterns, habitat relationships and land use status of high altitude rangelands and their interfaces in upper Bhaderwah valley (north-western Himalayas), Jammu and Kashmir, India

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The rangelands of upper Bhaderwah comprise of a mosaic of different ecosystems in the form of woodland, sub-alpine meadows and alpine rocky outcrops located at an altitudinal range of 3250 m asl to 4700 m asl. These interfaces are the rich repositories of biodiversity and ecosystem services. A large number of plant species are unique to the region and serve the local and regional economies. The present study attempts to present an overview of available biodiversity, especially the floristics in terms of composition, diversity, species richness and ethno-botanical relevance. The meadow vegetation typically comprises of herbaceous elements interspersed with the thickets of *Rhododendron* and *Juniper* merging with birch, oak, fir and spruce communities along the peripheries and lower slopes. The forest-meadow interface serves the most conducive habitat for brown bear, black bear, musk deer, Himalayan tahr, red fox besides monal and khaleej pheasants, western tragopan and many raptor species. Underlying causes of the high biodiversity are related to (1) the elevational variability with its concomitant range of climate conditions, (2) the diverse phyto-climate and variable topography and (3) the architectural variations in vegetation structure across different interfaces. Climate dynamics and disturbance also play major roles in maintaining a habitat mosaic, promoting greater local diversity. Over the years, these diverse eco-regions are exposed to high degree of human induced threats especially the tourism, nomadic pastoralism, plant extraction, hunting, military conflicts besides the changing climatic scenario. The study looks at the identification of impacts and setting up the conservation strategies for efficient conservation and management of these sensitive ecosystems.

Key words: Rangelands, species richness, ethnobotanical, ecosystem services, repositories, herbaceous, nomadic pastoralism, sensitive ecosystems

Conservation and Development Challenges in the Himalaya

Sejal Worah

WWF-India

The Himalayas play a significant and unique religious, social, cultural, economic and ecological role in India. However, actions at the local, state and national levels are undermining this very role of this very fragile ecosystem. The pressures on the Himalayan region in India are tremendous, and growing. Poorly planned and executed infrastructure projects, massive hydropower development, unregulated tourism, indiscriminate pollution, and climate change are all leading to irreversible damage to the ecology of the Himalayas which will have far reaching consequences not only within the region but also for many millions of people living downstream. This presentation highlights the conservation importance of the Himalayas, the value of the natural resources of the Himalayas for local communities, discusses the principal threats that are affecting the biodiversity and ecosystems of the region and examines some solutions for sustainable development. It draws on the experiences and on the ground examples from the work that WWF India has been doing for over two decades in both the Western and the Eastern Himalayas. The presentation shares specific experiences and lessons from WWF’s work on community-based tourism in Arunachal Pradesh, springshed conservation in Sikkim, sustainable livelihoods development in Darjeeling, conservation of high altitude wetlands in J & K and Himachal Pradesh, and river basin management in Uttarakhand. WWF’s work on the conservation of iconic species of the Himalayas including the snow leopard, red panda and black-necked crane as well as approaches to manage human-wildlife conflict will also be discussed.

Empowering Ladakhi Women

Thinlas Chorol

Ladakhi Women's Travel Company

Changing mind sets in Ladakhi culture. When Thinlas tried to find work as a trekking guide with agencies in Leh the men said she could not be a guide because she was a Ladakhi woman. When she took trekkers to homestays the women in the homestays thought she must be a foreigner as she could not possibly be Ladakhi. Both men and women believed that Ladakhi women could not be trekking guides, because they had never seen a Ladakhi woman being a trekking guide. However, they did not know Thinlas Chorol.

How do you change mind sets? By showing women that they can take control and responsibility for their own lives and do any job that they want to. By showing men that not only men, but also women can be independent, decision-making individuals and not just washing and cooking machines.

Yet Thinlas's father believed in her and lent her the money to start the Ladakhi Women's Travel Company (LWTC), a company providing female trekking guides. Started in 2009, with only 3 guides, LWTC needed to find more women interested in becoming trekking guides. By providing Ladakhi women with the opportunity to gain the experience and skills necessary to become trekking guides, while also earning an income, Thinlas has encouraged women to gain self-confidence and independence, both mentally and economically.

However, the empowerment of women in Ladakh still has a long way to go. There are many problems to face in how to empower women and support women as they empower themselves. What holds them back and how can Ladakhi society be convinced that this is a good and necessary step forward?

Water Resilience to Climate Change and Human Development

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Globally, freshwater represents only 2.5% of the total water content that is distributed in various water stores such as glaciers and ice caps (69%), groundwater (30%) and surface water (1%). As the world's largest exploitable store of freshwater, groundwater plays a critical role in sustaining domestic and irrigation water supplies, and environmental flows around the world. Groundwater and surface water have long been used for irrigation, industrial and domestic water supplies in the Himalayan region, particularly in India, Pakistan, Bangladesh and Nepal that are home to more than 1.5 billion people. In South Asian region, groundwater use has accelerated resource development over the past few decades and led to many major social and economic benefits. Groundwater-fed irrigation has become the mainstay of irrigated agriculture over much of Bangladesh, India, Pakistan, and the Terai plains of Nepal. Traditionally, surface water from rivers and ponds was used for both drinking and irrigation water supplies in these countries. However, over the last few decades, groundwater has largely replaced surface water because of its pollution and uncertainty in seasonal availability. For example, in Bangladesh, currently 97% drinking and nearly 80% of all irrigation water supplies come from groundwater. The use of groundwater for irrigation in India and Pakistan is around 60% and 35% respectively. In terms of water volume, India is the biggest groundwater user in the world. A recent estimate shows that in India, Bangladesh, Pakistan and Nepal combined the annual groundwater withdrawal is nearly 250 km^3 – approximately 35% of the world's total groundwater withdrawal. A substantial proportion of this groundwater is used to produce dry-season rice – the staple food in the Himalayan region. Recently, Bangladesh has made significant progress towards self-sufficiency in food grains primarily through groundwater-fed irrigation. It has long been perceived that the shallow groundwater in Bangladesh is fully replenished (recharged) during the monsoon season. However, recent studies using NASA's GRACE (Gravity Recovery and Climate Experiment) satellite observations have revealed that the terrestrial water storage (TWS), primarily groundwater storage is rapidly declining over many parts of Bangladesh and northwestern India (Figure 1). This is because groundwater is not recharged at the same rate as it is currently being withdrawn. This widespread depletion of groundwater storage is threatening the current and future food security of this region. In addition, variability and changes in global climate are likely to increase the uncertainty in freshwater resources as more frequent and intense climate extremes (i.e., intense precipitation, droughts and floods) will increase the variability in soil moisture and surface water storages. However, the impacts of climate change on groundwater storage are much slower as groundwater systems respond slowly to any change in biophysical environments. From this perspective, the strategic value of groundwater storage for global water and food security is likely to increase under climate change.

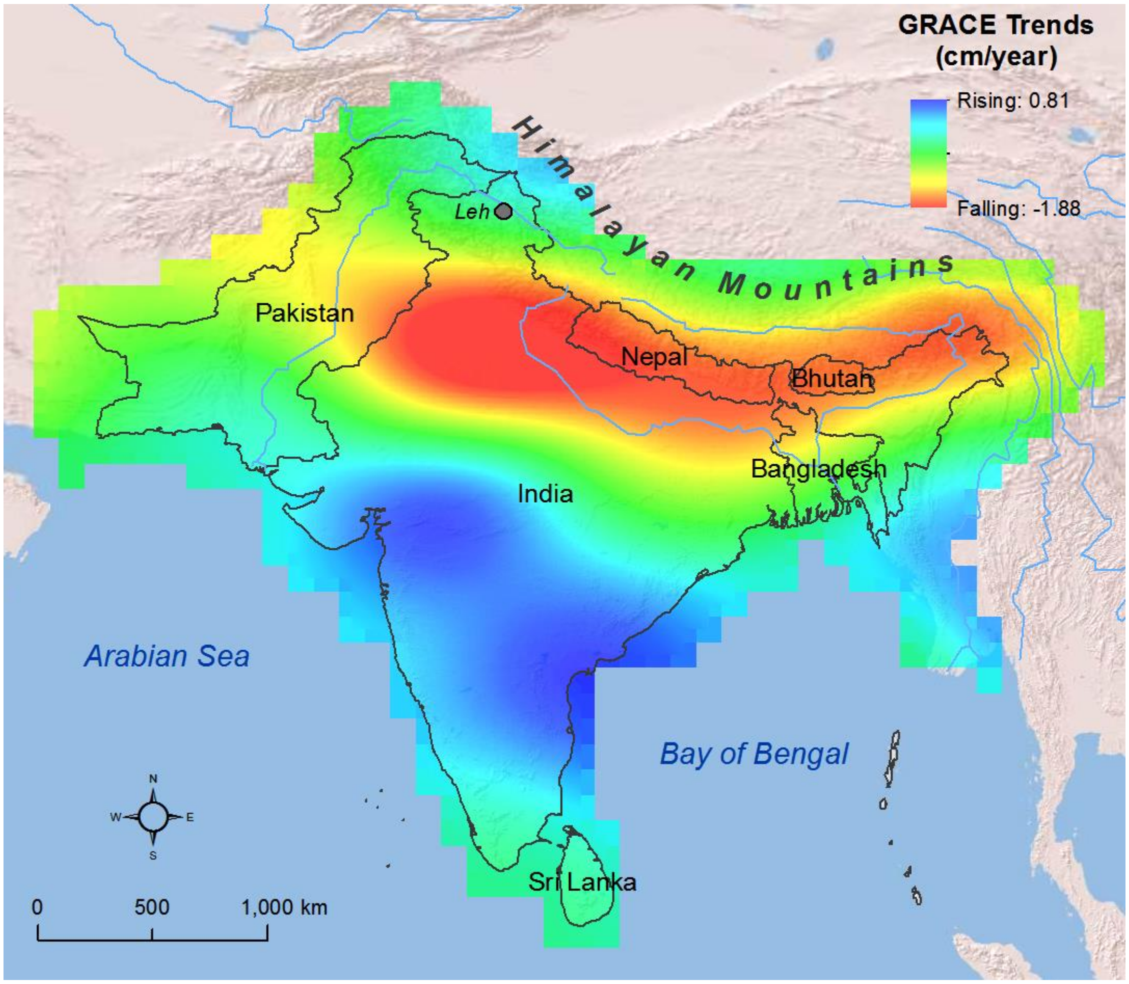

Figure 1. Linear trends (period: Jan 2003 to Dec 2012) in GRACE-derived changes in the total terrestrial water storage (TWS) in South Asia. Areas in red show declining trends in TWS whereas the areas in blue represent stable to slightly rising trends in TWS as revealed from GRACE satellite observations

Engneering challenges for development in mountainous areas

Gareth Hearn

Hearn Geoserve Ltd

Mountain areas present unique engineering challenges for development that are not replicated in lowland areas. These challenges take on a variety of forms, including complex and steep topography, unknown and sometimes unforeseen ground conditions, and the occurrence of geo-hazards, including seismicity, landslides, floods and erosion. For various natural and man-induced reasons the Himalayas pose some of the greatest of these challenges and there is a history of recorded successes and failures in the attempts made to engineer development projects in the region. The expansion and maintenance of the road network is probably the most demanding of all development programmes and it could be argued that some of the lessons from the past have not been fully learnt going forward. Furthermore, there are issues of land use change, climate change and other factors that serve to create an ever-changing environment in which to build and maintain infrastructure. These issues and the response of engineering design and management to them, will be addressed in this presentation.

Markets, Institutions & Regulatory Regimes for a Market for Water in Rural North West India

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The importance of water in human life, the economy and particularly, the agrarian economy is obvious. However, the manner in which this essential input is supplied, utilised and "priced" is only now being studied with the rigour which it deserves. This is on account of the fact, that water for long had been treated/considered as a "free" good particularly by economists and policy makers. Even when water scarcities started to (even in areas without deficient rainfall), it's shortage was treated as a problem that either could not be solved, or could be solved through large multi-purpose projects where quantifying costs and benefits were considered at the planning stage of such projects.

Establishing a market for water, or making institutional arrangements for its augmentation, distribution and utilisation at any level of aggregation, whether at the national level, state level, or the river basin level or the community level was neither a matter of enquiry for researchers in economics or an issue to be resolved by policy makers.

The literature with regard to the management of water resources specifically in North Western India is scarce. While there is literature that outlines the various techniques that may be used to recharge groundwater in the North Western Himalayas like spring recharging, contour trenching etc (Rohitashw Kumar *et al*) as well as works that argue that modern techniques with regards to rainwater harvesting can work in this region (Jasrotia *et al* 2009), academic research on institutions that manage water in this part of the country is rare. This is surprising as inter-community clashes regarding the use of water have been reported in Uttarakhand. The increase in temperature coupled with decreased rainfall during the winter and spring period is making current production system in the region unsustainable. Thus a knowledge of ground water recharge potential of water harvesting structure is important for sustainable management of water resources.

The objective of this paper is arrive at a theoretical construct that describe how a common property resource such as water may be managed in the North West Himalayas by synthesising the approaches of Ostrom and the property rights approach initially outlined by Hardin and to simulate the impact of a hypothetical propetrty rights based water management regime in Udhampur Block in Udhampur district. Specifically we focus on Rathian, Bradian and Rown Panchayats in the afore named block. These panchayats are placed on hilly terrain and experience seasonal water shortages and the nearest River Tawi is at a distance which makes water extraction next to impossible.

The conventional techniques used to harvest water will not work in these villages and more appropriate techniques that are suited to the Hills will have to be tried. Secondly the transfer of water from one panchayat to the other is different from that in non-Hilly states. Thus it would be of interest to see whether in such circumstances a market for water can be established.
Specifically, this study wishes to

1. To undertake a cost-benefit exercise of the various water harvesting techniques by estimating the extent to which harvestible water is increased and the investment that has

to be undertaken for such an increase to occur.

2. To work out the cost of investment required to make possible inter-community water transfer from one panchayat to the neighbouring panchayat
3. To design a system of incentives and penalties so that no member of the panchayat overdraws water
4. To estimate the amount that one panchayat should pay to a water surplus panchayat to get its water supply augmented.

Geothermal Energy: Tapping the heat from below

Joseph Moore

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Geothermal heat provides sustainable, baseload, energy for electricity generation and heating applications. Worldwide use of geothermal energy has increased steadily over the past few decades, and exploration and development are ongoing at unprecedented levels in Iceland, New Zealand, East Africa, Germany, Chile and Australia. Today, 24 countries generate electricity from geothermal energy and 78 countries use geothermal energy for direct uses. Yet, geothermal sources still represent less than one percent of global energy production. The accessibility of geothermal resources depends on temperature and depth.

Liquid-dominated reservoirs with temperatures of more than ~150°C can be used to generate electricity. These systems are common in areas where water is heated through deep circulation along faults. The geothermal water is passed through a heat exchanger in an Organic Rankine cycle binary plant containing an organic working fluid (such as iso-pentane) that is vaporized, passed through a turbine, and then recondensed in a closed loop. Because the liquid is never flashed to the atmosphere, as it does in a flash plant, binary plants release no CO_2 or other gases. Higher temperature geothermal systems, with temperatures greater than 225^{o}C, are found in the vicinity of young volcanoes but they also occur in rift zones and at mantle hot spots. Flash plants are commonly utilized to generate electricity from these geothermal fields.

Using the thermal energy from hot water directly is much more energy-efficient than generating electricity and resources suitable for such direct utilization are much more widely distributed than those with temperatures required for electric generation. Geothermal water at temperatures of 30 to 150° C is used for bathing, heating, and greenhouses in 75 countries. Large-scale district heating projects, for example, have operated in Reykjavik, Iceland since the 1930s. Today, 90% of the homes in Reykjavik are heated with geothermal water that is piped directly to radiators. There are no technological limitations to growth, however, utilization must be commercially viable and situated near a geothermal resource.

Ground source heat pumps are a form of direct use that exploits the lowest grade of geothermal energy - 10 to 20°C, at shallow depth in regions with moderate climates. Forty-three countries have heat pump installations. The relatively constant temperature of the ground allows both space heating and cooling of homes and buildings. Heat pumps currently account for nearly 50% of all direct use applications and their utilization is increasing ~20% per year. Worldwide, direct use and heat pumps together represent a significant energy saving equivalent to 100 million barrels of oil per year.

Hot springs discharge at 340 locations in India, with nearly half occurring in the Himalayan provinces. Exploration of India's geothermal systems has been limited, and none of the geothermal systems have been developed. These geothermal systems have significant potential for electric generation, with current estimates exceeding 10,000 MW.

Earthquake Hazard in Himalayan Region: How to Mitigate?

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The Himalayan seismic belt, extending from Kashmir to Arunachal Pradesh, has been seismically a very active region. During a short span of 53 years between 1897 and 1950, four great earthquakes (Shillong, 1897; Kangra, 1905; Bihar-Nepal, 1934 and Assam, 1950) of magnitude ~ 8 occurred in the region with vast devastation. However, no such earthquake has occurred since 1950. Many studies indicate that enough strains have accumulated to generate magnitude 8 or larger earthquakes in the Himalayan region. Where and when such an earthquake would occur is not known.

As short time earthquake forecast is not feasible and at the same time earthquakes shall continue to occur, the best solution is to develop earthquake resilient society. To meet this goal, the National Disaster management Authority (NDMA) has undertaken developing of scenarios of what would happen if an earthquake of magnitude ~ 8 occurs at a certain location.

A detailed "Multi-State Earthquake Scenario Project" for a hypothetical M 8 earthquake occurring at Mandi in Himachal Pradesh was undertaken in 2013. This location is close to the 1905 Kangra earthquake of M~ 8. States of Punjab, Haryana, Himachal Pradesh and the UT of Chandigarh were involved. It is estimated that if this M ~ 8 earthquake occurs in the middle of the night, up to 990 thousand human lives could be lost in these three states and UT Chandigarh besides enormous amount of financial losses. Involving all the State Disaster Management Authorities (SDMAs), other state machinery and with public participation, the final multi-state mega mock exercise was conducted in the tri-city of Chandigarh, Mohali & Panchkula and in Shimla for the hypothetical earthquake occurring on February 13, 2013 at 11.30 am. The exercise was simultaneously conducted at sixty locations including government buildings, malls, engineering college, hospitals, office complexes, airport, railway station, market area, schools, bus station, cinema halls, petrol stations etc. Several shortcomings in preparedness were identified. The best part was the public awareness generation.

Similar exercise has been conducted for the repeat of 1897 Shillong earthquake, and preparedness are on for the repeat of Bihar – Nepal earthquake of 1934.

Active Deformation and Seismic Hazard in the India-Asia collision zone

Tim J Wright

COMET, School of Earth and Environment, University of Leeds

The ongoing collision of India with Asia has created the largest deforming region on Earth today – the deforming zone stretches for more than 2000 km from the Himalaya, with seismic hazard distributed broadly within it. In this presentation, I will review our knowledge of the present day deformation in the India-Asia collision zone and discuss the implications for seismic hazard.

We are in the midst of a revolution in our ability to measure the deformation of the Earth's surface using satellite geodesy. Ground-based GNSS (GPS) instruments have proliferated as the technology has become cheaper and easier to use. At the same time satellite radar interferometry (InSAR) has enabled measurements of surface deformation to be made completely remotely, without instruments on the ground. I will discuss the latest geodetic observations of the India-Asia collision, focusing on new methods that we have developed that combine GNSS and InSAR to estimate the surface velocity field.

One long-standing question has been whether short-term measurements of the surface deformation field are representative of the long-term deformation rate. I will address this by examining the slip rates of several large faults, and will show that the vast majority of short-term geodetic slip rates are in good agreement with long-term rates derived from geological methods. In some ways, this agreement is surprising, but it can be explained using a model of earthquake cycle deformation that includes weaker material under faults.

Finally, I will give my perspective on methods for estimating seismic hazard. I will argue that geodetic estimates of strain rates provide an independent means of estimating seismic hazard that can be more robust than traditional methods based primarily on short-term observations of instrumental and historical seismicity.

Traversing Disciplinary Borders: Greening Social Development through Interdisciplinary Approaches – Lessons for the Himalyas?

Lena Dominelli

Durham University

Environmental issues are becoming important to social development as the earth experiences more disasters stemming from extreme weather events driven by climate change, natural hazards, population growth, and the demands of peoples' rising aspirations for a better life. Somehow, society has to solve these complex problems in equitable and fairer ways while at the same time not destroying the ecosystem that sustains human life.

This presentation considers how the hegemonic models of social development have tended to ignore issues of both environmental justice and social justice, and argues that equity and environmental justice need to be at the centre of enduring forms of development that protect the earth for current and future generations. Linked to neoliberal globalisation, these hegemonic models of social and industrial development prioritise getting resources from the earth cheaply and paying those who work to extract these as little as possible. And, the global companies making the decisions about such developments are usually unaccountable to local people and have a detrimental impact on both the earth and its inhabitants – plants, animals and peoples. I draw upon work I have done in supporting people from an interdisciplinary perspective that involves physical and social scientists working with community groups to consider examples of social development where alternatives have been able to meet people's needs for decent lifestyles without costing the earth. These include looking at renewable energy as a source of community development; recycling all materials and developing community self-sufficiency in order to revitalise a community; and reconstructing sustainable communities after earthquakes and tsunamis. The limitations of local community development are also discussed, and the case is made that for equitable, sustainable development to become the norm, transformations have to occur at the local, national and international levels. They also require new policies, particularly those that hold multinational corporations accountable to those affected by their decisions and the normalisation of sustainable practices by fully embedding them in daily life. What lessons can these experiences from elsewhere have for the peoples of the Himilayas?

The role of science and scientists in disaster risk reduction

Susanne Sargeant

British Geological Survey

The important role that science has to play in disaster risk reduction (DRR) and building resilience is widely acknowledged but often its potential is not fully realised. Many of the reasons why this is so are not ‘scientific problems’ but relate instead to the complexity of the interface between science and decision making.

Earthquake hazard is high throughout the Alpine-Himalayan collision zone and numerous efforts are underway to reduce the risk that millions of people are exposed to here. Using examples of projects in Bangladesh, Nepal and Kazakhstan, which seek to increase the impact of science in earthquake risk reduction and resilience building activity amongst a variety of risk stakeholders, I aim to show that the scientist also has an important role to play in ensuring that existing scientific knowledge and new research support DRR effectively.

In particular, these examples show that it is important for the scientist (1) to understand the context in which the knowledge is to be used, and engage with the relevant stakeholders, (2) to ensure that new research and the delivery of scientific information complements and supports existing DRR activities, inter-organisational relationships and the wider disaster management process, and to make use of existing structures or initiatives where possible, (3) to provide information in a way that it can be easily used by decision makers. These examples illustrate that it takes time to develop and implement the appropriate strategies that may be required to respond to these points. This type of approach may also take a scientist into unfamiliar and sometimes challenging territory but it is important if science is to support DRR and resilience building more effectively.

A Sustainable Mystic Avenue to Wellness in Himalayan regions: Linking ecological and economic concerns

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The main potential of tourism sector to stimulate economic and social development thereby transforming economies is now internationally acknowledged. Wellness tourism refers to the that are taken by visitors with the principle purpose being to improve their health and/or wellbeing. India is the most touted healthcare destination for countries like South-East Asia, Middle East, Africa, Mauritius, Tanzania, Bangladesh etc. In this globalized era, tourism has always been considered on top priority in India with the Governments at the centre as well as the states making highly focused efforts to exploit the tourism resources offered at the national and local level. What attracts medical tourists the most to India is its low cost treatment, compared to western standards, along with the diverse tourism opportunities. Here, tourists can enjoy the vivacious culture, amazing contradictions, diverse geography , the most unique attribute – unity in diversity and are able to receive an orientation that will help them improve their life in terms of health and general wellness. In the same context, Himalayas are enriched with all the natural resources supporting the wellness. It is blessed with all the unique natural features and attractions such as minerals, healing waters, nature base spiritual centers and various sacred sites. But modern approaches of attaining the wellness like spa and other treatments have deceived the concept. This study aims to define the realistic approach of Himalayas in fostering the complete wellness of the tourists at no cost considerations. Also this study approaches to identify the scope of wellness tourism in Himalayan region and various constraints / hindrances in the development of wellness tourism prospects in Himalayas. This study also gives some insights that can be used in forming a right strategy to promote India as an attractive health tourism destination on the international platform.

Key words: Sustainable, Himalayas, wellness, wellness, ecology, economy.

Himalayan Resources: Opportunities & Challenges. A Preliminary Study of Resources Usage & Expected Environmental Impact in Neelum Valley

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Neelum Valley is a 3621 Sq. Km, typical Himalayan river valley. Its 170000 multiethnic inhabitants share a rich cultural heritage. The valley is located at and divided by the Line of Control (LoC) at many places between competing armies. Cease fire was achieved in 2003 and valley started developing by tourism and other economic activities. This study is aimed to evaluate the opportunities, challenges and aggregate impact on environment in the valley. Methods used include NS Jodha's 'Mountain Specificities to assess the impacts of climate change & evaluation of sustainability by Buckley R.C five themes framework. Evaluation of Potentials & Challenges highlighted its unique heritage & culture known as Sharda Tirtha and civilization is an attraction for cultural and religious tourism. Wildlife, protected areas, mountains, meadows, lakes, water falls, forests and LoC are other tourists' attractions. Many hydro electric power projects are adding to development amidst environmental concerns. Climate changes are affecting Neelum valley like elsewhere in Himalayas. Aggregate impact is evaluated by making recorded observations about the population, governance, economy, consumption, pollution and protection. It revealed that population pressure is compromising sustainability; regulatory problems and of pollution threat. Heritage is very low on priority, lack of base line data. Presently, a fragile peace still exists amid conflict situation between nations. Actions are needed for tourism legislation, Community participatory waste management initiatives, sustainable tourism education in schools, human resource development, Provision of electricity as a basic fuel to marginalized communities on subsidized rate. Peace and demilitarization at LoC to reduce impact. Cross LoC &Trans Himalayan Cooperation for sustainable development & collective response in disaster situations.

Conceptualising Carbon Footprint and Offset measures for Rural Tourism Destinations

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Rural tourism is an opportunity for rural development. Local tourism impact in these destinations may vary from one rural region to another. In a rural tourism setting, all service providers to tourists which include the accommodation sector, the travel and transportation sector and all the other ancillary sectors supporting the needs of the tourist, may contribute to the deterioration of the environment in the course of their tourism activities. When current operational practices and activities of tourists are analysed, consumption supersedes carbon offset initiatives that should be undertaken to mitigate further deterioration. These options when explored is easily adopted by local businesses in a rural setting to be included as environmentally friendly value-add activities that involve the tourists and other tourism services providers. This is important in the ultimate aim of the industry to integrate workable policies in order to sustain businesses (profitability) and the environment in which they operate. Thus, the concept of "Payment for Environmental Services (PES)" on the form of carbon offset plans has been popularised to attract increasing interest in the industry to develop a mechanism to translate external, non-market values of the environment into real financial incentives for the local actors to provide their services. Based on relevant measures, tourists and tourism services providers should work towards creating mutually agreed upon carbon offset measures that will help conserve and protect the environment. Hence, this paper aims to identify relevant concepts in the area of carbon offset measures and PES by reviewing relevant literatures in the endeavour to identify common framework for carbon footprint measures and offsets in rural tourism destinations which will become significant opportunities, for sustainable business operations within rural tourism settings. Measuring carbon is the first step to managing the greenhouse gas that causes global warming. Counting your profitability by reducing your operational costs but hiding your greenhouse gas emissions is certainly a false economy. Hence, tourist and the service providers need to measure, monitor and reduce their harmful emissions for the benefit of the planet. By having an efficient and effective PES mechanism in place, tourists are educated on their travel impact and have the opportunity to contribute towards rehabilitation projects that will reduce their negative impacts to the environment as advocated by Al Gore in 'An Inconvenient Truth' whereby he estimates each individual could easily reduce their carbon footprint by 20 per cent.

Key words: sustainable tourism, rural tourism, carbon footprint, responsible tourism

Killing The Goose The Lays The Golden Eggs: The Impacts of Eagle Feeding Activities on Kilim River Basin, Langkawi, Malaysia

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Mangroves areas have evolved from merely a conservation area, catchments area, flood plains—into more diversified uses. The introduction of alternative or new tourism concepts like green tourism and ecotourism has not only spurred interests in mangrove areas, but also has exposed many wetland areas to the arrivals of a more diversified visitors, engaging in many kinds of activities. Among activities carried out by tourists at mangrove areas are bird-watching, canoeing, trekking and many more. Ecotourism activities at mangrove swamps has also attracted supporting industries like fish farming, sports tourism, floating restaurants and recreational boating. These businesses, while supporting the growth of tourism in general, do pose additional and unwanted threats to already fragile nature. The Kilim River Basin in Langkawi, a popular and once secluded spot in the legendary island of Langkawi in Malaysia, is not sparred from the advancement of tourists. Recently discovered as a new alternative attraction of Langkawi Island, the Kilim area quickly grows into popularity. However, without proper guidelines on the carrying capacity and the allowable activities at this fragile region, Kilim River area has deteriorated beyond repair.

Keywords: tourism, capacity, Kilim, eagle feeding, resource management

POSTER PRESENTIATONS (Programme order)

Seabuckthorn- next generation eco friendly crop for the fragile Himalayan ecosystem

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Ladakh, characterized by harsh climatic conditions like extreme temperatures (-28 to +33 ^{o}C), meager precipitation (102 mm annually) and extremely low relative humidity, is largely barren. With a mere 0.06% area under the cover of natural vegetation agricultural productivity is very low. That is why this part of J & K is rightly known as the cold desert. This hard and frugal environment has been endowed with an important bio-resource, the seabuckthorn (*Hippophae rhamnoides* L.). Plants of *Hippophae* are dioecious, thorny, winter hardy and drought resistant shrub or small tree.The taproot is quite robust, deep growing with secondary and tertiary roots forming an extensive network and symbiotically associated with nitrogen fixing bacteria – *Frankia.* All parts like leaves, fruits and seeds are known to harbor a battery of numerous bioactive compounds that are being utilized for medicinal, pharmaceutical and nutriceutical purposes. On account of these, seabuckthorn has earned various epithets like "Golden Bush of Himalaya," "Ladakh Gold", "Wonder Plant," and so on. Locally the plants are called "tSermang", "tSes-ta-lulu", "shibshu-lulu", "sTarbu", "Nak-tSer" and find use in amchi system of medicine, for fodder and fencing. Even though the people of Ladakh have been aware of its favorable health promoting effects since ages, yet the plant has not been utilized to its full potential. Many locals are also not aware of the promise this plant species holds. Efforts have been made by Ladakh Autonomous Hill Development Council, N.G.Os and self help groups for spreading the awareness about its multi-utility aspects thereby popularizing it. The locals need to partake seabuckthorn cultivation on a commercial scale and convert this nature's gift into an industry. To achieve these, it is imperative to identify the promising plants which bear large leaves, less thorns and bigger and/or heavier fruits. For the said purpose, a detailed investigation of the germplasm in Ladakh with respect to 46 qualitative and quantitative characters, has been carried out. Plants growing in five different populations each of Leh, Kargil and Nubra valleys of Ladakh region were screened. All exhibit resistibility and adaptability to dry and cold temperature. The plant by virtue of its extensive and nitrogen fixing root system help in improving the quality of soil and reduce its erosion. It also acts as barrier to flashfloods. These characters are of utmost importance for a place like Ladakh that has witnessed several cloudbursts including the most devastating one of August 2010. The investigation has led to the identification and documentation of some genotypes with certain important agro-economical traits. Some of the characters focused are fruit and leaf size, number and yield. Of the three areas scanned, plants growing in Kargil bear greater number of large sized fruits and are early maturing as compared to those growing in Leh and Nubra. By resorting to different selection strategies, the genotypes that hold promise can be made still better and varieties released for mass multiplication to the local farmers in this dry and water scarce region. This will also generate employment and help to improve the socio-ecological condition of this cold desert.

Key words: seabuckthorn; cold desert; early maturity; morphology; cloudburst.

Fossil Elephants of the North-West Himalaya

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The name 'Elephant' has both Greek and Latin origins being derived from '*elephas*', the Greek word for ivory and, from '*ele*' meaning arch and '*phant*' meaning huge in Latin. In Greek linguistics, 'elephos' represents an antlered beast or stag. Today there is only one species of elephant living on the Indian Subcontinent – the Asian Elephant (*Elephas maximus*), but 7 million years ago, during the Miocene epoch, there were at least 15 different species of Proboscideans (elephant-like creatures) living on the Indo-Gangetic plains and in the foothills of the rising Himalaya. All had enlarged incisor teeth, forming 'tusks', which varied in number and shape. Some of the Indo-Gangetic species were small, boar–sized animals called *Gomphotheres,* which had tusks in both their upper and lower jaws which they may have used, like living elephants do, for defence and to gather food, but they did not have a trunk. Over time, most members of the elephant family became larger. The *Mastodons,* stood 3 m tall and had long, curving tusks and a sizeable trunk, while the largest, a spectacular elephant ancestor called *Stegodon ganesea* that appeared in the Siwalik Hills during the Pleistocene epoch some 2 million years ago, had tusks so close together that its trunk had to hang to the side.

Stegodons and modern Asian elephants are both members of the mammalian Order Proboscidea (or, more informally, the proboscideans). The name is derived from the Greek *proboscis* and refers to the trunk that is a characteristic feature of most the species in this Order. Today, there are only two living species of proboscideans – the African elephant (*Loxodonta africana*) and the Asian elephant (*Elephas maximus*) – but in the geological past the Order was much more diverse and the fossil remains of at least 160 different species, and perhaps as many as 352 species, are known worldwide. They inhabited every continent except Australia and Antarctica.

The Pleistocene Siwalik mammalian faunas of the N.W. Himalaya of India are highly endemic. Although they include several taxa in common with Africa and south eastern Asia, they share few genera and probably not a single species with contemporary faunas of central Asia and Europe. For example, the Upper Siwalik Proboscideans belong to the genera *Protoelephas* and *Elephas* (or *Hypselephas)* while the age equivalent European ones belong to *Archidiskodon* (or *Mammuthus*). Similarly, *Stegadon* does not occur in Europe or in western Asia. This suggests that the N.W. Himalaya region remained isolated from the main routes of migration between Europe and south eastern Asia and so allowed endemic faunas to develop.

The discovery of the skull of *Elephas namadicus* (the 'Pampore Elephant') in the Upper Pleistocene part of the Karewa Group succession, together with the remains of a variety of other herbivorous and carnivorous animals, documents the hominine migration route into India and Afghanistan and suggests that the origin of Palaeolithic man in India must have been in Kashmir (Anthropologist Dr. D.K. Bhattacharya, pers. com.). Kashmir, Baluchistan and Afghanistan are the route of animal and hominine migration throughout the Pleistocene period and, perhaps, earlier.

The presence of stone tools associated with the 'Pampore Elephant', together with the signs of butchery of the elephant carcass, are the first direct evidence of the presence of hominines in South Asia during the Palaeolithic and has been described by B.M. Pandey, Dr. J.P. Joshi and Dr. M.C. Joshi, former directors of the Archaeological survey of India, as *'of vital importance as far as human activity in South Asia is concerned'* (The week, 3rd June 2001). If the preliminary dating of the finds is confirmed, it will *'push the human antiquity in India by 0.4 million years'* (Dr. D.K. Bhattacharya, pers. com.) from the current 0.2 million years.

As such, the Pampore discovery is only the third of its kind in the world. A similar association of elephant fossils and stone tools (here made of basalt and rarely of flint) was found on the banks of the River Jordan at Gasher Benot in Israel, again indicating the possibility of hunting and butchering by hominines. The elephant fossils from this locality have been dated to 780,000 years ago and these also had percussion marks, providing the oldest direct evidence of human activity. Similarly, cut marks on some Stegodon bones from the Island of Flores in Indonesia suggest that Stegodons were also butchered, and perhaps even hunted, by the diminutive *Homo floresiensis.* The occurrence of large-sized heavy duty Acheulian handaxes, picks, cleavers and chopping tools together with fossil remains of both *Stegodon insignis ganesa*, *Elephas namadicus* with other 'mega-mammals' and hominines in the Pleistocene age sediments in the Central Narmada Valley of Madhya Pradesh, suggests that hominines may have roamed widely across the mountains and plains of northern India during the Middle and Late Pleistocene butchering, and perhaps even actively hunting, large Pleistocene mammals, including elephants.

Foundations: D.N. Wadia and his links with the Geology Department at the University of Jammu.

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Early life and Education, 1883-1907

Darashaw Nosherwan Wadia (Figure 1), considered by many to be one of the greatest Indian geologists ever to have lived, was born in Surat in Gujarat on 25th October 1883, the fourth of nine children of Nosherwan and Goorverbai Wadia. His father, Nosherwan, worked as a Station Master for the Bombay, Baroda and Central Indian Railway and was descended from a respectable family of Parsee shipbuilders for the East India Company. Darashaw (know affectionately as 'Dara' to his family) began his primary education under the care of his strict maternal grandmother in Surat, first at a private Gujarati school then later at the Sir J. J. English School. The family's relocation to Vadodara, Baroda in 1894 offered the opportunity of a better education for Wadia, and as an 11-year-old he was enrolled in Baroda High School, and at the age of 16 moved to Baroda College, which was then affiliated to Bombay University. It was here that his passion for geology grew under the teaching of Adarjee M. Masani, a keen naturist and Professor of Natural History. At the time, geology was only formally taught in India at the universities of Calcutta (now Kolkata) and Madras (now Chennai) so Wadia was largely self-taught. He obtained two B. Sc. degrees during his time at Baroda College – the first in Zoology and Botany (1903), and the second in Botany and Geology (1905) – followed by M. Sc. in Biology and Geology in 1906 (Stubblefield, 1970; Bhat, 2007). Wadia was helped in his geological studies by the collection of geological specimens held in the Museum of Arts and Science at Baroda which had been established under the patronage of the then ruler of Baroda State, Maharaja Sayaji Rao Gaekwad.

The Jammu years, 1907-1921

On 6th July 1907, at the age of only 23, D. N. Wadia was appointed as the first Professor of Natural Science (Geology) at the Prince of Wales College in Jammu (Bhat, 2007). The College had been built in 1905 to commemorate a visit by King George V of England, then the Prince of Wales, and has since been renamed as the Government Gandhi Memorial Science College (Figure 2) and is now an affiliate of the University of Jammu. Wadia apparently found the new college to be '*congenial and the surrounding countryside geologically attractive*' (Stubblefield, 1970, p.545). During the 14 years (1907- 1921) Wadia spent at the College, he benefitted from great support and encouragement from the successive Principals of the College, Fram Dadina and S. Robson, and befriended the eminent geologist Charles S. Middlemiss, Fellow of the Royal Society. In 1909, Wadia married Miss Alan G. Contractor, the daughter of G. P. Contractor, a Gujarati engineering contractor, and an otherwise happy marriage was saddened by the death of their only daughter in infancy.

Figure 1. Professor Darashaw Nosherwan Wadia (1883-1969)

Figure 2. Govt. Gandhi Memorial Science College (formerly Prince of Wales College), Jammu.

Wadia published his first geological article, 'The Story of a Stone', in early 1909 – perhaps the only time in his long and distinguished geological career that he engaged in a popular style of writing (Bhat, 2007). Whilst preparing students at the Prince of Wales College for the Punjab University (Lahore) Examinations, he experienced difficulties in teaching geology resulting from, in his own words, "*the absence of any adequate modern book on the subject*", and so, with encouragement from Sir Thomas Holland, FRS and guidance from C. S. Middlemiss, then a Superintendent in the Geological Survey of India, he decided to take on the task of writing such a book himself; The 'Geology of India for Students' was first published in 1919 by Macmillan in London and its sixth edition of 1966 is still in use today. W. D. West, former Director of the Geological Survey of India and another doyen of Indian geology wrote enthusiastically about the book (West, 1965): "*written, as are all his contributions, in matchness, and in places almost Churchillian style, it has had a profound influence on generations of students of geology, attracting them where others might have repelled, and stimulating them to take a keen interest in the subject of Indian geology*". K. S. Valdiya, commenting on Wadia's 'The Geology of India' in similar vein wrote: *"The erudite book he wrote ……details his vast and intimate knowledge of the geology of the entire Indian subcontinent, embracing Pakistan, India, Bangladesh, Myanmar and Sri Lanka. This classical work made him not only a celebrity but also a guru of countless generations of students of geology all over the world".* The 6^{th} edition of the book is 536 pages long and is divided into three main sections; the first is relatively short and covers the physical features of India, the second is a huge contribution on the stratigraphy of India from the Archaean to the Recent, and the third is a relatively short section dealing with the Economic Geology of India (Glasby, 2009).

Figure 3. The Geological museum at Govt. Gandhi Memorial Science College, Jammu showing the tusk of *Stegodon ganesa* found by Professor D.N. Wadia.

Besides his lectures in Geology at the Prince of Wales College, Wadia also taught a course on Shakespeare and was a keen sportsman. His university holidays from 1907 to 1920 were spent studying the geology of the Siwalik Hills of the Himalaya with his students and collecting rocks, fossils and minerals to assist his lectures – the most notable of which was a 10ft-long tusk of the elephant-like *Stegodon ganesa*, found 6 miles north of Jammu at Jagti Village in the Pleistocene Upper Siwalik Formation (Wadia, 1925), which is now displayed in the Museum of the Geology Department of Govt. Gandhi Memorial Science College (Figure 3). During his time at Jammu, Wadia occasionally accompanied Middlemiss in his field-mapping traverses (Stubblefield, 1970) and pursued his personal research on stratigraphy, structure and palaeontology of the Kashmir Mountains with single-minded devotion (Bhat, 2007).

Figure 4. An example of the documents stored in the Jammu & Kashmir State Archives Repository in Jammu

Very few documents from D.N. Wadia's time in Jammu now survive, but a careful search of the State Archives in Jammu (Figure 4) has revealed several important documents which shed further light on his career at the Prince of Wales College. These include the official notification of his appointment as 'Professor of Science in Prince of Wales College, Jammu on the 2nd July 1907 forenoon' published in the Jammu and Kashmir State Gazette (28 Sawan 1964b, part 3) and also as Principal of the Prince of Wales College, in which role he replaced Babu Rajinder Nath Mukherjee BA, the acting Principal since 24th April 1907, who returned to his former position of Headmaster at Ranbir High School (Jammu and Kashmir State Gazette, 11 Hard 1964b; 14 Sawan 1964b). A copy of the 'Civil and Military List of the Jammu and Kashmir State' for the first half of 1908 in the Sate Archives also records D.N. Wadia as Professor of Science at a salary of Rs. 200/-, while in the equivalent list for the first half of 1910 shows his position as Professor of Natural Science with a salary of Rs. 225/-. The archive also contains an important letter from 'D.N. Wadia, Professor of Geology, P.W. College, Jammu to the Minister of Education, Jammu & Kashmir State', dated the 8th October 1911, recording his visit to the Indian Museum in Calcutta, starting from Baroda (where he had, presumably, been visiting his family) on the 28th June via Bombay, where he spent the rest of his summer vacation working in the Museum and Library under the direction of 'Superintendents and other Experts' of the Indian Geological Survey. After completing his work at the Museum, Wadia set off on a 'private tour about the Western Ghats', travelling to Jubbulpore and then to Nasik. At this time, Wadia was actively building up the collection of geological specimens at the College and this same letter records that:

"The Director of the Indian Geological Survey has kindly agreed to present to the College a number of valuable specimens of Indian Rocks & Minerals on certain conditions. A very large

size map on the scale of 1"= 32 miles, also he has kindly consented to present on a special representation being made for it"

Wadia returned to Jammu from his trip to the Western Ghats on the 30th August 1911 *"to look after the consignment of Minerals from America".* Wadia's original office desk and chair still in the procession of G. G. M. Science College; his chair, in particular, forms an important exhibit in their small but impressive Geological Museum (Figure

5), together (it is assumed) with many of Wadia's original geological specimens, although it is no longer possible to identify these specifically within the extensive collection of rocks, fossils and minerals.

Figure 5. Professor D.N. Wadia's desk (main photograph) and chair (inset) as preserved at Govt. Gandhi Memorial Science College, Jammu

Later Life and Career, 1921-1969

In 1921, Wadia gave a presidential address to the Geology Section of the Indian Science Congress on the position of Geology in India, the first of sixteen presidential addresses over the course of his career. Later that year, he left his position at the Prince of Wales College and joined the Geological Survey of India (Imperial) as Assistant Superintendent and, at the age of

38, was the first Indian geologist with a degree from a non-European university (Stubblefield, 1970; Bhat, 2007; Glasby, 2009) to be appointed to the Survey. He spent the next 17 years working for the Geological Survey of India building on, and extending, the earlier work of Charles Middlemass (1909, 1910) in southwestern Kashmir (Thakur, 2003), mapping of the Poonch area (Wadia, 1928) and the 8126.3m (26,660ft) high mountain massif of Nanga Parbat (Wadia, 1931, 1932), work which still shapes our fundamental understanding of the geological evolution of the Himalayan mountain belt today. In 1931 he published what is, perhaps, his most famous paper, on the 'Syntaxis of the Northwestern Himalayas' - the result of nine years of detailed field mapping of the south-west side of the Pir Panjal Range in Kashmir from north of Rajouri to Uri (1921-1925) and subsequently in the Mansehra district of Hazara on the west side of the syntaxis and then in the Kaghan Valley and further north in Chilas. This now classic paper (Wadia, 1931) and his associated work in the Himalaya won him both the Back Award of the Royal Geographical Society in 1934 and the Lyell Medal of the Geological Society of London in 1943. His love of, and devotion to, the study of the Himalaya was unlimited. Wadia eventually wrote ninety one original research papers, monographs on various topics and Records and Memoirs of the Geological Survey of India (Bhat, 2007).

Wadia also spent a year (1926-7) on study leave at the British Museum in London – his first visit outside of India – where he worked on vertebrate fossils found in Potwar and Kashmir, and travelled to geological institutions in Germany, Austria, Prague and Switzerland. He took a second tour abroad in 1935 to China, Japan and America, visiting many geological surveys and universities and establishing valuable contacts.

In 1938 he retired from the Geological Survey having reached the GSI retirement age of 55 and was invited to become Government Mineralogist in Ceylon, where he spent the six subsequent years carrying out a systematic survey of the island's geology (Thakur, 2003). He had remained a widower after his first wife's death in the mid-1930s, but in 1940 he remarried to Meher Gustadji K. Medivala, a well-respected mineralogist, in Colombo who became his constant companion and acted as his travel secretary (Bhat, 2007). In 1942, Wadia became General President of the Indian Science Congress, a post closely followed by his appointment as Geological Advisor to the Government of India in 1944, a position which required him to compose a national mineral policy. In 1948, he became the first Director of the Indian Bureau of Mines, and along with two assistants he outlined the 1948 Mines and Minerals Act, 1949 Mineral Concession Rules and Petroleum Concession Rules. In 1949 Wadia moved to a position as director of the Atomic Minerals Division of the Atomic Energy Commission, where he guided its development into a unit of 470 mining and drilling experts, geologists and geophysicists until his death on 15th June 1969 at the age of 86.

Conclusions

Professor Darashaw Nosherwan Wadia was a self-made, self-taught and self-disciplined geologist and a man of few words, quiet and retiring but of genial temperament (Bhat, 2007). In all his work, whether in scientific investigations in pure geology or mineralogy, geological survey or exploration for strategic minerals, oral or written presentation of a scientific theory or in administration he showed a flair for innovation, precision and a diligence for details that laid the foundations for subsequent geological investigations in India. As the first Professor of Natural science (Geology) at the Prince of Wales College in Jammu and, hence, founder of what eventually became the Geology Department at the University of Jammu, his memory has recently been appropriately honoured by the naming of the new University Museum as the 'Wadia Museum of Natural History'. This was opened by the Chancellor of the University and Governor of Jammu & Kashmir State, Mr. N.N. Vohra on the 22^{nd} April 2014 to mark the 130^{th}

anniversary of Wadia's birth. A bust of Wadia has been installed at the entrance of the museum to remind all visitors and students of this illustrious association.

Given the fundamental role that D. N. Wadia played in the foundation of geological teaching and research at the University of Jammu, it is entirely appropriate that the first volume of a planned new international peer-reviewed geoscience journal, '*Geoscience Magazine',* to be published by the Jammu University Geology Alumni Association (JUGAA) will be dedicated to the memory of this legendary Indian geologist.

Figure 6. Visitors to the Geological Museum at Govt. Gandhi Memorial Science College, Jammu in 2012 (from left, Satinder Singh, Principal; Chanchal Kumar, HOD Geology, GGM Science College; Bindra Thusu, Jonathan Craig, Sanjay Karlopia, Caryl Geen, Beth Craig-Geen, Ghulam Bhat, Rajesh Kumar)

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Reviewing and visualising natural hazard interactions to inform hazard mitigation and management priorities in the Himalaya

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Here we present a review of natural hazard interactions and a visualisation framework to improve analysis, understanding and integration into hazard assessment and management programmes. Interactions are discussed where a primary hazard triggers or increases the probability of secondary hazards, with examples drawn from the Himalayan Region. An example of one hazard triggering another hazard is a landslide triggering a flooding event. An example of one hazard increasing the probability of another hazard is wildfire increasing the probability of landslides. Examined hazards are grouped into six categories (geophysical, hydrological, shallow earth processes, atmospheric, biophysical and space), with a total of 21 different hazard types. Global hazard distribution maps and relevant literature demonstrate the existence of many of these in the Himalayan Region.

This review identifies 90 possible interactions through a wide-ranging review of grey- and peer-reviewed literature. Interactions can be grouped into three levels, based on how well the secondary hazard can be forecasted, given information about the primary hazard. The relative likelihood of triggering relationships occurring is also determined. The influence of a diverse range of 17 anthropogenic processes on these interactions is also discussed. Such processes include aspects of land-use change, sub-surface extraction and construction (relevant in many parts of the Himalayas).

This study synthesises, using accessible visualisation techniques, large amounts of information drawn from many scientific disciplines. It outlines the importance of constraining hazard interactions, and reinforces the importance of holistic approaches to disaster risk reduction. This approach also communicates important aspects of hazard interactions, facilitating analysis by both policy and practitioner sectors. Finally, it offers a framework for considering hazard interactions at resolutions appropriate to the Himalayan Region.

Unconventional and Conventional Petroleum Systems in the NW Himalayan Frontal Fold-Thrust Belt, Riasi, India

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The NW Himalayan frontal fold-thrust belt (FTB) in the Riasi area (situated c. 120km east of the prolific oil and gas producing Potwar Basin in Pakistan) is geologically prospective for hydrocarbon exploration. Hydrocarbon shows are known from this area which has remained largely underexplored despite possessing all the essential elements of both unconventional and conventional (true and hybrid) petroleum systems.

Several carbonaceous shale horizons with good hydrocarbon generation potential are present in the Himalayan FTB. The Palaeogene Subathu Group (Gp) shales [(average Total Organic Carbon (TOC) content 4 wt. %), thermally mature (Tmax 480ºC - 520ºC)] are in the gas window. The Neoproterozoic Sirban Limestone Formation (SLFm) crops out as inliers in thrusted contact with the Cenozoic successions and contains interbedded shales (avg. TOC c. 1 wt. % and Tmax 350ºC - 540ºC) and algal laminated dolostones (with moderate source potential). The Miocene Murree Group (Gp) sandstones, Plio-Pleistocene Siwalik Group (Gp) sandstones and the SLFm carbonates all have good reservoir quality. The chert & shale beds in the SLFm, mudstone & claystone beds in the Murree Gp and the Siwalik Gp have good sealing properties.

The Subathu Gp and the SLFm shales have (or, given the high level of thermal maturity, had) the potential to generate significant volumes of gas and liquid hydrocarbons to charge the reservoirs and traps (triangle zones, pop-up & duplex structures) in the Murree Gp, Siwalik Gp and the SLFm, respectively. Additionally, the Subathu Gp shales also present all the geological elements common to the unconventional shale gas systems.

The presence of source rocks, reservoirs and seals along with traps at multiple stratigraphic levels throughout the Neoproterozoic to Neogene succession, indicates that the Himalayan FTB merits further hydrocarbon exploration albeit against some technical and political challenges.

Outline of Temperature Structures in Himalayan Collisional Zone: A Review

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The present study deals with the temperature structures (e.g., mantle wedge and slab) in Himalayan collisional zone. It is notable that the depth of the top of the depth seismicity beneath arc volcanoes varies systematically with the speed of decent of the slab and having the scaling relations for thermal structure. So, the estimated maximum temperature in the mantle wedge, Tr is 1420°C, whereas temperature at the top of the slab, Ts ranges from 1081.3–1119.5°C. The average value of the temperature and standard deviation at the top of the slab is 1103±10.7°C. The study shows that the temperature of the mantle wedge is more or less stable and the slab temperature of the entire Himalayan belt is slightly varied. The slab temperature in Central Himalaya (except Sikkim) is comparatively higher than Eastern and Western Himalaya, which is well correlated with the pattern of strain rate distribution. The mantle wedge temperature of the Himalayan collisional zone is correlated with Kamchatka subduction zone (1450ºC) and Tohoku subduction zone (1400°C) in Northeast Japan. From overall observation, the Himalayan collisional zone is characterized with high compression and high seismic activity of the entire tectonic boundary along both the eastern and western sections. In these contexts, there might have a great possibility for large earthquakes to creep up in this region. The results of the research may contribute to explain geometry, rheology, heat transport and petrological processes of Himalayan collisional zone. Generally a temperature dependent process in the mantle wedge is responsible for the focusing of volcanic activity at the sharp fronts to the arcs.

Key words: Temperature structures, Himalayan collisional zone, volcanic activity, mantle wedge and slab, Himalaya-Tibetan orogen.

Recent Geological Hazard in Leh – A timely warning

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A flash flood and landslide in the Leh Valley of Jammu & Kashmir State, India, on 5th August 2010, resulted in 200 deaths and 80% destruction of the infrastructure near the disaster site. The geo-mechanism of this extreme geological event is best explained by reservoir wall rupture theory, whereby a landslide creates a natural wall across a channel (The Indus River in the Leh disaster) to form a natural reservoir. An increase in water volume leads to increased pressure and rupture of the reservoir wall resulting in a flash flood. This model requires the presence of a significant amount of soil moisture prior to landslide. Pre-existing soil moisture saturation is one of the key ingredients that when combined with heavy rain can lead to landslides (Kirshbaum et al., 2012).

Historically, landslides in Ladakh are known to be triggered by freeze-thaw weathering, seismic activity and glacial melt waters that erode and mobilize loose soil or rock on steep slopes. However, glaciers in Himalaya are retreating at an alarming rate in comparison to elsewhere. Thus, climate change, with the accompanying rise in global temperatures, has resulted in the production of a large quantity of melt over much of the Ladakh region. Furthermore, frequent and increased precipitation has led to increased land saturation, breaching the old climatic pattern. The land saturation in turn has influenced cultivation methods in Ladakh. These new developments are likely to increase the frequency of landslides and flash floods.

The August 2010 natural disaster in Leh was an eye opener for the state administration and the public at large. Although hydro-meteorological records are patchy, folk tales and references to past major flash floods exists in local memoirs. Many habitable areas in and around Leh, where two tectonic plates (Indian and Eurasian plate) are actively colliding, are covered by granite and very loose silt deposits as a result of erosion that has occurred over millions of years. Measures to forecast and prevent future natural hazards must be undertaken along with the sustainable resource development programme for this cold desert. In order to minimise the risk of future disasters, it will be necessary to monitor climatic changes and construct climatic models with a conservation plan in place.

From Fossil Fuel to Manual Energy: *The Windup Girl*

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This paper paints a picture of a catastrophic global future if the people do not change the way they live. Paolo Bacigalupi's novel *The Windup Girl* depicts a dystopia where global warming has raised the level of the oceans, a world where carbon fuel sources have depleted and manually wound springs are being used as energy storage devices and world dependent on human muscles as its primary energy source. It shows the worst industrial future powered not by oil, solar or any other green energy but by physical power provided by genetically modified beasts. Biotechnology is dominant and mega-corporations control food production through gene-hacked seeds and use bio-terrorism to create market for their products. The paper highlights how the world can be if the people do not use the natural resources carefully and how worst the future can be with the rise of bio-terrorism industry.

Key words: Bio-terrorism, dystopia, environmental collapse, fossil fuel, global warming.

Wind Energy Development in India: with special reference to Maharashtra State

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The potential of renewable energy like hydropower, biomass and solar energy is estimated to be 50, 00, mw, 15,000 mw, 50,000 mw and 5000 trillion KWH in India. A recent US agency study says on wind energy potential in India is between 7, 00,000 and 10, 00,000 mw (Sharma 2012). Since 2005, Maharashtra's power sector has been unable to meet electricity demand resulting in many hours of load shedding. The worst load shedding is observed in rural parts of Maharashtra. This has affected production loss in many sectors ranging from agriculture to industry. It is observed that peak period electricity shortage is more than 4,500 mw (More et al. 2007). There are many coal and nuclear plants proposals to generate power in Maharashtra, especially in coastal Konkan region. But there is strong appose to it on environment concern related to land, air and water resources. Thus there is a need to look for alternative approach to generate power in Maharashtra. Renewable energy sources like solar and wind energy can be helpful in meeting Maharashtra's energy requirement.

The present paper studies the development of wind energy in the state of Maharashtra, India. Wind energy is environment friendly with little or no effect on climate change. There is no danger of emission of Green House Gases (GHGs) like carbon di-oxide. Maharashtra state stands second to Tamil Nadu in terms of installed capacity to generate wind energy. There are more than 81 potential wind sites out of which state has recognized 28. They are located in districts of Satatra, Dhule, Nasik, Ahmadnagar, Sindhudurga and Sangli districts. Asia's largest wind park is installed in Dhule district. State has formulated policies to develop and enlarge wind power sector since 1998-99. During 2003 state regulatory commission's new tariff, minimum energy purchase from renewable sources has benefitted wind power sector. In Maharashtra out of an estimated potential of 4584MW, almost 1990 MW has been achieved with an estimated capacity factor of 14 per cent (Economic Survey of Maharashtra 2010).

Key Words: Renewable Energy, Power Crisis, Wind Energy

Studies on the analysis of cold arid soils of Lamayuru (moonland), Ladakh and its mycodiversity

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Soil samples were collected aseptically from various sites of Lamayuru(moonland) Ladakh, a cold desert in the Himalayan region which is about 3390 metres above sea level where the temperature vacillates between 27ºC in summer to –45ºC in winter. The study area Lamayuru(Moonland) is a peculiar landscape near Lamayuru on Leh-Kargil road, famous by the Lamayuru monastery (3540 m) and by the marked moon like landscape, locally called as Moonland on the opposite side of the valley. This area is quite distinct from its surrounding mountains as well as from other regions of Ladakh by its uneven, dry, unique enchanting ochrous yellow colour and marvellous appearance of its own kind. In addition, this peculiar type of soil supports no vegetation at all. In view of this, work was carried out to determine the soil properties which may probably inhibit plant growth on such soils. The samples were analysed with respect to their macronutrient (Nitrogen, Phosphorus, Potassium and Sulphur), micronutrient (Iron, Copper, Zinc and Manganese) and physico-chemical (Texture, pH, Electrical conductivity, Temperature and Organic Carbon) properties. Moreover, the soil samples were screened for the presence of mycoflora by using dilution plate technique. A total of 20 fungal species belonging to 9 genera were recovered and they were identified on the basis of their macro and micro-morphological features using various taxonomic keys and other relevant literature. The recovered fungi included eight species of *Aspergillus* (*A. flavus, A. niger, A. fumigatus A.parasiticus, A. niger, A. versicolor, A. ochraceous and A. sydowii*), three species of *Penicillium* (*P. griseofulvum, P.italicum, and P.puberulum*), and one species each of *Cladosporium* (*C.cladosporioides*), *Curvularia (C.pallescens), Alternaria (A.alternaria), Rhinocladiella, Paecilomyces* (*P.liliacinus), Drechslera (D.australiensis),Ulocladium (U.Botrytis), Dendriyphiella (D. vinosa)* and *Trichoderma (T.viride)*. The present study shows that the analysed soils were found poor in the essential nutrients while the pH of all the soil samples was either neutral or slightly alkaline. In addition, a large number of mitosporic fungi exists in the cold arid soils of Lamayuru (moonland), Ladakh and the most prevalent species were represented by that of *Aspergillus* followed in decreasing order by *Penicillium* with their occurrence in almost all the fifteen (15) sampling units. Most fungi in dry and cold habitats, are adapted to low temperatures, repeated freeze and thawing cycles, low water availability, osmotic stress, desiccation, low nutrients availability and high UV radiation. Fungi play irreplaceable roles for ecosystem functioning. They may adopt different lifestyles, for example saprotrophs, symbionts or parasites thus due to their ecological plasticity, may adapt to harsh environments precluded to most of life forms. In stressing conditions, their role is even more crucial for the recycling of organic matter or favoring nutrients uptake. When the conditions become really extreme and competition is low, fungi focus on extremotolerance and evolve peculiar competences to exploit natural or xenobiotic resources in the particular constrains imposed by the environment. Most of the fungi recovered are economically important.

Climate change - Health of human and natural systems in Himalaya

Stéphanie Piffeteau

Instiute of Environmental Science, Geneva

Context

Climate change is one of the major challenges of the 21st century. The scientific community is clear now that climate warming is happening. The Intergovernmental Panel on Climate Change (IPCC) Five Assessment Report notes that the average global surface temperature is likely to rise by 4,8°C over the next century.
When one component of the ecosystem composed of living and non-living entities of a particular area is changed or disturbed, the influence is manifested in other part of the ecosystem. Thus the meteorological conditions can affect the health of human and natural systems.
Currently, climate causes approximately 70% of natural disasters, altering features of natural landscapes and affecting directly 211 million people per year.
Some people are more vulnerable than others. People living in mountainous regions are particularly vulnerable. The health effects are also expected to be more severe in developing countries.
The Himalayan countries are in both mountainous and developing. Clearly, they are facing climate change-induced consequences.
In this context, research activities are undertaken to review and analysis the situation of the human and natural health, the climate change and the adaptation of vulnerable community in Himalaya.

Study objectives

The three main objectives are:

- To explore relevant research on climate change and health of natural and human systems in Himalayan countries, especially in Bhutan and Nepal.
- To identify best practices and lessons learned from adaptation to climate change and in the health sector.
- To list the existing policies, programs, projects and actions in the field of research.

Expected results

In the context of climate change in vulnerable countries in Himalaya, the main result is to gain a better understanding of the complex dynamics between the key concepts of this research such as climate change, health of natural and human systems, adaptation of vulnerable community and responsibilities of stakeholders. Another goal is to improve the adaptation to the adverse threats and impacts on health.

Methodology

The first step of my research is built on a desk study.

This study consists of a literature review and an analysis of existing data about climate threats and impacts on natural and human systems in a mountain area, the Himalaya.
The literature review focuses on relevant existing knowledge about the impacts and threats of climate change on the "determinants of health and well-being" including social and environmental conditions such as water, air, soil and housing.
The research also goes a step further by exploring the adaptive capacity of vulnerable community and the involvement of stakeholders through their policies, programs/projects and actions.
All relevant data are collected from different organizations or institutions that are involved, such as civil society, the private sector, international organizations, governments and universities.
As my research approach is systemic and not linear, the dynamic and complex interactions between different entities mentioned above will be presented. For example, the people with underlying health conditions can be at increased risk for health effects from climate change.
Moreover, my presentation will describe the situation in two specific vulnerable countries crossed by the Himalayas: Nepal and Bhutan.

For more details on the thesis: http://www.unige.ch/ecohum/Collaborateurs/Piffeteau.html

Fluctuating shorelines of Pangonng Tso Lake during Holocene

H.S.Saini, S.A.I.Munjtaba and Anil Joshi

Geological Survey of India, Faridabad

The Pangong Tso is largest, close, saline lake in Himalaya situated at an elevation of over 4000 m. Located within the migmatite and granite of the Pangong Tso Group, its northwestern part in India is bound by the Pangong and Tangtse strands of the Karakoram Fault. Geographically, it is located in the rain shadow of the NW Himalaya, receiving precipitation of 200-500 mm from SE Asian monsoon and also the glacial melt water. Earlier studies have shown three phases of intensified monsoons during Holocene in the intervals 2.1–3.4 ka, 7.2–8.4 ka, and 9.6–11.0 ka when the lake levels increased (Gasse *et.al.,* 1996).

The dried-up lake margin has gravelly and evaporite bearing gravelly terraces, about 5 m thick patches of tilted lake sediments and water marks on the rocky bank. Over 15 m vertical contraction of lake level has been recorded. The sediments along the southwestern and northwestern margins of the lake show lacustrine clay, silty-clay and evaporite deposits. In desiccated northwestern part evaporite bearing white clayey terraces contain carbonate, sulphate and nitrate minerals, indicating enhanced rate of evaporation as a major cause of lake contraction.

Quartz OSL dating of four samples carried out from two five meter high sections of lake deposits near Man village suggests that these were deposited after ca. 7 $\pm$ 0.6 ka and exposed after 3.6 $\pm$ 0.3 ka. The nature of sediments indicates deposition under semiarid and cool (not dry) conditions. Two OSL dates of 4.3$\pm$0.2 ka and 3.6$\pm$ 0.3 ka from the middle and upper parts of second section indicate that depositional conditions did not change dramatically during this period. After about 3.6 $\pm$ 0.3 ka, warming of climate started during which a meter thick oxidized sand was deposited and gradually the lake deposits were exposed due to drying-up of lake.

Gasse, F., Fontes, J.C., Van Campo, E., Wei, K., 1996. Holocene environmental changes in Bangong Co basin (western Tibet). Part 4: Discussion and conclusions. *Paleogeography, Paleoclimatology, Paleoecology* 120, 79–92.

Geographer Planner’s Role towards Sustainable and Safer Tourism Oppuritunities

Gurpreet Singh Sandhu

HRA International

Today countries like United Arab Empire are getting their foreign reserves by the trade of Petroleum. Nowdays these countries are develpoing Tourism Sector to sustain their economy after the extent of petroleum reserves. The erection of ‘Burj Khalifa’ and other engennering extremes are few indicators of tourism oppuritunities.

Smillarly in India Tousism sector is plying important role and attracting forginers from throughout the world due to its Historical, Relgious and Recreational tourist sites. Thus these sites are growing day by day and even planning for new sites are groing.

But Tourism in india has other side in the form of Stampedes at relgious places during Festivals and devastating action at Kidharnath, has also raised need for Sustainable and Safer Tourism. Thus this paper will highlight the importance of Geographer and Planner towards making Sustainable Tourism Sites with originality. This will be disscussed in 2 Phases.

Phase 1 **Site Evaluation Techniques**
In this phase work of site evaluation on ‘Snake’ river USA will be taken as example and how these Techniques help in Sustaining Tourist Sites rather then for other purposes.

Phase 2 **Urban Plannnig roe in Preservation and Conservation of Historical Sites**
This will highlight the role of Urban Planner toeards safe gaurding the Historical sites for maintanigs their originality through Various Plans Etc.

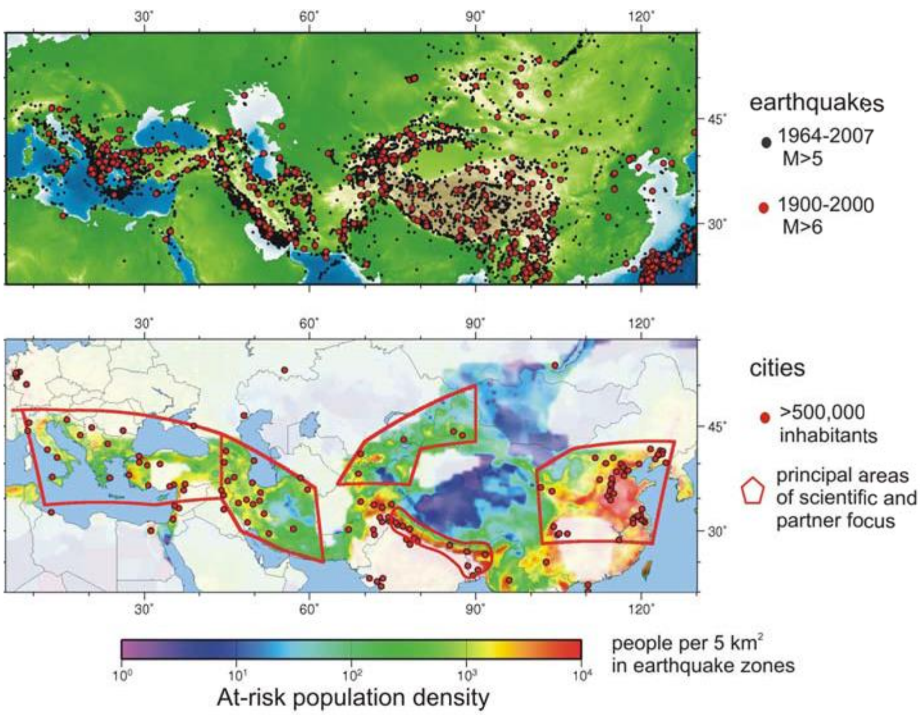
Conclusion
Thus over all the Techniques and the Various Plans or the Work of Geographer and Urban Planner will help in developing tourism which is Sustainable and Safe with its originality.

Earthquakes without Frontiers: A Partnership for Increasing Resilience to Siesmic Hazard in the Continents (2012-2017)

Susanne Sargeant

British Geological Survey

Earthquakes without frontiers is a consortium grant funded by the UK's Natural Environment Research Council (NERC) and Economic and Social Research Council (ESRC). Led by James Jackson at Cambridge University, the project brings together natural and social scientists from Durham, Hull, Leeds, Northumbria and Oxford universities and from the Overseas Development Institute, British Geological Survey, the National Centre of Earth Observation and the Institute of Hazard, Risk and Resilience, as well as collaborators in China, Kazakhstan, Kyrgyzstan, India, Italy, Greece, Turkey, Iran and Nepal.



Between 2 and 2.5 million people have died in earthquakes since 1900. Approximately two thirds of those deaths occurred in earthwuakes in the continental interiors. Over that time interval, advances in the scientific understanding of earthquakes have been translated into impressive resilience in places where the hazard is well understood. Comparable advances have not, however, taken place in most parts of the continental interiors, where the hazard is still much less well identified and poorly understood. This grant brings together a group of earth scientists with a long track record in integrated earthquake science, social scientists who have extensive experience in exploring the vulnerability and resilience of communities in disaster-prone regions, and experienced practitioners in the communication of scientific knowledge to policy makers.

This project has three overarching objectives:

- To provide transformational increases in knowledge of the distributions of primary and secondary earthquake hazards in the continental interiors
- To identify pathways to increased resilience in the populations exposed to these hazards
- To secure these gains over the long term by estabilishing a well-networked, trans-disciplinary partnership for increasing resilience to earthquakes

The research is focused on three regions: North East China, Iran and Central Asia; and the Himalayan mountain front. In each of these regions we will be working closely with local scientists, policy-makers and organisatons, both government and non-governmental.

Composition, distribution, diversity, indigenous uses and conservation status of threatened medicinal and aromatic plants of upper Bhaderwah valley, Jammu and Kashmir, India

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The upper reaches of Bhaderwah are characterized by a rich diversity of ethno-medicinal and aromatic plants as well as a rich heritage of traditional medicine practices. Owing to the rising demand in the market, their easy access and ample availability in the region, there has been an unprecedented exploitation of this natural wealth in the recent past. In order to ascertain the current distribution status of medicinal and aromatic plant species and the extent of threat to their natural habitats, a study was conducted in different sub-alpine and alpine forest interfaces in upper Bhaderwah at an elevation of 3300 m asl to 4500 m asl. The primary data was collected following random quadrat protocol using different indices for species composition, distribution patterns, richness and diversity. The secondary information was obtained by holding informal interviews and group discussions with family elders on different uses of medicinal and aromatic plants.

A total of 154 species belonging to 103 families and 137 genera have been recorded from the study area. Majority of plants are used for treating external injuries and curing stomach, skin, eyes, urine, blood and liver related ailments. Several plant products are used by the locals as spices and condiments and for making herbal tea, soups etc. Out of the total, forty five species have been identified as threatened. *Aconitum heterophyllum, Aconitum violaceum, Meconopsis aculeate, Dioscorea deltoidea, Podophyllum hexandrum, Berberis lyceum, Jurinea macrocephala, Dactylorhiza hatagirea, Bergenia ciliata, Bergenia stracheyi, Trillium govanianum, Picrorhiza kurroo, Arnebia, benthamii, Pleurospermum brunonis, Taxus wallichiana* etc. are highly preferred species and their unabated commercial extraction from wild may completely wipe out their populations from the region in near future. As a part of conservation strategies, the stringent monitoring of the populations and habitats of threatened medicinal and aromatic plants, their restricted harvesting and habitat protection are suggested.

Key words: Ethno-medicinal, indigenous, aromatic, commercial extraction, condiments, restricted harvesting, habitat protection.

Thoreau and Aesthetics of nature

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Literature for the ages has been reflecting the issues and challenges of life as it is a well known fact that literature is a slice of life. Thoreau has been in all his works generally and *Walden* in particular sensatising the people about the importance of sustainable resource development. The present poster aims at looking in detail that how *Walden* plays a key role in making the people conscious about their relentless and ruthless treatment of nature which will surely lead us to natural hazards and risks and how literature fulfils its duty in disseminating the facts to general masses, laymen on one hand and helps the scientists on the other. Henry David Thoreau, often called the first environmentalist, never found a companion that was so companionable as nature. His theory of nature was to advise people to conserve nature. In *Walden* he expresses his deep grief for the cut down trees. He takes nature not as a source of enjoyment but the Wild Nature, which is nature untouched by human beings.

Walden can be studied in context to ECO-CRITICISM which is the new offshoot of literary theory focussing on the "relationship between literature and environment".

He just hopes for the future that each town should have a park or rather a primitive forest of 500 acres or a thousand acres where a stick should never be cut for fuel or recreation .If we will not quit our habit of conformity and prejudice towards nature then there is no doubt that the adage 'ECOCIDE MAY LEADS TO GENOCIDE' will come true.

Key words: Nature, conversation, wild life, Eco criticism , Natural hazards and risks.

Hydrocarbon Potential of Lower Palaeozoic Tethys Himalaya, India

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The Tethys Himalaya – the deformed sedimentary sequences of the Palaeozoic/Mesozoic northern Indian continental margin - is located between the Indus Tsangpo Suture Zone (subducted ocean) in the north and the major thrusts in the south (crustal shortening) (Fig.1). It extends along the entire length of the Himalaya from Nanga Parbat in the west to Namcha Barwa. The Tethys Himalaya in India is represented by the Kashmir, Zanskar-Spiti and Kinnaur-Uttarakhand basins with near-continuous thickness of 500 to 16,000m ranging in age from Precambrian to Cretaceous except in Zanskar where it extends to Eocene.

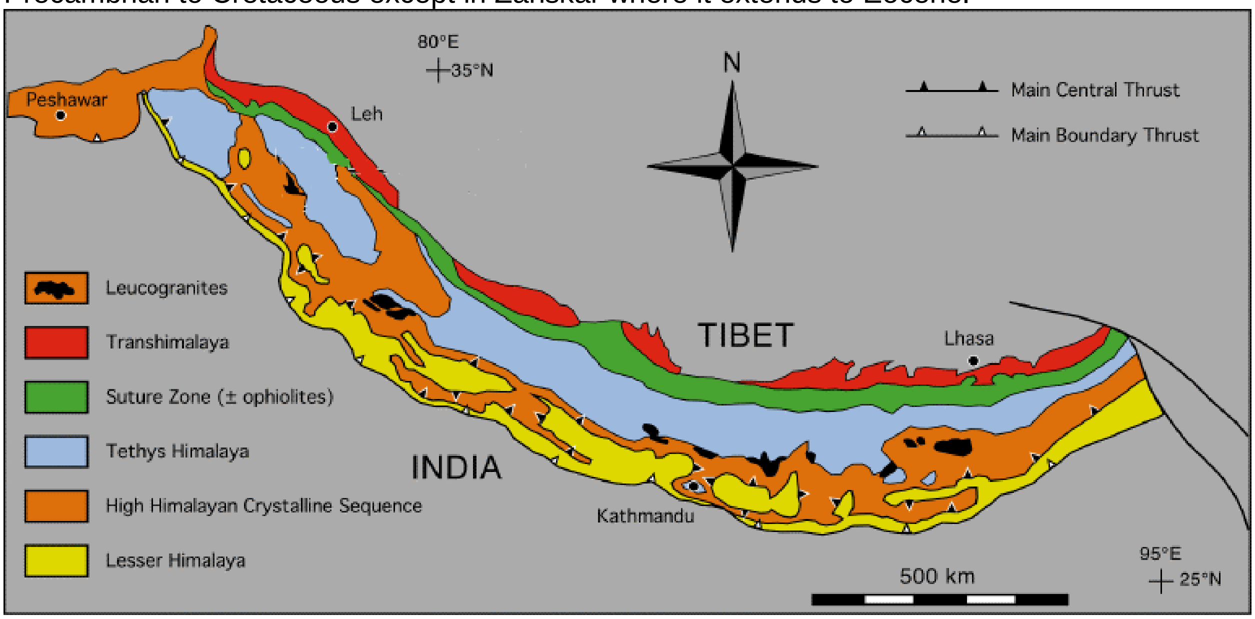

Fig. 1Geologic-tectonic map of the Himalaya modified after Le Fort 1988

Lower Paleozoic sections, dominated by siliciclastic sediments have been studied for fossil content in the context of Himalayan tectonics and thermal maturation. A limited number of data is already available including information on invertebrates, microfossils, palynomorphs and algal remains. However, there are many sections unstudied due to the hostile conditions.

Ordovician-Silurian shales are dominantly grey black in colour and contain a rich and diverse organic-walled microflora, dominated by marine plankton along with Amorphous Organic Matter (AOM) of indeterminate origin and abundant semi-structured vitrinite-like fragments – an organic-rich assemblage capable of generating hydrocarbons prior to the uplift of the Himalaya. Hydrocarbons from this phase may be preserved in favourable tectonic structures. At present the Thermal Alteration Index (T.A.I.) of palynomorphs varies from 3.25 to 3.75 indicating the high thermal maturation of the organic matter as a result of Himalayan tectonics.

The area was part of Gondwana and situated at ~25^0 to 30^0 S while the vast majority of Gondwana was then at higher latitudes and documents evidence of the Hirnantian glaciation. There are no glacial deposits of the Hirnantian glaciation in the Tethyan Himalaya however, major truncations occur and sedimentation rates increase strongly during this time-interval. A change in sediment flux due to a fluctuating sea-level would bring nutrients and vitrinite-like fragments (from nearshore) into the marine environments and trigger blooms of microflora/ -microfauna ultimately depositing the observed organic-rich sediments.

Tourism Influx: Environment, Socio-Economic and Cultural Dynamics of Ladakh Region

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Ladakh region is one of the important parts of Jammu and Kashmir State having distinct culture, believes, race, ethos, language, habitat, economy and political issues as compared to the rest of Kashmir and Jammu province of the state. Ladakh Trans-Himalaya lies in the north of the Zanskar Trans- Himalayan range and south of Karakoram Range. The region used to remain closed for the rest of the world till 1974 because of its strategic location and unique cultural values. In 1974 Ladakh was, for the first time opened for the tourists. In 1974 the total number of tourists (foreigner as well as domestic) who visited Ladakh region was 574 and in 2012 it was 1,78,970. This unprecedented increase in the number of human population in the form of tourists in the region shows immediate impact on its fragile environment, culture, economy, life style and society of the area. Increased population exerted huge pressure on existing natural resources (land, water and soil). One can notice the obvious impact of tourism on the costumes, food habits and livelihood of the people of the region. In this presentation, the presenter will try to explain through the pictorial comparative analysis of the region before 1974 and after 1974 till date the impact of opening of the region for the tourists on the region. The different pictures of different locations and on different aspects have been collected right from 1970s and the same pictures of the same locations and same aspects taken in 2013. The endeavour has also been made on the comparative analysis of some tourist hot spots like Pangong Lake, Puga Valley and some monasteries. This can be analysed that there has been a drastic change among these places before and after the opening of Ladakh for the rest of the world. The focus has also been put on the change in land use and land cover of Leh city and surroundings. The pictures reveal that there has been a drastic decline in agricultural land in Leh city and surroundings. The agricultural land has been used for commercial activities particularly for construction of hotels, guest houses and shops. There are some pictures of Leh market in 1970s and we have the same pictures of 2013, which shows that there has been drastic change in the construction patterns and increase in the number of shops. There is a picture which compares the women selling seasonal vegetables in 1970s and in present times. Earlier Leh market was dominated by the local agricultural surplus products like barley, wheat, peas and vegetables and now a day the market is dominated by antique items which are the centre of attraction for the tourists. A model will also be used in the presentation to demonstrate the climate change influencing the tourism and the change in land use and land cover of the area.

Key words: Society, Tourism, Dynamic, Culture and Economy

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