Holocene Glacier Change in High Mountain Asia workshop at INQUA 2019 Congress, Dublin

Ann Rowan, Lewis Owen, Josephine Hornsey

Ann Rowan, Department of Geography, University of Sheffield, UK a.rowan@sheffield.ac.uk
Lewis Owen, University of Cincinnati, USA
Josephine Hornsey, University of Sheffield, UK

Holocene Glacier Change in High Mountain Asia Oral Session
We convened an oral session at the 2019 INQUA Congress in Dublin on 24th July 2019. The aim of the session was to bring together researchers investigating recent glacier change in the High Mountains of Asia using a wide range of different approaches. As the conference location was in Europe, we attempted to avoid a bias against researchers from the study region by advertising this session directly to organisations in India and Nepal with relevant research interests. We invited two speakers to contribute to this session; Dr. Sourav Saha, an Early-Career Scientist from UCLA, and Milap Sharma, a Professor of Geomorphology at JNU in Delhi. Both speakers are Indian Nationals, and due to issues in obtaining a visa Dr. Saha was unable to attend. His talk was presented on his behalf by his PhD supervisor Lewis Owen. We were honoured that Prof. Sharma was able to join us for this meeting as he does not usually attend meetings in Europe and made a valuable contribution to our session.

Session workshop
After the oral session of six talks (see attached pdf of the programme) we held an informal lunchtime workshop in the conference venue, where lunch was provided for speakers and invited guests. Some of the audience also collected a meal elsewhere and returned to the workshop. This provided an excellent opportunity to discuss questions that arose from the oral presentations, challenges of research in this field, future directions and avenues for possible collaboration. Overall, the workshop added considerable value to the oral session for the convenors and we hope for other delegates as well.

Actual expenditure compared to initial budget
The BSG support was acknowledged during the session and workshop, and in all emails sent in advance of these events. The funds requested for speaker travel were unused, as Dr. Saha was unable to attend and Prof. Sharma was happy to cover his own costs. As a result, the only expenditure was the cost of lunch for 12 people at the workshop, in total Euro 333.00 (GBP 308.65). The remainder was unspent and can be returned to the BSG.

Holocene glacier change in High Mountain Asia

Terrestrial Processes, Deposits and History

Time: 11:30 - 13:15

Date: 26th July 2019

Location: Wicklow Meeting Room 1 (Level 2)

Posters will be on display on Friday 26th July in Liffey Hall A and B and the abstracts are available to download in the poster session for Friday.

Chairperson: Ann Rowan

O-1141

10Be dating of Holocene moraines in the Himalayan-Tibetan orogen: noise versus signal

Sourav Saha[1,2], Lewis A. Owen[3], Marc Caffee[4]

[1]University of California, Los Angeles, Los Angeles, USA. [2]Northern Kentucky University, New Port, USA. [3]University of Cincinnati, Cincinnati, USA. [4]Purdue University, West Lafayette, USA

Abstract

Cosmogenic ^{10}Be dating has been used to date young moraines in the eight glaciated valleys of the northwestern and Central Himalaya. Following the north-south (Low to high) precipitation gradient the study areas include: Stok, Lato, Karzok, and Parkachik valleys in the Zanskar range; Hamtah and Kulti valleys in the Lahul Himalaya; Bhagirathi valley in the Garhwal Himalaya; and Lhotse Nup valley in the Khumbu Himal. Also, four hundred and sixty published ^{10}Be ages are compiled to reconstruct regional stages in the 73 glaciated valleys spread throughout the Himalaya, Tibet, Pamir, and Tian Shan. Whenever possible, additional dating methods, for example, radiocarbon, are used to date moraines independently. We also measured the contribution of prior exposures (i.e., inheritance) to cosmic rays by targeting independent, historically dated moraines. To further detect climate signals from the geological spread, regional Holocene glacier chronostratigraphies throughout the orogen are developed by grouping glaciated regions with comparable climatic characteristics. Three major climatic groups (or five climatic regions) are defined across the orogen using Cluster Analysis (CA) and Principal Component Analysis (PCA). Local glacial stages in each climatic group are then compiled and analyzed for regional stage reconstruction using a combination of the radial plotter, probability density function, and Student’s t-test. Extents of Holocene glacier advances are also reconstructed using detailed geomorphic mapping and estimating equilibrium-line altitudes (ELAs). Glacier sensitivities are assessed using modern glacier hypsometries, climate sensitivity (c), and lag time (τ). The net changes in temperature (ΔT) between periods of reconstructed regional glacier advances are also reconstructed using glacial length change (dt), c, τ, and a linear inverse glacier flow model in 66 glaciated valleys across the different climatic regions throughout the orogen. Our results show a high degree of uncertainty of cosmogenic dating of moraines boulders of less than 2 ka old. However, the issue of high-degree of ^{10}Be

age scattering due to prior exposure is more pronounced in cold-based less erosive (~15.3–11.8 ka) and five Himalayan-Tibetan Holocene glacial stages (HTHS) at ~11.5–9.5, ~8.8–7.7, ~7.0–3.2, ~2.3–1.0, and

O-1142

Holocene changes of the Nepalese Mera glacier: preliminary results

vincent jomelli[1], Patrick Wagnon[2], Fanny Brun[3], Etienne Berthier[4], Regis Braucher[5], Aster Team[6]

[1]CNRS, Meudon, France. [2]IRD Université Grenoble, Grenoble, France. [3]Université Grenoble, Grenoble, France. [4]LEGOS OMP, Toulouse, France. [5]CNRS Université Aix Marseille, Aix en Provence, France. [6]7 Aix-Marseille Université, CEREGE CNRS-IRD , Aix en Provence, France

Abstract

Recent studies of High Mountain Asian glaciers using satellite images revealed large regional mass balance variability over the last two decades mainly attributed to distinct climate conditions. This complex pattern makes it difficult to quantify the impacts of anthropogenic forcings on this trend. Two major issues for such quantification are related to a limited knowledge of i) long term glacier changes, ii) the natural forcings effects on glacier evolution. Mera debris-free Glacier (27.7°N, 86.9°E, 5.1 km^2) is one of the rare monitored glaciers in Himalaya (Dudh Koshi basin, Everest region, central Himalaya) making possible a full understanding of processes driving glacier mass change. Moreover the numerous and well preserved moraines downstream offer a unique opportunity to document Mera mass balance changes in the past. In 2014 and 2017 twenty boulders were sampled on the four largest moraines close to the front position and dated using cosmogenic method. ^{10}Be ages span the Holocene. Two fresh moraines close to the current front position were formed during the last millennium while the two lowest ones were formed during the late and early Holocene respectively. Such pattern reveals a glacier history similar to glacier in central Himalaya and in regions, such as the European Alps, out of monsoon climate conditions. We then analyzed possible climate conditions responsible for such changes by applying a glaciological model calibrated on current glaciological observations. Based on this analysis we explored the possible influence of external and internal climate drivers on such chronology.

O-1143

Investigating asynchronous retreat of glaciers in the Khumbu region, Nepal.

Josephine Hornsey[1], Ann Rowan[1], Stephen Livingstone[1], Duncan Quincey[2], Derek Fabel[3], David Rippin[4], Martin Kirkbride[5]

[1]University of Sheffield, Sheffield, United Kingdom. [2]University of Leeds, Leeds, United Kingdom. [3]Scottish Universities Environmental Research Centre (SUERC), East Kilbride, United Kingdom. [4]University of York, York, United Kingdom. [5]University of Dundee, Dundee, United Kingdom

Abstract

Himalayan glaciers comprise the most extensive body of ice outside of the Polar Regions, with their meltwaters sourcing some of the largest river systems in Central Asia (Bolch, et al., 2012). They have experienced negative mass balance since their last known maximum during the regional Little Ice Age (Rowan, 2017). Despite glaciers being an important indicator for regional climate change, the inaccessibility of Himalayan glaciers has resulted in a relative dearth of data to describe their state, both current and past. In particular, assessments of past change between modelled and measured data differ due to insufficient observations and process understanding (Hock, et al., 2017), making the prediction of glacier evolution uncertain. Investigating glacier response to past climate change through examining relict landforms offers additional validation for their long-term behaviour, advancing our understanding on what may control their response to future climate change so that predictions of meltwater input into local water resources can be more robustly assessed.

Here, we present a glacial geomorphological map of the Khumbu region, Nepal, which facilitates much greater insight into the Holocene glacial history of the Khumbu Glacier and its tributaries. The mapping was completed using SPOT7 Imagery, the NASA High Mountain Asia Digital Elevation dataset, and fieldwork. Field mapping was supported by Schmidt Hammer measurements taken from *in situ* boulders on moraine crests. We mapped Holocene moraine systems surrounding the Khumbu Glacier and two of its tributaries: the Changri Nup and Lobuche Glaciers. The Khumbu and Lobuche Glaciers are both characterised by large proximal lateral and terminal moraines surrounded by smaller, superimposed moraines. The Schmidt Hammer values collected from boulders reveal similar exposure between these two glaciers. Changri Nup Glacier has fewer moraines, with no evidence of reworking, and lower Schmidt Hammer values. There are also smaller glaciers with a series nested moraines indicative of a stepped retreat. By combining the results of the mapping and Schmidt Hammer with analysis of glacier hypsometry, we explore controls governing the pace and style of glacier retreat.

References

Bolch, T. et al., 2012. The State and Fate of Himalayan Glaciers. Science, 336(6079), pp. 310-314.

Hock, R., Hutchings, J. K. & Lehning, M., 2017. Grand Challenges in Cryospheric Sciences: Towards Better Predictability of Glaciers, Snow, and Sea Ice. Frontiers in Earth Science, 5(64), pp. 1-14.

Rowan, A., 2017. The 'Little Ice Age' in the Himalaya: A review of glacier advance driven by Northern Hemisphere temperature change. The Holocene, 27(2), pp. 292-308.

O-1144

Quantifying post-Little Ice Age mass change in the Himalaya

Ethan Lee[1], Duncan Quincey[1], Jonathan Carrivick[1], Simon Cook[2]

[1]University of Leeds, Leeds, United Kingdom. [2]University of Dundee, Dundee, United Kingdom

Abstract

Himalayan glaciers store the greatest volume of ice beyond the Polar ice sheets, but their response to Holocene climate change is not very well documented in the literature. Recent work has focussed on modern glacier dynamics and on reconstructing Last Glacial Maximum extents, while glacier extent during the Little Ice Age (LIA) is relatively poorly understood. The limited research undertaken so far on LIA Himalayan glacier extent has demonstrated asynchronous retreat due to local topographic controls, and suggests that the LIA glacial advancement in this region peaked around 1500 AD with widespread retreat since 1850 AD. Here, we present an inventory of LIA extents across the entire Himalayan region, and provide a first-order estimate of the mass loss since the LIA. We take the Randolph Glacier Inventory (RGI) version 6.0 to represent present day glacial extents and use these data overlaid on recently released High Mountain Asia (HMA) 8m Digital Elevation Models (DEM) and remotely sensed images to digitise interpreted LIA glacial extents. By interpolating an estimated LIA glacier surface we can then quantify areal and volumetric changes between the two epochs. In a final step, the results of their volumetric change are used to quantify the contribution of Himalayan glaciers to sea-level rise (SLR) since the LIA, and to characterise the regional variability in mass loss across the range, taking into consideration possible topographic and climatological controls.

O-1145

Geochemical provenance of a supraglacial debris cover in relation to changing tributary discharges of a Himalayan compound glacier

Martin Kirkbride[1], Sophie Sherriff[1], Ann Rowan[2], David Egholm[3], Duncan Quincey[4], Evan Miles[4]

[1]University of Dundee, Dundee, United Kingdom. [2]University of Sheffield, Sheffield, United Kingdom. [3]Aarhus University, Aarhus, Denmark. [4]University of Leeds, Leeds, United Kingdom

Abstract

The century-scale mass balance of glaciers in the monsoonal Himalaya is related to the northward penetration of the summer monsoon. We test the hypothesis that large glaciers straddling climatic gradients comprise tributary catchments whose mass balances are asynchronous, by studying spatial variation in the geochemical composition of the Khumbu Glacier debris cover. This non-surging glacier comprises multiple compound sources forming a debris-covered tongue terminating 11 km south of the Himalayan Divide. 21 samples of supraglacial sediment 900 years to reach the terminus; in contrast, debris from the Western Cwm has had a transport time of

O-1146

Holocene Glacial Fluctuations in the Himalaya: Results and Limitations

Milap Sharma

Jawarharlal Nehru University , New Delhi, India

Abstract

The climate of Indian sub-continent is the product of the Himalaya. The huge expanse from the East to West, and South to North, not just works as a water-tower but also conditions the sub-continental climate in a variety of ways. The varied topographic configurations that exist has undergone varied and complex climate-landscape interactions over the geological past. Many phases of glacials and inter-glacial episodes are engraved in the landforms the dominate the present day landscape. Many details of the previous glacial and related processes have been obliterated in the dynamic environment. Although relationships and chronologies have been established between glacials and the ISM and the Mediterranean Westerlies, yet little is understood of the relative role of the Polar Streams and the N-Easterlies in impacting the weather and the glacial expansions within such a huge expanse.

Available chronologies define the general trends in Holocene glacier oscillations that the largest advance during early Holocene in the monsoon influenced Himalayan region. This advance is represented by impressive suites of sharp-crested moraines, dated by the numerous researchers, to between ~11.5 and 8.0 ka. The mid-Holocene moraines have been dated in several regions, with the most extensive in the semi-arid Western part. Five glacial advances have been identified (semi-arid western Himalayan-Tibetan stages for the Holocene in the semi-arid western end of the Himalayan-Tibetan orogen. On the other hand, Murari et al (2014) have reported eleven monsoonal Himalayan-Tibetan stages during the Holocene for the monsoon-influenced regions. Correlation of stages also suggest that there are strong correlations with periods of enhanced monsoonal influence in the Himalaya and Tibet. In recent study, Saha et al. (2018) also recognized seven Himalayan Holocene regional glacial stages for the northwestern end of the Himalayan-Tibetan orogeny i.e. There are immaculately preserved mid and late Holocene relict landforms in the Chenab, Beas and Ravi Basins of the Western Himalaya, constrained within 8.1 ka to 1.0 ka. However, the drumlin field indicate a gradual waning between 6.0 ka and 4.0 ka, and accelerated retreat until ~1.0 ka. The ^{14}C ages further suggest that the period between ~ 12th to 18th Century AD was relatively warmer than today, allowing settled agriculture and related activities in the glacier forefields. There is no denying that a gradual retreat of glaciers began in the 17th Century AD that increased many folds after the mid 19th Century. However, a robust relationships needs to be built of the upland-foreland basins with reference to waxing and waning of glaciers of the Himalaya and the adjoining mountains to understand relative roles of different climatic pattern that control the sub-continent.