River dynamics in the Himalayan foreland basin

Elizabeth Dingle

School of GeoSciences, University of Edinburgh (elizabeth.dingle@ed.ac.uk)

Project summary

Many of the rivers of the Ganga Plain are prone to abrupt switching of channel courses (avulsion) causing devastating floods over some of the most densely populated regions on the globe. Despite this, our understanding of the factors that control the dynamics of these rivers downstream of the Himalaya is surprisingly limited. Rivers in the east Ganga Plain can be broadly defined as shallow aggrading channels that frequently avulse and flood, whilst those in the west are described as degrading systems with incised channels that have been historically more stable. This project seeks to better understand the primary controls on channel morphology across the Ganga Plain and to help identify the sensitivity of such systems to longer term projected climate change and anthropogenic pressures. It is hypothesized that patterns of aggradation, incision and river morphologies represent a balance of the sediment flux and sediment grain sizes delivered to the Ganga Plain from the mountain catchment, and the accommodation produced by subsidence in the underlying foreland basin.

Fieldwork summary

Processes driving landscape evolution (tectonics, climate and lithology) vary spatially and temporally in the mountain catchment, generating differing quantities and calibre of sediment exported into the Ganga Plain. Sediment flux and grain size should therefore also vary along the mountain front. Consistent and reliable sediment flux data are limited and there are even fewer extensive published data on grain size distributions across the mountain front. One output of my fieldwork will be the first extensive set of grain size distributions along the Himalayan mountain front. The fieldwork will also generate new sediment flux data for a number of rivers from concentrations of cosmogenic ^{10}Be in river sands, which can be used to calculate catchment wide erosion rates averaged over 10^2-10^4 years. The effect of stochastic inputs on ^{10}Be concentrations will also be considered to improve confidence in sediment flux estimates. This will be achieved by characterising the natural variability in ^{10}Be concentrations in ancient river terrace sediments deposited during periods of relatively stable Indian summer monsoon strength (10-7 ka) and modern (<1000 year) event bed sediments that are well documented about the mountain front (Sinha *et al.,* 2010; Wasson *et al*., 2013). This will aid our understanding of the role of stochastic controls on detrital ^{10}Be concentrations.

Methods

With the financial support of the BSG, I was able to spend four weeks in Feb/March 2015 working along the Sarda, Gandak and Kosi rivers in northern India and southern Nepal. The main aim of this fieldwork was to collect detailed grain size measurements from bedload exposed on gravel bar deposits within the modern channels. Measurements were taken from upstream of the mountain front and continued downstream, until gravel deposits were exhausted at the gravel-sand transition. On average there were 8-12 sites along each river. Both surface and subsurface measurements were obtained using photo counting and volumetric sieving methods (Figure 1), respectively. At each site 100-350 kg of gravel bar deposit was sieved though 0.1, 1, 2 and 4 cm sieves. Pebbles coarser than 8 cm were individually weighed, and samples of the <0.1 cm fraction have been brought back to the UK for further sieving. With the BSG grant, I was able to fund a field assistant to help with subsurface sampling. These results will be compared to those obtained from similar work in October 2014 from the Ganga and Yamuna rivers in the west Ganga Plain.

Figure 1 Subsurface grain size measuring. Step 1 – dig a huge hole!

With the additional time in the field, I have been able to collect a total of thirty cosmogenic ^{10}Be sand samples, largely from dated river terrace sediments in the Ganga valley and modern river sands. From these samples, I hope to be able to characterise the natural variability in ^{10}Be concentrations over the past 10 ka, and provide a greater degree of confidence in any sediment flux estimates made from modern river sand exported to the Ganga Plain. Further funding has recently been acquired from NERC to analyse these samples at the SUERC Cosmogenic Isotope Analysis Facility.