Report of the 2013 BE expedition to observe climate change in the Himalayas

Introduction – scientific leader, John Griffiths (Meteogroup)

In the summer of 2013 British Exploring (BE) organised and ran a 6 week expedition to Ladakh, in the Indian Himalayas .While it is sparsely populated and fairly remote Ladakh can be reached relatively easily be air from New Delhi and as such was chosen as a potential site for a series of annual expeditions with British Exploring. BE's goal is to help educate and promote leadership qualities in young people through exploration and conducting a variety of scientific research.

Meteorologically it is an important area with the monsoon rains fuelling the great rivers of the subcontinent, such as the Indus and Ganges. In recent years the region has been subjected to increasing rainfall rates with an extreme flooding event in 2010, which took the lives of many Indian citizens. Further the hydrology of the region is seen to be changing with increasing melt water from the declining glaciers (Thayyen and Gergan, 2010). Part of the expedition would monitor and record short-term data of meteorological variables such as maximum temperature and wind speeds. Another part would measure the mass change of the glaciers. To provide long term data, as part of a longitudinal study, a weather station would be erected and left to record data over the next 3 years, the data helping to supplement the fairly sparse information on the weather in the region and its increasing impact on extreme weather events.

I would like to record my thanks to Steven Colwell (British Antarctic Survey), British Exploring, John Moores Liverpool University, Campbell Scientific and the Royal Meteorological Society for their part in donating, lending and supplying both advice and the equipment for the expedition.

I am also grateful to two young members of my meteorological team who volunteered to contribute to this article. James Roberts describes the difficulties of setting up and commission a met station at 5400m, in what was a fairly inhospitable region. The second part is written by

Matt Route, who presents some of the data he recorded and its possible use.

The expedition was a great success, a proving ground for our young explorers and scientists of the future.

Reference: Thayyen R. J., and Gergan J.T. (2010) Role of glaciers in watershed hydrology: a preliminary study of a "Himalayan catchment", *The Cryosphere*, 4, pp 115–128, available at www.the-cryosphere.net/4/115/2010/, accessed 12th Sept 2013

The razing of a met station – by James Roberts

Our team of 12 was given the task of setting up the met station. We decided to place the station as high and as close to a glacier as possible so it would give us readings of climatic conditions over a number of years and which could be related to any glacial movements, recorded by another team. It was planned as a six-day expedition away from base camp.

We set out laden with tents, provisions and carrying the weather instruments, and the box to house them, on a stretcher. After successfully crossing a fast flowing, icy river that ran through our valley we climbed up out of the valley. The next task was to ascend a nearby mountain where we could leave the met station. This was particularly difficult to do at an altitude of 5000m with our heavy packs and the stretcher. However, a good team spirit and regular changing of stretcher bearers saw us arrive at our first camp around midday. Having set up camp and with the bulk of our weight gone, we pushed on with the met station to a place that would become our Camp 2 site.

Having spent the night at camp 1 we returned with our equipment back up the short but very steep slope to Camp 2 and the met box at around 5200m. Unfortunately one of our team had become ill the day before and remained at Camp 1. Although he made an effort to climb to Camp 2 with one of the medics it was quickly realised that he was suffering with altitude sickness and he was taken down to a nearby hospital, where HAPE was confirmed (HAPE is where fluid builds up in the lungs and it can kill easily if one doesn't descend quickly).

Leaving the bulk of our kit at Camp 2 we continued to ascend to the proposed site for our met station at 5450m. The station was set up near a glacier at the end of the valley. Unfortunately we had technical difficulties and the data logger failed to take readings. We returned to Base Camp rather down-hearted but with the hope that another opportunity might arise to fix the station later on during the five-week expedition.

A week later we returned with a team of six people to fix the electrical fault. Climbing just under 700m in four hours, we reached the Met station, corrected the fault. The met station is set to record every three hours over the next year. This was a true achievement for the whole team and I hope that we obtain some insightful data to add to current research in better understanding climate change. Ultimately I hope that this will help improve conditions for the people of the area.

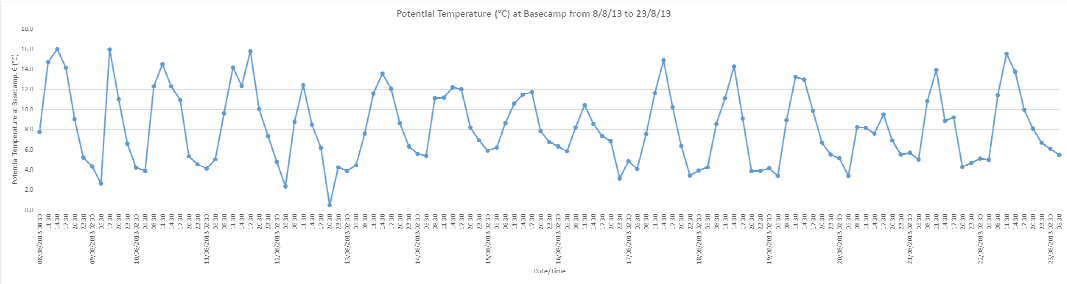
Determining the meteorological variables - Matt

During the expedition, Kestrel 4000 portable weather stations were used to collect meteorological data including Temperature, Wet Bulb Temperature, Humidity, Barometric Pressure, Wind Speed and Wind Direction. In a two week extensive window between the 8th August and 22nd August readings were taken consistently at 3 hour intervals. During the night, values were automatically stored on a Kestrel attached to a portable weather vane at a fixed location 4875m above sea level (asl). In the daytime, measurements were taken manually at different locations in the valley, under shade in order to avoid errors caused by direct solar radiation. The maximum temperature recorded on the expedition was 31.0°C on the 27th July at 3200m asl in a small settlement called Choglamsar about 10 miles East of Leh, the capital city of Ladakh. The minimum temperature was 0.2°C on the 12th August, however, it is believed that it may have fallen significantly lower than this at some of the altitudes that we stayed at overnight but unfortunately we were unable to measure these values. On the 5th August at 17:45 local time a gust of wind reached 18.9ms^{-1} (42.3mph) caused by the valley

channelling fast winds directly down the valley and bringing with it an intense rain storm.

Photo 1: Intense rainstorm in out valley

We would typically expect rainfall totals in August to be around 18mm (Thsangspa & Raina, 2011), however, we believe we typically received 2-3mm of precipitation almost every day, meaning that we would have received considerably above average rainfall for the month. After the expedition the temperatures were converted to a potential temperature for our base camp at 4875m asl where the average pressure was 567hPa using the equation below, and the results can be seen in graph 1 below. Potential temperature assumes that the measured air parcel cools adiabatically until it reaches a specific pressure.



Graph 1: Potential Temperature (^{o}C) at Base Camp

Potential Temperature Equation:

$$\theta_b = T\left(\frac{P_0}{P}\right)^{R^*/c_p}$$

Where:
θ_b is potential temperature at basecamp
P_0 is pressure at basecamp (567hPa)
P is measured pressure
T is measured temperature
R* is the meteorological gas constant for air (287 $Jkg^{-1}K^{-1}$)
C_p is the specific heat capacity of air at constant pressure (1004 $Jkg^{-1}K^{-1}$)

Reference: Thsangspa T. I. and Raina A. K. (2011) *Ladakh Simplified: An Unofficial Handbook of Buddhist Ladakh,* LAY Publications, Leh, p 74. E-book available at www.Pothi.com.