ANNEX I

2nd report on SEED project (Identification of landslide phenomena and landslides prone areas into the CKNP and in its buffer zone)

Dr. Chiara Calligaris, Prof. Giorgio Poretti, Dr. Shahina Tariq and Mr. Hawas Khan

Introduction

The aim of the project, part of the SEED one, is to define the landslide prone areas inside the borders of the Central Karakorum National Park (CKNP). Landslides are phenomena that could involve also wide areas depending from their typologies and the geological and geotechnical conditions. Gravity is one of the main triggering factors worldwide recognized characterizing a wild territory as the on of CKNP. These phenomena mainly have their onsets on the top of the young mountains where rock falls are the most common known type of landslide. Rack falls phenomena have their evolution into detritical fans clearly visible on steep bare slopes. Their evolution in shape is easy to predict following the geomorphology of the studied areas. Usually, at the toe of the screes, where the slopes have lower values, is possible to identify villages and/or cultivated fields. These settlements are usually located in dangerous areas and, for this reason, even if their location is outside from the CKNP borders, they need to be studied and protected creating surveys protocols identifying methodological approaches. The elevation of the mountains is high and landslides having their triggering zones into the CKNP could end their traveling paths in the CKNP buffer zones with a vertical evolution. For this reason, during the filed survey it has been decided to survey also areas located outside from the borders of CKNP but connected with it through onsets areas.

The Haramosh valleys

During the survey, the researchers had the possibility to investigated mainly two different places: Khaltaro area and Mani glacier valley.

The area in which Khaltaro village is located is North-South oriented and the geostatic problems are related to the north-south faults (Reilkoat fault) and to the conjugated ones that make the rock very weak from a geotechnical point of view. The road to reach Khaltaro is in bad conditions, landslides are daily occurring, many of them, where the rock is bared, are rock falls and debris flows, instead where the soil is present, rotational landslides are the dominant phenomenon.

Figure 1: Road to Khaltaro and Dasso villages builted on alluvional terrace. The instability is very high as the danger while running this road.

Figure 2: Detritical fan upstream a small village located before the intersection to Muruk.

Figure 3: Debris flow on the way to Khaltaro. Its return time is several times a year, depending on the rainfall. Red arrow is indicating the movement direction.

Figure 4: "Fresh" landslide on the way to Khaltaro. Repeated rock falls created a wide heterogeneous fan. The grain size of the boulders and clasts is clearly visible. Also in this position, as for the described debris flow, the return time is several times a year. Red arrow indicate the movement direction and the slope angle (about 45°).

Figure 5: Khaltaro landslide, the main scarp is clearly visible; its high is approximately 4m.

Khaltaro landslide is a sliding movement of detritical material over a rocky surface. The length of the crown is approximately 200m, the high of the main scarp is about 4 m (Figure 5 and 6), all around the crown there are tension cracks 1,5m wide (Figure 7). Walking on the main body, is possible to identify several longitudinal tension cracks with a gap of 10 to 15cm. This landslide is particular because, at the toe of the slope, on the right side of the river, there is the village with houses and fields. The phenomenon is directly insisting on the settlement. Witnesses told that the movement begun one year ago. Now the Pakistani government located some tents in a safer place (Figure 8), close to the village in order to avoid the worst.

Figure 6: A monitoring moment: measuring the main scarp with a rope. The debris material is sliding over a sloping strata angle as the slope.

Figure 7: Tension crack on the right side of the landslide with a gap of 15cm.

Figure 8: Researchers on the main body of the landslide. On the background is possible to see the blue tents belonging to the Civil Defence.

Mani glaciar valley is an East-West oriented valley. To reach it is necessary to pass trough Dasso village and to Barche. Going after Barche, to the Way to Gure, is possible to come across a debris flow phenomenon that invested the main road and all the cultivated fields present in the valley (Figure 9).

Figure 9: Debris flow deposits that covered all the cultivated fields. The photo is realized from the upper point of the fan.

Figure 10: Upper side of the alluvial debris flow fan.

Going on from Gure to the internal side of the glacial valley, an alpine valley is present on the way to Baskari glacier. Here landslide phenomena are rare due to the intense vegetation present in the area. Himalayan fir are all over and grass and bushes cover the slopes (Figure 11). On the Mani Glaciar valley instead, a u shape valley is present and the glacier eroded the banks giving rise to several landslides (Figure 12).

Figure 11: Baskai Glacier valley: landscape view.

Figure 12: Mani Glacier valley: U shape is evidenced. Several "small" landslides (rock falls and rotational) are occurring along the bank sides of the valley. The activity is highlighted by the trees disposition along the banks.

The Bagrot valley

Bagrot valley is a North –South oriented valley in the buffer zone area of the CKNP. From the road located in hydrographic left of the Gilgit river, a jeepable road is going into the valley. This road along all its way until the meeting point with the glacier, is scattered by landslides. Along both sides of the Bagrot valley the slopes are interested by active detritical fans (Figure 14). In several points the road is interested by active landslides that block the road when a paroxysmal event occur. On the way are still visible the traces of an ancient slipped volume that blocked completely the Bagrol Gah river (Figure 13) creating a lake. From the road is possible to see the presence of old lacustrine deposits located over the alluvial terrace.

Figure 13: panoramic view of the Bagrot valley from S to N.

Figure 14: Detritical fans along the road into Bagrot valley.

Proceeding from South to North, on the road there is an active landslide (Figure 15) that causes big problems to the passage of vehicles. The phenomenon started with a rock falls and created a fan of heterogeneous material. Half part of the slopes along the whole valley is interested by detritical fan due to rock falls that decrease the slope inclination of the entire valley.

Figure 15: An active landslide on the road to Bagrot valley.

Before arriving in Datuchi village, on the hydrographic side of the valley, there is the presence of a big debris flow deposit. This debris flow is made by really small size material in which there is the presence of gold particles. The Chinese people offered the Pakistani to work on the deposit and to give to the Pakistani the 40% of the founded gold. Pakistani refused the offer.

Figure 16: Golden debris flow.

On the slopes over Datuchi village, a long belt of detritical fans is present. These fans are active where there is no vegetation, instead where the water is present and grass, shrubbery, bushes and trees are on site, the slopes can be considered stable (Figure 17).

Figure 17: Scree slopes over Datuchi school.

At the end of Bagrot Valley, Hinarche glacier is present at the toe of Diran peak. The valley has a typical U shape given by the glacial erosion (visible also on the image). The slopes of the valley are gentle with a belt of detritical fans at the bottom of the slopes. Frontal and side moraines are present in the valley (Figure 18). Vegetation is quite rare at the elevation of the frontal part of the glacier.

A curiosity: glacier ice is cut by the residents into pieces of about 40kg, carried downhill by the donkeys and sold to be used in Gilgit into the refrigerators.

Figure 18: Hinarche glacier, landscape view.

The Hopar valley

To reach the Hopar Glacier valley it is necessary to pass through the village of Nagar. Access to Nagar is difficult: an old road has been overwhelmed by a landslide forcing the inhabitants to build a new road on the left side of the valley. Several landslides are present (Figure 19, 20).

Figure 19: Detritical fans along the road to Nagar.

Figure 20: Old road to Nagar interrupted in several points by landslides. Red arrow indicates one of the interrupted points.

Upper Nagar village is protected from the Hunza river by a ridge of about 4400m. This situation allowed the inhabitants to build a nice and quiet village. At the end of the village, on the way to Hopar, a landslide is overhanging the cultivated fields and the houses. This landslide is in moraine material and is due to the steep slopes (Figure 21). To stabilize it, it will be necessary to reconstruct the entire slope with terraces as they are doing in Italy in the San Remo area. This will allow the cultivation of more fields and to have a better hydrogeological control of the area. Drainage will be recommended.

Figure 21: Upper Nagar landslide inside the red circle.

Figure 22: A landscape view of the Hopar valley; both sides of the valley are scattered with landslides. Detritical fans, due to rock falls are present everywhere and characterize the whole valley. The erosion is progressive and creates a lot of instability also along the sides of the moraines.

Figure 23: Erosion along moraines and alluvial terraces. The erosional process creates widespread instability. Landslides occur due to foot river erosion and from the intense runoff during monsoon rainstorms.

Figure 24: Landslide events.

Figure 25: on the way to Holshal, a landslide with a yearly return time.

Figure 26: Hopar Glacier o Bualtar Glacier, the valley is wide and the bank sides of it are dotted by landslides an detritical fans for a width of about 350m from the glacier upper surface level. Along the slopes also during the survey, rock falls occurred. Daily glacial erosion is creating an increasing instability in the rocky sides.

Figure 27: North view of the glacier, frontal moraine deposits are present everywhere. The glacier, during its eroding movement is creating instabilities on the sides of the valley.

Figure 28: Panoramic view of the left side of the Hopar Glacier, at the bottom of the slope several detritical fans, indicating the evolving erosional processes are present at the bottom of the steep slopes.

Figure 29: View of the lower part of the Hoper Glacier. In the background the eroded slopes can be seen.

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Figure 30: Barpu Glacier in the background; the moraine deposits are featured some of which are partially vegetated. As for the Hoper Glacier, the bottom part of the slope is completely eroded and the gravitational phenomena are one of the main protagonists of the landscape.

Figure 31: Frontal moraine of the Barpu Glacier.