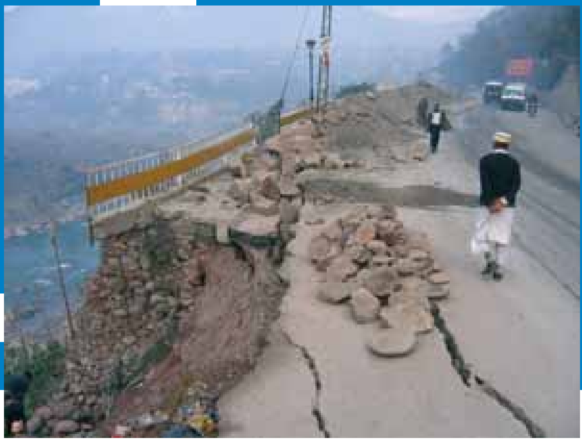
Disaster Risk, Livelihoods and Natural Barriers, Strengthening Decision-Making Tools for Disaster Risk Reduction.

A Case Study from Northern Pakistan



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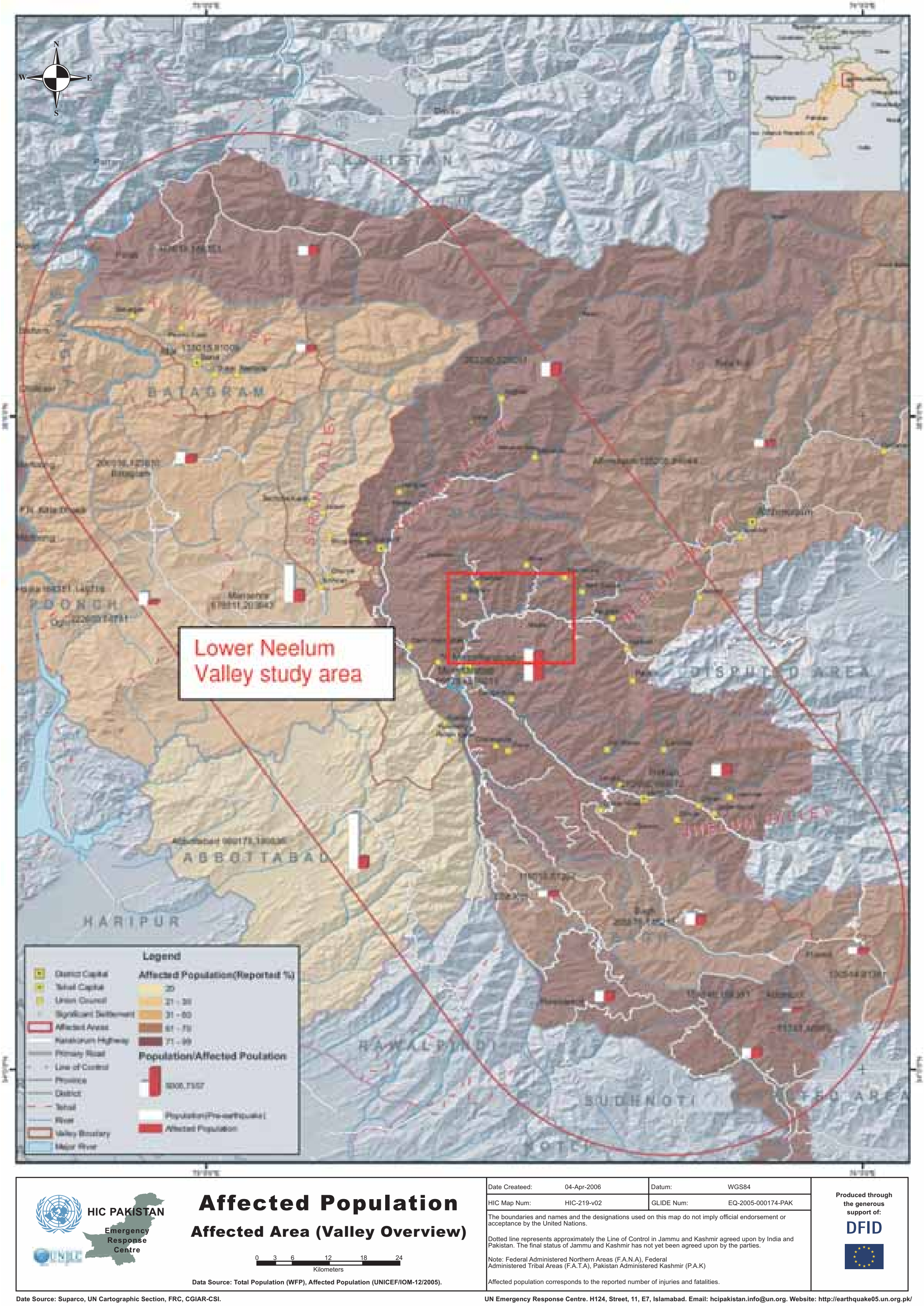
Acronyms

AJK	Azad Jammu and Kashmir, Pakistan
ERRA	Earthquake Rehabilitation and Reconstruction Authority, Pakistan
GIAN	Geneva International Academic Network
GIS	Geographic Information Systems
GSP	Geological Survey of Pakistan
IADB	Inter American Development Bank
ICIMOD	International Center for Integrated Mountain Development
IFAD	International Fund for Agricultural Development
IFRC	International Federation of Red Cross/Red Crescent Societies
IGAR	Institute of Geomatics and Analysis of Risk (University of Lausanne)
ISDR	International Strategy for Disaster Reduction (U.N)
IUCN	International Union for Conservation of Nature
IUED	Institut Universitaire d'Etudes de Développement, (Institute for Development Studies), Geneva
NWFP	North West Frontier Province
NDMA	National Disaster Management Authority
SDPI	Sustainable Development Policy Institute, Pakistan
UNDP	United Nations Development Programme
UNEP/GRID/ EUROPE-DEWA	United Nations Environment Programme/ GRID/EUROPE-Division of Early Warning and Assessment
WFP	World Food Programme (U.N.)



Map 1: Area of Study

1. Executive Summary

The October 8, 2005 earthquake in Northern Pakistan measured 7.6 on the Richter scale, causing an estimated 73,000 deaths and thousands without adequate shelter and food to survive the harsh winter (ERRA 2006). The epicenter was in Neelum Valley, just north of Muzaffarabad, the capital of Azad Jammu and Kashmir (AJK) where an estimated 90% of all buildings were either damaged or completely destroyed. A number of landslides, possibly 1,000 were triggered by the earthquake and affected a large number of communities in the surrounding steep valleys. Landslides remain the greatest threat to communities, especially during heavy rainfall and July/August monsoon rains (GSP 2007a). Major risks to human life include the possibility of large-scale rock slides in Kaghan, Neelum and Jhelum valleys and the persistent pattern of shallow and deep landslides in each subsequent monsoon season (Bulmer et al. 2007)

The interdisciplinary research project, Disaster Risk, Livelihoods and Natural Barriers, Strengthening Decision-Making Tools for Disaster Risk Reduction, a Case Study from Northern Pakistan, funded by the Geneva International Academic Network (GIAN) small grant programme, attempts to profile the disaster that took place in Neelum Valley, AJK. Its goal is to strengthen decision-making tools by identifying the main land use factors and land use strategies that affect the vulnerability of communities in Neelum Valley. The small grant was awarded to a consortium of partners lead by the World Conservation Union (IUCN) Ecosystem Management Programme, the Graduate Institute for Development Studies, Geneva, IUCN-Pakistan, UNEP-GRID/EUROPE, Division of Early Warning and Assessment and the University of Lausanne/ Faculty of Geosciences, Institute for Geomatics and Risk Analysis.

Cracks above Muzaffarabad: Abdur Rauf Qureshi, IUCN-Pakistan, 2007

For this purpose two missions arrived in Pakistan. One in November 2006, which was essentially a scoping mission to meet with stakeholders, and to assess existing information on landslides, geology, and land use strategies, and one in March/April, 2007. This was a survey of community land use strategies which was conducted in two villages in Neelum

Valley, near Muzaffarabad, using focus groups and semi-structured interviews. Field work to collect data on landslides and land use in the study area was initiated and completed in July 2007.

The selected study area was a steep V-shaped valley, that was highly prone to landslides and was located in the lower Neelum Valley, adjacent to Muzaffarabad. Access to the valley was blocked for 47 days following the earthquake and the road is still prone to landslides. The valley was chosen for its distinctly deforested right bank, which is mainly privately or collectively owned, compared to the more densely forested left bank, that is under greater state protection. The methodology for profiling the landslides was based on remote sensing of high-resolution satellite images (courtesy of UNIL-IGAR) and on-ground data collection of the value of damage to forested, agricultural lands and infrastructure, casualties, ownership and land use. Much of the data was recorded as GIS files and was included in the GIS database that has been made available to local decision-makers.

The data collected on 100 landslides, 17 crack zones and 3 flood areas shows that the grazing, deforestation and road construction were "preparatory factors" (Crozier 1986) for the massive landslides triggered by the earthquake. Twenty-four landslides that occurred after the earthquake were triggered by rainfall. As expected, the left bank of the valley, with a predominant forest cover had fewer landslides, even though the slope average is greater and the epicenter of the earthquake is estimated to have been located here. Overall, an estimated 56% of all landslides were due to land degradation, caused mainly by deforestation and grazing. Poor road construction, terracing and gravel extraction are some of the other major preparatory factors, responsible for landslides.

The economic damage from the earthquake was considerable. For the study area, the damage to habitations, roads, agricultural and forested land, is estimated at 1.4 million Swiss francs (72 million rupees. This amount does not include the cost of damages to the power supply, which is estimated at 4.8 million Swiss francs (238 million rupees), of which half was probably due to landslides. The socio-economic survey concludes that the likelihood of landslides and earthquakes in the future is high for the two surveyed villages. Most respondents are aware of the danger posed by the cracks and many households are trying to avoid risk by reconstructing their houses in safer places in their village. With a few exceptions, most communities were not clear about the link between deforestation and landslides and requested assistance and information on how to mitigate them.

Improved tools for decision-making include access to high-resolution satellite images; a GIS-based tool which includes slope gradient, vegetative cover, active landslides, crack zones; a landslide susceptibility map; a simple methodology for gathering geological data on landslides, land use data: grazing, terraces, deforestation, roads, habitations, etc; and a damage assessment with economic data on lost forest and agricultural land. This interdisciplinary approach to assessing landslides offers policy makers a more holistic picture of their underlying causes and an improved foundation for designing a sustainable disaster risk reduction strategy.

Recommendations include the need to work with communities to establish locally-adapted monitoring, mitigation and early warning systems. It is also recommended that free or low-cost satellite images and GIS software be made readily available by donors and international organizations to developing countries. GIS-based tools are essential for a spatial understanding of hazards. It was also felt that data collection on landslides should go beyond geology and include information such as land use, ownership, vegetative cover and economic damage to provide a larger perspective of the underlying causes of landslides in order to design effective disaster risk reduction actions. The role of protective forests, which is firmly established in parts of Europe, should be examined as cost effective natural barriers to disaster risk reduction in mountainous areas. The final product of the study is a CD-Rom that contains study findings, recommendations and maps.

2. Rationale for GIAN-Pakistan Study

2.1: A multi-disciplinary approach to understanding landslides

The frequency of hazardous events is affecting greater numbers of vulnerable populations, especially in coastal and mountainous areas (ISDR 2004). Natural hazards by themselves do not create disasters. Disasters are caused by a lack of preparedness, market inequities, poor governance, population pressure, lack of access to land and degraded natural resources. Risk mitigation means addressing the root cause of disasters, namely vulnerability and poverty. With the advent of the International Decade for Disaster Reduction in the 1990s, the idea that poverty underlies natural disasters has been strongly voiced by international actors such as the International Strategy for Disaster Reduction, the World Bank, UNDP and UNEP.

Another facet, which is beginning to receive greater attention in the literature on natural disasters is the environmental dimension, i.e. the protective role played by ecosystems in abating the full impact of natural hazards (ISDR 2007, Sudmeier-Rieux et al. 2006, Abramovitz et al. 2002). The Millennium Ecosystem Assessment, an international study of the world's ecosystems has brought attention to ecosystem services and their value in supporting human livelihoods. Organizations such as IUCN and UNEP are emphasizing the protective role played by ecosystems for disaster risk reduction, such as coastal mangroves, sand dunes, coral reefs, riverine estuaries, inland wetlands, and forests on steep slopes.

Goats grazing in Neelum Valley: Karen Sudmeier-Rieu, UNIL 2007

In the aftermath of the Kashmir earthquake, the devastation caused by the massive and pervasive landslides can be attributed to population pressures that have lead to deforestation and poor roads built on fragile slopes (a consequence of poor governance and development). Any effective strategy for mitigating the complex cause and effect between eco- and social systems must be multi-disciplinary by nature. Disasters create the need for immediate, short-term reaction but effective disaster management requires long-term, systematic solutions.

While there are multiple calls for interdisciplinary, applied research on disaster risk management both in the natural and social sciences literature, few interdisciplinary studies been published to date (Alcantara-Ayala 2004, ISDR 2007, Zingari and Fiebiger 2002)

“Scenarios associated with the occurrence of disasters are complex systems that need to be assessed from interdisciplinary and trans-disciplinary points of view. Such approaches need to address, in a parallel and integrated manner, the interactions between hazards and the types of vulnerability in each threatened community” (Alcantara-Ayala 2004).

2.2: Landslides and underlying causes rooted in development

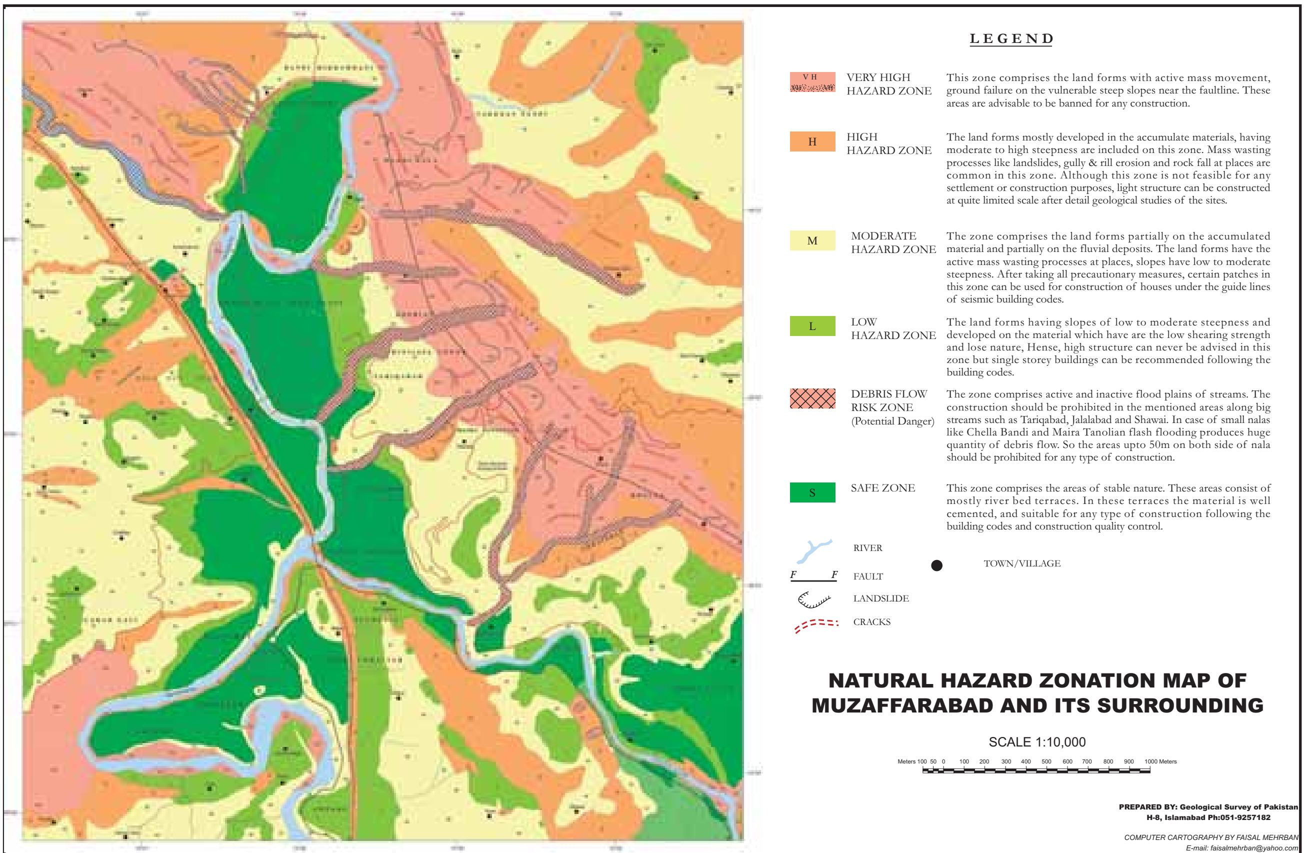
Landslides can be considered a symptom of fragility, either natural or human-induced. A small seismic shock to a sensitive system can cause a landslide, whereas a system with higher buffering capacity may sustain little reaction to seismic shock (Hufschmidt et al. 2005). In the case of Kashmir, a highly sensitive system received a great shock, resulting in massive landslide damage. Over time, a steady state will be reached once all active landslides have self-annihilated - through a reduction of slope angle or by exhausting all susceptible material (Hufschmidt et al. 2005). In the meantime, areas with cracks and active landslides can continue to pose significant risk to communities.

There are multiple causes of landslide susceptibility, such as weak geological structures (limestone, silt and clays), morphological, tectonic uplift, physical (intense rainfall, earthquake), and anthropogenic (excavation of slope toe for roads, loading of slope due to irrigation, deforestation, irrigation) (Cruden and Varnes 1996). Anthropogenic factors are considered “preparatory factors”, whereas rainfall or earthquakes are “triggering factors” (Crozier 1986). Rainfall can actually be considered both: it contributes to slope instability and it triggers landslides.

Deep root systems are believed to play a major role in holding soil in place on steep slopes, underlining the importance of maintaining vegetative cover. After a damaging event such as an earthquake, a lag period of 3-6 years, corresponding to loss of root strength can be expected after which more landslides may occur on forested slopes with damaged roots (Kimmins 1987). Vegetative solutions may not suffice for certain deep-seated landslides, which may require considerable engineering solutions. Such costly techniques may not be readily available to a developing country; however more shallow landslides may be stabilized with locally available materials. Digging drainage trenches to avoid water seeping into cracks may help prevent mass movement, however the existence of groundwater makes crack zones extremely dangerous, even in the absence of rainfall (GSP personal communication 2007).

A study of the impact of clear cutting, road construction and landslides in the western Cascade Range in Oregon with unstable volcanic-clastic rock showed an increase in slide erosion by 2.8 times due to clear cutting, compared to pre-logging levels (Kimmins 1987). Along roadsides, the increase was 30 times. Both combined increased slide activity by five times over a 20-year period (Kimmins 1987). Even under conditions of high rainfall, steep forested slopes are generally stable (Alexander 2005). This stability is assured if forest cover is continuously maintained, but indiscriminate removal of forest followed by high rainfall, can lead to disastrous results (Pryor 1982, Saldivar-Sali and Einstein 2007, Phillips and Marden 2005). Deforestation, if not replaced by other sustainable land use, can contribute to increased frequency and severity of floods and landslides (Zingari and Feibiger 2002, Alexander 2005, Phillips and Marden 2005).

Protection forests are commonly used in mountainous areas of Europe to protect exposed villages from rockfall, avalanches, landslides and abate flooding. These forests are managed for their protective value, are off-limits for development and in Switzerland, the federal and local governments spend considerable resources to maintain them. Nevertheless, protection forests offer a comparable protection to engineered solutions to reduce risk from mountain hazards at a much lower cost (Dorren et al. 2007). Certainly, for developing countries, the restrictions imposed by a protection forest pose a different set of questions and policy choices of risk reduction and economic development. However, considering the high cost of landslides and flooding, investing in protection forests may be the most cost effective solution to reducing mountain hazards.



Map 2: Hazard map of Muzaffarabad, GSP 2007

For the earthquake-affected area, a number of deep-seated landslides will continue to pose severe threat to roads and adjacent villages (GSP 2007a, Bulmer et al. 2007). The Geological Survey of Pakistan has made a first classification of the most dangerous spots around Muzaffarabad and a survey of landslides in Neelum Valley is being published. Other information for policy makers are slope maps and, landslide susceptibility maps, which should include slope gradient and geology (Petley et al. 2005). However, for this study other variables such as vegetative cover, rivers, roads and proximity to epicenter have been included. Landslide susceptibility maps provide an excellent tool for understanding the relationship between these variables, but they are not detailed enough for planning. For effective risk mitigation, a hazard map, if possible at the 1:10,000 should be developed (see above hazard map of Muzaffarabad) to highlight high-to-low risk areas. Although such maps are currently being developed by Pakistani authorities, the Geological Survey of Pakistan, they require significant resources in manpower and time. Therefore we feel that the development of hazard maps falls outside the scope of this study.

The policy response to hazard maps will be limited if planners and policy makers in mountainous areas are not made aware of the anthropogenic causes of landslides - the most common being road construction, and deforestation - factors closely related to economic development and vulnerability.

The following sections will provide the geographical, geological and demographic setting of the study area before detailing the study itself.

3. Background

3.1: Geographical and geological situation of study area

Azad (free) Jammu and Kashmir, has an estimated population of 3.5 million, and is considered a separate state, indirectly controlled by Pakistan. The area is densely populated, with 264 persons per square km, and an average family size of 7.2 members (AJK Planning and Development Department 2005). Approximately 88% of the population is rural and depends on the forests for their fuel wood, timber, grazing and water requirements. The area is situated in the pre-Himalayan hills and livelihoods have been carved out of steep hillsides where agriculture is possible on the lower hillsides (up to 3,000 m). Approximately 42% of the area is forested, 13% is under cultivation and 42% is considered uncultivable used mainly for grazing. The remaining is urbanized (AJK Forest Department 2001). Presently, most of the lowland forests of AJK and Pakistan are badly degraded or have been destroyed, due to the slow upward creep of deforestation for domestic use, grazing, or commercial logging. Approximately 5% of Pakistan is forested (Ahmed and Mahmood 1998).

The majority of the population of AJK is dependent on some type of cultivation as its main subsistence, or to supplement their income. The main crops are maize and wheat (on slope terraces) and rice (on lower slope terraces), together with a variety of vegetables and fruits. The most common farm animals are chicken, buffalo, sheep and goats, which can be seen grazing on very steep hillsides. A large proportion of the population depends on remittances from family members working in nearby towns, or abroad. At 66% for both males and females, AJK's the literacy rate is relatively high, compared to 60% for Pakistan (AJK Planning and Development Department 2005).

The average rainfall in the Muzaffarabad region is 1367 mm (average 1995-2000), with 30-60% in the form of snowfall between December and February. During July and August, there are monsoon rains and "cloud bursts" which can bring as much as 100mm of rain during a single event, causing significant damage as flash floods or landslides. With changing climate conditions, more intense rainfall patterns can be expected throughout the year. During 1995-2000, temperatures ranged from 30-40° C during summer months and 0-10° C between December and January (AJK Planning and Development Department 2005).

AJK has its own elected parliament, budget and government agencies, but shares common foreign policy, currency and army with Pakistan. Its main sources of exports, primarily to Pakistan, are timber and royalties from power generated by the Mangla dam. The dam and the headwaters of Neelum, Jhelum and Poonch rivers are strategically vital as they irrigate lower Pakistan's agricultural economy. Sedimentation, due to high soil erosion has already necessitated a multi million dollar up-raising of the dam. Post earthquake landslides are expected to accelerate sedimentation.

Geologically, the area is situated along the arc collision zones between the Main Karakorum Thrust (MKT) and the Main Mantle Thrust (MMT) (GSP 2007a) in the pre-Himalayan zone. The earthquake was caused by the rupture of the northwest-southwest Muzaffarabad thrust fault (Bulmer et al. 2007). It can be considered the result of the interaction between three tectonic elements viz. (a) the Himalayas (b) the Indo-Pakistani Shield and (c) the Salt Range, each of which is moving independently. The thrust zone has a NNW orientation and is largely covered by Murree Formation, which is a mix of sandstone, siltstone and shalestone, followed by the Abbottabad Formation, of dolomitic limestone (GSP 2007a, Schneider 2006). The Murree formation is characterized by impermeability and is susceptible to landslides due to rainfall (GSP 2007b).

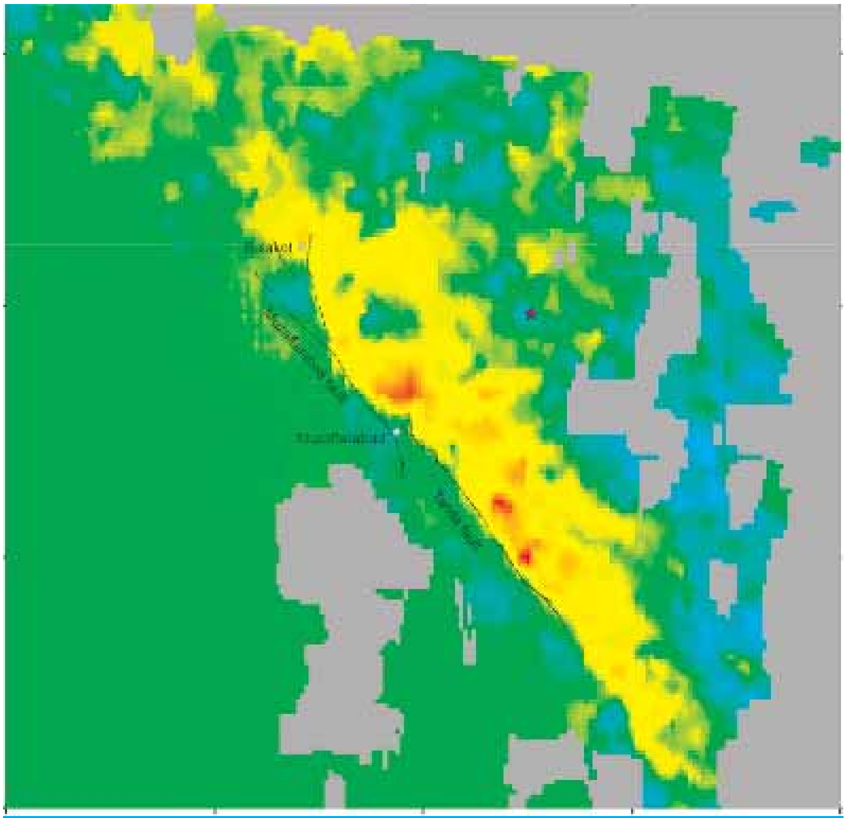
3.2: Observations of the situation in earthquake-affected AJK as of September 2007

The main towns affected by the earthquake were Muzaffarabad, AJK and Balakot, (NWFP) where an estimated 90% of all buildings were either damaged or destroyed. A number of landslides, possibly 1,000 were triggered by the earthquake and affected a large number of communities in the surrounding steep mountain valleys. Major risks to human life include the possibility of large-scale rock slides in Kaghan, Neelum and Jhelum valleys and the persistent pattern of shallow and deep landslides in each subsequent monsoon season (Bulmer et al. 2007, Petley et al 2006). Root shaking is believed to have caused considerable damage to roots on slopes with remaining stands and will likely be the cause of future landslides (IUCN-AJK personal communication 2007).

The largest mass movement triggered by the earthquake was the Hattian landslide, with a volume of approximately 80 million m^2 and covering an area of nearly 5 km^2. According to eye witnesses, it ran down 1,000m vertically and 2.75 km laterally on the other side of the valley within half a minute (Schneider 2006). The landslide created two dams, one reaching 250-350m, and a lake, posing a great risk of out bursting.

As a result of the 2005 earthquake, uplifting forces up to 5 m occurred on a narrow belt of dolomitic limestone (Abbottabad formation, lower Cambrian era), along the northwest-southwest Muzaffarabad Thrust Fault.

Landslides continue to pose a threat to communities especially during the July/August monsoon rains (GSP 2007a). Unusually heavy rains in March 2007 triggered a number of slides on slopes with active landslides and cracks. Roads are particularly dangerous, as they often pass between steep cliffs and the river while undercutting fragile slopes. In one event, a bus was swept off a road south of Muzaffarabad due to a landslide, killing all 45 passengers. Some refugee camps remain on the outskirts of Muzaffarabad and a number of people continue to live in extremely basic shelters. The availability of drinking water is still a problem for many households which spend more time fetching water. A number of ERRA (Earthquake Reconstruction and Rehabilitation Authority)-type houses have now been built with earthquake-resistant standards. These houses, with 1 m high cement walls and light upper materials, mainly tin, are however poorly



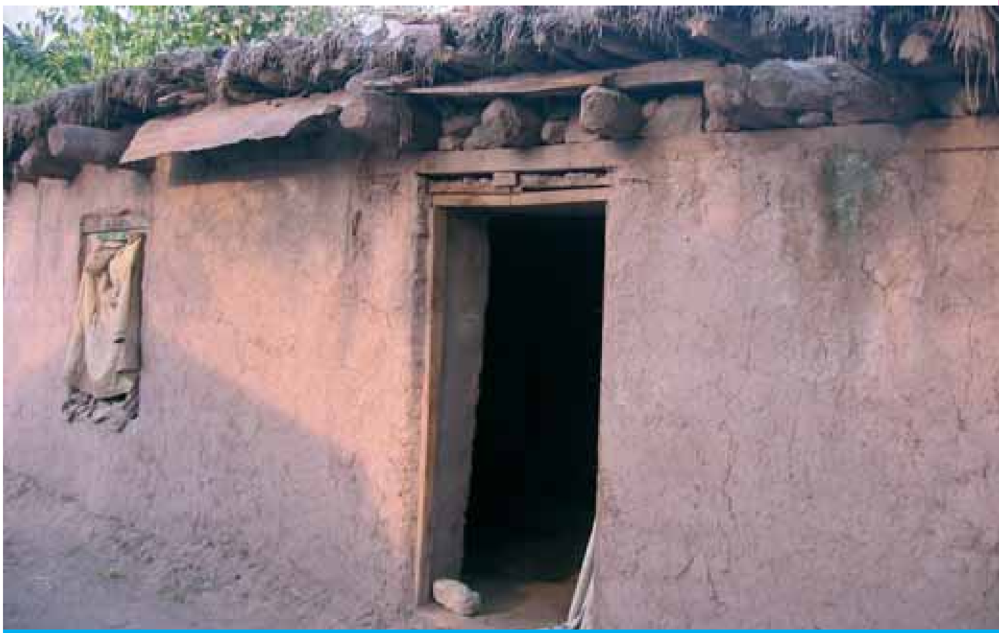
Map 3: SAR Line-of-sight displacement (color) and active fault (black line) from aerial photo interpretation by Nakata and Kumahara (2005) From Tobita et al. Geological Survey Institute, Japan (Red zones = 5 m uplift)

insulated for cold winter and hot summer conditions, compared with the traditional houses built of timber stocks, mud and rocks. Waste management and rubble disposal is improving, but they remain major environmental problems.

Displaced people are returning to villages in great numbers to rebuild their homes (WFP personal communication 2007) and men who would otherwise migrate to cities for work, prefer to stay in the villages to protect their families (as of April 2007). Destroyed fields and irrigation systems have reduced the number of cultivated fields. Many are complaining about the lack of available labour for house reconstruction, unclear construction norms and a sense of dependency created by continued relief operations.

Most local government agencies were heavily affected by the earthquake, not just in terms of lost offices and equipment, but also lost personnel. At the AJK University over 400 students and four teachers lost their lives, and the facilities were completely destroyed. With donations from the Turkish government the campus was rebuilt, but many government offices continue to function at lower capacity. Computer facilities, communications and inter-agency coordination remain very basic. To facilitate humanitarian operations restrictions on foreign movement in AJK were eased post-earthquake, but with the dwindling number of foreign NGOs, restrictions are being tightened again.

With assistance from the UNDP, the Pakistani government has created a



Traditional "katcha" house Karen Sudmeier-Rieux, UNIL, 2006

National Disaster Management Authority and a framework for disaster risk management (NDMA 2007). It is too early to say how effective the agency will be. Considerable work needs to be done to carry the agency from its existence on paper to on-the-ground actions. The Earthquake Reconstruction and Rehabilitation Authority (ERRA), the main government agency created to channel foreign aid for earthquake relief and recovery operations is establishing its strategy for capacity-building for disaster risk reduction. It has developed an elaborate environmental strategy which prescribes reforestation of degraded areas, the establishment of nurseries and waste management. The strategy is becoming operational and will be implemented through already existing organizations, notably the AJK Forest Department and the AJK Environmental Protection Agency.

Most of the humanitarian and aid agencies with which we spoke (IFRC, WFP, UNDP-Muzaffarabad and ERRA) have shifted from relief to recovery operations. All of these agencies have included a livelihood focus in their actions. WFP (World Food Programme) pays communities (food for work) to rebuild retention walls and is working closely with the AJK Forest Department. UNDP is conducting community-level forestry training, establishing nurseries and planting trees on communal lands. IFAD is mainly supporting micro-loan programmes for the purchase of livestock. IFRC is planning a capacity-building programme for community-level disaster preparedness, with district branches which will manage relief stocks and form disaster management working groups (IFRC personal communication 2007). However at the time of printing, no concerted effort was underway to raise community awareness about landslides and crack mitigation through locally adapted monitoring and soil stabilization techniques.

3.3: Details of study area: Neelum Valley

The GIAN study area is in the lower part of the Neelum Valley, northeast of AJK's capital, Muzaffarabad, with an estimated population of 100,000. Neelum is a steep, V-shaped valley with an estimated slope range from 35-65° and average width of 15 km. The epicenter of the 2005 earthquake was located here, approximately 19 km from Muzaffarabad (Bulmer et al. 2007). Due to extremely difficult terrain, the valley was blocked for 47 days following massive landslides. The valley is clearly divided by its forested, north-facing left bank, which has fewer villages and is mostly state-owned, with fewer private and communal lands, or shamilat. The right bank is south-facing, to a large extent deforested, except for a few remaining, reforested stands and trees planted on privately-owned lands.

In addition to serving an important purpose as partial headwaters for the Mangla dam, Neelum Valley is home to the Machiara National Park. Located at 2,000-4,000m, the park comprises a variety of ecological niches of the Himalayan Moist Temperate Forest type and a number of highly endangered species, such as the Western Horned Tragophan Pheasant, Snow leopard, Musk Deer and Cheer Pheasant (Khurshid 2005). Transhumance is commonly practiced in Neelum Valley, and the park provides important rangelands for the valley's livestock, providing a valuable resource to the population.

Department of Agriculture, AJK: Karen Sudmeier-Rieux, UNIL, 2006

3.4 Local institutions and land tenure relevant to disaster risk reduction in AJK

Local institutions of potential importance to successful disaster risk reduction include the AJK Forest Department, Integrated Land Management's (ILM) "cluster organizations", supported by the World Food Programme and IFAD. UNDP also has community-based organizations in the region. Such groups, organized into women's, men's, or mixed groups have been established over the past 10-15 years to prioritize development needs, such as sanitary facilities, the building of retention walls, reforestation, tree nurseries and to fund micro-loan credits for the purchase of livestock or seedlings. Social cohesion and religious leadership can be an effective means of organizing prevention and post-disaster operations.

Experience from other mountainous areas demonstrates how communities have evolved to reduce risk, such as spreading land holdings geographically (Dekens 2007a). At the outset of the project, it was not clear to what extent such coping mechanisms prevail in this area; whether communities were aware of the risks posed by newly activated landslides and cracks and whether any land stabilization measures had been undertaken. A successful mitigation strategy should take into account coping mechanisms and land tenure, which affect vulnerability and risk.

The specific types of land tenure in AJK fall into five broad categories:

1. **Private lands:** These are usually obtained through inheritance or purchase. Private lands constitute 37% of the total land (personal communication, local Land Registrar patwari and IUCN-AJK coordinator, 2007).

2. **Shamilat:** These are lands previously owned by the state. Historically, they were set apart for joint possession by a village for pasture, graveyards, woodlots or water facilities (Cernea 1989). Over time, land has been given by the village or appropriated for use by families. Thus previously communal lands have become privately managed communal lands, now used primarily for grazing or wood collection. Shamilat lands constitute approximately 10% of the land.

3. **State forest lands, or demarcated forests:** These lands are the property of the state and under the Forest Department's control. Concessions include grazing, dead fire wood collection, timber for house construction, lopping of certain trees for fodder and agricultural implements, grass cutting, torchwood extraction from stumps, free collection of fallen trees of less than 4 feet circumference except deodar, timber for mosques and other religious buildings, collection of medicinal plants for domestic use (other than those for which contract or lease has been approved), collection of thatching material and collection of fruit and nuts (Poffenberger 2000, and local Land Registrar, patwari personal communication 2007). State forest lands constitute approximately 43% of all land.

4. **Khalsa Land:** This is state-owned land under the control of the Revenue Department and its land use may be forested or bare. It is state reserve land and can be handed over to any department for official use or allotted to any landless individual, on the condition that it is bare and trees do not exist on it. Khalsa lands constitute approximately 7% of the land.

5. **State- owned grasslands:** These lands are also the property of the state and were traditionally reserved and managed by the army to provide mule fodder. Generally these are grasslands without trees or forests. The army is handing the land back to the government through the revenue or forest department, either to house refugees (from the Kashmiri conflict in the past) or for afforestation. These lands may also be reserved for grazing, but not in every village. State-owned grasslands constitute approximately 3% of the land.

Land degradation has been most rampant on the "state forest lands", where encroachment and the illicit removal of trees has been rampant. State control here is limited (Poffenberger 2000). The local population has not been included in decision-making over these lands, which have experienced the least successful attempts at reforestation, as compared to shamilat and private lands (IUCN- AJK coordinator, personal communication 2007).

Landslide in Saidpur village, killing one child on her way to school during monsoon rains, July 2006, Jonas Nessi, UNIL, 2007

4. GIAN Study

4.1: Goals, objectives and expected results

As stated in GIAN's procedures relative to the "small grants programme", such projects should at a minimum be:

- Quick inquiries;
- Related to sustainable development;
- Involve a real relationship between the academic world and at least one international organization
- Be action-oriented and interdisciplinary in nature.
- Not exclusively academic, but include a practical component that focuses on real problems for which society expects solutions in the short or medium term.
- Innovative, creating new synergies and networks.

The goal of the GIAN-Pakistan study is to strengthen decision-making tools for disaster risk reduction in mountainous areas. By understanding the linkages between land use, land use practices, resources management and disaster risk reduction, development, humanitarian and donor agencies focused on disaster risk reduction can improve their risk reduction programs for mountainous regions.
The objectives are:

1. To identify and analyse the damages and losses caused by the landslides triggered by the 2005 earthquake in lower Neelum Valley, AJK.

2. To examine natural and human-induced land use factors related to landslides in lower Neelum Valley, AJK.

3. To estimate to what extent forest cover played a role as natural barriers to landslides.

A fourth objective, intended for phase II, was included in this phase:

4. To examine community land use strategies that impact the vulnerability of communities in lower Neelum Valley, AJK.

Expected results:

1. Identify which tools, data and type of information can most effectively improve decision-making for reducing disaster risk in mountainous areas.

2. Establish a profile of the landslides in the earthquake-affected area considering topography, roads, streams, vegetated and non-vegetated areas using satellite imagery.

3. Assess the area, type and cost of damage to forests and livelihoods from landslides and flooding in terms of surface area destroyed, type of land lost and number of lives lost in the study area.

4. Identify the land use factors that may have affected the landslides, such as roads, construction, agricultural terraces, cultivation on slopes, irrigation channels, grazing and deforestation by field check and satellite imagery.

5. Identify areas of potential risk to the population, such as active or potential landslides, cracks and damaged tree stands.

6. Identify community land use strategies that may contribute to, or reduce risk for the population of lower Neelum Valley.

7. An established communications network between IUCN-AJK and key local government agencies, and NGOs working in the field of disaster risk reduction.

4.2: Methodology

4.2.1. Site selection

a. Preliminary criteria for site selection were established as follows:

- Presence of IUCN or its members on the ground
- A high-risk community (degraded), and highly impacted by landslides (to be determined); a low-risk community (area with high vegetation cover, either well-managed or protected, and thus low-risk to landslides– to be determined)
- Feasible considering project time constraints, winter accessibility and security issues
- Possible study area in Siran Valley, Mansehra district or North West Frontier Province, which was affected by the earthquake
- Availability of satellite images and possibly use of GIS data and analysis.

Road to Noor Behni, Kohori village in Neelum Valley: Jonas Nessi, UNIL 2007

b. Lower Neelum Valley in AJK, from north of Muzaffarabad to beyond the town of Pattika, in a 10 km radius of the river (approximately 12 kms along the river), or 100 km^2 was finally selected as it met the following criteria:

- Greater IUCN staff presence
- Possibility of comparing land use and vegetative cover between the valley's right bank (RB) (largely deforested, under greater private ownership) and its left bank (LB) (greater forest cover, with forest management protection)
- We found that it was outside the scope of this study to distinguish between a high and low-risk community
- Similar geological features between the valley's LB and RB
- One variable, soil moisture regime, differs considerably between the south-facing RB and the north-facing LB. However, there is evidence that similar vegetation, notably blue pine (Pinus Wallichiana) was abundant on the RB 60 years ago, corresponding to pre-independence;
- The valley was severely affected by landslides, and its communities continue to

be exposed to great risk from crack zones and landslides

- Few studies have been conducted here and GSP had not been able to reach the valley until recently due to difficult accessibility

4.2.2. Research design

The fundamental research question of the study is what role did land use factors, especially: vegetative cover, roads, terraces, and ownership play in the occurrence of landslides in the study area? Our hypothesis is that land use, especially vegetative cover and road construction will significantly impact the occurrence of landslides.

A second research question relates to the usefulness of socio-economic data: land use, ownership, risk perceptions in addition to geological information for improving decision-making tools for disaster risk reduction.

The multi-disciplinary study has four main components:

1. Assessment of information needs, available information, existing data and literature review. The first mission was spent almost entirely on tracking down maps, studies, and meeting with stakeholders and key informants.

2. Landslide susceptibility model and map: "Modelling probability of landslides occurrence and potential link with deforestation in North Pakistan" was developed by Mr. P. Peduzzi (UNEP-GRID-EUROPE), assisted by intern/student Mr. R. Klaus (Klaus 2007). The goal of the model is to ascertain whether deforestation in the region has reduced slope stability. The analysis was made using different regression analyses for areas covered by sparse forests, dense forests and grassland using Landsat satellite images from 1979 and SPOT images from 2001, tracing deforestation over time. The analysis then involved extracting parameters such as variation/steepness of slopes, presence/absence of forest, distance from epicentres/fault line, road, rivers or trails and type of geology. A regression analysis was then performed to determine whether there is a correlation between the variables.

3. Landslide profiling of the study area was conducted by remote sensing of Quickbird (0.6m) satellite images and a 60-day field study to collect data on land use, vegetation type, damage to forest land, agricultural land, habitations, ownership, underlying causes of landslides, hazard assessment, and casualties. The landslides were visited on foot, with geographical coordinates and data collected and recorded by IUCN-AJK coordinator Mr. A. Rauf Qureshi, assisted by geology students at the University of Muzaffarabad, Department of Geology. Data was recorded as GIS shape files and in an Excel table, and was sent to UNIL-IGAR/IUCN-EMP for final data analysis and creation of maps. Photos were taken of most landslides. Training in GIS with local partners was conducted by UNIL-IGAR staff during the second field mission.

4. A socio-economic survey of two villages to understand land use strategies and coping mechanisms of communities. Assisted by researchers from Islamabad-based Sustainable Development Policy Institute, (an NCCR partner), an exploratory study was conducted in two villages using focus group discussions and semi-structured interviews. The discussions were facilitated by a close-up photo of the selected villages, (from the high resolution Quickbird image), providing a basis for discussing issues related to land use, risk and coping mechanisms.

5. Results

5.1: Information needs

The goal of the first Pakistan mission was to assess information needs in order to better define the GIAN project and useful outputs. Meetings with a wide variety of stakeholders, decision-makers and communities underscored the interest and need for the GIAN-Pakistan study. In addition, we informed a number of national and local government officials about the study and received considerable encouragement. Based on the interviews, we identified the following information needs and actions that would be useful for successful disaster risk reduction in earthquake-affected AJK.

Information needs

- Identification of the high risk areas
- Determining which factors may aggravate future landslides: terraces, roads, grazing, damaged root systems, deforestation
- Identifying possible mitigation actions
- Assessing the role of vegetation in stabilizing slopes
- Understanding techniques for landslide stabilization
- Understanding community awareness of risk and coping mechanisms
- How to institutionalize disaster risk management
- How to integrate prevention measures in development projects and land use planning

A survey of "information holders" (Ministry of Environment, ERRA and other research institutions) found that no studies specifically addressing the topic of vulnerability and landslides are currently underway. The major exception is a geological study led by Dr. A. B. Kausar, Geological Survey of Pakistan of some parts of earthquake affected NWFP, the Hattian Landslide, the Muzaffarabad area and lower Neelum valley is being published. ERRA announced its plans to begin land stabilization activities including reforestation in the near future. They expressed interest in the GIAN-Pakistan study.

5.2: Landslide susceptibility model

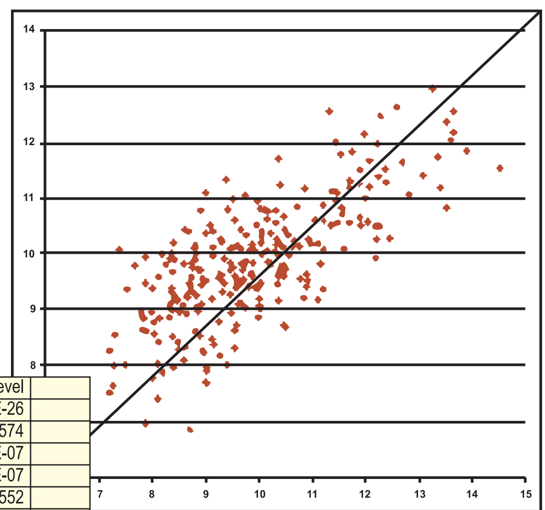
Regression between observed and modelled areas of landslides

N = 270

r = 0.7367

R^2 = 0.5427

Adj.R^2 = 0.5340



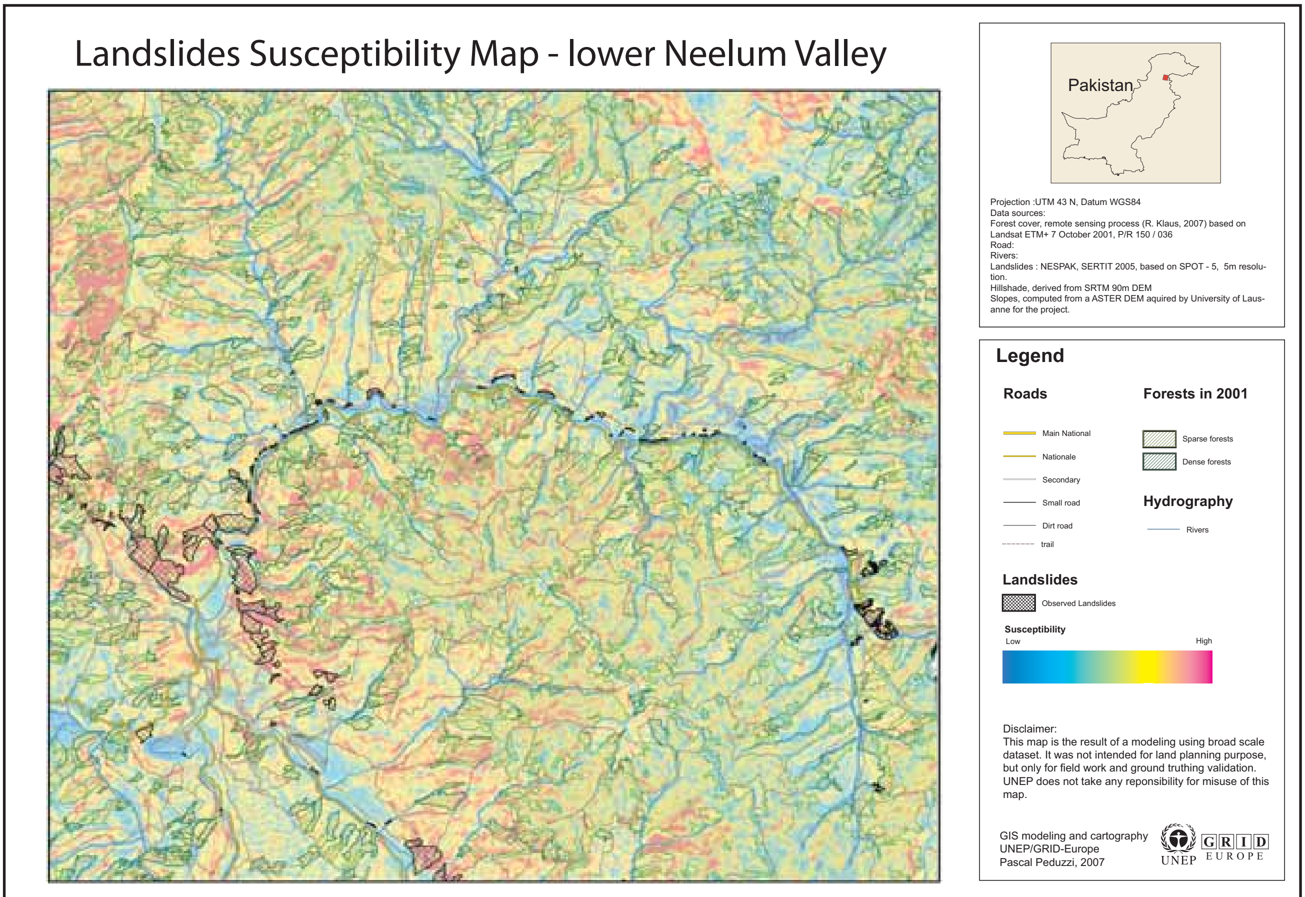
	B	p-level
Interept	7.881077	3.05586E-26
GEO_CLAS	0.220023	0.000452574
FAU_E_LN	-0.15578	2.44824E-07
RIV_E_LN	-0.13837	5.75614E-07
TRAILELN	-0.07553	0.010346552
AS_SLMAX	0.065372	1.38723E-30

- The study confirms the hypothesis that landslide occurrence is higher on steep slopes, close to rivers, trail and fault lines and that it depends on geology types.
- The results from this research show the positive role of forests in decreasing the risk of landslides.
- It shows that globally available datasets can be used to select layers of information to be gathered and narrow the areas where deeper analysis should be conducted.
- Given the broad resolution of the information used, this should, however, not be used for land use planning, but only for selecting areas where further detailed study should be conducted and type of information to be gathered. (Peduzzi 2007)

The model achieved is solid (r = 0.74 and 54% of variance explained).
The variables selected are:

- Type of geology
- Slopes
- Distance from fault
- Distance from rivers
- Distance from trails

The variables are independent from each-other: no auto-correlation is suspected.
The p-value of the parameters is much smaller than 0.05, meaning the confidence of selection is much higher than 95%. (Peduzzi in prep.)



Map 4: Landslide susceptibility map (UNEP-GRID-EUROPE/DEWA)

5.3: Hazard profiles of the study area

5.3.1. Total data set: landslides, cracks flood zones

The study area, lower Neelum River Valley comprises approximately 381 km^2 between 73°24'19 E, 34°30'7.2N and 73°36'43 E, 34°30'16N. Within this area, data were collected on 100 landslides and 17 crack zones that were triggered by the earthquake, as well as 3 flood zones and 24 landslides triggered by rainfall. The small data set for flood zones will not be included for most of the data analysis. Landslides were analyzed on the Quickbird satellite image and cover all major landslides within the study area. The crack zones that were selected are not exhaustive, but represent those that were most obvious while conducting field work. The three flooding zones are those that caused the most damage to the northern Muzaffarabad area and that remain a great risk to the population.

Table 1 Landslide and crack type

Type of landslide[1]	n=100
Slump	62%
Slump and fall	21%
Fall	16%
Slump and mudflow	1%
Type of crack	**n=17**
Horizontal	47.1%
Oblique	41.2%
Vertical	5.9%
Network	5.9%

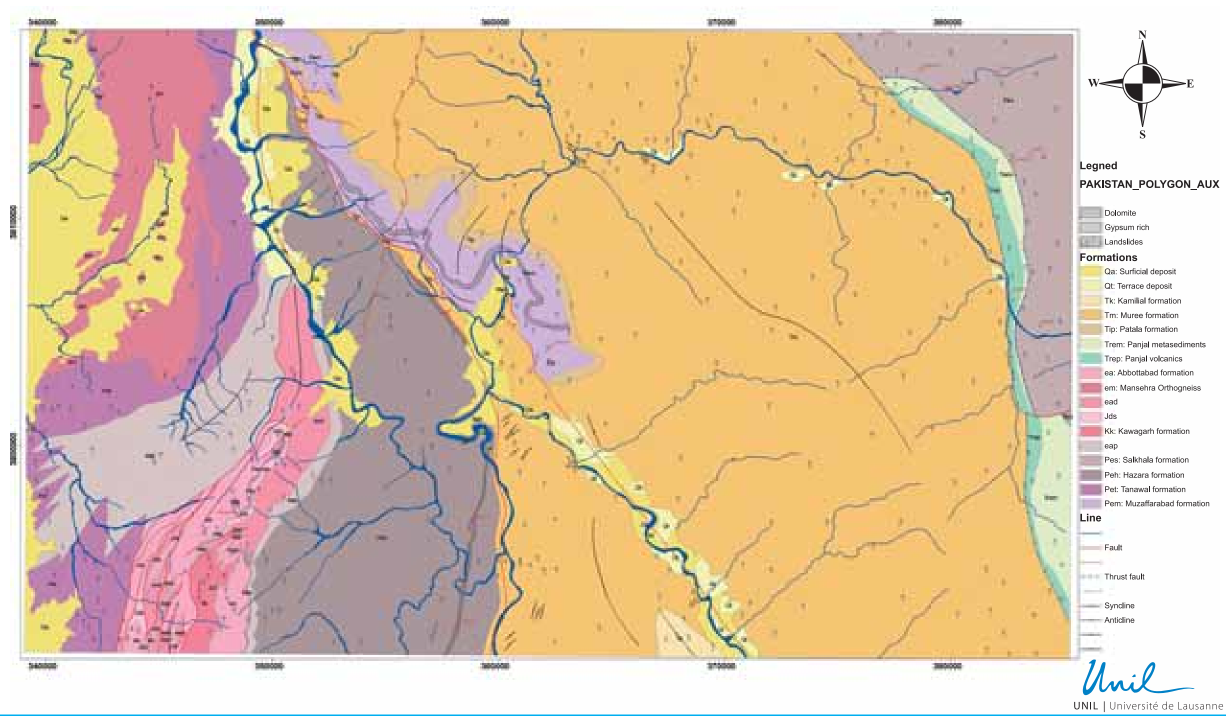
Table 2 Lithology[2], slope gradient, surface area

	As a result of EQ		As a result of ensuing rainfall	
	Landslides n=100	**Crack zones n=17**	**Flood zones n=3**	**Landslides n=24**
Murree formation	57%	58.8%	0.0%	N/A
Abbottabad formation	25%	29.4%	100%	N/A
Lokahart/ Hangoo/ Kuldanna/ Chorgali formations	9%	0.0%	0.0%	N/A
Alluvium/ Colluvium/ mix with Abbottabad formation	9%	11.8%	0.0%	N/A
Slope gradient (degrees)				
Average	51	25	27	N/A
Min	25	0	15	
Max	90	55	41	
Surface area (km2)	17.02	N/A	N/A	0.427

Tables 1 and 2 describe the geological features of the hazards surveyed: 100 landslides, 17 crack zones and 3 flood zones which occurred as a result of the earthquake. It is likely that there are actually more than 100 landslides due to an aggregation of several small slides, which should have been counted separately. We also describe 3 flood zones and 24 landslides. Only surface data were collected for the latter. The majority of landslides occurred on the Murree formation (in light orange on the geological map), previously described as "characterized by impermeability and susceptible to landslides due to rainfall". The largest landslides occurred around the Muzaffarabad area in the highly fragile Abbottabad formation, which exists as a narrow strip (light purple, S-shaped on map 5), following the fault line just northeast of the city.

[1]The landslide categories are those used in Pakistan and are defined as follows:
- Fall; free felled material
- Slump; mass of land which slides in creeping movement
- Fall and slump; started as fall but its lower section moved as slide
- Mudflow; water saturated material

[2]Murree formation: mix of sandstone, siltstone and shale (early Miocene era)
Abbottabad formation: dolomitic limestone (lower Cambrian era)
Kuldanna Formation (Greenish shales)
Lokahart Limestone, Hangoo formation, Chorgali Formation (Shales)



Map 5: Geological map of lower Neelum Valley (UNIL-IGAR based on GSP map)

Table 3. Land use surrounding landslides (multiple categories possible)

	Landslides n=100	Crack zones n=17
Grazing/ deforested	54.8%	54.4%
Terraces	24.0%	17.6%
Habitation	23.8%	4.4%
Forests	17.0%	5.9%
Water channel	14.0%	0.0%
Vehicle road	9.3%	4.4%
River	5.0%	0.0%
Reforested	1.5%	2.9%
Commercial	1.5%	0.0%
Footpath	1.0%	0.0%
Bridges	0.5%	0.0%
Landslides	0.5%	13.2%
Water supply	0.3%	0.0%
Ownership of land surrounding landslides		
Private	50.0%	52.9%
Private/shamilat	23.0%	11.8%
Private/government	17.0%	5.9%
Government	10.0%	17.6%
Shamilat	0.0%	11.8%

Table 3 shows the breakdown of land use surrounding the land-slides, for which data were collected for all sides of each landslide (north, east, west and south), therefore multiple categories were possible. Grazing and deforested areas dominate the entire study area, followed by terraces and habitation, strengthening the assessment of a very densely populated area. Ownership is largely private, or combined private and shamilat (state-owned but privately managed land).

Table 4 shows the type of vegetation for landslides and cracks. These were predominately covered with grass, and mixed with shrubs or broad leaf trees, mostly poplars (Populus spp.), robinia (Robinia Pseudodaccia), mulberry (Mourus Alba) acacias (Acacia Modesta) and walnut (Juglans regia). cheer pine (Pinux roxburghi) and blue pine (P. Wallichiana) are conifers that are well adapted to rocky soil, drought and common grass fires.

Table 5 provides an economic assessment of the damage caused by the major landslides and flood zones in the study area to forest lands, agricultural lands, commercial and private houses, infrastructure and the number of casualties in the study area. The economic damage due to landslides is estimated at 72.3 million Pakistani rupees (1.4 million Swiss francs) and does not include damage to the power supply (237.8 million Pakistani rupees), of which approximately half can be attributed to landslides. This cost is a considerable economic setback to the region and the number of landslides could have been halved with improved natural resources management. Data on lost agricultural land in crack zones were not collected, and the scope of the study did not allow for estimating lost agricultural revenues. Perhaps in a future study, these data could give reliable estimates of the impact on the local economy.

Table 6 shows cross tables for geology/landslide type

Table 4. Vegetation surrounding landslides (multiple types possible)

	Landslides n=100	Crack zones n=17
Grasses	92%	100.0%
Shrubs	86%	82.4%
Broad leaf	70%	23.5%
Chir pine Pinux roxburghii	38%	23.5%
Blue pine P. Wallichiana	16%	0.0%
Deodar pine Cedrus deodar	0%	0.0%

Table 5. Damage assessment

	Landslides n=100	Crack zones n=17	Flood zones n=3
Forested land			
Area (ha.)	352.6		
No. Trees	1'908.0		
Vo. (Cft)	95'950.0		
Value (rs)	11'351'500.0		
Agricultural land			
Area (ha)	11.9		2.2
Value (rs)	37'800'000.0		55'000.0
Buildings (shops and houses)			
Number	35.0		6.0
Value (rs)	8'650'000.0		180'000.0
Other			
Bridges, roads, equipment, vehicles	15'425'000.0		1'250'000.0
Total damage assessment (rs)	**72'306'500.0**		**1'485'000.0**
Value (CHF)	**1'446'130.0**	**n/a**	**29'700.0**
Damage to power supply		**237'780'000.0**	
(estimated 50% due to landslides, 50% due to EQ)			
Value (CHF)		**4'755'600.0**	
Casualties	**81**		**24**

Table 6. Cross tables geology and landslide/ geology and vegetation

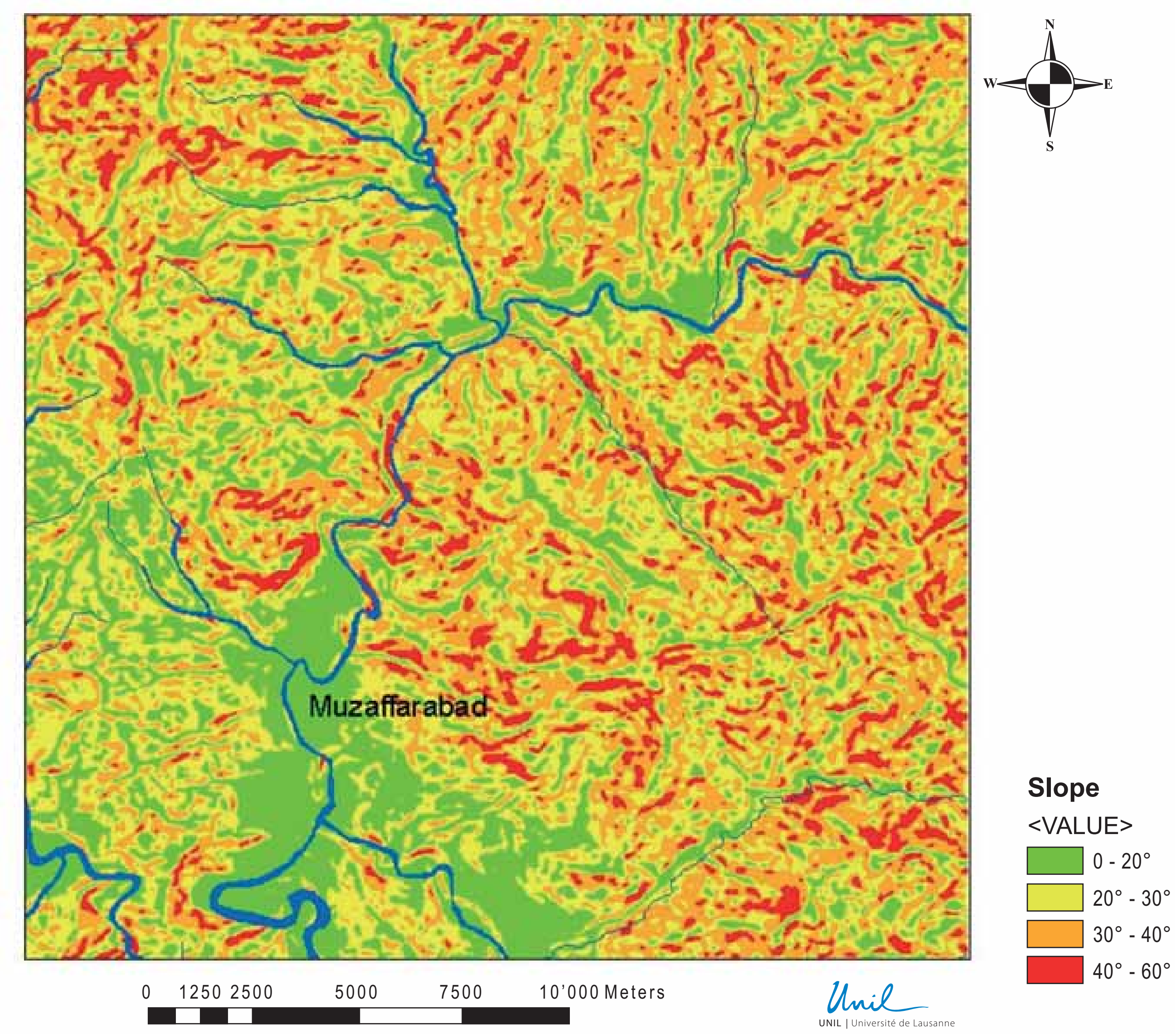
			Lokahart/ Hangoo/	Alluvium/ Colluvium/ mix
a. Geology and landslide type	**Abbottabad f.**	**Murree f.**	**Kuldanna/ Chorgali**	**with Abottabad formation**
Fall	28.0%	12.3%	0.0%	22.2%
Slump	60.0%	70.2%	66.7%	11.1%
Slump and fall	12.0%	15.8%	33.3%	66.7%
Slump and mudflow	0.0%	1.8%	0.0%	0.0%
			Lokahart/ Hangoo/	**Alluvium/ Colluvium/ mix**
b. Geology and vegetation type	**Abbottabad f.**	**Murree f.**	**Kuldanna/ Chorgali**	**with Abottabad formation**
Broad leaf	31.1%	19.3%	17.1%	33.3%
Grasses	29.7%	30.7%	34.3%	25.9%
Shrubs	23.0%	31.3%	22.9%	33.3%
Chir pine Pinux roxburghii	16.2%	9.0%	25.7%	7.4%
Blue pine P. Wallichiana	0.0%	9.6%	0.0%	0.0%
Deodar pine *Cedrus deodar*	0.0%	0.0%	0.0%	0.0%

Table 7. Qualitative assessment of hazard potential

Present status	**Landslides n=100**	**Cracks n=17**
Active	97%	
Inactive	3%	
Hazard potential		
High	80%	82.4%
Medium	14%	5.9%
Low	5%	11.8%

where slump type landslides were mostly found on the Murree, Abbottabad and mixed Lokahart formations. There are more broad leaf trees and cheer pine on the Abbottabad formation landslides, while on the Murree formation landslides there are mostly grasses and shrubs. These areas are commonly used by the population and indicate a higher level of degradation.

Table 7 presents an estimation of the present status and the hazard potential which is defined as the likelihood that a landslide or crack may become reactivated under current conditions. According to these data, the hazard potential is high for a large number of landslides and cracks surveyed.



Map 6: Slope map based on Digital Elevation Model (DEM)

5.3.2 Comparative data set between LB and RB

As outlined in the research design, the goal of the comparative data set is to compare landslide characteristics, land use, vegetative and damage assessments between lower Neelum Valley's RB and LB.

The data in table 8 illustrate a geological difference between lower Neelum Valley's RB and LB and reflects the lower number of landslides, LB = 16, RB = 84. The RB is characterized by slump landslides, Murree formation and a lesser slope gradient than for the LB which experienced a greater number of slump and fall slides of alluvium/

Table 8. Comparative data, Geological characteristics

	Landslides n=100	RB n=84	LB n=16
Type of landslide*			
Slump	62.0%	69.0%	25.0%
Slump and fall	21.0%	14.3%	56.3%
Fall	16.0%	16.7%	12.5%
Slump and mudflow	1.0%	0.0%	6.3%
Geology of landslides			
Murree formation	57.0%	60.7%	37.5%
Abbottabad formation	25.0%	27.4%	12.5%
Lokahart/Hangoo/Kuldanna/Chorgali	9.0%	8.3%	12.5%
Alluvium/ Colluvium/ mix with Abbottabad formation	9.0%	3.6%	37.5%
Landslide slope average (degrees)			
	51	50	55
Min	25	25	35
Max	90	90	80
Surface area km^2	17.02	13.45	3.57

Table 9. Surface area of rainfall triggered landsliders post EQ

	Landslides n= 24	RB n = 22	LB n = 2
Surface area km2	0.427	0.335	0.092

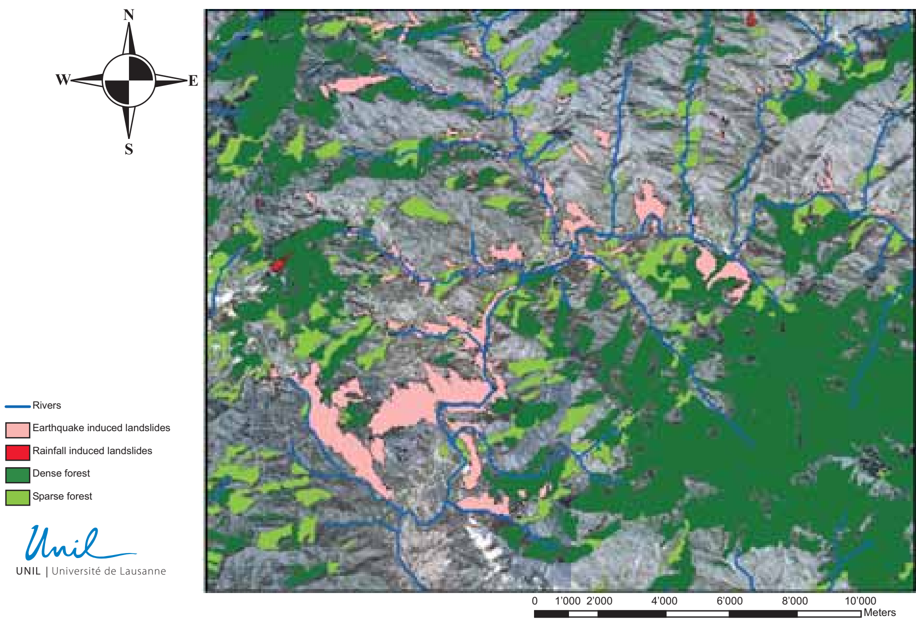
colluvium/ Abbottabad formation. The surface area of landslides triggered by the earthquake was significantly higher on the RB.

The surface areas of landslides triggered by rainfall was noted but other data were not collected due to time and budget restrictions. We note however, the higher frequency of landslides on the RB versus LB caused by rainfall.

Data from Table 10 show a difference in vegetation cover and the level of grazing surrounding the landslides on the LB compared to the RB, confirming the landslide susceptibility model and analysis of the Quickbird satellite image. More landslides on the LB seem to have been caused by vehicle roads as compared to the RB. Ownership differences confirm a difference in management, with a higher percentage of land under private/shamilat on the RB as compared to the LB where the forests are more restricted to public use. However, the type of state management was not considered and could be the focus of further study.

Table 10. Comparative data land use and ownership Landuse (multiple responses possible)

	Landslides n=100	RB n=84	LB n=16
Grazing / deforested	54.8%	59.6%	29.7%
Terraces	24.0%	23.5%	26.6%
Habitation	23.8%	22.9%	28.1%
Forests	17.0%	16.1%	21.9%
Water channel	14.0%	15.5%	6.3%
Vehicle road	9.3%	7.4%	18.8%
River	5.0%	2.7%	17.2%
Reforested	1.5%	1.8%	0.0%
Commercial	1.5%	1.2%	3.1%
Footpath	1.0%	0.9%	1.6%
Bridges	0.5%	0.3%	1.6%
Landslides	0.5%	0.6%	0.0%
Water supply	0.3%	0.3%	0.0%
Ownership of land surrounding landslides			
Private	50.0%	50.0%	50.0%
Private/shamilat	23.0%	27.4%	0.0%
Private/government	17.0%	14.3%	31.3%
Shamilat	0.0%	0.0%	0.0%
Government	10.0%	8.3%	18.8%



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Map 7. Lower Neelum Valley vegetation cover, 2001 based on data obtained from UNEP-GRID-EUROPE/DEWA. Quickbird image taken October 22, 2005 courtesy of UNIL-IGAR. Landslides are depicted based on satellite image and field verification.

The large impact of landslides in Neelum valley is clearly demonstrated by Map 7. Rainfall induced landslides through July 2007 can be detected as red polygons, mainly scattered in the north eastern corner of our study area. They are less significant in area, albeit relatively frequent, as compared to the earthquake triggered landslides. Map 7 also clearly demonstrates the higher vegetation cover of the LB, compared to the RB.

Table 11. Qualitative assessment of causes and future threats

Apparent causes of landslides RB and LB	**Landslides n=100**	**RB n= 84**	**LB n=16**
Deforestation +steep slope/			
cultivation/excavation/river	56.0%	59.5%	37.5%
Steep slope+river/road	39.0%	35.7%	56.3%
Cracks+ monsoon rains	5.0%	4.8%	6.3%
Future threats			
Deforestation + timber rolling/gravel			
excavation/road construction/river	39.0%	41.7%	25.0%
Road/ river cutting toe	34.0%	27.4%	68.8%
Cracks +road	15.0%	16.7%	6.3%
Rain water/drainage	8.0%	9.5%	0.0%
Repeated fires for burning grasses.	2.0%	2.4%	0.0%
Gravel excavation	1.0%	1.2%	0.0%
Irrigation channel	1.0%	1.2%	0.0%

Table 11 provides a qualitative assessment of the main "preparatory" factors underlying the observed landslides. Deforestation combined with steep slopes, cultivation, excavation or proximity to rivers is the main factor for 56 percent of all landslides. The percentage for the RB is somewhat higher at 59.5 while a combination of steep slopes undercut by a road or river predominate the landslides on the LB. Under "future threats", the main concern for future landslides on the RB is deforestation, while road construction is a greater problem for the LB.

5.3.3. Hazard profiles – Conclusions

- The study points to the strength of satellite images and GIS tools for mapping and analyzing land use and natural hazards. It also demonstrates the need for "ground truthing" via field work for data collection and verification, especially of crack zones.
- The data respond to our study question and hypothesis: land use plays a significant role in the occurrence of landslides, especially vegetative cover (broad leaf and native pine species), which significantly reduce the occurrence of landslides; and road construction, which significantly increases the occurrence of landslides.
- The LB, with higher slope averages and which possibly received greater shocks from the earthquake (epicenter location), received significantly fewer landslides.
- The data also concur with the findings from the landslide susceptibility model, showing a strong correlation between deforestation/grazing, road and terrace construction and landslide occurrence.
- The study shows that the occurrence of landslides is also affected by land ownership and management regimes, with significant policy implications. Deforestation/grazing and landslides are most common on private lands or state-owned lands managed by private owners.
- An estimated 56% of landslides surveyed are due to human-induced factors, especially deforestation, grazing, poor terracing, habitations located on exposed slopes and road construction. The remainder are due to proximity to rivers, steep slopes and geomorphological features.
- The damage inferred by landslides in lower the Neelum Valley amount to an estimated 72 million Pakistani rupees (1.4 million Swiss francs), not including the damage to the power supply, which is estimated at 238 Pakistani rupees (4.8 million Swiss francs). This cost is a significant economic setback to the region and could have been reduced with improved natural resources management.
- The economic cost of mountain hazards, in this case landslides and flooding, to lives, livelihoods, houses,

lost forests and infrastructure is enormous. The relative cost of maintaining protective forest cover should be taken into account in forest management plans and private owners should be strongly encouraged and given incentives to maintain forest cover.

5.4: Land use strategies, risk perceptions and vulnerability: An exploratory survey of two villages in Neelum Valley

5.4.1. Introduction

Social institutions, land tenure rights, access to resources and economic considerations are key factors that determine how individuals manage their resources, or their land use strategies. Experience from other mountainous areas shows that a number of community land use strategies have evolved to reduce risk, such as spreading land holdings geographically or communicating warnings of imminent hazards, especially for hazards such as flooding (Dekens 2007a). In areas with rapid population increases and lack of suitable agricultural land, certain traditional risk reduction practices may no longer function. A successful mitigation programme may require changes in land use, such as reforestation, retention walls, drainage schemes, improved terracing, improved management of communal lands etc. Such efforts can only be successful with the participation of communities. Local knowledge of risk, risk avoidance schemes and possible barriers to changes in land use strategies should be mapped before designing mitigation actions.

Destroyed house in Saidpur: Karen Sudmeier-Reiux, 2007

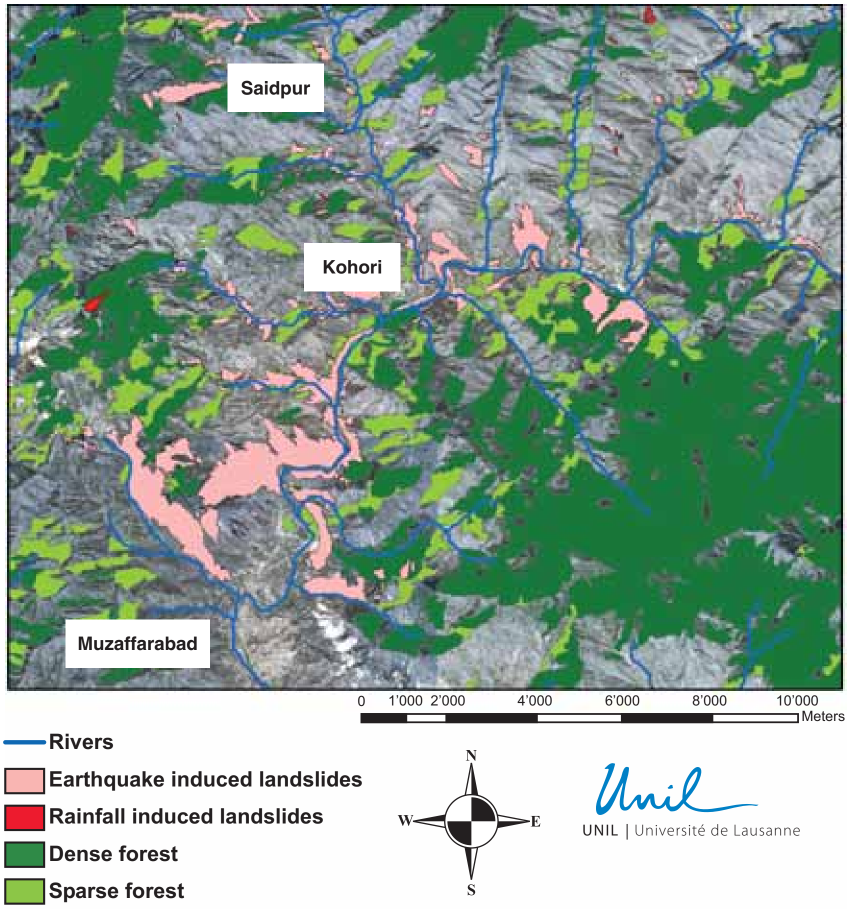
We need to clearly define the distinction between vulnerability and risk due to natural hazards. Poor communities face a number of factors that can make them vulnerable: crop failure, lack of fuel wood, lack of employment, droughts, access to clean water, disease, climate change and hazards such as landslides and flooding (Wisner et al. 2004). Risk from a natural hazard exists when there is a threat to human lives, buildings or livelihoods. It should be seen as having two components, the likelihood of something adverse occurring and the consequences if it does (Crozier and Glade 2005).

5.4.2. Study questions

- Which land use strategies to reduce risk from landslides and flooding existed before the earthquake and how have these changed as a result of the earthquake?
- How do communities perceive risk due to natural hazards before the earthquake and after?

Policy implications:

- What strategies for risk reduction may be adopted by the population?
- What is the most effective strategy for reducing disaster risk on a community level?



Map 8: Location of Saidpur and Kohori villages and Muzaffarabad, Neelum Valley

By land use strategies, we understand:

a. Deforestation, terracing and grazing
b. Local knowledge of slope stabilization techniques and causes of landslides
c. Strategies for reducing risk from landslides, flooding and erosion
d. Placement of land holdings and links to land use strategies

5.4.3. General description of villages surveyed

Situated at an altitude of approximately 1,800m, Saidpur village, with a pre-earthquake population of 1,300 is accessible via a steep jeep road on the right bank of Neelum River, 32 km from Muzaffarabad. The journey takes 1.5 hours under clear weather conditions and a bus provides daily service to Muzaffarabad. A tributary stream of the Neelum River cuts through the village and a footbridge links its two parts. The bridge is relatively new (pre-earthquake) and a number of drownings had occurred before it was built. Higher peaks (3,000-3,500m) tower the village, as do other smaller villages on the steep slopes.

The main part of the village is near the river and has gentle terraces where mainly maize and wheat are grown. Approximately two-thirds of the village land is privately owned, and one-third is Shamilat land. Land owners have planted trees around their houses, such as poplar and apple trees. Blue Pine trees (Pinus wallichiana) still exist in patches, especially on very steep slopes or in the creek beds.

Approximately 100 persons lost their lives during the earthquake and its aftermath. There are approximately 50 houses here, and two schools, one private, one public. The public school had 50 students before the earthquake, now it has 40. The fees for private schooling, including the cost of uniforms, shoes and books come to approximately Pakistani rupees 1,200-1,500rs. per month (24–30 CHF). There is now a basic health unit, established after the earthquake as a result of which access to health facilities has improved considerably. In all, the village has an estimated 160 houses. Two of the people surveyed from Saidpur said they were to move to another location.

Kohori village had a pre-earthquake population of approximately 5,000. It is the first town or village in the Neelum Valley approximately 18 km from Muzaffarabad. The village centre houses mainly shopkeepers, teachers and office workers, many of whom commute to Muzaffarabad. In the surrounding hamlets that are perched on the hillside live farmers and people who work in Muzaffarabad.

The town was completely destroyed during the 2005 earthquake. It had at least 4 schools, all of which were either damaged or completely destroyed. The main part of the town is situated on relatively flat land, and only those landowners located near the river were directly affected by landslides. Few of those surveyed have fields or farm animals.

Noor Behni is a hamlet, which is a part of Kohori village, and was selected for its steep terrain and close proximity to landslides. More of the residents here owned land and farm animals. Many farm animals had actually died due to disease before the earthquake, thus the high concern with livestock. The hamlet has about 50 houses. Quite a few of the residents of this hamlet expressed a desire to move to another place.

5.4.4 Survey methods and sampling issues

Access to the villages was relatively difficult, requiring a considerable walk by foot on steep bridal paths. The survey was conducted in early April, 2007 and was halted for two days due to rain that made the Neelum River road impassable. A total of 12 surveys were conducted in Saidpur, which included 4 focus group discussions. Fifteen surveys and 4 focus group discussions were conducted in Kohori and Noor Behni. At the outset, the survey was to be qualitative and exploratory, in order to be used as a case study. It was expected that this would help to improve the survey tool for use elsewhere. As such, enough qualitative data were gathered to formulate a case study while the quantitative data can be used to support it, but is not sufficient for extrapolation due to a small sample size. The sample size for Noor Behni is n=6. The data are interesting, although they should be viewed with great caution!

The research team consisted of two female researchers and two males. The female researchers targeted female respondents (13 out of a total of 27) and female focus groups (2 out of 6). In some cases, the female respondent was joined by a male family member who then tended to dominate the discussion. Thus, one intended female focus group became mixed and male-dominated and several household survey originally intended with females became male surveys.

Households were sampled by the research team so as to reflect as wide a spectrum as possible. Thus the group was a diverse one that included the poor, middle income and wealthier families; families that lived on steep terrain who were affected by landslides, and some who lived on flatter terrain.

5.4.5. Data Analysis

Qualitative responses from focus groups and household surveys were tabulated and counted to rank in order of importance for questions. Quantitative data included respondents' occupation, household size, ownership status, self-reported vulnerability index (pre- and post-earthquake), knowledge of landslides pre-earthquake and a self-reported living conditions index, monthly expenditures and estimates of wedding expenses.

Analysis of quantitative data: The responses to questions 2, 4, 7 and 8 were tallied in Excel sheets, and a simple sum and averages were computed for each village.

For all three sites:
Total respondents n= 27
Female respondents: n =13
Male respondents: n =14

Question 1: Household size and literacy rate.

Average household size: 9.2
Average literacy rate: 71.51%
Official literacy rate for AJK: 66%
The literacy rate for the sample is relatively high and can be attributed to its proximity to Muzaffarabad.

Question 2a: Risk perceptions. Which of the following factors were of greatest concern to your village/household before the earthquake?

Question 2b: Which of the following factors were of greatest concern to your village/household after the earthquake?

Table 12. Pre-earthquake household concerns

Before earthquake	Saidpur n=12	Kohori n=9	Noor Behni n=6	Total n= 27
2aa Employment	2.10	1.11	1.67	1.63
2ab Crops	1.30	1.00	1.17	1.16
2ac Livestock	1.20	1.00	1.00	1.07
2ad Pests	1.40	1.00	1.67	1.36
2ae Drinking water	1.40	1.22	1.00	1.21
2af Winterized house	1.30	1.00	1.00	1.10
2ag earthquake safe house	0.90	0.89	0.50	0.76
2ah Drought	1.50	1.00	1.00	1.17
2ai Medical facilites	1.70	1.44	1.83	1.66
2aj Fuel wood	1.20	1.33	2.00	1.51
2ak earthquake danger	0.90	0.67	0.50	0.69
2al Landslides danger	1.10	0.89	1.33	1.11
2am Flooding danger	1.20	1.11	1.17	1.16
2an Erosion	1.30	0.88	1.00	1.06
Other factors: school	0.00	0.67	1.20	0.62
Total sum averages	**18.90**	**14.00**	**17.67**	**16.86**

Table 13. Post-earthquake household concerns

Factors of concern	Saidpur n=12	Kohori n=9	Noor Behni n=6	Total n= 27
2ba Employment	2.40	1.89	2.33	2.21
2bb Crops	2.80	2.14	2.67	2.54
2bc Livestock	2.40	2.00	3.00	2.47
2bd Pests	1.70	1.17	1.40	1.42
2be Drinking water	2.50	1.67	1.50	1.89
2bf Winterized house	2.60	2.44	2.17	2.40
2bg earthquake safe house	2.90	2.67	2.67	2.74
2bh Drought	2.10	1.22	1.33	1.55
2bi Medical facilities	1.60	1.56	1.00	1.39
2bj Fuel wood	1.40	1.56	2.17	1.71
2bk earthquake danger	3.00	2.78	3.00	2.93
2bl Landslides danger	3.00	2.56	3.00	2.85
2bm Flooding danger	2.20	1.67	1.83	1.90
2bn Erosion	2.20	2.25	2.33	2.26
2bo Other	1.00	1.43	1.80	1.41
Total sum averages	**33.80**	**27.11**	**31.67**	**30.86**

Tables 12 and 13 show self-reported concerns voiced by respondents before the earthquake and after the earthquake. Questions 2a and 2b are also indicators of the risk perception of natural hazards. Respondents were asked to weigh those factors that they were most concerned about on a scale from 1 to 3. (3= greatest concern, 2= concern, 1= little concern). The higher numbers for Saidpur correspond to its higher vulnerability. It also reflects lower income levels, difficult accessibility and difficult living conditions.

Almost two years after the 2005 earthquake, landslide and earthquake risk are the predominant concerns of all three villages/hamlets, followed by a concern for earthquake proof buildings. They rank above economic concerns.

The responses are quite logical considering the varied topography of the three sites. Kohori was most affected by collapsing houses, Saidpur and Noor Behni by landslides, loss of land and livestock.

Question 3: Historical knowledge of landslides/flooding and land use patterns

Summary:

- Few people recalled landslides in Saidpur and Noor Behni before the earthquake. When they occurred these slides were said to be "manageable."

- Most people were unaware of the risk of landslides before the earthquake.

- A major flooding event was recalled by a respondent in Saidpur some twenty years ago. It killed the respondent's daughter. Otherwise, most houses were situated away from the floodplain on the hillsides and not in danger of flooding.

- Deforestation was slowly creeping upwards to provide households with fuel and construction wood.

- Upon probing, no respondents believed that trees from the area had been commercialized. On the other hand, they mentioned the lack of firewood for their own consumption.

- Some women mentioned that they walked six hours every other day to collect firewood.

- One person mentioned that reforestation on her land had not been successful due to grazing.

- One person believed that more and more households were switching to gas and the use of firewood was diminishing.

Discussion with ILM project managers, IUCN-AJK coordinator and the patwari (land registrar)

- Some reforestation has taken place through the Integrated Land Management Programme (ILM) which was supported by the World Food Programme. This was mainly on private lands and shamilat lands, which are managed by adjacent land owners. Reforestation has been the most successful in this area.

- WFP had created a nursery and provided micro-loans for the purchase of seedlings.

- Reforestation on other state lands i.e. State forest lands or Khalsa are the least successful, as there is no ownership by the local population and the state does not have the resources to adequately manage this land.

Question 4: Concern about landslides, erosion and flooding

Question 4a: Do you believe that factors other than the earthquake contributed to the landslides?

- All respondents mention that the main factor that contributed to landslides, other than the earthquake, is rain.

- When probed, only one group mentioned the link between deforestation and landslides. Cracks and landslides occurred throughout the hills, with perhaps more landslides on barren hills.

- It is felt that in the future, this question should be accompanied by a probe to inquire whether deforestation may lead to landslides.

Table 14. Pre and Post-earthquake household concerns: erosion, landslides, flooding

Pre earthquake concern	Saidpur n=12	Kohori n=9	Noor Behni n=6	Total n= 27
4b Erosion	0.71	0.50	0.50	0.57
4c Landslides	0.57	0.33	1.17	0.69
4d Flooding	0.57	0.33	1.00	0.63
After earthquake concern				
4e Erosion	3.00	2.17	2.17	2.44
4f Landslides	3.00	1.50	3.00	2.50
4g Flooding	1.86	1.33	1.50	1.56

Table 14 confirms that there was little concern for landslides before earthquake, while after the earthquake, the concern for landslides and erosion is considerable.

Question 5: Local knowledge and strategies for reducing risk from landslides, flooding and erosion

Summary:

- Respondents clearly recognize that their land is at risk due to cracks and landslides.
- Most respondents are not cultivating high-risk lands and have moved their homes to safer location, which may have been cultivated in the past.
- Many respondents recognize that retaining walls and plantations may help reduce landslides and erosion.
- Most respondents are overwhelmed by the number of landslides and cracks and do not know what measures to take.
- Some respondents are looking to the government and WFP for assistance with landslide stabilization.
- On the spread of landholdings: Rice paddies are situated in terraces near the river, maize and wheat are cultivated on terraces on hillsides and grazing land is situated higher up on the slopes. This strategy was evolved to maximize the use of water and land resources, but it resulted in land degradation, mainly due to grazing.
- Land has been divided through inheritance and land purchases. When probed, no family claimed that the divisions were made with the intention of reducing risk due to landslides (earlier the earthquake risk due to landslides was not a consideration). The division of landholdings is done mainly to reduce food insecurity.

Question 6: Challenges since the earthquake

Summary: (Number of responses by order of importance)

- (23) Reconstruction: expensive materials, labour shortage, unclear construction guidelines, road access, compensation problems, lack of available land
- (15) Landslide danger: dangerous road to Muzaffarabad, danger to pathways and houses, some families want to relocate
- (12) Water supply
- (9) Economic problems:
  - Cost of living has increased
  - Due to loss of land, people are compelled to purchase more food
  - Insufficient government compensation
  - Unemployment has increased
  - Men are unwilling to leave their families to find work, so their income has decreased
  - Dependency on foreign aid has increased.
- (4) Decline in community values: some respondents

views are telling; “There is more greediness”, and “People are only thinking of themselves.”

- Domestic work load has shifted:
  - o Fetching water takes more time and is still predominately done by women.
  - o Firewood collection is now divided more evenly between men and women (to be verified).
- Use of firewood may be declining in favour of gas (to be verified)
  - o Many households have been able to use wood debris from demolished houses for fuel wood.

If we accept the data and sample sizes, we note that Saidpur received the lowest coefficient and Noor Behni, the highest. The figure for Noor Behni is probably skewed

Table 15. Household survey pre-earthquake – living conditions index (SDPI)

Before earthquake	Saidpur n=12	Kohori n=9	Noor Behni n=6	Total n= 27
7a Type of house	1.73	2.33	1.33	1.80
7b ownership status	1.82	1.78	2.00	1.87
7c # of bedrooms	3.45	4.22	2.67	3.45
7d guest room	2.27	3.89	5.00?	3.72
7e separate room for animals	1.00	1.00	1.00	1.00
7f indoor latrine	2.73	2.89	2.17	2.59
7g electricity	1.00	1.00	1.00	1.00
7h amount of land (kanals)	2.09	1.11	1.67	1.62
7i radio	0.64	1.00	0.67	0.77
7j cassette player	0.64	0.89	0.67	0.73
7k TV	1.09	1.33	1.17	1.20
7l VCR	0.91	1.11	0.83	0.95
7m refrigerator	0.36	2.00	0.00	0.79
7n washing machine	1.64	2.33	2.50	2.16
7o sewing machine	0.91	0.56	0.67	0.71
7p mobile phone	0.27	0.89	0.50	0.55
7q bicycle	0.00	0.22	0.00	0.07
7r motorcycle	0.00	0.22	0.00	0.07
7s car	0.00	0.56	0.00	0.19
7t Suzuki pickup	0.27	0.00	0.50	0.26
7u cows	2.09	1.11	2.00	1.73
7x goats	2.36	0.56	1.83	1.58
7y sheep	0.55	0.00	0.33	0.29
7z hens	1.09	0.33	1.33	0.92
Total sum average	**28.91**	**29.00**	**29.83**	**29.2**
Amount of land (kanals)[3]	18.82	2.13	10.00	**10.31**

[3]8 kanals = 1 hectare

due to the high number of guest rooms reported (by all respondents), this in spite of less land being available, smaller reported pre-earthquake houses, and lower overall economic status of this hamlet as compared to Kohori. Economic levels pre- and post-earthquake can also be considered one type of vulnerability assessment.

These coefficients probably better reflect our observations of living condition levels. We note that Saidpur, and possibly Noor Behni were more affected by the earthquake and landslides in terms of lost livelihood level than Kohori. These figures also confirm the figures in Question 2: Saidpur with higher pre- and post-earthquake concerns also lost more income than Kohori. Little confidence should be placed in the Noor Behni figure. Of noted interest is the increase in mobile telephone use, which increased by 32% as compared to before the earthquake.

Figures for questions 8 and 9 also confirm our observation of living standards in Kohori. Kohori has a more diversified economy, is less vulnerable to landslides, (compared to Saidpur and Noor Behni) and has greater dependence on

Table 16. Household survey post-earthquake– living conditions index (SDPI)

Post-earthquake	Saidpur n=12	Kohori n=9	Noor Behni n=6	Total n= 27
7a Type of house	1.18	1.44	1.00	1.21
7b ownership status	1.82	1.67	2.00	1.83
7c # of bedrooms	2.18	1.22	1.83	1.75
7d guest room	1.36	1.67	2.50	1.84
7e separate room for animals	0.82	0.33	0.67	0.61
7f indoor latrine	1.45	2.22	1.50	1.73
7g electricity	1.18	1.00	1.00	1.06
7h amount of land	2.00	1.00	1.33	1.44
7i radio	1.73	0.89	0.50	1.04
7j cassette player	0.45	0.78	0.50	0.58
7k TV	0.55	1.00	0.33	0.63
7l VCR	0.36	1.11	0.83	0.77
7m refrigerator	0.64	2.00	0.00	0.88
7n washing machine	1.18	2.33	1.00	1.51
7o sewing machine	0.73	0.44	0.67	0.61
7p mobile phone	0.55	0.89	1.00	0.81
7q bicycle	0.09	0.00	0.00	0.03
7r motorcycle	0.00	0.25	0.00	0.08
7s car	0.00	1.25	0.00	0.42
7t Suzuki pickup	0.27	0.00	0.50	0.26
7u cows	1.00	0.14	0.83	0.66
7x goats	0.18	0.71	0.83	0.58
7y sheep	0.00	0.00	0.33	0.11
7z hens	0.91	0.44	0.83	0.73
Total average	**20.64**	**21.25**	**20.00**	**20.63**
	-28.62%	-26.72%	-32.95%	-29.47%


Woman carrying firewood, Muzaffarabad: Karen Sudmeier-Reiux, 2007

the land for agricultural revenue, which has dropped as a consequence of the earthquake and landslides.

5.4.6. Focus group discussions

Most of the discussions were initiated with a close-up image of the group's village. Most of the discussion revolved around the damage to households, the type of losses incurred, the history of deforestation of the village and the actions they thought should be undertaken to reduce the likelihood of future landslides. Most of the discussions can be summed up in the following encounter with a group of farmers in Kohori village:

"When asked whether they had ever experienced landslides before the earthquake, they could not recall any such incident. They said that it never happened in their lifetime and was a new phenomenon for them, that is why they were not able to come up with any sort of coping strategy. Though they had heard that trees could control landslides, they were not fully convinced of this, nor did they have any experience of major land erosion in their area. They said that they pitched the borders of their terraces with stone and that only occasionally these walls collapsed.

They said that historically the forests in this area were not very thick. They believed that forests were not dense because of the increased population. They were of the view that although there was no particular timber mafia yet, the need for wood for construction and fuel was the reason behind the felling of trees." Farmers in Kohori village, AJK April 2007

5.4.7. Conclusions, land use strategies, risk perceptions and vulnerability

We now return to our initial study questions:

1. Which land use strategies to reduce risk from landslides and flooding have existed from before the earthquake and how have these changed after it?

- Few respondents recalled landslides prior to the 2005 earthquake. The few slides that did occur had been managed either by avoiding them, or by building retaining walls. Erosion was more actively managed by retaining walls, and in many cases, by planting trees along the slope of the contours.

- The current situation, with numerous landslides, cracks and gullies surrounding the villages, has overwhelmed the population. Many said that there was little use building retaining walls as the rain just washes them away now. They are aware of and fear landslides and cracks, as they have stopped cultivating many of their most exposed fields.

- We observed that very few cracks had been mitigated with filling or drainage trenches. Only 8 respondents out of 27 mentioned planting trees or grass, 13 mentioned retaining walls and a large number of respondents didn't know what measures to take.

2. How did communities perceive risk due to natural hazards before the earthquake compared to after it?

- It was consistently observed that respondents were little concerned with natural hazards before the earthquake. The few landslides were considered manageable and no other measures taken to curb them.

- Risk perception shifted considerably after the earthquake. Saidpur village was most concerned with employment before the earthquake. Landslides, earthquake and earthquake safe housing became its main concerns after the earthquake. For respondents from Noor Behni respondents, firewood was its main pre-earthquake concern, while landslides, earthquakes and livestock become the main post-earthquake concerns. These respondents are also more exposed to steep slopes. For Kohori, earthquake and earthquake safe house were its main post-earthquake concerns, as the village is situated on relatively flat land and less dependent on cultivating terraces.

5.4.8. Policy implications

1. What strategies for risk reduction may be adopted by the population?

- The population appears open to measures for securing the landslides and cracks, wherever possible, as many such practices have been used in the past. There seems to be a lack of information about the importance of draining and filling cracks.

- Simple monitoring schemes are likely to be adopted by communities and could serve as early warning tools.

2. What is the most effective strategy for reducing disaster risk at the community level?

- As families complete the construction of their houses, there is window of opportunity to engage in land stabilization practices: locally adapted stabilization practices using low-cost materials, fast growing local grass and trees along slope contours, and where necessary, the use of mesh and retaining walls.

- The ILM programme (through the AJK Forest Department), supported by WFP can be an effective champion of this approach. WFP is already engaged in rebuilding retaining walls as a work for food programme. This programme can be expanded to include the widespread planting of grass and trees. IFAD's micro-credit programme, which currently mainly involves the purchase of livestock could be expanded to include nurseries. IUCN can play a significant role in supporting the WFP, AJK Forest Department and IFAD with expertise in landslide stabilization techniques, and the use of locally adapted grass and tree species.

3. Other observations:

- Some landslides and cracked areas need to be classified as high risk and be completely avoided. For this, a hazard map prioritizing high-to-low risk areas and priority measures for each site should be developed. This is beyond the scope of this project.

- The other significant issue is the state of roads in AJK. Access to markets and transportation for employment plays a key role in diversifying incomes and reducing vulnerability. Improved road design with locally adapted landslide stabilization measures could have a significant impact. A collaborative effort could include the nascent AJK Road Authority, the Geological Survey of Pakistan, the AJK University – Institute of Geology, the AJK Forest Department through the partnership building efforts of IUCN- Pakistan.

- The shift from firewood to gas for cooking seems to be taking place in the area as the cost of collecting firewood is becoming almost the same as the price of gas. Government policies to support the distribution and price of gas may have considerable positive influence on reducing deforestation rates.

6. Study outputs and in-kind contributions

1. Landslide susceptibility map (UNEP-GRID-EUROPE, Mr. Peduzzi).
   In-kind contribution: significant technical assistance in developing landslide susceptibility model and map of earthquake-affected northern Pakistan by Mr. Peduzzi.

2. Digitalized geological map of the area based on GSP map (UNIL-IGAR).
   In-kind contribution: significant technical assistance in GIS development and analysis from UNIL-IGAR, notably from Professor. Jaboyedoff, Mr. Nessi, Mr. Dubois and Mr. Breguet.

3. Map of landslides and slope map (UNIL-IGAR based on IUCN-AJK field work).
   In-kind contribution: significant technical assistance, notably from Professor. Jaboyedoff, Mr. Nessi, Mr. Dubois and Mr. Breguet.

Locally adapted soil stabilization techniques: Abdur Rauf Qureshi, IUCN-AJK 2007

4. Quickbird (0.6m) satellite image of the study area (financed by UNIL-IGAR)
   In kind contribution: over 15,000 CHF in financial contributions from UNIL/IGAR, not including technical expertise.

5. Economic inventory of the losses due to landslides in the study area (IUCN-AJK).
   In-kind contribution: by IUCN-Pakistan staff and resources in Islamabad and AJK to coordinate the research study.

6. A report identifying local knowledge of landslides and locally adapted possibilities for slope stabilization.
   In-kind contribution: significant contribution by IUED's professor Ronald Jaubert in research design and result analysis; contributions by IUCN-Pakistan staff time and resources in Islamabad and AJK to coordinate the research study.

7. Technical assistance to local partners in GIS (Geographic

Information Systems) (IUCN-AJK coordinator, University of Muzaffarabad, and the Department of Planning and Development).
In-kind contribution: significant technical assistance from the UNIL-IGAR team for local training in GIS.

8. A student from the University of Geneva completed an internship with UNEP-GRID-EUROPE and received training in remote sensing, and GIS techniques.
In-kind contribution: significant time was contributed by UNEP-GRID-EUROPE in supervising the student intern.

9. Profiles of 100 landslides (slope, geology, land use, ownership, vegetation, economic loss and casualties).
In-kind contribution: this work was based on field work conducted by IUCN-AJK coordinator Mr. A. Rauf Qureshi in collaboration with AJK University at Muzaffarabad, a new collaborative effort. Two GPS units were purchased by UNIL-IGAR for use by IUCN-AJK coordinator.

10. Possible publication highlighting a multi-disciplinary approach to understanding disaster risk reduction for mountainous areas (planned for winter 2007-2008).

The final product of the study is a CD-Rom containing study findings, recommendations, maps and data. It will be presented to local decision makers by the IUCN-AJK coordinator and made widely available. Main findings and maps will be distributed via the IUCN-Pakistan website, possibly via UNEP, and will be sent to a number of organizations with wide distribution networks (ICIMOD, the Mountain Development Forum and the Disaster and Environment network).

6.1: Other outcomes as a result of GIAN- Pakistan

- A new collaborative effort was established between UNEP-GRID-EUROPE, IUCN-EMP, IUCN-P and academic institutions IUED and UNIL-IGAR. The partners have expressed an interest in organizing a conference in Islamabad on ecosystems and disaster risk reduction and possibilities for funding are being explored.

- A proposal has been submitted to apply for funds from the Swiss Development Cooperation for further study of community needs for disaster risk reduction in North West Frontier Province, Pakistan.

- A grant proposal has been developed to apply for funds from the Global Risk Identification Programme, administered by UNDP.

- A network for further collaboration has been established between key stakeholders in disaster risk reduction in Pakistan: IUCN Pakistan and the Geological Survey of Pakistan, the AJK Forest Department, AJK Department of Planning and Development, Pakistan Ministries of Environment, the Earthquake Reconstruction and Rehabilitation Authority and the AJK University and the University of Lausanne, IGAR.

- A scientific poster was presented at the University of Lausanne meeting, "Natural Hazards Meeting, August 31-September 1, 2007 " (1ere Journée de Reflexion sur les Dangers Naturels), as well as at IUCN Asia Regional Conservation Forum(RCF), September 10-14, Katmandu, Nepal.

7. Summary of findings and recommendations

7.1: Findings

- A majority of landslides (56%) were caused by human-induced factors. The most significant amongst these is deforestation and grazing, poor terracing and habitations located on exposed slopes and road construction. The remainder are due to proximity to rivers, steep slopes and geological features.

- The damage inferred by landslides in lower Neelum Valley is estimated at 72 million Pakistani rupees (1.4 million Swiss francs), not including damage to the power supply, which is 238 Pakistani rupees (4.8 million Swiss francs).

- The economic cost of landslides constitutes a significant economic setback to the region and could have been reduced by half with improved natural resources management.

- There are numerous crack zones which create a major risk factor during abundant rains and should be monitored, possibly at the community level.

- Risk perception of future landslides remains high in the villages surveyed.

- Many survey participants were aware of the need to drain water away from cracks and landslides, however we observed few examples of drainage.

- Communities have adapted to risk by abandoning exposed fields and houses and by reconstructing houses according to ERRA standards (these houses are made with light materials, yet poorly adapted to the climate) but they may be forced to cultivate exposed fields as relief assistance dwindles.

- Most families are staying in villages, even if risks are high and due to a lack of relocation options. The result is a reduction of arable land and a loss of income.

- Men who migrated for work returned to villages to reconstruct their houses.

7.2: Recommendations

7.2.1. Strengthening tools for decision-making towards disaster risk reduction in mountainous areas:

- Access to high-resolution satellite images which should be made free or at low cost not only in post-disaster situations, but long term for mountainous regions exposed to mountain hazards. Examples include the SERVIR Global Earth Observation System of System for Mesoamerica, a joint NASA/U.N. venture.

- GIS-based tools should include slope gradient, vegetative cover, active landslides and crack zones. GIS software should be made available to developing countries for free or at low cost after a disaster.

- Landslide susceptibility maps provide a larger scale view of areas where landslides occur and the importance of land use variables, especially vegetation and road construction. Training on creating such maps can be funded by donors and programmes aimed at capacity building for disaster risk reduction.

- Landslide susceptibility maps are based on models and are thus not appropriate for detailed planning. Detailed risk maps should be developed by knowledgeable agencies, which have the authority to make policy changes, such as recommending the evacuation of high risk populations.

- Post-disaster assessment should include a simple methodology for gathering data on land use such as grazing, terraces, deforestation, roads, habitations, ownership and economic damage, in addition to geophysical assessments. This interdisciplinary approach to assessing landslides offers policy makers a more holistic picture of the land tenure situation, and underlying causes of landslides that should be the first step in designing a sustainable disaster risk reduction strategy.

- Post-disaster socioeconomic surveys should be conducted to understand land use strategies, coping mechanisms, risk awareness and vulnerability issues. This is necessary in order to design community-level mitigation programmes and incorporate risk reduction into development activities.

7.2.2. Natural barriers and risk reduction in mountainous areas:

- The role of protective forests, which is firmly established in some European countries, should be examined as cost-effective natural barriers to disaster risk reduction in mountainous areas.

- The costs of maintaining forests for protection should be carefully weighed against the enormous cost of a full blown landslide or flooding event.

- Establishing community-level early warning systems and monitoring cracks, landslides and flood areas is critical for reducing risk in mountains. These systems can be simple and can involve working with the local religious leader to announce imminent threat via the town mosque, and establishing a stick and string method for checking on crack movements.

- Awareness about the dangers of cracks, the need for drainage schemes and the link between vegetative cover and landslides is a necessary component of disaster risk programmes, and should include private land owners as well as managers of state-owned resources.

- The shift from firewood to gas for cooking seems to be taking place in the study area as the cost of collecting firewood reaches the same level as the price of gas. Government policies that support the distribution and price of gas may have considerable positive influence on reducing deforestation.

- Awareness and training in locally adapted soil stabilization techniques, planting fast growing trees, shrubs and grasses on contours and slopes, proper terracing, retention walls and road construction methods can be effective components of disaster risk reduction.

- Road construction is another major source of slope destabilization and any plans for new roads need to include proper grading and locally adapted techniques for slope stabilization such as placing vegetative mesh, combined with soil stabilizing plants. Exposed roads should receive priority attention from road authorities. Expertise on proper methods for soil stabilization can be obtained from IUCN-Pakistan.

- Other capacity-building measures for mountain communities should include community-level first aid training, emergency first aid kits, access to radios (where there is coverage) and a ready stock of blankets and food.

- Integrating disaster risk reduction in programmes and institutions such as education, roads, health and natural resources management is necessary to improve disaster preparedness and recovery post-disaster. This includes the importance of sharing information and skills among local partners.

- Enforcing zoning regulations that deal with risk from landslides, flooding and earthquakes in the construction of public buildings is a political issue, but is essential to reducing disaster risk.

- The evacuation of population that is at high risk is essential, but is one where cultural and significant political issues come into play.

8. Conclusions

Natural disasters in mountainous areas such as that which occurred in 2008 in Kashmir require an understanding of the underlying causes in order to design effective risk reduction programmes. For developing countries, the underlying causes of landslides are definitely linked to problems of economic development, poverty and resource degradation. The goal of this study was to understand how to strengthen tools for decision-making to reduce disaster risk. Our objectives were to examine the links between land use and landslides using satellite images, landslide susceptibility modeling and on-site data collection, including a socioeconomic exploratory survey of risk perception and land use strategies. This interdisciplinary approach to assessing landslides offers policy makers a more holistic picture of the underlying causes of landslides and an improved basis for designing a sustainable disaster risk reduction strategy.

Recommendations include the need to work with communities to establish locally-adapted monitoring, mitigation and early warning systems; the ready availability of free or low-cost satellite images and GIS software, by donors and international organizations for all hazard-prone mountainous areas. GIS-based tools are essential for a spatial understanding of hazards. Data collection on landslides should go beyond geology to include land use, ownership and economic damage to provide a larger perspective on causes and mitigation options.

The study demonstrated a strong link between vegetative cover, ownership and forest management regime, terracing, road construction and landslides. The policy implications are clear: there is a need to include improved resource management into risk reduction strategies, including building awareness and incentives for private owners to participate in increasing vegetative cover. Road construction is another major source of slope destabilization and any plans for new roads need to include proper grading and locally adapted techniques for slope stabilization, such as placing vegetative mesh, combined with soil stabilizing plants. The role of protective forests, which is firmly established in some European countries, should be examined as cost-effective natural barriers to disaster risk reduction in mountainous areas.

Particularly difficult is the challenge of prevention. Unfortunately, history has proved that institutional and behavioral change is most likely to occur as a result of a shock to the system and this makes prevention extremely difficult to implement. The challenge to governments, international organizations such as ISDR, UNEP, IUCN and other donors is to act long term and to push for prevention before disaster strikes. We hope that the study we have presented here adds to the growing literature on the need for preventive measures in mountainous regions; in particular improved natural resources management, adapted road building, monitoring and increasing awareness about mountain hazards. To this end, making tools such as satellite images, GIS software and training available to decision makers and planners in disaster-prone regions may contribute significantly toward disaster risk reduction.

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