# CASE STUDY :

# DISASTER RISK, LIVELIHOODS AND NATURAL BARRIERS, STRENGTHENING DECISION-MAKING TOOLS FOR DISASTER RISK REDUCTION, NORTHERN PAKISTAN

**Prepared by IUCN Pakistan, for the report *"The Role of Environmental Management and Eco-Engineering in Disaster Risk Reduction and Climate Change Adaptation"* (ProAct Network 2008), available at www.proactnetwork.org**

## 1. BACKGROUND INFORMATION

The October 8, 2005 earthquake (EQ), measuring 7.6 on the Richter scale led to around 73,000 deaths and left thousands without adequate shelter and food to survive the harsh winter (Earthquake Reconstruction and Rehabilitation Authority, ERRA, 2006). The epicentre was in Neelum valley towards the north of Muzaffarabad, the capital city of Azad Jammu and Kashmir (AJK). Overall, AJK suffered badly from the EQ with approximately 90% damaged or completely destroyed buildings. Besides, a number of landslides, possibly close to 1,000, were triggered during the EQ affecting a large number of communities in surrounding steep mountain valleys. Landslides remain the greatest threat to communities during heavy rainfalls, especially in the monsoon (Geological Survey of Pakistan (GSP), 2007a).

The project attempts to profile the effects of disaster in the Neelum Valley. The aim is to strengthen decision-making tools by identifying the main land use factors and strategies that affect the vulnerability of communities in the valley. The project studied the area with the help of satellite images, onground truthing, meetings with communities and government officials, using questionnaires and consulted official reports and other documents.

**Cracks in the plains of Muzaffarabad due to the EQ**
Abdur Rauf Quereshi, IUCN Pakistan, 2007

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Early Warning and Assessment and the University of Lausanne / Faculty of Geosciences, Institute for Geomatics and Risk Analysis.

## 2. PROJECT DESCRIPTION

### OBJECTIVES

1. Identify and analyse the damages and losses caused by the landslides triggered by the EQ in the lower Neelum Valley
2. Examine natural and human-induced land use factors related to landslides in the valley
3. Estimate the role of forests as natural barriers to landslides
4. Examine community land use strategies that impact the vulnerability of communities in the valley. Although this objective was intended for phase II, it was included in this phase.

### LOCATION AND CONDITIONS

AJK, with an estimated population of 3.5 million, is considered a separate state under indirect control by Pakistan. The region has its own elected parliament, budget and government agencies but shares common foreign policy, currency and army with Pakistan. The economy of AJK depends mainly on exports, primarily to Pakistan in the form of timber and royalties from power generated by 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 large project to address this issue. Post EQ debris flows are expected to accelerate sedimentation.

AJK is densely populated, 264 persons/km2, with an average family size of 7.2 members (AJK Planning and Development (P&D) Department, 2005). 88% of the region's population is rural depending on natural resources, especially forests for fuel wood, timber, grazing and water. AJK is situated in the pre-Himalayan hillsides 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 AJK has forest cover, while 13% is under cultivation and the remaining land is used mainly for grazing (AJK Forest Department, 2001). Presently, most of the lowland forests of AJK are degraded or entirely destroyed due to slow upward creep of deforestation for domestic use, grazing, or commercial logging (Ahmed and Mahmood 1998).

Agriculture is the key livelihood option and an income supplement for a major part of the AJK population. Variety of crops are grown, chiefly maize and wheat (on slope terraces) and rice (on lower slope terraces), together with a variety of vegetables and fruits. Livestock is also an important source of living for the AJK inhabitants. Common farm animals include chicken, buffalo, sheep and goats. In addition, remittances from the family members working in nearby towns, or abroad also is a major source of income. The literacy rate is in AJK is 66% for both men and women (AJK P&D Department 2005).

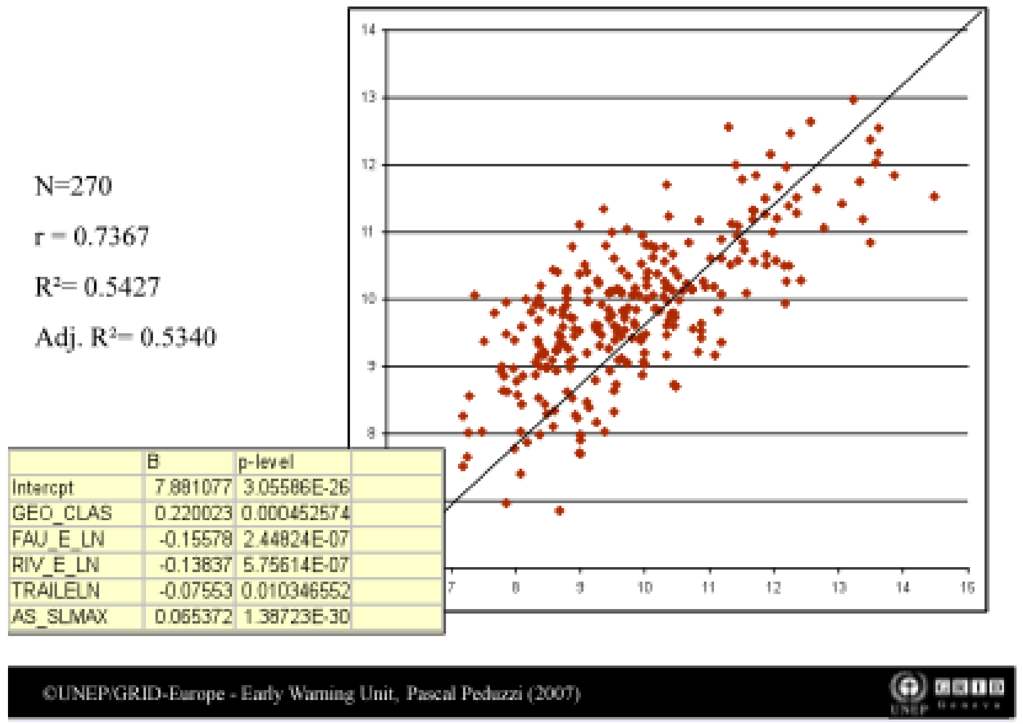


The average rainfall for Muzaffarabad is 1 367 mm as recorded during 1995-2000, with 30-60% in the form of snowfall during December to February, above 2000m. Monsoon occurs during July and August, and cloud bursts can bring as much rain as 100mm during one shower, causing significant damage as flash floods or debris flows. Intense rainfall patterns can be expected throughout the year with changing climatic conditions. During 1995-2000, the temperature ranged between 30 to 40° C during summers, and 0 to 10° C during winters (AJK P&D Department 2005).

The area is situated in the pre-Himalayan zone, along the arc collision zones between the Main Karakorum Thrust and the Main Mantle Thrust (GSP 2007a). The earthquake was caused by the rupture of the northwest-southwest Muzaffarabad thrust fault (Bulmer et al. 2007). This can be considered as the result of interaction between three tectonic elements, including those of the Himalayas, Indo-Pakistani Shield and Salt Range, which are moving independently. The thrust zone has a north - northwest orientation and is largely covered by Murree Formation, which is a mix of sandstone, siltstone and shales, 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. RESULTS

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. It also shows a positive role of forests in decreasing risk of landslides. 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)




| | B | p-level | |
|---|---|---|---|
| Intercpt | 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 | |

Figure 1: Regression between observed and modeled areas of landslides

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 2007)

The study reveals that besides natural factors the human interference has also aggravated the disaster. Some salient findings of the study are as following:

A majority of landslides surveyed are due to human-induced factors, especially deforestation and grazing, poor terracing and habitations located on exposed slopes and road construction, the remainder is related to proximity to rivers, steep slopes and geological features.

- The damage inferred by landslides in lower Neelum Valley is calculated around PKR 72 million (US$ 1 million), not including damage to the power supply, which amounted to PKR 238 million (US$ 3,5 million). This cost constitutes a significant economic setback to the region, which could have been conceivably reduced, possibly with improved natural resources management.
- Crack zones are numerous and create a major risk factor during abundant rains that 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, few examples of drainage were observed.
- Communities have adapted to risk by abandoning exposed fields and houses and by reconstructing houses per ERRA's standards (use of light material for construction). Also, they may be forced to cultivate exposed fields as relief assistance dwindles.
- Most families are staying in villages, even if risks are high and usually due to lack of relocation options.
- Due to the damage caused by the EQ, particularly landslides, arable land was reduced. Also, income from other sources reduced such as men who migrated for work to other areas returned to their villages to reconstruct their houses.



| | **Landslides n=100** | **Crack zones n=17** |
|---|---|---|
| Grazing/ defores | 54.80% | 54.40% |
| Terraces | 24.00% | 17.60% |
| Habitation | 23.80% | 4.40% |
| Forests | 17.00% | 5.90% |
| Water channel | 14.00% | 0.00% |
| Vehicle road | 9.30% | 4.40% |
| River | 5.00% | 0.00% |
| Reforested | 1.50% | 2.90% |
| Commercial | 1.50% | 0.00% |
| Footpath | 1.00% | 0.00% |
| Bridges | 0.50% | 0.00% |
| Landslides | 0.50% | 13.20% |
| Water supply | 0.30% | 0.00% |
| **Ownership of land surrounding landslides** | | |
| Private | 50.00% | 52.90% |
| Private/ *shamilat* | 23.00% | 11.80% |
| Private/ governm | 17.00% | 5.90% |
| Government | 10.00% | 17.60% |
| *Shamilat* | 0.00% | 11.80% |

Table 1: Land use surrounding landslides (multiple categories possible)

The above table shows the breakdown of land use surrounding landslides, 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 highly densely populated area. Ownership is largely private, or combined private and shamilat (state owned but privately managed land).

At least three years period is required to establish effective disaster risk reduction. It will be permanent solution. It includes reforestation and landslides stabilization. The protective role of forest is acknowledged at all the levels and the department has started efforts for mitigation measures. The government has also given due importance to this sector and the Year 2007 was declared as "Year of Plantation" by the government of AJK.

## 4. SUSTAINABILITY

Ecosystem management can be helpful in disaster risk reduction only if it is adopted on sustainable basis. The sustainability can be ensured with active participation of communities in decision making, planning, implementation, monitoring and evaluation process. In addition to it distribution of benefits between state and communities will create the sense of ownership among the communities and will provide them benefits also. In AJK emphasis has been given to community participation for the last 15 years and is still continuing which is an indicator that in future same will continue and interventions will sustain.

## 5. LIMITATIONS ON THE USE OF ECOSYSTEMS IN THIS PARTICULAR HAZARD

The limitations to use ecosystems are many; including the topography and geology of the area making the ecosystem fragile due to increased population pressure or natural hazards. The ownership pattern is also another issue making the ecosystem vulnerable. As such the land tenure in AJK falls into five broad categories:

**Private lands:** These are usually obtained through inheritance or purchase, constituting 50-55% of the total land.

**Shamilat:** These were 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. These constitute 25% of the area.

**State forest lands or demarcated forests:** This is 10% of the overall area and the property of state 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 four 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).

**Khalsa Land:** This is state owned land under the control of revenue department, which may be forested or bare. The land can be handed over to any department for official use or allotted to landless individuals. Khalsa lands constitute 7% of all overall area.

**State-owned grasslands:** These are also state property traditionally reserved for army to provide mule fodder. Currently, the army is handing over the land to the government, which will be further transferred to the Revenue or Forest departments. These grasslands constitute approximately 3% of the area.



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

The foregoing table " Land use surrounding landslides (multiple categories possible)" shows that damage was more in privately owned lands than forests which are state owned land. The private lands have less trees than the state land.

## 6. IMPLEMENTATION COSTS

According to the initial estimates prepared by the Department of Forest, AJK it will take three years for the rehabilitation of damaged forest and the estimated cost will be PKR 1 million (US$ 17 million). After initial rehabilitation, the maintenance will be done by the department with its regular budget. The rehabilitation programme focuses on both hard and soft components, including vegetative and engineering structures. The hard engineering structures include diversion channels, retaining walls, check dams, etc.

Reforestation is carried out under general programme at state level but the rehabilitation projects are in addition to general programme in the earthquake -affected areas. Reforestation will be financed by AJK government.

## 7. CARBON BENEFITS

Carbon benefits in terms of air quality monitoring can be measured. Also, the study has emphasised on the role of vegetative cover and protected forests to address the landslide issue. The recommendations of this study, if implemented by the government, would result in increasing the vegetative cover and forest area in AJK, which would lead to carbon sequestration in the region.

Total area to be reforested is 7 500 ha of conifers and broad leaved species of the localities.

## 8. CONCLUSIONS AND LESSONS LEARNED

Natural disasters in mountains such as in Kashmir 2005 require an understanding of the underlying causes in order to design effective risk reduction programmes. For developing countries, the underlying causes of debris flows are certainly 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 for disaster risk reduction. Toward this goal, our objectives were to examine the links between land use and debris flows using satellite images, landslide susceptibility modelling and on-site data collection, including a socio-economic 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 in establishing locally-adapted monitoring, mitigation and early warning systems; free or low-cost satellite images and GIS software, made readily available by donors and international organizations following natural disasters. GIS-based tools are essential for a spatial understanding of hazards; and 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 management regime, terracing, road construction and debris flows. It is highest in the deforested area used as grazing field followed by terraces, habitations and then forested area as indicated in the foregoing table. The policy implications are clear: a need to include improved resource management into risk reduction strategies, 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 are firmly established in some European countries, should be examined as cost effective natural barriers to disaster risk reduction in mountainous areas. The department of Forest of AJK is promoting biological measures for controlling landslides. The government of AJK declared the year 2007 as "Year of Plantation" due to importance of the forests and their role that they play for protection of land is being emphasized.

Of particular difficulty is the challenge of prevention. Unfortunately, history has proven that institutional and behavioural change is most likely to occur as a result of some type of shock, making prevention extremely difficult to implement. This is the challenge of governments, international organizations such as ISDR, UNEP, IUCN and donors – to act in the 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 awareness building 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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