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Risk-conscious Reconstruction in Pakistan-administered Kashmir

A Case Study of the Chakhama Valley

Markus N. Zimmermann[1]* and Shireen S. Issa[2]
** Corresponding author: markus.zimmermann@ndr.ch*
[1] NDR Consulting GmbH, Riedstrasse 5, 3600 Thun, Switzerland
[2] Aga Khan Development Network, Islamabad, Pakistan

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The Chakhama Valley, a remote area in Pakistan-administered Kashmir, was badly damaged by the 7.6-magnitude earthquake that struck India and Pakistan on 8 October 2005. More than 5% of the population lost their lives, and about 90% of the existing housing was irreparably damaged or completely destroyed. In early 2006, the Aga Khan Development Network (AKDN) initiated a multisector, community-driven reconstruction program in the Chakhama Valley on the premise that the scale of the disaster required a response that would address all aspects of people's lives. One important aspect covered the promotion of disaster risk management for sustainable recovery in a safe environment. Accordingly, prevailing hazards (rockfalls, landslides, and debris flow, in addition to earthquake hazards) and existing risks were thoroughly assessed, and the information was incorporated into the main planning processes. Hazard maps, detailed site investigations, and proposals for precautionary measures assisted engineers in supporting the reconstruction of private homes in safe locations to render investments disaster resilient. The information was also used for community-based land use decisions and disaster mitigation and preparedness. The work revealed three main problems: (1) thorough assessment of hazards and incorporation of this assessment into planning processes is time consuming and often little understood by the population directly affected, but it pays off in the long run; (2) relocating people out of dangerous places is a highly sensitive issue that requires the support of clear and forceful government policies; and (3) the involvement of local communities is essential for the success of mitigation and preparedness.

Keywords: *Earthquake; disaster; sustainable recovery; risk assessment; disaster risk reduction; Pakistan; Kashmir.*

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Chakhama Valley: badly hit by the October 2005 earthquake

The Chakhama Valley is one of the most remote areas of Pakistan-administered Kashmir. The valley is home to around 34,000 inhabitants living in 14 villages. The 14 villages in turn comprise around 34 hamlets dispersed over a number of steep and narrow tributary valleys. The Chakhama Valley covers about 150 km^2, and altitudes range from 980 m to more than 4000 m (Figure 1). The area is subject to intense monsoonal precipitation as well as heavy rain and snowfall in winter. Maize, wheat, pulses, and a variety of vegetables are grown in the valleys and terraces, with parts of the area experiencing ideal climatic conditions for fruits such as apple, walnut, pear, plum, and apricot. Sheep, goats, and cows are also reared. The economic capacities of the population are limited, with remittance of funds from working migrants being a major means of cash support.

The 7.6-magnitude earthquake that struck India and Pakistan on 8 October 2005 resulted in around 73,000 deaths (including almost 30,000 children); another 100,000 were severely injured or disabled, and nearly 3 million were left without shelter (ERRA 2006). In the Chakhama Valley, which is traversed by two tectonic fault lines, the Main Boundary Thrust and the Panjal Thrust, the effects of the earthquake were devastating (according to Aga Kahn Development Network's [AKDN] damage assessment):

- More than 1850 deaths (5.5% of the population) occurred, and another 1100 people were severely injured.
- Approximately 5000 houses (about 90% of the total) were irreparably damaged or destroyed.
- Forty to fifty percent of livestock perished.
- All government facilities, including 45 schools and all 4 health facilities, were destroyed.
- Irrigation canals, drinking water supply, link roads, and the main road connecting the valley to nearby commercial towns sustained extensive damage.
- All shops and businesses were destroyed.
- Widespread psychosocial trauma was experienced.

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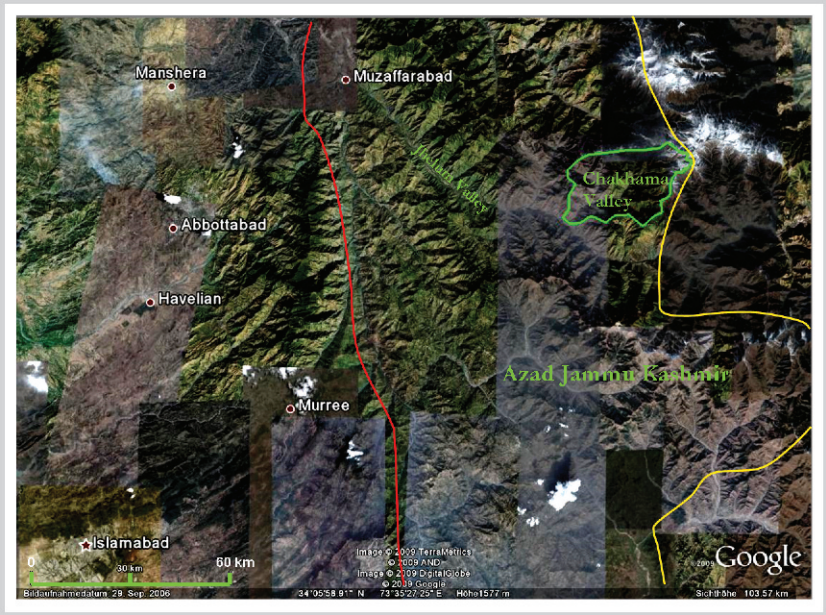
FIGURE 1 The Chakhama Valley along the Jhelum River. The orange line marks the "Line of Control" between India and Pakistan; the red line marks the border between Pakistan and Azad Jammu Kashmir (borders not authoritative). (Source: Google Earth; accessed on 18 April 2009)



- The probability of landslides, rockfall, and flooding increased (Figure 2).

Facilitating recovery: reducing existing risks and preventing new ones

In early 2006, in response to the Pakistan government's request for support, the AKDN, with the approval of the government's Earthquake Reconstruction and Rehabilitation Authority (ERRA), initiated a multisector, community-driven reconstruction program in the Chakhama Valley to render communities in the affected areas more resilient, as stipulated by the International Recovery Platform (IRP 2007). The program was conceived on the premise that the scale of the disaster required a response that would address all aspects of people's lives quickly and responsibly so as to assist communities in dealing with the psychosocial and socioeconomic impacts of the earthquake. Program objectives included:

1. Supporting and promoting the establishment of grassroots, community organizations;
2. Promoting disaster risk management with an emphasis on community-level preparedness, as well as recovery in a safe environment;
3. Facilitating the reconstruction of seismic-resistant homes by training local craftsmen to build demonstration houses and providing material and technical assistance to homeowners;
4. Training health and education professionals for enhanced social service provision;
5. Reconstructing critical socioeconomic infrastructure, including school and health facilities; and
6. Facilitating the (re)creation of sustainable livelihoods.

This paper focuses primarily on objectives 2 and 3, that is, the AKDN's efforts to promote disaster risk management by mainstreaming this aspect of programming throughout its physical reconstruction work in the Chakhama Valley. AKDN's experience and lessons learned in the Chakhama Valley are expected to be applicable to similar remote mountainous contexts as well as postdisaster situations.

Considering multiple risks for disaster-resilient reconstruction

The footzone of the Himalayas in Pakistan-administered Kashmir possesses a medium to high degree of landslide hazard, according to the World Bank's hot spot study (World Bank 2006). In Chakhama, rock formations in the vicinity of the fault lines are highly deformed, fractured, and sheared. The intense shaking of the recent earthquake caused new openings of pre-existing fractures and cracks. Infiltration and percolation of rainwater and snowmelt within the system of fractures increased substantially after the earthquake (GeoConsult 2007). Due to more frequent saturation of the soil and rock formations, their strength has declined significantly, resulting in numerous slope movements such as bank collapse, landslides, rockfalls, and large-scale debris flows (Figure 3).

FIGURE 2 Debris flow in March 2007 caused further damage to shelters built after the earthquake at Nardajian (upper valley). (Photo by Markus Zimmermann, 15 July 2007)

Although such events occurred in the area before the 2005 earthquake, as expected, they have become more frequent and intense since the earthquake and are causing more damage (Sudmeier-Rieux et al 2008). Moreover, the human impact on slope stability (such as through road and water channel construction) is another important triggering factor that should not be underestimated (Owen et al 2007). In addition, landslides are transporting large amounts of sediment into river systems and gullies. The consequences—debris flows and riverbed aggradation—are raising the flood hazard level in many locations.

Given the nature of the environment, the AKDN has required a comprehensive assessment of the seismic and other localized environmental risks before any major reconstruction is begun. This approach is in line with the Hyogo Framework for Action (HFA 2005), the guiding document for disaster risk reduction. The underlying principle was to obtain and share (with the communities) technical as well as historical indigenous information about the types and frequencies of hazards and their risk potential so as to plan and reconstruct accordingly. Strengthening local disaster risk management capabilities was a central objective of the program (UNCRD 2004).

Assessing risk

Even though all reconstruction undertaken by the AKDN employs seismic-resistant construction techniques and standards, the most critical decisions were related to where to build, or rather, where not to rebuild. Microzonation of the program area was commissioned to enable estimation of the total seismic hazard from ground shaking and related phenomena by taking into account local site conditions (geological, geomorphological, geotechnical, and seismological aspects). The study produced, inter alia, a microzonation map that classified the Chakhama Valley into three seismic hazard zones: medium, high, and highly hazardous (NESPAK 2007; Figure 4). The study also provided general guidelines for new and existing construction for each of these hazard zone categories.

An immediate consequence of the study was to rule out the construction of public buildings (schools and health clinics) in the highly hazardous part of the valley. Furthermore, this information was shared with relevant government authorities to encourage awareness of the study results before government-funded construction is undertaken in the future. Site-specific geotechnical studies were then carried out in the other two seismic hazard zones to ensure the incorporation of zone-specific seismic resistance and other mitigating measures into the design of the selected schools and health facilities.

It also became clear very quickly that the earthquake had dramatically increased the risk of more frequent and intense rockfall, landslides, and debris flow, as observed in other areas as well (Sudmeier-Rieux et al 2008). This information, coupled with evidence of enhanced slope degradation following the monsoons and heavy winter rains, prompted the AKDN to commission the mapping of the prevailing localized hazards in the Chakhama Valley (GeoConsult 2007). This localized hazard assessment resulted in the following outcomes:

- Geotechnical conditions along canals, roads, schools, and water supply systems were analyzed and site-specific recommendations for mitigation provided.
- Geotechnical analysis of slopes above housing sites was carried out, and hazards from slope instability phenomena (landslides, rockfall) and from channel processes (flooding, debris flows) were classified and mapped.
- Safety conditions were assessed for houses to be reconstructed.

FIGURE 3 Landslide affecting the road to the upper Chakhama Valley. (Photo by AKDN, 4 April 2007)

- Recommendations were made to reduce risks from natural hazards at particular settled sites.

The team of geologists conducting the assessments followed a multihazard approach for each site, addressing all prevailing hazards by documenting the phenomena and analyzing their magnitude as well as their probability of occurrence (qualitative approach). The work included:

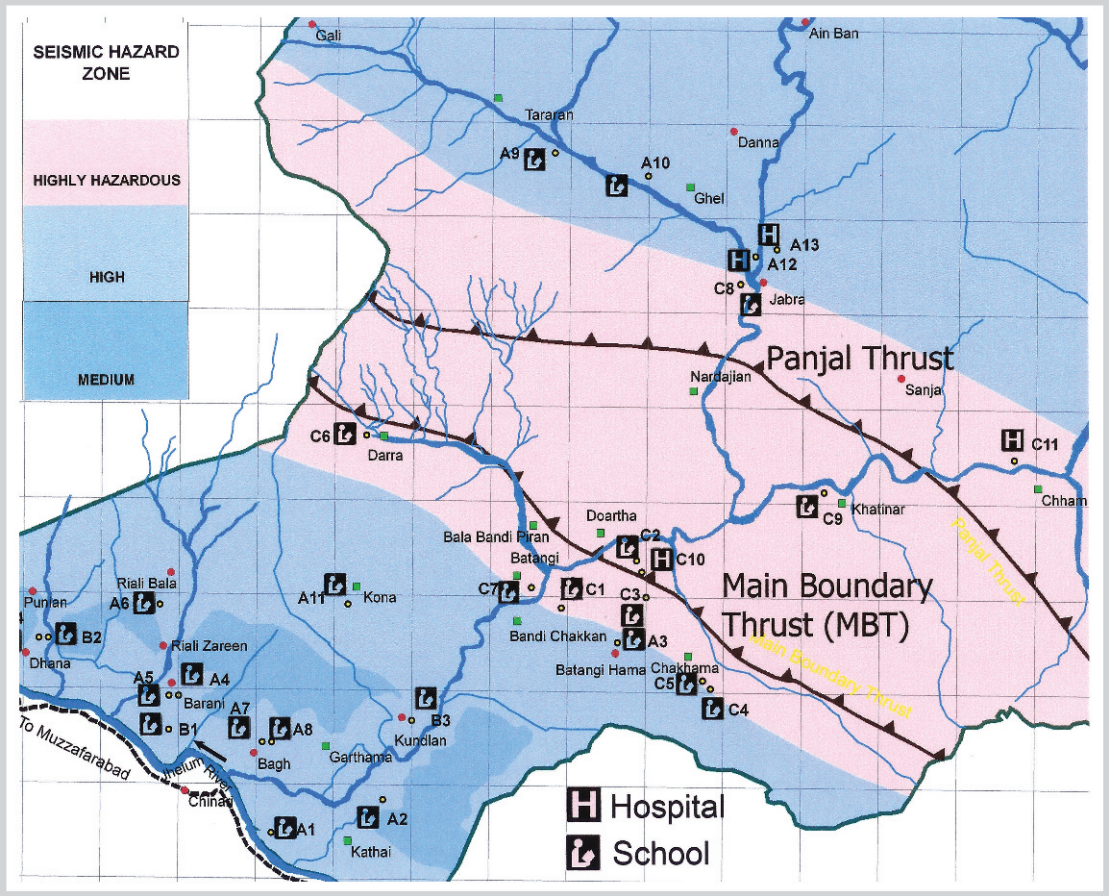
- Primary field investigations by junior specialists along infrastructure lines (canals, roads, water supply systems) and at housing sites;
- Review of field investigations by senior specialists;
- Documentation of slope phenomena and stability conditions in profiles and sketch maps along infrastructure and for housing sites;
- Mapping of hazards for housing sites (villages) at a scale of approximately 1:8000 (using a 0.6 m close-range satellite image); and
- Short description of each site and recommendations for reducing risk at particular sites, as necessary.

Fostering disaster-resilient communities: translating the technical language of risk for better preparedness

Understanding that people's lives cannot be effectively and sustainably rebuilt without involving them in decision-making and implementation of the program, the AKDN emphasized "community mobilisation, [aided by] the establishment of democratic grassroots-level village organisations for men and women, as the programme's fundamental activity, upon which all other aspects of the programme have been built" (Kanji 2008). Given the emphasis on community involvement, the team of geologists was regularly accompanied by community representatives who provided historical information about local hazards and also helped identify residents living in homes located in unsafe areas. These community representatives were nominees of the village organization and as such were trusted and well-reputed community members who possessed an understanding of historical natural disaster-related events in their respective villages. Scientific assessments were thus combined with local knowledge to produce comprehensive sketch maps of each hamlet and its hazard risks, with recommendations for reducing risk. The incorporation of local knowledge was critical (ISDR 2008), and it clearly contributed to local ownership and acceptance in the Chakhama Valley. Moreover, discussion of findings on site with the AKDN's reconstruction team allowed for rapid incorporation of the information into program implementation.

"A key element of the programme has been to help communities understand and mitigate against the natural risk that they face in their living environment" (Kanji 2008). The AKDN also conducted sessions in communities to transmit the technical knowledge gained through the microzonation study, soil studies, and hazard assessments and to support subsequent land use decisions (Figure 5). Most sessions, especially in villages where a significant percentage of settled area was deemed partially or completely unsafe (see section below on safety classifications), were also attended by the team of geologists. During each session, the community was briefed about the purpose of the session, and sketch maps of settled areas of the village were shared. Questions from residents were fielded by the geologists and/or AKDN staff, as appropriate. Geographical or structural markers were used to identify houses located in unsafe areas. Possible relocation from unsafe areas and mitigation efforts for partially unsafe areas were also discussed.

FIGURE 4 Earthquake microzonation map for Chakhama with main fault lines and essential infrastructure (schools, basic health units). Maps at a scale of 1:10,000 and 1:25,000 are also available for effective planning. (Source: NESPAK 2007, original scale 1:50,000)



Community sessions were conducted jointly for men and women and were organized by local male and female social mobilizers. As these sessions were conducted from mid-2007 onward (more than one year after the AKDN had initiated work in the area; ie much community mobilization had already occurred), organizing joint sessions with men and women was not particularly challenging. Ensuring attendance by larger groups of residents was more challenging. However, the issue of representation was addressed during the following year when a wider range of community representation was facilitated during the participatory development of village disaster preparedness plans. These plans are based on multirisk assessments and designed to (1) enhance the communities' awareness through the reinforcement of hazard sketch maps and (2) help them think through practical and realistic mitigation measures and response plans based on local capacities.

Practical classification of areas according to safety

Hazards are generally characterized according to their magnitude and frequency (SDC 2005). However, for ease of understanding by villagers and nontechnical staff, a simpler categorization was developed to express hazard potential in terms of safety (Table 1). Given the environment, no areas are completely safe; hence the term "relatively safe" was considered more appropriate. In addition, the difference between the "unsafe" and "highly unsafe" categories became difficult to quantify from a practical perspective, and these two categories were later merged into the "unsafe" category.

Of the valley's approximately 5800 houses, 80% were judged to lie within the relatively safe areas. Fifty-four percent of the houses in the "unsafe" category are found in the upper valley villages, with another 27% in the middle valley. The remaining 19% lie in the lower valley.

Integrating hazard information into infrastructure and housing projects for increased safety

Building, operating, and maintaining infrastructure works in the Chakhama Valley has no doubt always been a difficult endeavour. Steep valleys, unstable slopes, and the

FIGURE 5 Discussion of localized hazard assessments with communities in one of the villages. (Photo by AKDN, 12 September 2007)

crossing of countless rivulets and gullies constitute a major challenge for engineers. The sites of particular structures (schools, basic health units, water supply systems) were assessed and recommendations made to enable engineers to choose appropriate locations and improve overall structural safety (see Box 1). Linear structures (canals, roads) were systematically checked for geotechnical threats (slope failures, landslides, rockfall, debris flows). Each section that was prone to failure was described, and recommendations were outlined (see Box 2).

Informed decisions about the proper location of homes to be reconstructed are of utmost importance. The classification of hazard levels in terms of safety had three important purposes: (1) it encouraged families residing in unsafe areas who have alternative land to construct their future homes in safer areas and, for those who were unable to do so, to at least relocate temporarily during monsoon and winter months; (2) it allowed the AKDN to ensure that support was given only to homeowners whose land was considered "relatively safe"; and (3) it helped initiate discussion with the government about additional compensation for families living in areas where homes could not be reconstructed.

Knowledge about locations where natural hazards do not occur should guide the reconstruction process. Where the assessment showed that the assumed magnitude is limited, the risk was reduced by (1) strengthening buildings against the impact of natural forces, (2) executing mitigation works to stabilize the starting point of hazardous processes, or (3) protecting the impact zone. Finally, developing locally accepted and understood warning systems and response plans based on local capacities enhances risk reduction. The village disaster preparedness plans that were later developed served this purpose.

In light of the above-mentioned benefits of integrating hazard information into projects, it must be acknowledged that such assessments are sometimes time consuming and

TABLE 1 Simplified categorization developed to express hazard potential in terms of safety.

Category	Description of risk and suggested measures
Relatively safe	Sites where the probability of slope movement and flood or debris flow is determined as minimal. Such areas do not require remedial works.
Partially unsafe	Areas with some probability of small-scale slope movement or other hazards. These areas can be stabilized with remedial measures that do not have unreasonable cost/time implications vis-à-vis potential benefit.
Unsafe	Areas with a higher degree of probability and magnitude of hazardous phenomena that require a significant investment of resources and time for stabilization. These areas should be avoided when deciding on land use for human settlements.
Highly unsafe	Areas characterized by maximum probability and magnitude of hazard. In view of project duration and resources available, these sites are believed to be untreatable.

thus can delay reconstruction. In this context, the active involvement of the community and government can relieve some of the pressure to rebuild quickly.

Lessons learned: upfront investments for enhanced awareness and reduced risk

Disaster risk reduction is becoming increasingly important as climate change and other factors combine to increase the frequency and degree of natural disasters. Indeed, it is no longer possible to think of development or reconstruction projects without integrating disaster risk reduction into them (UNDP 2004).

The AKDN's experience of taking this approach in the Chakhama Valley has provided a valuable opportunity to learn from the complexities involved in defining, assessing, and mitigating against risk, especially in a postdisaster mountain context. Better comprehension of how risk is understood and assessed by communities, before making sizeable investments in assets such as land and housing, is an area that requires much more work and experience. Nonetheless, the AKDN's evolving knowledge in this area has highlighted some key issues that can be considered in terms of integrating disaster risk management in contexts similar to that of Chakhama:

- The assessment of disaster risks and integration of risk-reduction measures into projects contributes to the sustainability of these investments. While appropriate (safer) locations must be identified, this action is not sufficient. In many places, structural measures play a critical role in preventing the occurrence of a hazard (eg slope stabilization) or mitigating its impact (strengthening the structure), thereby protecting investments and paving the way for future development gains. In addition, nonstructural efforts (mainly disaster preparedness) also contribute directly to reducing the vulnerability of communities and households.
- Hazard and risk assessments need to be systematic, technically sound, and clearly understandable. Categorization of areas according to risk or safety should be easily understood and, more importantly, agreed to by the community. Close collaboration between scientists and the community is essential, as hazard assessments can delay construction and the active involvement of the community can relieve some of the pressure to rebuild quickly.
- Systematic risk assessments are time consuming, represent upfront financial investment without obvious tangible benefits in the short term, and may be conducted using a variety of methods. Particularly in a postdisaster context where the pressure to reconstruct quickly is ever-present, the willingness to make informed, albeit somewhat delayed, decisions is rather limited. Nevertheless, investments in disaster risk reduction pay off in the long run, as the integration of remedial measures at the beginning does not increase the costs of the investments excessively.
- Given that the frequency and intensity of most natural hazards are linked to those of other hazards and to climate extremes, a multihazard approach is a prerequisite for gaining a comprehensive understanding of risk and hence for responsive disaster risk reduction. In Chakhama, whereas seismic risk was given due consideration, the very likely and indeed more threatening probability of other secondary hazards (landslides, mud or debris flows, flooding) was of greater daily concern to communities. Hence, seismic microzonation studies were coupled with site-specific geotechnical studies and localized hazard assessments of settled areas.
- Whereas multirisk approaches account for the several facets of the natural environment that may affect lives and livelihoods, multi-input responses cater to the

BOX 1: Protecting homes in villages at risk: the case of Bandi Chakan

Bandi Chakan is located about 1 km southwest of one of the main fault lines (MBT; see Figure 4). Part of the village is categorized as being in a highly hazardous seismic zone, with the remaining area lying in the high seismic zone category. Earth shaking has resulted in significant slope instability in the areas above the village.

Rockfall is the main threatening process. Huge boulders (several meters in diameter) frequently reach the upper part of the village. Fortunately, soft-soil agricultural terraces stop the boulders just above the main cluster of houses. The areas above the main road are considered unsafe. Remedial measures against such large boulders are impossible. Hence, approximately 40% of the more than 250 houses located in this village are in unsafe or partially unsafe areas.

Working closely with the Bandi Chakan community, sketch maps were developed to help villagers better understand their living environment with respect to natural hazards. As a result, some 27 families (representing about 20% of unsafe houses) decided to rebuild their homes on land deemed "safer" by the assessments (and, in some cases, moved out of the valley to safer areas), whereas another 8–10 households temporarily relocate during harsh monsoon or winter weather, when localized hazard risks are exacerbated. However, safety conditions for households in unsafe locations in this village remain a major challenge.

multiple dimensions of life and livelihoods affected when disasters strike. Integration of risk reduction in reconstruction is more effective and long-lasting when the knowledge gained from risk assessments is simultaneously applied to housing reconstruction, social and economic infrastructure recovery, and livelihood re-creation.

Lessons learned: an enabling policy environment is a prerequisite for effective disaster risk reduction

The upfront investment in financial and human resources required for disaster risk management presents a daunting challenge for developing countries, which often lack these very resources. Even so, governments can play a proactive role in the integration of disaster risk management into development planning as stipulated by the Hyogo Framework for Action, Priority 1 (HFA 2005). By better understanding the contextual constraints to effective risk reduction, governments can work with relevant partners to develop relatively low-cost responses and an overall enabling policy environment that emphasizes:

- Increasing community awareness and preparedness;
- Encouraging relocation through policies that prohibit rebuilding in unsafe areas or supporting the retrofitting of existing homes in seismically active areas, and facilitating the provision of safer land that, when possible, is in the vicinity of previous residences;
- Undertaking essential mitigation works, where possible, in partnership with interested donor agencies; and
- Finding innovative ways to facilitate the incorporation of remedial measures, for example, through the involvement of local residents in community-based efforts for small-scale mitigation efforts, especially in areas considered partially unsafe.

BOX 2: Protecting critical infrastructure: the Kathai canal

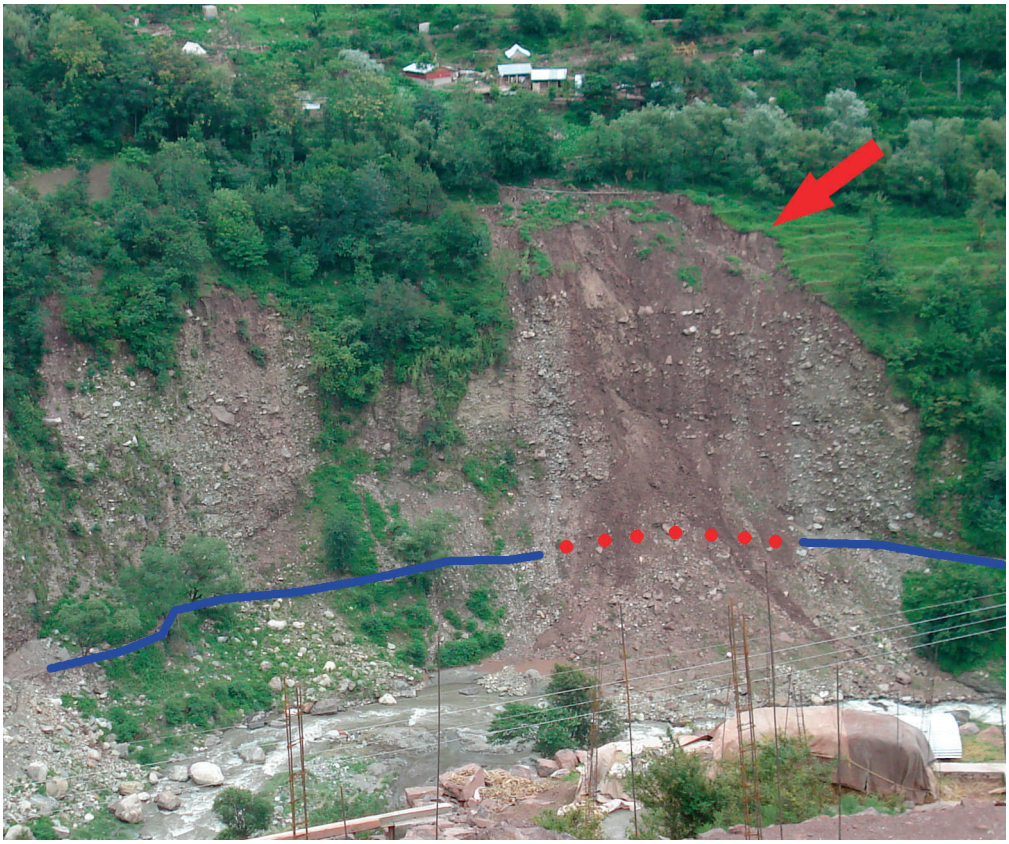
Postearthquake reconstruction of the Kathai canal was completed in late 2006. The canal, which is 6 km long, 1 m wide, and 0.6 m deep, stretches from beyond Bandi Chakan village to the base of the valley beyond Kathai village. The canal is expected to provide about 0.2 m^3/s of water and irrigate between 200 and 300 hectares of land for about 250 households in 2 villages. Reconstruction work involved canal widening and proper lining for seepage control.

The slopes along the canal are of an alluvial nature, comprising gravel, cobbles, and boulders with sand and silt. The slopes are generally stable in dry conditions but begin to move when saturated, particularly in the upper portions. Landslides, slope failures, and falling debris after heavy rains in early 2007 caused significant damage to the canal (Figure 6).

The mitigation work required to secure the canal was discussed with the communities benefiting from the canal. It was clear that these communities would not be able to carry out the work themselves and would require significant assistance. The economic importance of the canal, and concerns about the safety of the communities living in the vicinity of the canal, persuaded the AKDN to provide the necessary support.

At critical points where landslides were a particular threat (Figure 6), the canal was protected with concrete slabs so that debris could flow over the covered/slabbed section of the canal. Retaining walls were constructed where required. In the most critical section, the freshly accumulated debris in the canal was carefully stabilized for rehabilitation.

FIGURE 6 Kathai irrigation canal (blue line); most critical section for rehabilitation (red dots) with highly unstable slope above (arrow). (Photo by Markus Zimmermann, 3 July 2007)



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