A Participatory and Multi-Scale Diagnosis for Developing a Soil Conservation Strategy for Eastern Bhutan

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Abstract: Land degradation by soil erosion and landslides has been recognised as a constraint for sustainable land-use in Eastern Bhutan for a few decades. However, the extreme diversity in agro-ecological zones, the relative inaccessibility of the region, the lack of reliable data and the limited research capacity made it very difficult to develop a relevant land management strategy. To address this issue, a simple diagnostic multi-scale survey was developed which integrated knowledge of land-users, extension agents and researchers.

In the course of 1 year, a preliminary picture of land degradation in Eastern Bhutan emerged, including major causes, geographical differentiation and trends in land degradation. These insights enabled to formulate general guidelines for a soil conservation strategy. An important additional output was that extension services increased their awareness and knowledge about land degradation, which will enable to make future soil conservation programs more effective.
Keywords: diagnostic survey, soil conservation strategy, multi scale, participation, bhutan

1 Problem analysis

Eastern Bhutan covers an area of about 12,000 km^2 and has a very rugged landscape. It has a extreme diversity of agro-ecological zones, as altitude range from 200 m in the tropical South till 6,000 m a.s.l. in the alpine North (LUPP, 1997) with a gradient of annual rainfall from 3,500 mm till 800 mm (and probably less in the alpine areas). It is home for about 28,000 households, and the agricultural fields are mainly located on the upper hillslopes as the valley bottoms are mostly steep and inhospitable. Although Eastern Bhutan is still relatively rich in natural resources, the pressure on the land in the Eastern region is the highest in Bhutan. Visual observations of water erosion from steep agricultural fields and spectacular landslides[1] indicate that soil erosion control has a role to play in sustaining agricultural production and land-use. However, no data are available and records of erosion are piecemeal. Moreover, research capacity is limited in terms of manpower and equipment. The challenge is how to start research and to develop a soil conservation strategy in such a scientific unexplored environment?

The wide diversity of agro-ecological and economic situations in Eastern Bhutan makes that every case of land degradation is in a sense unique. Therefore, one option could be to limit ourselves to a number of detailed case studies. However, the risk of this approach is that we end up with piecemeal and anecdotic case studies, which inhibits a more generic understanding of land degradation. Rather than hiding under the assumption of the ‘uniqueness of every situation’, the authors believe that a generalised analysis of land degradation processes is very much needed. In this way, we can better organise our knowledge about land degradation and it will become easier to scale up success stories in the future. Implementing such a generic analysis is of course more easily said than done, as assessment of the occurrence and causes of land degradation in the Eastern region is a huge task. There are many different ways to tackle such an exercise. One could start with measuring soil loss at some runoff plots, but the problem is how to select representative sites and how to upscale these results? An alternative is to start from the big picture. For example: identifying susceptible areas from regional slope, land-use and rainfall

[1] This study focussed at soil erosion and landslides caused by land-use, and ignored land degradation caused by geological causes or road construction.

information. Such an exercise could tell us something of potential erosion, but the reality could still be different. In addition, both approaches will not tell us anything about the perception of erosion by farmers and their indigenous coping strategies.

2 Objective

The objective of this exercise was to develop a simple diagnostic methodology, which would enable us to define in a limited period of time an appropriate research and development strategy for soil erosion and landslide control. This diagnosis was expected to enable us to preliminary answer the following questions:

- Where do erosion and landslides occur most frequently?
- How does land degradation compare with the past ?
- What are the most important causes?
- What are the indigenous coping strategies?

3 Approach

Considering the constraints mentioned above, a middle path approach was suggested (Details of the methodology and results can be found in Turkelboom *et al.*, 2002).

3.1 Principles of the diagnostic survey

- *CONTEXT SENSITIVE*: If the survey has to lead to a strategy to better manage land resources, it was felt that the diagnosis should go beyond the physical assessment of soil erosion and landslides. Therefore, the socio-economic context of land degradation was assessed as well.
- *MULTI-SCALE:* The proposed approach combines a regional diagnosis with more detailed appraisals in a few well-selected villages. Each level entails a different degree of area coverage and a different depth of analysis, resulting in a complementary picture (Fig. 1). A regional survey is characterised by a large coverage area, but the analysis is rather superficial; whereas the village studies cover only a small area, but allows for a more in-depth analysis. The integration of information of the different levels is expected to provide both an in-depth understanding, as well as an overall overview of land degradation in Eastern Bhutan.

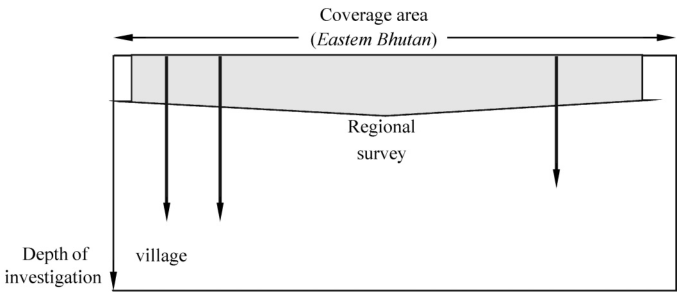

Fig. 1 Complementarity of the regional survey and the village level studies for assessing land degradation.

- *APPRECIATION OF LOCAL KNOWLEDGE*: Two groups of local knowledge were identified. Land-users are the most important information sources to understand local-specific land degradation issues. However, there are many farmers and their knowledge is not always easy accessible. Therefore, discussions were held with well-selected groups of farmers who were living in affected villages. Although the knowledge of the block-level extension agents (EAs) is probably less detailed compared to the knowledge of farmers, they were still considered as an important information source as their knowledge is reasonably accessible. In the Eastern region, there are 66 administrative defined blocks and each of the block has 2 to 3 extension agents (for respectively agriculture, livestock and forestry).

- *INTERACTION OF DIFFERENT TYPES OF EXPERTISE*: The land degradation survey entailed a lot of open discussions, which were aimed to encourage an active participation of land-users, extension staff, soil scientists and researchers of other disciplines. In this way, a productive interaction was created between different sources of knowledge, and a general increased awareness about land degradation and conservation was obtained.

3.2 Steps of the land degradation survey

The complete exercise took about 1 year time and was conducted during 1999. The survey included the following 8 steps:

Step 1. *Review and interpretation of secondary data:* All available secondary information about land degradation was reviewed, such as scientific literature, project reports and unpublished data sets. In this way, we could make the most out of the limited time and resources available, and avoid duplications. The most useful information on the regional level was obtained from the analysis of rainfall data and from interpretation of geological and soil classification reports.

Step 2. *Training of extension agents (EAs):* At each of the six eastern districts, a half-day training of EAs was organised. During the training, definitions, symptoms, causes and effects of different land degradation processes were explained and discussed, by using Bhutanese examples. In total about 100 extension agents were trained in diagnosis of erosion and landsides.

Step 3. *Mapping of land degradation on geog level based on EAs experience*: The extension agents were requested to map the occurrence of gully erosion and landslides in their mandate area with colour sketch pens. Land-use maps on block level were made available. For the mapping exercise, thresholds for mapping land degradation were explained (i.e. minimum degree of land degradation required in order to qualify for mapping). In addition, EAs were requested to indicate the trends and causes of the different types of land degradation. Some EAs relied on their past observations and perceptions, while others returned to their blocks and did the mapping exercise by means of field observations and/or discussions with farmers.

Step 4. *Regional land degradation map by digitising the EAs maps:* A compilation of all the individual EAs maps via GIS resulted in a regional map for soil erosion and landslides for Eastern Bhutan.

Step 5. *Selection of degraded blocks, and within each selected block a selection of one (or two) degraded village for further study:* In each of the selected blocks, one large village or two small, similar and nearby villages were selected. It is important to remark that the selected blocks were not aimed to be representative or 'average affected blocks'. Instead, sites with more advanced land degradation symptoms were selected for a number of reasons:

- Land degradation can be most easily observed and analysed when land degradation processes appear in full severity.
- Assuming that land degradation is accelerating in Eastern Bhutan, it makes more sense to survey more degraded villages. In this way, findings of these more 'advanced' villages can become useful for presently non-degraded but threatened villages. However, sites, which appeared to be quite unique in the degree and type of erosion, were avoided.

In total, 9 blocks were selected covering the sub-tropical and temperate zones (elevation range: 900 m a.s.l.— 2400 m a.s.l.). There was a great variation in slope angles of agricultural fields, but on average the slopes were gentle to very steep (25%—60%).

Step 6. *A rapid and participatory land degradation survey:* Each survey took about 2.5 days each (excluding transport) and was conducted in close co-operation with the EAs. The survey focussed on land degradation processes, farmers' perceptions of land degradation and farmer coping strategies. The type of collected information is shown in Table 1. Information was collected by means of visual methods borrowed from RRA and PRA (e.g. matrix scoring, trend voting, transect walk) and own field observations. This approach enabled the facilitators to probe into issues and to stimulate discussions with small groups of farmers (on average between 3 to 8 farmers per group). However, the exercise was not completely free rolling. The objectives of the exercises were well defined in advance, while formats to note down the collected information were prepared. To crosscheck collected information, each exercise was done twice and where possible verified with field observations. Therefore, the exercise could be called a 'guided RRA'. At the end of the exercise, a preliminary analysis of the land degradation process was conducted and possible solutions were identified with all the facilitators. Where possible, these results were discussed with the farmers.

Step 7. Briefing of the district agricultural officers about the obtained results, and sending draft report to the respective district and block EAs for comments.

Step 8. Finalising the land degradation report.

Table 1 Summary of the information gathered during the land degradation field exercises

FOCUS	ISSUES	INFORMATION SOURCE	
		Farmer information	Field observation
Farming systems and livelihoods	Trends in assets and livelihood sources (past + future).	x	
Land degradation	Trends (past + future).	x	
	Causes.	x	x
	Effects (for different land-use types).	x	x
Soil conservation (SC) measures	Starting date of SC methods + trends (past + future).	x	
	SC methods for different land-use types.	x	x
	Effectiveness of SC for different land-use types.	x	x
Analysis	Preliminary analysis of land degradation.	Based on the above information	

4 Results

4.1 Land degradation analysis

Land-use dynamics

From the case studies, it emerged that important changes in the farming systems of Eastern Bhutan have taken place during the last 30 years. The pressure on natural resources has increased considerably due to the rapid growing human and cattle population and improved market access. This pressure has partially been absorbed by expansion of the agricultural land, but more important was the increased intensification of land use. Intensification was obtained by higher productivity on smaller landholdings and by change in land-use type (i.e. evolution from shifting cultivation to dryland, and where possible to wetland and fruit orchards). As a result, the sources of livelihood were gradually transformed. The income from cereals and local products (which could not compete with substitute products) declined, while income from horticultural crops, non-farm activities and commercial non-timber forest products has steadily increased. The transition from a subsistence economy to a mixed market-subsistence economy resulted in improved standards of living and can certainly be considered a success story. However, this success also came with a price. The more intensive use of natural resources in fragile ecological environments led in certain cases to land degradation. Nevertheless, crop damage by wild animals, diseases and pests are generally considered as more important crop constraints then erosion and soil fertility decline.

Causes of land degradation

It was striking that for the majority of the observed cases, erosive runoff was generated outside the affected fields. Especially hillside irrigation structures and areas with low cover and high soil compaction are important sources of runoff (e.g. degraded pasture, forest litter collecting areas without undergrowth, deforested and burned hill slopes, paths and residential areas). Important in-situ field factors which contribute to erosion are: low soil cover, slope concavity, and long & steep slopes.

In the field, it was not always easy to make a distinction between natural and human-induced landslides, as these factors often interact. However, the most important causes for land-use induced landslides were steep slopes, unstable soil, deforestation, increased water infiltration and uncontrolled gullies. In a few cases, landslides were developing in huge livelihood-threatening ravines, which were cutting as a knife through the landscape (Gurung *et al*., 1999).

During the field surveys also symptoms of 'tillage erosion' was observed. Tillage erosion is the downslope movement and rolling by soil caused by the tillage movement and gravitational forces. This phenomenon can be most easily recognised by the 'tillage steps' at the top of a cultivated field. As tillage steps expose subsoil, they generally show a redder colour and a more compacted topsoil than the rest of the field. As a consequence, soil fertility at the tillage step is lower, while fertility at the bottom of the plot gradually increases (Turkelboom *et al*., 1999). Tillage erosion was most frequently observed in steep dryland fields which were cultivated for several decades.

Geographical distribution of land degradation

The mapping exercise showed that soil erosion and landslides is taking place all over the Eastern region, but for very different reasons:

- Southern tropical belt: In the southern region, the occurrence of water erosion and landslides are linked to the high and intensive rainfall. High intensity storms are very common in the south (on average more than 30 storms ≥20 mm/24h per annum). As soil erosion is mainly controlled by high-intensity storms, there is a high risk for soil erosion. However, abundant tropical vegetation is preventing the widespread occurrence of erosion. As such, erosion is mainly taking place at places with low soil cover (i.e. agricultural fields and rural infrastructure). In contrary to soil erosion, landslides are induced by prolonged, heavy rainfall. An annual rainfall between 2,000 mm to 3,500 mm, a high incidence of heavy storms (at least 2 storms per year of 100 mm/day), a dominance of phyllite and schist, and geological unstable foothills (*Siwalik*) explain the frequent occurrence of landslides.
- Middle mountains: Although rainfall intensity and total rainfall is significant less in the middle mountains, erosion and landslides are still frequent. Important factors leading to land degradation are: steep and long agricultural land, deforestation around high-populated areas, poor management of irrigation water, rural infrastructure and the presence of phyllite and schist (prone to sliding).
- Alpine area: Although no site was selected for this survey, previous observations indicate that also this area is prone to erosion and sliding. Rainfall intensity is assumed the lowest in the region, but erosion can still take place due to the lack of vegetation. Land-use induced landslides are mostly found in degraded pastures. However, most landslides in this area are associated with natural denudation processes.

Trends in land degradation

Most interviewed farmers indicated that the occurrence and intensity of water erosion and landslides has been increasing during the last 30 years. This is probably a correct assessment if one considers the major land-use changes that took place during the last few decades. The most important changes related to land degradation are: population growth, deforestation, the expansion of dryland to more marginal land, the increase of wetland area, the more intensive land-use and the expansion of rural infrastructure. Some farmers associated this environmental degradation with a decline in religious beliefs among the younger generation and the ceasing of certain religious ceremonies.

4.2 Indigenous land management strategies

The survey indicated, contrary to common believe, that there is a wealth of indigenous soil conservation measures (e.g. stone walls, diversion ditches, gully stabilisation, reclamation of slipped land). An interesting feature is that the so-called soil conservation measures are often multi-purpose. Some of the measures were even not intended to control erosion (e.g. border strips), but have an erosion-controlling side-effect. The advantage of these measures is that they are simple, easy to maintain and well-adapted to the local agro-ecological environment. When the soil conservation measures are well established, they can control erosion very efficiently. However, when the soil conservation measure is poorly maintained, it is possible that it will create additional erosion. For example: gaps in buffer strips and unlevelled terraces can lead to a concentration of runoff.

In some special cases, it was observed that erosion was used to increase soil fertility. We came across three cases, where farmers harvested fertile soil from a residential area, a staple or a burned hillslope via runoff. With every severe rainstorm, soil mixed with organic litter flushed down, which then (partially) sedimented in an agricultural field. One farmer at Jarrey claimed that the soil fertility of her field could be maintained solely by this type of 'village fertilisation' and by manure dropped by cattle returning to the village.

In contrary to soil erosion control measures, we observed relative few measures to control or stabilise landslides. Nevertheless, there were a few interesting exceptions, where farmers were successful in stabilising a slided area successfully. Examples are: planting useful trees along the escarpments, reclaiming the slipped land for agriculture by stone terraces, leaving the land adjoining to a landslide/ravine fallow, and performing a religious ceremony to chase away the evil spirits which cause landslides.

5 Guidelines for a soil conservation strategy for eastern bhutan

From this rapid survey it became clear that when erosion or landslides are threatening livelihoods, land-users do respond by taking land-conserving measures. This is according the thory of 'induced innovation' (Binswager and Ruttan, 1978). However, there are often constraints that inhibit farmers to take action. Most important constraints are:

- Erosion and soil fertility decline is considered a less urgent crop constraint, compared to wild animal damage and pest & diseases.
- Impact of erosion is often not visible in the short term.
- Land degradation was often observed in common land, but the 'open-access' regime (where nobody is really responsible) often prevents the community to take constructive action (Ostrom, 1990).
- When runoff is generated upslope, then it is often difficult for downslope land-users to control erosion and landslides in their fields.
- When land degradation is caused by other stakeholders (e.g. erosion or slides caused by roads, irrigation channels or construction sites), then most farmers expect government agencies to take remedial actions.
- When landslides occur, farmers often lack technologies for stabilisation and rehabilitation.
- Based on the survey observations, it could be recommended that a future soil conservation strategy should contain the following components:
- Using or improving existing indigenous measures should be the starting point for any soil conservation program in Eastern Bhutan.
- Only if no local solution is available, outside technologies should be considered. It is very useful to ask farmers for feedback about alternative conservation measures at the early stage. This feedback will help to screen out the feasible options out of the solutions suggested by outsiders.
- In fields with severe tillage erosion, soil fertility improvement measures should be considered for the upper parts of these fields.
- A soil conservation program should avoid blanket recommendations, but measures should be based on field observations of susceptible sites.
- Possibilities and criteria for 'using' erosion for nutrient harvesting should be explored.
- A soil conservation program should take into consideration the geographic diversity of causes for soil erosion and landslides (southern belt, middle mountains and alpine zone).
- Where degradation is severe and the soil conservation is not feasible, alternative profitable and sustainable land-uses should be explored.
- Crop constraints, which are perceived more important by farmers, should be addressed at the same time while promoting soil conservation.

- When degradation goes beyond the private land, the community should be involved by using community based natural resources management (CB-NRM) strategies. If other stakeholders are part of the problem, they should be urged to join the stakeholder group to find a solution.
- Finally, awareness campaigns will help to alert farmers in the early stages of land degradation (e.g. posters, video, inviting farmers to visit a very degraded site).

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