

# WATERSHED MANAGEMENT IN BHUTAN

Binayak Bhadra<sup>1</sup> and Philippe Alirol<sup>2</sup>

*(International Centre for Integrated Mountain Development<sup>1</sup> and Chamonix, France<sup>2</sup>)*

---

## Introduction

The patterns, intensities, and modes of resource utilisation in Bhutan may be examined in terms of human interventions, such as the traditional subsistence sector activities, modern commercial/economic activities, and infrastructure-building activities. Data on household natural resource interactions is scarce and the more readily available macro-level data leads to generalised conclusions. This constraint has led to the analysis of typical farming systems, that have been arbitrarily chosen to represent a continuously changing spectrum of practices ranging widely between plant and animal breeding, rather than a specific watershed case study.

The pastoral system is prevalent at high altitudes, called the yak-zone, and is based on raising yak and sheep. The yak herders lead a semi-nomadic life moving from one habitation to another, dictated by the availability of fodder. In each place they cultivate a small amount of land for barley, millet, and buckwheat. Growth rates for yak population were higher than expected during the period 1976 to 1980 because a family needs the support of more animals as their individual productivity falls due to decreased fodder availability. This, of course, creates a vicious circle. Also, where in the past diseases periodically decimated a herd, the popularisation of veterinary medicine and vaccines have upset this regulatory mechanism and the population may well exceed the carrying capacity of the pasture, even in the yak-zone. The higher pastures lack nutritive grasses but at a slightly lower altitude, where animals are grazed in the winter, there is the potential for productivity improvement.

## Outstanding Issues

The provision of winter fodder is a problem in almost all of Bhutan, and is caused primarily by land overuse. Grazing rights have to be obtained from the Government on a perpetual year-to-year payment basis but some winter pastures have become common property, open to grazing by all. Soil fertility and climate indicate a good potential for productivity improvement but until the pasture grazing can be better regulated, this will not be realised. It calls for a rejuvenation of the local traditional institutions to monitor pasture grazing.

The agro-pastoral system combines animal husbandry with cropping activities. Land use emphasis is on pasture. It is practised mainly at the middle altitude level, known as the wheat-barley zone, but overlaps into the rice cultivation zone.

The animals, predominantly cattle, goats, and sheep, are grazed from one forest to another to exploit the complementary forest fodders. There is as yet no assessment of carrying capacity but the forests that are used all year round appear to be losing their regenerative ability. This can cause more deforestation in the long run than fuelwood or timber extraction. The situation is not improved by pasture and forest burning as less and less time is being allowed between each consecutive burning because of the population pressure on the land. Winter fodder availability may improve if farmers use irrigated fields in between cropping, to grow their own.

Maize is the major crop grown in the dry lands and rice is grown lower down on the wet, irrigated valley terraces. Shifting cultivation, or *Tsheri*, is common and although the tendency has been to expand the cleared area, government discouragement and household labour constraints have put pressure on the people to simply reduce the duration of the rotational cycle. Productivity of the soil is progressively reduced through over-cultivation and also through bad terracing methods which lead to topsoil and nutrient loss in the monsoon period.

A possible solution to this decreasing productivity lies in improved irrigation, although gravity canals are already constructed with extraordinary skill, and also through the careful use of fertilisers. It would be possible to develop small reservoirs and combine them with lift irrigation, but cattle dung, being an obvious fertiliser, cannot easily be utilised because cattle are grazed in the open and are often moved, making the collection of their dung a difficult task.

Finally, productivity levels could be raised with the use of more modern farming tools but it should be stressed that the present rudimentary, wooden ones do have the advantage of not digging deep thereby preventing wind erosion of the deeper soil that is richer in organic nutrients. Deeper cultivation techniques would be unwise without the attainment of better irrigation, manure, and soil cover, during the windy seasons. The main handicap in all these suggestions for improvement is labour scarcity.

At lower altitudes, an agricultural system is practised where rice paddy cultivation is predominant. The climate is also suitable for winter wheat and horticulture. The area is known as the rice zone and suffers from deforestation and a lack of irrigation which eventually implies a severe reduction in the availability of fuelwood and animal fodder. Cropping intensities vary over Bhutan and are dependent, primarily, on labour availability. In some areas, the maximum crop yield is maintained throughout the year, and in others, lack of manpower has led to paddy being established over a six month period, and harvesting being drawn out, often precluding winter wheat.

Although there has already been some progress, more improvements in terracing, irrigation, and the use of fertilisers, could still be made in the rice zone. The Government is focussing on the intensification of land use rather than its extension. This would entail improvements such as wider terracing and contour building, with the support of strengthened farmer organisation to maintain and operate irrigation schemes. A serious effort is being made to form compost and litter into effective fertilisers.

Livestock in this area are grazed, where possible, in pasture and forests. But where these have become degraded beyond use, crop residues, particularly straw, are used. Fodder scarcity is a nationwide problem. The approach should be to use traditional regulatory institutions and arrangements and community participation, so that forest grazing can be made less harmful to the tress, for example, through rotational use.

Despite heavy use of forests and pastures, and the generally fair to poor quality of the vegetation, particularly in pastoral areas, there is very little evidence as yet of severe erosion in Bhutan. Erosion is most pronounced in areas of winter pasture, where excessive grazing and fuelwood extraction, combined with a dry, windy climate, has led to the loss of the fine topsoil that has been loosened by animals' hooves. However, the loss of production from pastures due to the practice of pasture burning, combined with the climatic conditions, has weakened the vitality and vigour of trees in surrounding areas, and this implies long-term damage. Deforestation also takes place higher up in the yak zone, but here heavily used pastures have been taken over by more tenacious bamboo bushes which provide an effective shield against erosion.

*Tsheri* cultivation can have a direct and indirect effect on the watershed; although *Tsheri* patches are often surrounded by trees which provide a certain degree of shelter, the wind can move fine particles of soil and ash quite a long distance. Where the pasture is burned, organic plant nutrients are converted into inorganic, soluble salts that are carried away by streams during the rainy season and the nutrient loss is high. Indirectly, *Tsheri* effects the hydrological regime in terms of runoff and water yields, but these do not attain significance until the land under *Tsheri* becomes a large part of the total area of the watershed. They depend upon factors such as soil and ground porosity and the geology of the area, and there is a lack of data on this.

Severe erosion is often caused by sloped land cultivation, but in Bhutan, particularly in the south, the terraces are usually level. This, however, makes them prone to saturation during the high intensity rains, resulting in damage that requires the work of many people to repair.

Commercial use of watershed land seems to have had a limited detrimental effect so far. The main cash crop has been potatoes, and orchards have been developed; both of which are generally harmless to the watershed, but in southern Bhutan the development of orange orchards and cardamom fields has been accompanied by a land encroachment process that could cause landslides and erosion.

Although the Government earns 9 per cent of its total receipts from royalties and taxes on forest, commercial logging was restricted so that some formal management could be set-up to ensure that only particular species of trees are extracted and only from designated areas. The government wants to maintain 60 per cent of the land under forest but although inaccessibility protects overaged trees in northern Bhutan, logging extraction in southern and eastern Bhutan has denuded many hills that are now susceptible to landslides and erosion. A veneer and sawmill complex at Gedu, that was set up by the Government with assistance from UNDP, requires quality logs, most of which, they cannot get from the stipulated logging areas of forests. Moving further afield and increasing the scope of the logging area would entail certain environmental damage, and would also increase the level of investment needed in infrastructure.

Lemon grass oil has a good market and there is a small distillery plant in the Mongar District, to extract the oil from the grass. Mature grass which is not relished by animals for grazing is used, but it does provide the needed ground cover in light of the dry climate and the fragility of the ecosystem where it grows. The stills also use a substantial amount of fuelwood, so the extraction of both raw materials must be regulated and monitored.

There is a real danger related to the pine resin-tapping that occurs mainly in eastern Bhutan. Excessive resin-tapping can weaken the trees and make them even more prone than they already are to disease and fire. Consequently, the deforestation that results would leave the land open to erosion.

The presently adopted pasture improvement strategy consists of identification of suitable pockets for pasture development, through fertility management and pasture-seeding. However, the most significant pasture-improving activity would be grazing management, as well as seeding and the introduction of *Rhizohium* inoculated clover seeds.

Hydropower development has been taking place in two complementary directions, the development of small plants distributed near population centres and large single projects, of which the Chukha Project is the largest with an investment of Nu 2,000 million (Bhutanese currency) and a peak power output of 336 MW. The project is a runoff river scheme with tunnel and power house built completely underground. The tunnel provides a 465m drop between Chimakothi and Chukha and the water is delivered through two intake shafts. The project is

designed with an elaborate desilting chamber, so apart from the high dam, the project construction does not create any surface disturbance, minimising erosion and landslide hazards.

Road building in Bhutan has progressed rapidly. The process of construction itself does not appear to have disturbed the environment too much, although a minimum amount of surface damage is unavoidable. In a few exceptional instances, landslips have taken place on the road and some culverts have created erosion down stream, but the effects are very localised. Black-topping activities induce a certain amount of tree-felling due to the fuelwood requirement for heating and melting the bitumen. This is normally not very significant because road construction through forested areas of Bhutan entails felling trees on the alignment, that can be used as fuel. At present, fuelwood demand for black-topping is nominal but this factor can have significance in the future when more tarred roads are constructed.

### **Programmes and Policies**

There is a high degree of concern for the conservation of the natural environment in Bhutan, illustrated by many explicitly stated policies with regard to forest, land, or pasture conservation. A move to completely prohibit commercial tree felling in 1979, was partly on account of the need to maintain ecological stability through adequate forest cover and partly to ensure a good economic value for forest wood and timber. Similarly, explicit policies were adopted regarding land and pasture resources, arising out of the realisation that human and animal population pressures are rising rapidly, and that if over-exploitation is allowed to continue soil fertility will decline and there will be significant danger of erosion. However, there is no clear coordination between these sectoral policies. Therefore, what is needed is a mechanism for coordinating all resource conservation policies within a national policy. Such a mechanism could be provided within a multidisciplinary planning framework, based on the principles of watershed management.

National policies for agricultural development are handicapped by lack of accurate and reliable data, particularly on land capability. Classification of the latter would make it possible to adopt the optional land use policy commensurate with the respective carrying capacities of good, average, and marginal land. Thus areas most suitable for afforestation, pasture development, and intensive cultivation, could be determined. The lack of resource data means that an integrated framework of policy analysis can not be made effective.

The other important policy gap relates to the identification of areas which, although small, erode noteworthy amount of soil/silt into existing rivers. These hot spots can be comparatively easy to control provided that accurate information on them is obtained. In Bhutan, where the majority of the area in the watershed is relatively trouble free, extra effort can be focussed on selected areas. This management "by exception" would not only mean reduced outlay in watershed conservation activities but could also provide benefits through prevention of greater damage that may accrue if the hot spots are left unattended. Policies dictating preventative measures appear to be most appropriate in Bhutan as the present overall conditions of the watershed do not create any alarm.

There has not been a project that can be considered an integrated watershed management scheme in Bhutan. There are proposed schemes; such as the Intensive Area Development Project, that are testimonies to the existing awareness of the need to have integrated schemes, but so far the control of the watershed has been through a series of seemingly unconnected measures in the fields of land development, resettlement, irrigation, animal husbandry, pasture development, and forestry.

In land development, soil erosion has been reduced through terracing, contour building, drainage channel construction, and also the promotion of compost and fertiliser application to maintain the quality of the soil. However there is still a lack of supply of complementary farming inputs and arrangements made for marketing the outputs.

The resettlement programme was launched with the aims of reducing population pressure on land, and locating people in areas with easier access to rural services. Implementation of the programme may have suffered on account of data and information gaps on land capability and soil productivity. This reinforces the need for adequate project planning and evaluation data, and scientific research at the project level.

The Small Farm Development and Irrigation Rehabilitation Project has renovated and constructed irrigation systems with training built into the programme. Other existing schemes include the Taklai Irrigation Scheme assisted by UNDP and the Gaylegphug Area Development Project assisted by the Government of India. Watershed management components have been included and prospects look good, but problems have arisen because of inadequately performed soil surveys and analysis.

The focus in the animal husbandry sector has been on scientific breeding and the introduction of improved husbandry practices. Very little has been allocated to develop pasture resources, and this may need to be increased and grazing rights defined, so that the most effective use can be made of the pasture available through rotational grazing.

The main objectives of the present forestry schemes are to fill data and information gaps to prepare for conservation and management plans and to set-up industrial and production plans designed to increase the value of wood and wood products currently being exported from Bhutan. Filling data gaps has been quite successful so far, due primarily to the Pre-investment Survey (1974-79) carried out with Indian assistance, and has been considered adequate for the preparation of broader conservation and management planning and strategy. The location of industries has to be carefully planned because of the high cost of transportation of the timber. This demands detailed information on existing and potential forest resources, combined with data on external markets, so as to maximise the benefits to Bhutan. Thus, data gathering, market research, and product innovations, are all needed to fill the present gaps. However, the most critical gap appears to be the absence of the work standards that have to be followed in all activities related to logging operations in the fragile environments of Bhutan, so that problems can be prevented from the start.

## **Conclusions**

Watershed management efforts in Bhutan relate mostly to preventative measures augmented by the treatment of hot spots for the reduction of erosion, landslides, and nutrient loss. The need for coordination between the schemes will grow fast and it may become necessary to have a separate institution which will specialise on watershed management activities. There is also scope for improving the policy analysis and implementation capability of various central and line agency institutions. This requires data and information on land use, climate, household level resource use, human and animal population statistics, demographic parameters, and soil classification. The priority in agriculture is accorded to the development of land and soil conservation activities; linked to this should be a strong policy on afforestation and pasture improvement.

The institutional development as well as the potential impact of the various schemes proposed, needs to be examined. This is important, particularly in Bhutan, where resource use policies are based on sectoral concerns of line agencies. It will require a further understanding of the interaction between biological and physical processes; for example, research should be done on the extent to which *Tsheri* cultivation has an adverse effect on soil fertility. There should be applied research into the productivity of specific types of pasture and forest lands; the latter with regard for its use as winter grazing and as a source of timber

Records must be maintained relating to the production levels of the various crops, legumes, and fodder. Data is not available either on the productivity of livestock, particularly hybrids and crosses, under different feeding arrangements. Some areas of Bhutan suffer from strong winds and it is not clear to what degree topsoil loss is taking place. In these areas research on wind erosion should be a priority.

No specific training exists in watershed management at present. Such training would particularly benefit many lower level technical staff in departments such as agriculture, animal husbandry, and forestry. There has been limited training in topics related to soil and water conservation at the Kunglung Training Institute and the Lama Gumpa Forestry Training Centre has provided basic groundwork with an introduction to ecological principles. More emphasis should be put on practical community and social forestry. If farmers, who are trained at departmental farms, are taught watershed management techniques together with basic animal husbandry and agriculture, farming practices may improve substantially in the future, both from a productive and ecological point of view.