Agricultural Land-Use in Eroding Uplands: A Case Study in the Philippines

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Keywords: Farming systems — Farmers' landform and soil classification — Land-use — Erosion

«Sa pira ka adlaw maubos ang lupa kang tubig kag wara't lupa nga mabilin kag ang mga tawo sa Valderrama maagto sa America kag ang mga taga America maagto sa Valderrama»

Anthony R. Tamba, 8 years (farmers child)

(One day the water will eat all the soil and nothing will be left, and the people of Valderrama will come to America, and the Americans will come to Valderrama)

Summary

As part of a farming systems' study, a survey of the agricultural land-use in Valderrama, a mountainous municipality of Antique province in the Philippines, was carried out. Farmers' landform and soil classification proved to be a good key to understand the land-use in relation to the erosion and the colluviation or alluviation processes.

Farmers pointed lack of financial support, soil erosion, poor road infrastructure, and high population density as major development problems. Sheet and rill erosion are prominent on sloping land and determine the field location, the type of conservation measure and the type of crops the farmer will opt for. River bank erosion is an important problem in the valley bottom, often destroying the best agricultural land. Farmers developed a method to reclaim part of these losses. As a consequence of population pressure and limited availability of suitable land, some farmers are obliged to rely on soils highly susceptible to erosion. Locally severe gully erosion was observed on abandoned terraced land. Farmers explained to have given up its maintenance, due to depleted fertility. The soil chemical analyses indicated low pH and very low phosphorus status in this area.

Résumé

Dans le cadre d'une étude des systèmes agraires, une analyse de l'utilisation des terres à Valderrama, une municipalité montagneuse de la province Antique aux Philippines, a été effectuée. Connaître la classification des types de relief et des sols des agriculteurs s'est avéré utile pour comprendre la relation entre l'utilisation des terres et les processus d'érosion et de colluviation ou d'alluviation.

Le manque de support financier, l'érosion, l'accessibilité limitée de la région et la pression démograpique ont été identifiés comme problèmes majeurs de développement par des agriculteurs. L'érosion en nappes et en rigoles est prédominante sur les pentes. Elle détermine l'emplacement des champs, ainsi que les mesures conservatoires et les types de cultures que l'agriculteur applique. L'érosion des berges constitue un problème important dans le bas-fond des vallées, détruisant souvent les meilleures terres. Néanmoins les agriculteurs ont développé une méthode afin de récupérer une partie de ces pertes. En raison de la pression démographique et de la disponibilité limitée de bonnes terres, certains agriculteurs se voient obligés de mettre en culture des sols fortement susceptibles d'érosion. L'érosion en ravines dans un stade avancé a été observée, cause de terrasses abandonnées. Les agriculteurs expliquaient avoir abandonné leur utilisation et maintien suite au déclin de leur fertilité. Les analyses chimiques démontrent une forte acidité et des valeurs très basses en phosphate.

1. Introduction

With the increased awareness of problems evolving from environmental degradation, development projects set up nowadays are aiming at promoting «sustainable development». In order to conceive appropriate and sustainable development policies and research needs, understanding the potentials and limitations of the agricultural systems, and their socio-economic settings, is essential.

Land degradation and erosion are prominent problems in mountainous tropical regions. The present paper aims at highlighting these problems in a specific region of the Philippines, with particular interest to farmers' perspective. It is becoming a common ground that the knowledge systems of traditional peoples' management of natural resources can be a worthwhile source of information (e.g. (12)).

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Received on 25.10.1993 and accepted for publication on 12.10.1994.

A farming systems' study was conducted from April to July 1992 in the municipality of Valderrama, Antique province, as part of the training course organised by the International Centre for development oriented Research in Agriculture (ICRA). Previously conducted farming systems' studies in the region were all carried out in less remote areas (3, 4, 5, 6, 7, 8 and 13). The general objectives of the study were to identify specific constraints for agricultural development and to formulate recommendations for further research and development relevant to the upland areas of the province.

Antique is one of the four provinces of Panay island in the Western Visayas. Valderrama is approximately 40 km north of the provincial capital San Jose (Figure 1). It is a mountainous area, the elevation ranging from sea level to somewhat above 1000 m asl. Slopes are generally steep, the summits and crests sharp. The Cangaranan, a braided river, further dominates the landscape. The river bed consists predominantly of boulders and gravel. Most of the farming activities take place in the valley bottom on alluvium. The rainy season starts in May and lasts till November. The incidence of typhoons influences the amount and the intensity of the rains. Daily rainfall records for 1984-'85 reported by Tasic et al. (13), show maximum values as high as 200 to 250 mm per day. The mean annual precipitation for Valderrama for the period 1956-1986 is 3366 mm while the mean annual air temperature is 27°C (9).

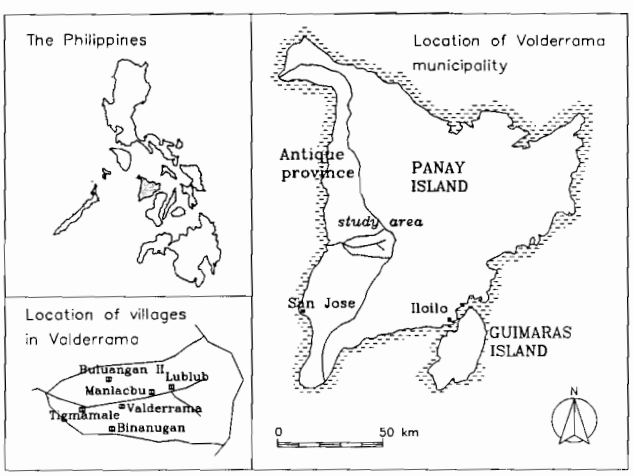


Figure 1 - Location of the study area.

2. Material and methods

In a first phase, a general appraisal of the farming systems was obtained through extensive interviews and field observations. The focus was on one village (Lublub) selected for its representativeness with regard to landscape characteristics and because of its remoteness. The interviews were conducted in 30 of the 207 households of Lublub. The sample was stratified according to farmer's land ownership/tenantship status and the type of land he had access to. This approach enabled to gather in the shortest time, a wealth of information on various aspects of the farming systems. Most prominent problems could be identified and first hypotheses on their causes and relations formulated. These could later be tested for their relevancy in the municipality. The procedure is inspired by the Rapid Rural Appraisal approach (e.g. (11)). The first phase was concluded with a workshop during which the results were presented. Representatives of governmental and non-governmental organisations as well as barangay captains, who represented the farmers, were invited. The workshop served as a validation for the overall picture obtained by the team and to conduct a Causal Tree Problem Analysis (CTPA) with the participants to identify problems and discuss possible solutions. This exercise was inspired by the Goal Oriented Project Planning method (e.g. (2)).

In a second phase, the study focused on specific problems which had been defined through the CTPA. To get a better understanding of problems related to soil erosion, the agricultural land-use was investigated in four villages. Two villages are in the valley bottom (Tigmamale and Manlacbu), while two were selected for their mountainous setting (Binanugan and Buluangan II). A toposequence study was done in each village during which soild characteristics such as slope, soil depth, soil texture and parent material were assessed. The type of erosion (sheet, rill, gully and land slides) and its severeness (from none to very severe) were recorded. Information on the cropping practices was gathered through informal interviews, parallel to field observations. Attention was particularly given to the crop species, the crop arrangement (sole or intercropped), the tillage methods, and anti-erosion measures.

In order to assess the soil nutrient status, soil samples of the upper 30 cm were taken from 12 plots along the toposequences. Eleven samples were taken from agricultural land, taken to be representative for their topographical location. One sample was taken from a reforested area with *Casuaria equisitifolia* for comparison with the agricultural land. Soil pH was measured using a calomel electrode with a 1:1 soil/water suspension. The organic matter content was estimated by perchloric digestion. Relative values of the nitrogen status were obtained using a soil test kit of the Department of Agriculture. Potassium content was determined by flame photometry with sulphuric acid extract of the soil. Phosphorus content was determined according to Olsen's method (10).

3. Results and discussion

3.1. Characteristics of farming systems

The most important crop in the area is wetland rice, which is also the staple food. Farmers will opt to plant rice wherever sufficient water is available, and inputs such as fertilizers and pesticides are almost exclusively applied on these fields (Figure 2). Wherever sufficient water is available, rice will also be grown during the dry season. Else mungbean (*Vigna radiata)* or maize will be planted as food crops. Groundnut, tobacco, onions or sugarcane may be grown as cash crops. Land on slopes above 18% is legally declared as «forest land», though it is mainly covered by grasses, *Imperata cylindrica*. Due to population pressure, farmers have been forced to take this land into cultivation.

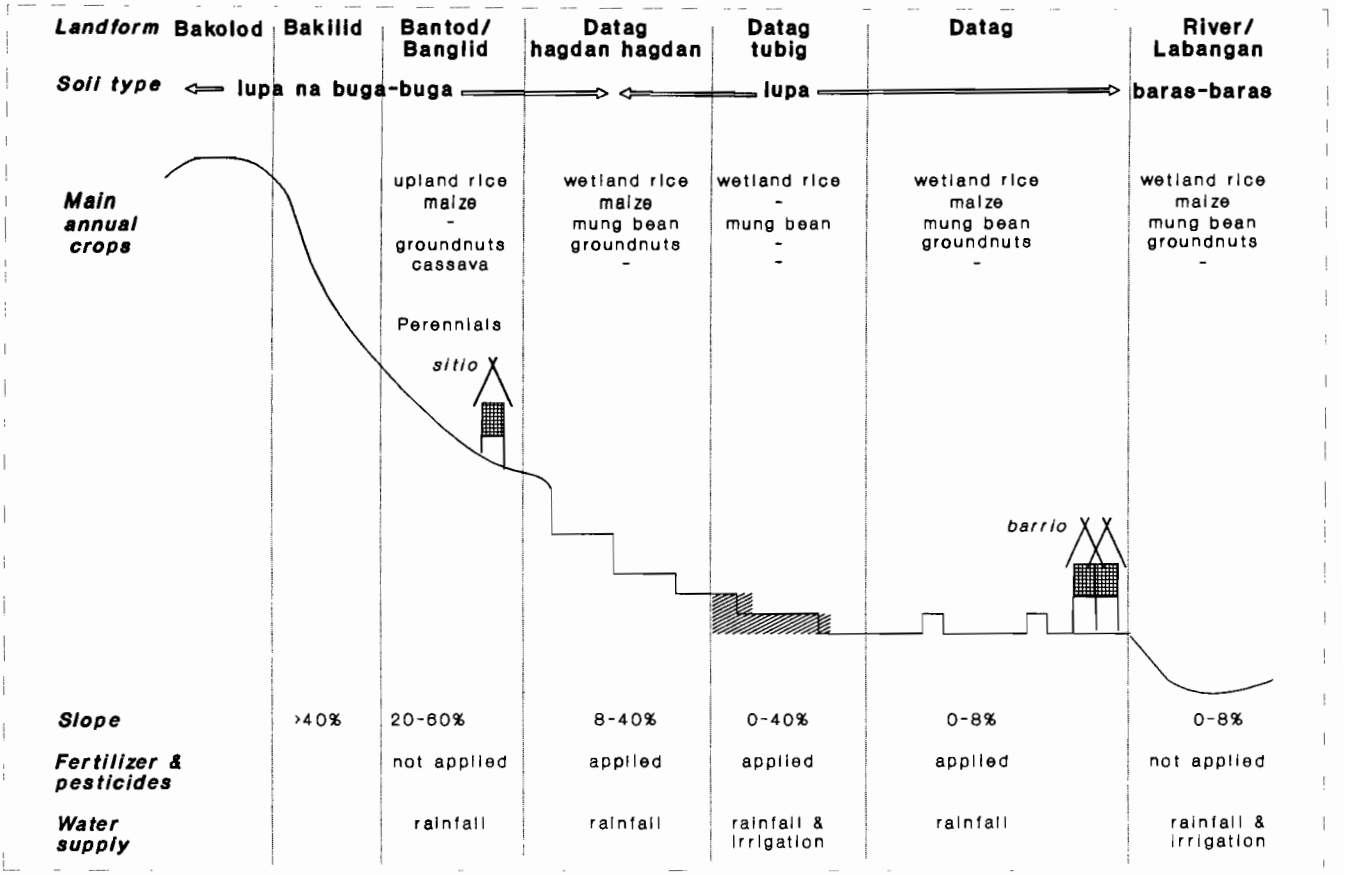


Figure 2 - Farmers' landform and soil classification with corresponding agricultural land-use (based on transect in Lublub).

Many farmers have part or all of the land they cultivate, under a tenancy agreement. Tenants usually share the yield in a 50:50 arrangement with the landlord, after subtracting costs made for fertilizers, pesticides and land preparation. A detailed description and analysis of the cropping and livestock production activities, and related socio-economic aspects, can be found in ICRA (8).

3.2. Problem analysis by farmers

The Causal Tree Problem Analysis (CTPA) done by the farmers' representatives, highlighted the overall problem of malnutrition (Figure 3). It is explained as a direct consequence of low productivity. Four basic problems are recognised by the farmers. The first identified problem is the «lack of money», hampering the development of irrigation facilities. «Soil erosion» is a second perceived problem, causes of which are partially attributed to the «burning of forests», and partially to «inappropriate farming practices». Farmers relate the latter to the insufficient advice they get from technicians due to the poor road infrastructure («lack of Transportation/Roads»), which is a third major problem. Soil erosion hampers the development of irrigation, but may just as well lead to the deterioration of existing irrigated fields. Taking into account the limited availability of cultivable land, high population density «overpopulation» is perceived as a fourth major problem. Farmers point a causal relationship between the scarcity of adequate land (*datag*) and «low productivity». Productivity should here be understood as the total production of the municipality, and not as productivity at field level.

3.3. Farmers' landform and soil classification

Farmers' landform classification encompasses the following units varying according to topographical location (Figure 2):

Bakolod: top of a hill (cultivated or not).

Bakilid: very steep slopes and not cultivated; usually covered by grasses or forest.

Banglid: slopes which are so steep that they cannot be ploughed.

Bantod: steep slopes, but which can still be ploughed.

Datag hagdan hagdan: terraced land.

Datag tubig: either flat or terraced land which is irrigated.

Datag: flat area in the valley bottom with deep alluvial soils, and

Labangan: flat area within or close to the river bed, bunded with stones. This is done to entrap finer sediments so as to reclaim arable land [Photograph 1].

Most of the soils on the sloping areas belong to the Alimodian sandy clays soil series (1), they are Dystric Cambisols. These are the soils on the steep slopes and to some extent, of the higher located terraced land. Farmers call these soils *lupa na buga-buga*, meaning «soils under formation». Dystric Gleysols and Dystric Fluvisols are found on the lower terraced land as well as in the valley bottom and river bed. Farmers call these soils *lupa*, meaning «true soil», and these are the soils where wetland rice is typically grown. Sandy soils, called *baras-baras*, occasionally occur in these areas as well. The most common distribution of these soil types is presented in Figure 2.

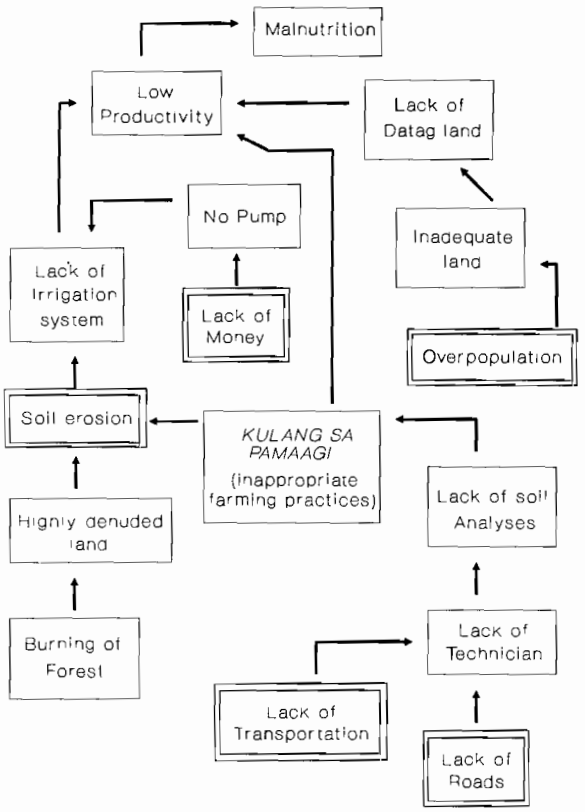
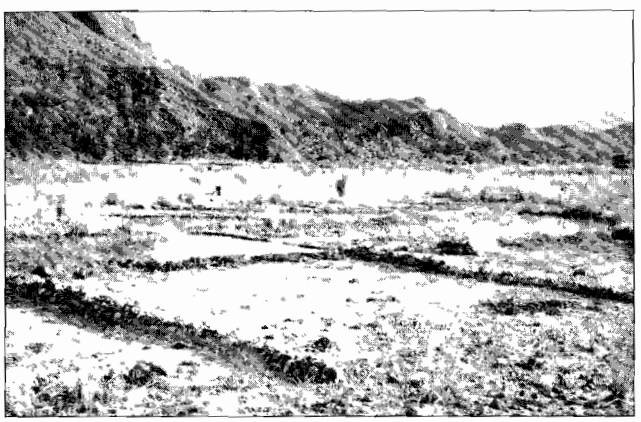


Figure 3 - Causal tree problem analysis diagram as perceived by farmers' representatives.



Photograph 1 -
Labangan: land under reclamation.

Farmers' landform classification coincides with its actual or potential land-use and is more elaborated than their soil classification. The latter rather reflects the specific soil suitability for wetland rice along with the most striking soil properties (texture, profile depth and drainage status).

3.4. Land-use on the major landform types

The following paragraphs describe the land-use on the major landform types as presented in Figure 2.

Banglid and *Bantod* land. On steep sloping land, upland rice varieties, cassava, maize, sweet potato, groundnut and banana are the most common crops. Banana and cassava are usually grown at the steeper ends bordering the fields. Often observed intercropping arrangements are: rice and maize; rice, maize and banana or cassava; groundnuts and maize.

Datag hagdan hagdan land. Farmers terrace land for the cultivation of wetland rice. The terrace walls are made of earth, usually covered with grasses. Sometimes trees are grown on the terrace bunds, most commonly coconut trees. Farmers were found less willing to terrace land which they had under tenancy, because of the long term uncertainty of its use.

Datag tubig land. Irrigation water is supplied by gravity, mostly through unlined channels taping from small springs. Only in one village (Tigmamale) an off-take structure and a cemented channel system exists. The use of water pumps was not observed in the municipality, in contrast with the lowland areas along the coast were the use of diesel pumps seems to be wide spread.

Datag land. Land in the valley bottom is predominantly used for the cultivation of wetland rice. Only in the dry season when there is not sufficient water for rice, other crops like onion, tobacco, mungbean or groundnut are grown here.

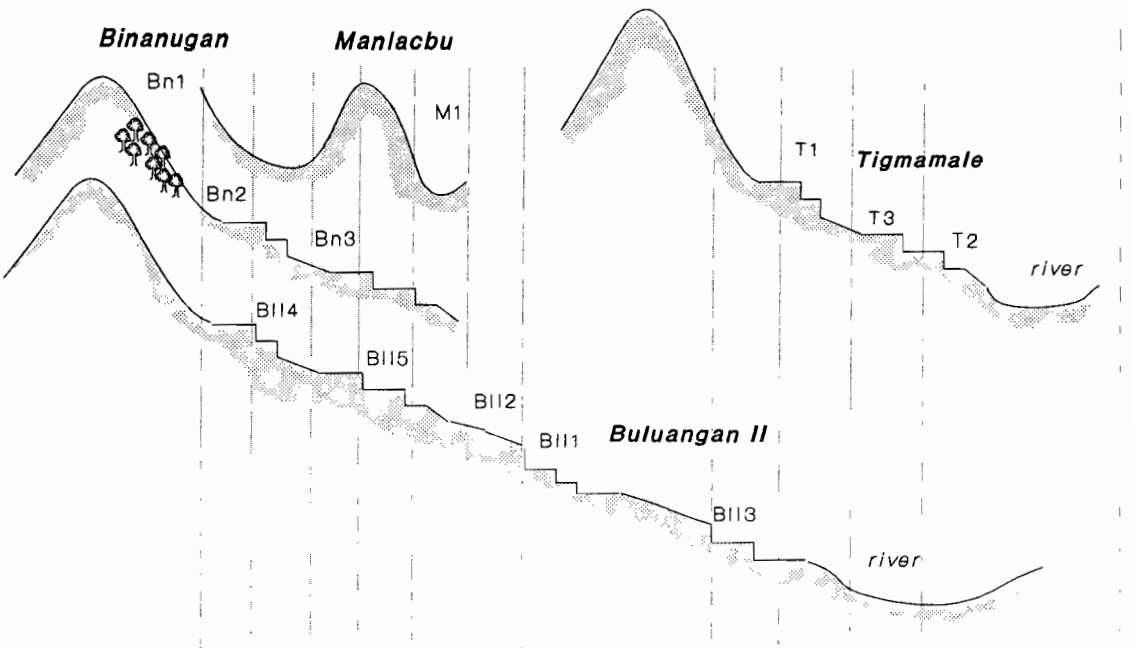
Labangan land. Crops most often grown on land under reclamation are rice, maize, groundnut and mungbean or it might be used as pasture land. Crops will only be planted at the beginning of the rainy season, if the likelihood of the parcel to be flooded is low. Hence, some of this land might be used for three crops a year, while some might only be suited for planting from August onwards, i.e. after the peak of high intensity rainfall. Farmers often reported that their *labangan* used to be *datag* land that had been destroyed by the river, and only after several years were they able to reclaim it.

3.5. Soil characteristics

The soil depth of areas which were not affected by erosion was generally at least 50 cm; under forest cover even up to 72 cm on slopes as steep as 80%. Soil texture was mostly fine textured (clay, silty clay or silty loam) (Figure 4). The parent material was either mudstone, shale or sandstones.

As can be seen in Figure 4, the soils were slightly (pH 6.0-6.7) to moderately acidic (pH 5.6-5.9). The sample collected in the forest (Bn1) was strongly acidic (pH 5.0). All but two of the twelve samples had medium values for the organic matter (OM) content, ranging from 2.0 to 3.5%. The highest OM content (3.5%), coinciding with the lowest pH (5.0), was found under forest cover of *Casuarina equisetifolia* (Bn1). Medium values were obtained for the nitrogen content for almost all fields, except for the forest soil and for one sample taken from a field planted with mungbeans (Bn3) which had high values. Both mungbean and *C. equisetifolia* have the potential of fixing atmopsheric nitrogen.

All the soils samples had moderately high (160 ppm) to high (240-320 ppm) or even very high ratings (>350 ppm)



Evidence of erosion	-	-	+	-	++	+	+	++	-	-	-	-
Slope (%)	80	22	27	15	27	15	80	30	8	20	3	2
Soil depth (cm)	72	20	100	60	20	50	72	50	50	50	50	50
Texture	SC	SiL	SiL	C	SiL	C	SiL	SC	C	SC	LS	LS
pH	5.0	6.1	5.8	5.9	5.6	6.1	6.5	6.7	6.1	6.0	6.4	6.5
Organic Matter (%)	3.5	1.5	2.0	2.3	2.0	1.5	2.0	2.0	2.5	2.5	2.0	2.5
Nitrogen	H	M	M	H	M	M	M	M	M	M	M	M
Phosphorus (ppm)	4	27	5	13	4	24	11	10	28	15	20	26
Potassium (ppm)	304	160	432	280	280	560	352	336	608	368	800	624

Figure 4 - Evidence of erosion in relation to soil characteristics (- none, + moderate, ++ severe erosion; SC Silty Clay, SiL Silty Loam, C Clay, LS Loamy Sand; H high, M medium Nitrogen content).

for potassium. The highest values originated all from colluvial material (M1, BII3, T2 and T3).

Nine of the samples soils had medium values for phosphorus, ranging from 10 to 28 ppm. Three samples had markedly low values (two of 4 and one of 5 ppm). These low values seem to be related to their lower pH values (Figure 4). One of these soils was under forest (Bn1). The two others (BII4 and BII5) were in areas affected by severe gully erosion.

3.6. Erosion processes

3.6.1. Sheet and rill erosion

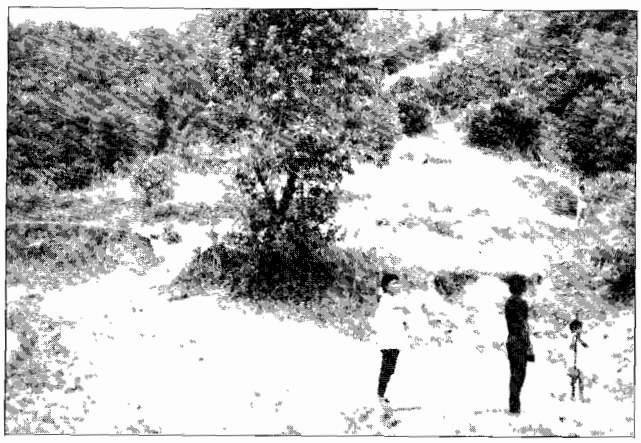
Sheet and rill erosion was observed on almost all fields on steep unterraced land (*banglid* and *bantod*). Farmers have the tendency to locate these fields either at the foot of the hills, where part of the soil particles and soil fertility losses due to erosion will be compensated by colluviation. Alternatively, they will locate them close to the crest where run-off is relatively limited and hence erosion will be restricted. To reduce erosion hazards a diversion ditch is usually provided at the hill side of the field and grass bunds are maintained parallel to the contour lines.

At times, rice fields were observed on extremely steep slopes (60% or more) and at places on very shallow soil, virtually on bare rocks. Some farmers are apparently forced to cultivate under these extreme conditions if they want to make ends meet. In a survey on the rice production, about 59% of the respondents reported not to be able to produce enough rice to cover their own consumption (8). Rice being the stapel food, every farmer seems to grow rice, irrespectively of potential erosion hazards.

Farmers were sometimes observed to deliberately enhance erosion so that the sediments would accumulate on lower lying terraced land or on land which they were converting into terraces. Where the area above the fields was not large enough, farmers explained not to be interested in terracing the sloping land as they would not be able to harness enough water to grow wetland rice. They preferred to leave it like that despite the evident erosion, and to use it for the cultivation of traditional upland rice varieties for which they could get a good price.

3.6.2. Gully erosion

Severy gully erosion was observed in the village of Buluangan II. Farmers explained to have abandoned to cultivate some of the terraced fields because of depleted soil fertility (Photograph 2). They were therefore not interested in maintaining the terraces and did not mind the ongoing erosion. The soil samples taken from these areas (BII4 and BII5, Figure 4) showed relative low pH values and had very low phosphorus status. This seems to confirm farmers' claim on the loss of soil fertility.



Photograph 2 -
Abandoned and deteriorating terraced land due to depleted fertility.

3.6.3. River bank erosion

Of all villages visited, river bank erosion was a very important problem in Lublub. According to farmers, Lublub used to be one of the most populous villages in the area and was known as the rice bowl of the watersehd. However, due to river bank erosion, a great part of its best agricultural land in the valley bottom (*datag*), has been lost. This forces farmers to rely more and more on the steep sloping land and has also stimulated an out-migration. In Lublub, the river is even threatening part of the main settlement and some houses had already had to be moved.

3.6.4. Landslides

Evidence of the occurrence of lanslides was only observed on very steep land and on land which had not been under cultivation. Farmers related related these to earthquake events.

4. Conclusions

Lack of financial support, soil erosion, poor road infrastructure and high population density were pointed out by farmers' representatives as the major development problems, eventually resulting in malnutrition. Farmers' landform classification revealed to be a good key to understand the agricultural land-use in relation to the landscape dynamics. Major landscape processes are:

— sheet and rill erosion on sloping land, and reciprocally colluvial deposition at the foot hills;

— river bank erosion, and alluvial deposition in the bottom valley.

Land-use on sloping land is determined by the risk of sheet and rill erosion. Unterraced fields (*banglid* and *bantod)* are preferably located, either close to the hill crest where sheet and rill erosion is limited, or at the foothills where colluvial deposition will occur. Erosion risk on these fields are further limited by maintaining grass bunds and by providing run-off diversion ditches. *Terraced fields (*datag hagdan hagdan) are only found where sufficient water can be harnessed to cultivate wetland rice. This implies a substantial catchment area uphill, and consequently the terraces act as colluvial traps.

The best agricultural land (*datag*) is found in the valley bottom on alluvium. River bank erosion is a challenging problem to farmers, threatening and often destroying the best of their land. Nevertheless, they have developed a method to reclaim some agricultural land by entrapping sediments (*labangan*).

Farmers' soil classification system is less elaborated than their classification. It directly reflects the suitability for wetland rice cultivation.

Farmers were well aware of erosion problems and in general also able to cultivate in a sustainable way, even on slopes exceeding 18%. Occasionally this seemed to be upset by problems related to the accessibility of land and to the maintenance of soil fertility:

— Farmers were only found willing to make the effort of terracing land when they have some guarantee on the landownership. Moreover, to make ends meet, some farmers have to make use of land which is highly susceptible to erosion.

— On one site severe gully erosion was observed, starting from abandoned terraces. Farmers reported to have given up cultivating and maintaining them due to the lost of fertility. This seemed to be confirmed by the soil analysis indicating rather low pH and very low phosphorus status.

The ambition of the paper is to illustrate farmers' use of land in an area which is highly susceptible to erosion and to analyze related problems, and not to make a statistical analysis of the on-farm situation, which is beyond the researcher's control.

Ackowledgement

The authors would like to thank all the farmers and friends of Valderrama for their hospitality and their kind cooperation. Thanks also to the staff of the Antique Integrated Area Development Foundation (ANIAD) for all the support as well as to the head and the staff of the Laboratory of the Department of Agriculture in Iloilo, The Philippines, for analyzing the soil samples. The authors are grateful to Professor Dr Roberto R. Araño, tutor and facilitator of the team, and to Mr Narayan Shrestha and Mr Foday Turay for their substantial contributions as members of the interdisciplinary team. Professor Jozef Deckers, Mr Hal Mettric and anonymous reviewers are gratefully acknowledged for commenting on earlier drafts of the article.

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