Mapawa Catchment: The MSEC Benchmark Site in the Philippines
(Based on Country Report)

Introduction

Soil erosion in the Philippines is a major threat to sustainable production on sloping lands where mainly subsistence farmers carry out food and fibre production. Sloping lands occupy about 9.4 million ha or one-third of the country's total land area of 30 million ha. The sloping topography and the high rainfall subject the cultivated sloping lands to various degrees of erosion and other forms of land degradation. Field experiments conducted in the IBSRAM *ASIALAND* Management of Sloping Lands network sites in the Philippines showed that up-and-down slope cultivation resulted in annual erosion rates averaging about 100 t ha^{-1}, depending on the rainfall and kind of soil. It was estimated by the Bureau of Soils and Water Management that about 623 million metric tons of soil are lost annually from 28 million ha of land in the country.

The Philippines has a high population growth rate of 2.3% and the National Census and Statistics Office (NCSO) estimated about 76.3 million Filipinos in 2000. With increasing population and limited arable land, agricultural production activities are now being carried out on hilly and mountainous lands. Recent trends show that more and more of the sloping lands are being used for agriculture to support the needs of the burgeoning population.

The present approaches on soil conservation and management primarily hinge on the biophysical impacts of soil erosion on on-site productivity but have limited success in improving the quality of life of farmers in developing countries. In the Philippines, the major focus of soil conservation is to minimize or stop soil erosion and not to manage it to increase agricultural productivity. There have been few undertakings in the last 10 years that dealt with the social, economic, political, and institutional aspects of soil erosion. While research and development activities are slowly experiencing a paradigm shift in the study of natural resources like soil, the approaches used in organizing and using data and information on soil erosion and conservation have not yet reflected this change.

The Management of Soil Erosion Consortium (MSEC) is now employing in Asia the principles advocated by the new research paradigm for research on sustainable land management that meets the twin needs of increased productivity and resource conservation. The catchment, which is a topographically delineated land area drained by a common stream system, is used as a unit for the assessment of resource use management and planning. In particular, the new paradigm addresses the following concerns: 1) incorporation of indigenous knowledge related to land use management into resource-use evaluation systems, 2) capability to assess the implications of these indigenous practices for soil erosion and its on- and off-site effects, and 3) establishment of practical indicators of sustainability that relate to both the state or condition and process.

Benchmark Catchment

The site selection team evaluated two pre-selected sites in the Philippines from January 19–27, 1997: the Patgan Catchment in the west coast of Luzon Island and the Manupali Watershed in southwest Mindanao.

The site selection mission finally selected the Manupali Watershed as the MSEC site in the Philippines. It is where the Sustainable Agriculture and Natural Resource Management Collaborative Research Support Program (SANREM CRSP), with a strong participatory and socioeconomic component is also being conducted. The specific site selected was the Mapawa Catchment.

The Mapawa Catchment, located at Sitio Mapawa, Songco, Lantapan, Bukidnon. Lantapan is about 40 km west of the provincial capital of Bukidnon, Malaybalay city, and 140 km southeast of Cagayan de Oro city, the closest trading centre and port of the provinces of Mindanao (Figure 1). It is situated at the footslope of Mount Kitanglad Natural Park. It is around 4 km from Mount Kitanglad which has been declared a protected area. Coordinates $08^0$26'50" north latitude and $125^0$56'35" east longitude may be used as reference for locating the catchment.

The steepness of the slopes and the rainfall characteristics make the soils very susceptible to erosion especially under disturbed or cultivated condition. The inventory team recommended that erosion monitoring and soil conservation management research be undertaken. Also identified as major concerns in the area are, sedimentation, water quality problems, and nutrient pollution.

Biophysical characteristics

Biophysical and socioeconomic characterization helps to understand the conditions in a given area and the various factors affecting the land use decision of the farmers. This allows the buildup of a knowledge base for use in the identification of problems, opportunities, and constraints within and outside the watershed (PCARRD-DOST-DENR-FMB-DA-UPLB-CFNR-FDC/ENFOR, 1999). This also provides information for clarifying research priorities, extrapolating research results, and targeting relevant technologies to appropriate areas (Enters, 2000).

Geology, physiography, and landform

Mapawa Catchment is situated on the southern slopes of Mount Natotong. The footslopes comprise deeply incised basalt and pyroclastic materials which originated from the adjacent volcanic peak of Mount Kalatungan.

The study area looks like an elongated, narrow leaf with the slope gradient facing southeast. Elevation ranges from 1,080 to 1,505 m asl with an average of 1,300 m (Figure 2).
The watershed shape factor is 0.69 km with rolling to sloping terrain with slopes of 8 to 35% (Figure 3).

Climate

Mapawa Catchment is relatively wet and humid with rainfall more or less distributed throughout the year. Mean annual rainfall is 2,537 mm (Table 1), with rainfall peaks in June to September. The driest months are February to April.

The temperature ranges from a minimum of 17.5^{0}C in February and March to a maximum of 30.4^{0}C in April and May. The mean annual temperature is 23.6^{0}C.

Soils

The soils of the catchment area are deep clay, acidic, and with low cation exchange capacity and base saturation. The organic matter content of the surface soil horizon is high, except for the eroded phase. The soils of the catchment are mostly Ultisols except for the eroded phase (possibly Inceptisols).

The mapped soils of the catchment area are tentatively classified locally as follows:

Soil series/type	Average slope (%)	Area (ha)
Adtuyon clay (deep)	15–35	74
Adtuyon clay, bouldery phase	8–18	29
Adtuyon clay, eroded phase	15–35	21
Creek escarpment zone	50	93

Water resources

The surface hydrology is ephemeral or intermittent (dry during summer months and with running water during rainy months). The creeks in Mapawa Catchment are tributaries of the Alanib River (Figure 4). The drainage pattern is asymmetrical in nature, which indicates that the surface materials are relatively homogenous. They develop where bedrocks do not outcrop the surface to block or deflect stream channels. The drainage density is about 6.15 km km^{-2}. Creek frequency is approximately 2.19 km^{-2}. Drainage pattern and density are excellent indicators for assessing the health of the catchment, its responses to human interventions with the suitability and impact of land uses and practices.

There are two main creeks in the catchment, namely, Tungogon and Mapawa. The creeks traverse a total length of about 5.61 km southeast and flow out to the Alanib River. Tungogon Creek divides the Tungogon microcatchment while Mapawa Creek transects the Mapawa microcatchment. Table 2 presents the morphometry of the creeks.

Vegetation and land use

Information on the farming system; composition, type, and structure of plant communities; plant density; and canopy and groundcover in the catchment area is vital to the understanding of the role vegetation plays in the physical processes at the site.

The area is composed of forest plantations of *Eucalyptus spp.*, *A. mangium*, *A. falcataria*, and *Eucalyptus* mixed with jackfruit; open grassland with cogon and ferns; coffee, cropland (with corn, root crops, and vegetables); and shrubs and bamboo with pioneer species (Figure 5).

Population

The catchment site is within Sitio Mapawa. Mapawa is one of the seven 'sitios' (hamlet) of Barangay Songco which is one of the 14 'barangays' (villages) in the municipality of Lantapan. The catchment is currently occupied by 70 households. With an average household size of 4–6 persons, the catchment has approximately 155 people, a density of 1.7 persons ha^{-1} or 170 persons km^{-2}. In the analysis of migration patterns in the Philippines done by Cruz *et al.* (1992), population densities exceeding 117 persons km^{-2} are already considered high. As the population density in the Mapawa Catchment is more than this figure, it is considered as high and may have a significant influence on erosion. In general, the movement of the population in the uplands is due to an expanding need for cultivable land.

Information on the settlement and land use history of Mapawa came from the participatory rural appraisal (PRA). Table 3 shows the key events in the history of Mapawa Catchment from the time it was established to the present. The table indicates that several land use interventions have been introduced in the area. Most of the interventions introduced concern soil conservation. These projects/programmes have increased the farmers' perceptions of soil erosion. The farmers identified soil erosion as a problem, although they did not consider it a major one. Soil erosion reduces soil fertility and consequently yield is also reduced. However, the farmers identified lower yield as a minor problem. Since decline in productivity due to soil erosion can only be evident after a relatively longer time, the farmers may not have yet fully realized the impact of erosion.

Composition of the village population

The Tala-andig tribe is an ethnic group in the area. However, migration of the farmers from other places has slowly reduced the percentage of the Tala-andig population. Of the 31 farmers currently cultivating in the catchment, 39% are Cebuanos and 35% are Tala-andigs. The rest are Boholano (10%), Igorot (10%) Misamisnon (3%), or Davaoenio (3%). The migrants have brought with them their cultural practices, which are significantly different from the indigenous Tala-andigs. The settlement pattern of the catchment reflects the history of Lantapan.

The Tala-andigs practice their traditions and beliefs, which are associated closely with the environment where they live. Although they have been overtaken by the Cebuanos in terms of population, the Tala-andigs still have a major influence in the area. Understanding their beliefs and their bases are important especially when developing and planning interventions. These interventions have to build on their existing indigenous knowledge and traditions. For instance, before any work in the farm begins, they perform a ritual to ask for a blessing. The farmer together with his family and other participants pray to the spirits, and offer food, wine, and coins. They believe that the offering will bring more from their labour. They also offer sacrifices. Dressed and cooked chicken is placed on a bamboo table with flags or white cloth. The offerings should not be placed on the soil, otherwise they will offend the spirit. Richer farmers usually offer pigs instead of chickens. These rituals are however slowly disappearing especially among younger farmers who have embraced Christianity.

Predominant occupation and typology of farming practices

Farming is the major occupation of most of the occupants in the catchment. Other occupants are either carpenters, businessmen, or privately employed. The farmers in the area prefer to plant corn, potato, and trees (*Eucalyptus spp.*, mosisi), cabbage, sweet peas, snap beans, and sweet potato. Other crops grown are coffee, banana, onion, sayote, tomato, carrots, Chinese cabbage, bell pepper, squash, and cassava. The most common cropping patterns in the area are corn-corn; potato-cabbage; corn-sweet pea; cabbage-corn-potato-snap beans; snap beans (monocrop); sweet potato-corn; and sweet pea (monocrop).

The farming systems in the catchment are based on the production of corn and rootcrop vegetables for subsistence and for sale. Hence, on-farm income is obtained from the sale of these crops. Figure 8 shows the crops planted by the farmers in the catchment and the relative position of farms where these crops are produced.

Chemical fertilizers, pesticides, and fungicides have become the most indispensable inputs in vegetable farming according to the key informants. They reported the following rates of application on a per hectare basis:

- For leafy vegetables like cabbage, lettuce, wongbok, and cauliflower, three bags of complete fertilizer are applied at planting time and two bags of urea (46-0-0) are used as sidedressing.
- For fruit and root crops like white potato and tomato, one bag of complete fertilizer (14-14-14) and two bags of compost as sidedressing.
- Organic fertilizers like chicken manure are also applied at planting at the rate of three spoonfuls per hill whenever they are available.

Chemicals applied to control insect pests include Cymbus and Kocide. These are applied based on the recommended dosage. Fungicides like Maneb and Dithane M-45 are also used whenever there is a need to control fungus infestation.

Access to markets

The participatory agricultural and rural systems appraisal (PARSA) conducted in Barangay Poblacion, Lantapan reported that there is only one dealer of agricultural input in Lantapan (Villancio *et.al.,* 1995) Agricultural inputs are purchased either from this dealer or from the markets in Valencia and Malaybalay. Farmers who have capital, go to these markets to buy the agricultural inputs they need. Those who do not have enough capital get their inputs from private traders who provide advance financing to the farmers. In return, the farmers should sell their produce to these traders at a lower price.

The farmers sell their produce to nearby towns or to the middlemen who pick up their farm produce. A dirt road, which is too difficult to traverse, especially during the rainy months, is used by the residents to transport agricultural produce from their farms to a small trading post in Barangay Songco. The road stretches 3 km from sitio Mapawa to this trading post. Transporting produce from sitio Mapawa to this point costs the farmer ₱20.00 for an animal-drawn sled.

Farmers usually sell their produce in Aglayan, the nearest market. It costs P17.00 from the Songco trading post to Aglayan by jeepney. Other markets are in the cities of Malaybalay and Valencia.

The high costs of transportation could significantly reduce the profit of farmers. The costs and returns analysis of producing the various crops in the catchment indicates that transportation cost is a major component of cash expenses. For potato, transportation cost amounts to about 17% of the total cash expenses and is the third major cash expense item after labour and fertilizers.

The farmers ranked bad roads as their number one problem. The state of the road undoubtedly influences the choice of crops to grow. The farmers tend to grow crops with little transport losses as evidenced by their crop preferences. Among the reasons why corn and potato rank highest in the farmers' crop preference is that these crops are not highly perishable and there is no trucking damage.

Access to agricultural information and credit

The agricultural technicians (ATs) of the Lantapan municipality are the main source of information on agricultural innovations. These ATs are assigned by the municipal government to provide assistance to the farmers. Collaboration with the municipal government through the ATs is therefore crucial in soliciting the participation of farmers in designing, testing, and transferring soil management technologies.

The farmers in the catchment cited lack of capital as their second most serious problem. Crop production requires substantial cash outlays for inputs such as fertilizers and pesticides and for transporting the products to the market. Having no capital on hand, the availability of credit would be crucial for the farmers to obtain adequate inputs needed to optimize crop production.

An earlier survey (Villancio *et al.,* 1995) reported that a rural bank (Lantapan Rural Bank) provides credit services to farmers. In 1995, the bank participated in providing agricultural loans and other credit services. It also participated in the special financing scheme under the various government programmes. However, the bank suffered from low repayment. At present, the bank provides loans only to those with collateral to offer. Land titles are acceptable common collateral.

Structure and function of local organizations

The general principles for the control of degradation are similar worldwide, but each country must develop its own conservation and rehabilitation policy, strategies, and programmes, tailored to its own unique circumstances. A fundamental requirement is that governments provide the back-up services the land users need if they are to contend with land degradation problems. These include strengthening and rationalizing relevant government institutions, establishing an advisory system as well as attending to the legislation, training, and research needs of the conservation effort (FAO, 1995).

There are several community-based organizations/projects within and outside the MSEC catchment site. The MSEC and SANREM projects conducted in the area are coordinated by PCARRD. They are implemented by various agencies such as Department of Environment and Natural Resources (DENR), Central Mindanao University (CMU), and University of the Philippines Los Banos (UPLB). The International Center for Research in Agroforestry (ICRAF) is also conducting activities in the area and works in a consortium involving the UPLB and CMU. The municipal government of Lantapan assigns ATs who provide technical assistance to the farmers. Each AT is assigned to one or several barangays. Other organizations conducting activities in the area are the Kitanglad Integrated NGO (KIN) which is a non-government organization (NGO), the Mapawa Integrated Social Forestry Association (MAISFA), and the Mapawa Tribal Council (MATRICO).

At the municipal level, PCARRD established the Lantapan Project Holders' Committee (LPHC) composed of a Steering Committee (SC) and the Technical Working Group (TWG). The SC is composed of representatives from national and international agencies with projects at Lantapan such as PCARRD, Southeast Asia Regional Center for Graduate Study in Agriculture (SEARCA), Australian Center for International Agricultural Research (ACIAR), and ICRAF. The Northern Mindanao Consortium for Agriculture and Resources Research and Development (NOMCARRD), Bureau of Agricultural Research (BAR), CMU, Lantapan Local Government Unit (LGU), Province of Bukidnon as well as the regional offices of the Department of Agriculture and DENR are also represented in the SC. The TWG is composed of coordinators/project leaders of the various research and development projects being implemented in Lantapan municipality. Also included are NGOs and the Municipal Agricultural Office. The LPHC is the integrating mechanism at the municipal level, NOMCARRD at the regional level, while PCARRD integrates MSEC R&D activities at the national level.

Conflicts and land tenure

Administrative conflict is almost nil since the catchment is within only one barangay, a political administrative unit under the municipality of Lantapan. Linkage with the political setup would be easier since only one administrative head, the barangay chairman, has to be consulted.

Erosion control technologies require an initial investment, which produces benefits in the long term. Farmers who do not have long-term rights to the land they cultivate have shorter planning horizons and are therefore seldom interested in improving or protecting that land.

Most of the land within the Mapawa Catchment is considered private land. Areas have been declared public land such as those that are located at the centre of the sitio. Other areas considered as public land are found in the upper portion, which belongs to another sitio. Some farmers only till the land and pay rent to the owners.

Table 1. Climatological data of the project site (adapted from Malaybalay PAGASA Station).

Month	Rainfall (mm)	Temperature (^{0}C)		
		Maximum	Minimum	Mean
January	124.5	29.7	17.8	22.8
February	95.9	28.3	17.8	22.9
March	103.2	29.4	17.5	23.4
April	104.4	30.4	18.2	24.3
May	222.5	30.2	19.1	24.0
June	307.1	28.8	19.2	24.0
July	315.9	28.0	19.0	23.5
August	300.3	28.1	19.0	23.5
September	327.0	28.3	19.0	23.6
October	299.4	28.5	18.8	23.6
November	187.3	28.8	18.6	23.4
December	149.8	28.3	18.2	23.2
Annual	2537.3	28.8	18.5	23.6

Source: Climatological norms (1951–1985) PAGASA, 1987.

Table 2. Morphometry of creeks found within the study area.

Creek	Length (km)				Average slope (%)		
	Segment 1 (U_1)	Segment 2 (U_2)	Segment 3 (U_3)	**Total**	U1	U2	U3
Tungogon	0.800	0.375	0.985	2.160	19.17	31.61	12.69
Mapawa	0.780	1.745	0.925	3.450	20.00	16.87	12.97

Table 3. Key events in Mapawa Catchment, 1972–2000.

Year	Key event
1972	Sitio Mapawa was established with only 5 households
1973	Inauguration of Sitio Mapawa; long drought; trees died
1978	Start of logging, all trees were felled
1979	Start of 'kaingin'
70s – 80s	Many people planted potato but did not succeed due to bacterial wilt (BW)
1981	Coming of MMWDP. People planted various trees (*Gmelina*, falcata, pine trees)
1983	Long drought; trees were burned
1989	Extension school was established but burned down in the same year
1990	Start of planting cabbage in lieu of potato; this did not succeed due to diamond back moth (DBM)
1993	PPAEP came and held seminar on contour farming
1994	SANREM research started; distributed tree seedlings
1994	Philippine Eagle came in, conducted training on soil conservation and introduced livelihood projects through loans
1994	NPAs started where promotion of protecting the natural resources was held; farming on protected areas was strictly prohibited
1995	Start of ICRAF research. Also conducted training on natural vegetative strips (NVS) technology
1997	El Niño phenomenon; remaining trees were burned
1999	Start of MSEC Philippines project
2000	70 households were established in Sitio Mapawa

Table 4. Drainage area of the microcatchments in Mapawa and the location of weirs and rain gauges

	Location		Drainage area (ha)
	Latitude (north)	Longitude (east)	
A. Weirs			
Main weir	08 02' 51.7"	124 56' 31.2"	91.00
Weir No. 1	08 03' 03.8"	124 56' 33.7"	24.82
Weir No. 2	08 03' 32.7"	124 56' 27.5"	16.74
Weir No. 3	08 03' 33.2"	124 56' 23.8"	14.90
Weir No.4	08 02' 59.8"	124 56' 28.0"	1.50
B. Rain gauges			
Rain gauge 1	08 02' 53.1"	124 56' 25.9"	
Rain gauge 2	08 03' 00.5"	124 56' 35.4"	
Rain gauge 3	08 03' 19.8"	124 56' 37.3"	
Rain gauge 4	08 03' 18.2"	124 56' 22.5"	
Rain gauge 5	08 03' 31.7"	124 53' 20.8"	
AWS	08 03' 11.1"	124 56' 29.8"	

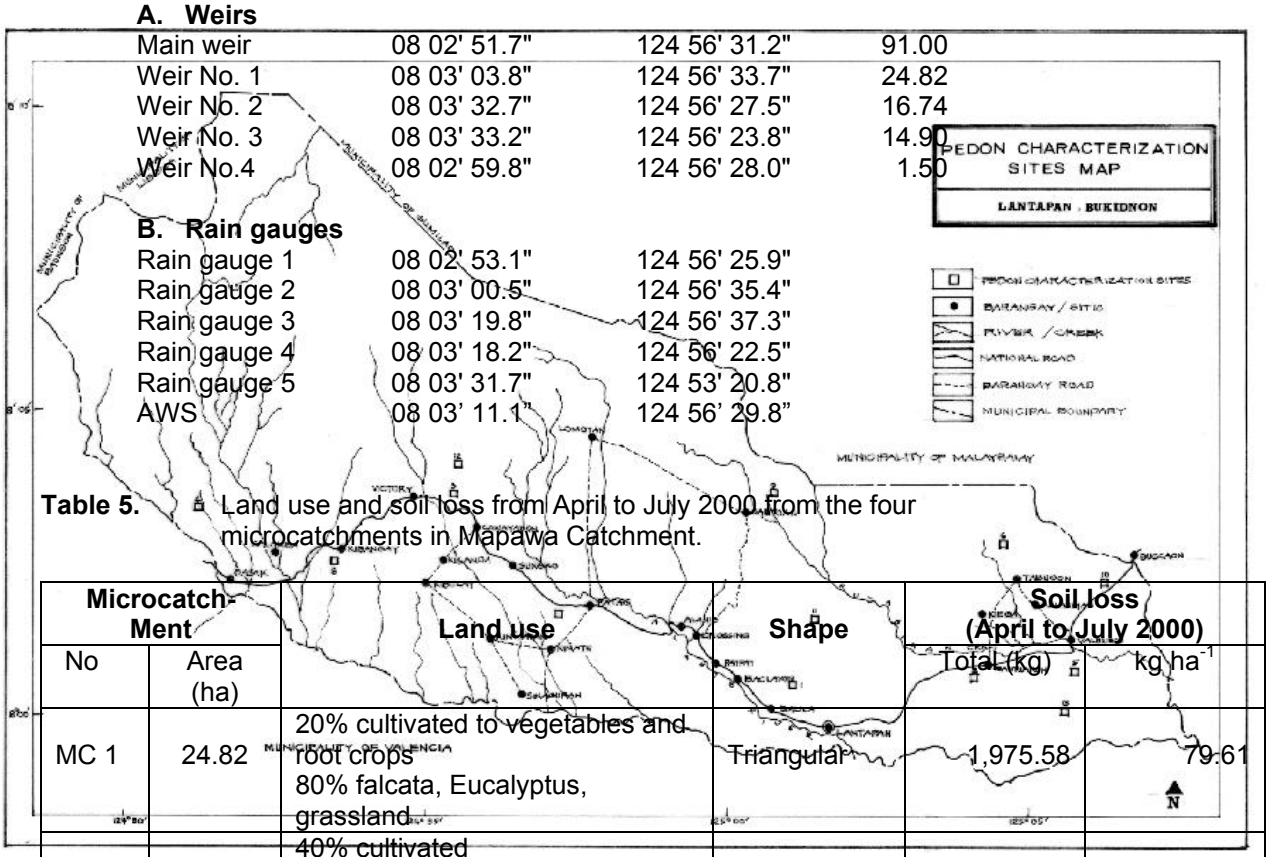

Table 5. Land use and soil loss from April to July 2000 from the four microcatchments in Mapawa Catchment.

Microcatch-Ment		Land use	Shape	Soil loss (April to July 2000)	
No	Area (ha)			Total (kg)	kg ha^{-1}
MC 1	24.82	20% cultivated to vegetables and root crops 80% falcata, Eucalyptus, grassland	Triangular	1,975.58	79.61
MC 2	16.74	40% cultivated 60% grassland	Elongated	6,108.39	364.90
MC 3	14.90	10% settlement, 90% grassland	Elongated	7,997.24	536.73
MC 4	1.50	50% cultivated (14% of cultivated area is left bare) 50% grassland, trees	Rectangular Cultivated area adjacent to stream	23,028.65	15,352.43

Figure 1. Location map of Lantapan, Bukidnon.

Figure 3. Topographic map of Mapawa catchment.

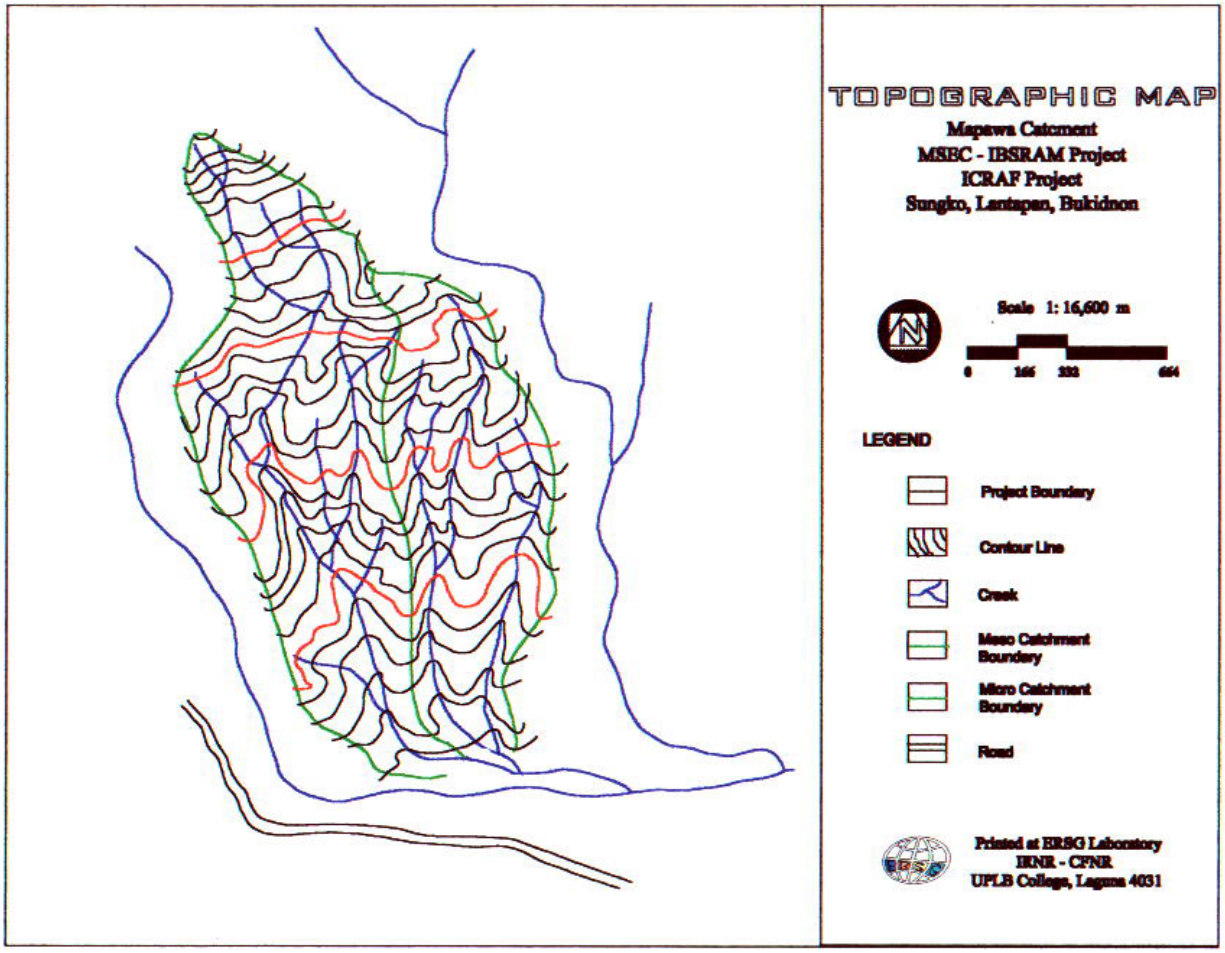

Figure 2. Drainage pattern of Mapawa catchment.

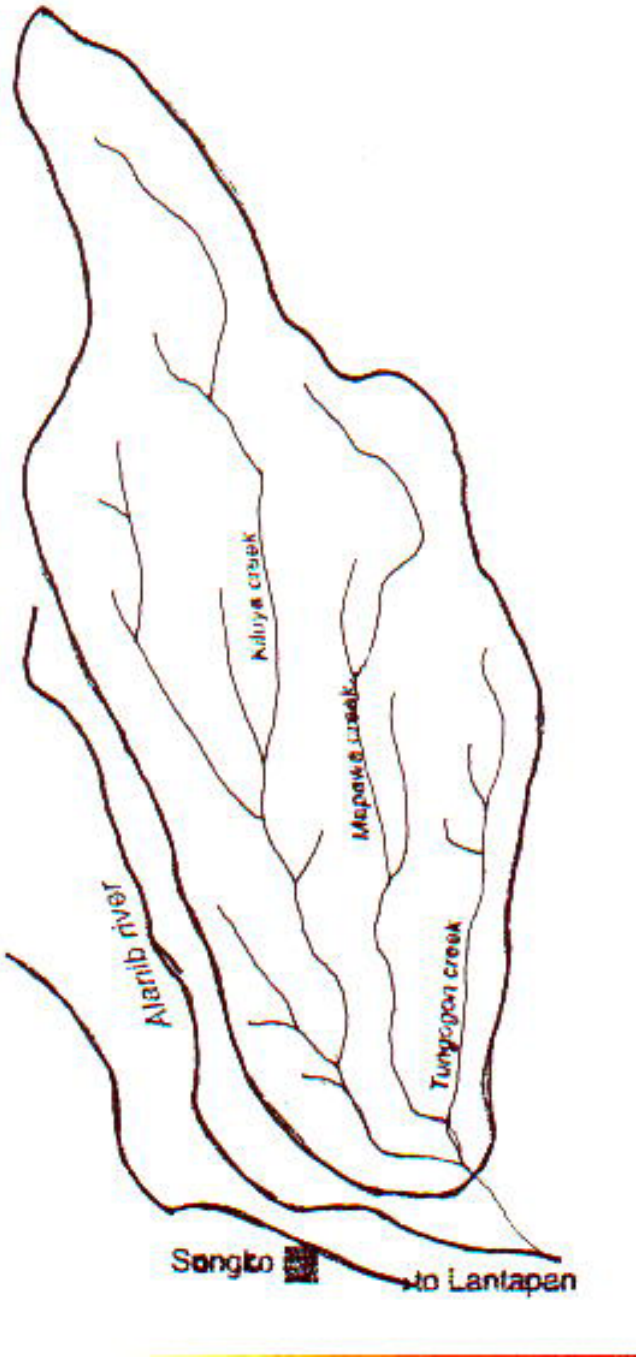

Figure 3. Vegetation/land use map of Mapawa catchment, 1999

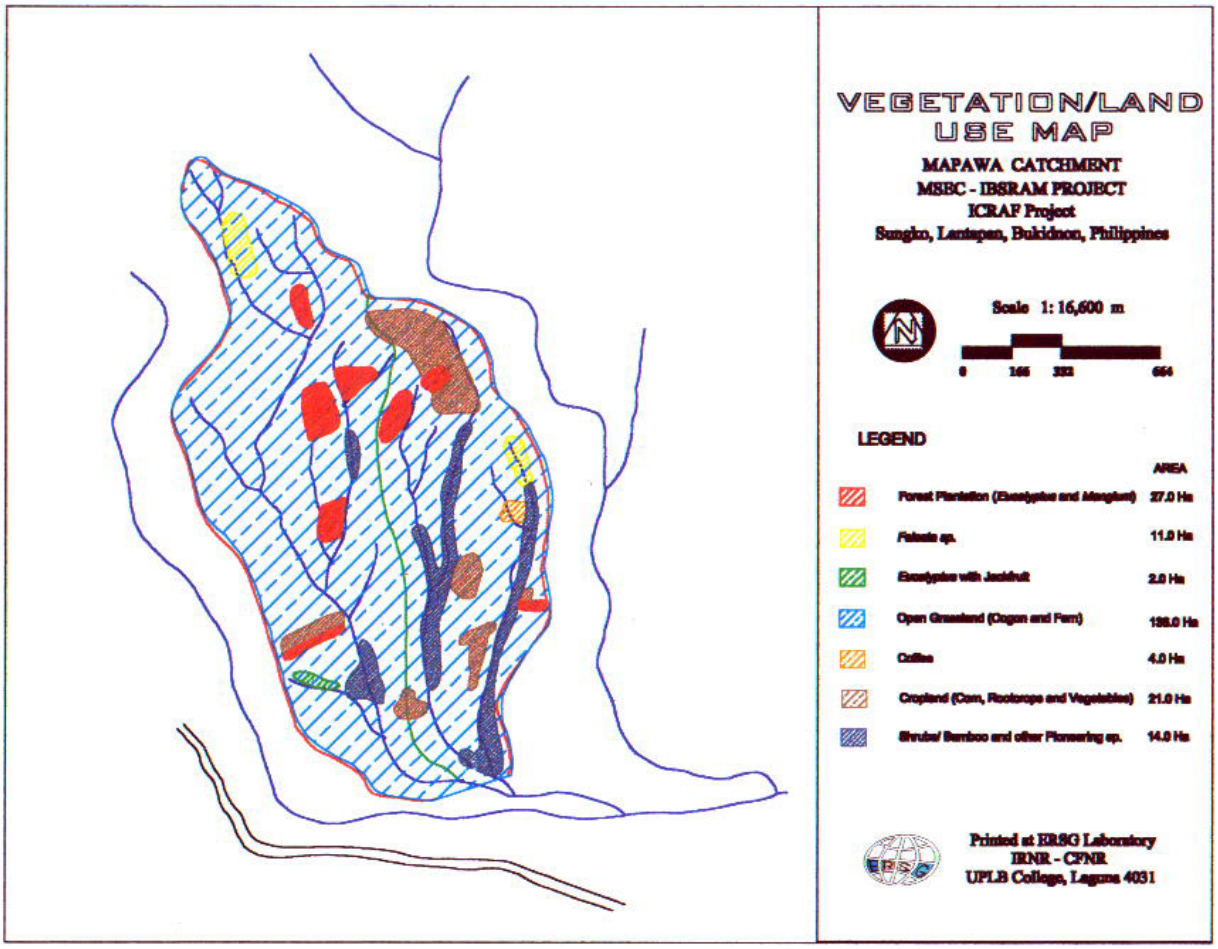

Figure 4. Crop distribution in Mapawa catchment.