Catchment Approach to Combating Soil Erosion in Thailand

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INTRODUCTION

In Thailand, soil erosion has been identified as a major problem in sustaining agriculture on steeplands. It causes severe on- and off-site environmental and socioeconomic impacts. To address these concerns, the Royal Forest Department (RFD) and the Land Development Department (LDD) entered into an agreement with the International Board for Soil Research and Management (IBSRAM) in Bangkok to implement the collaborative project entitled, "Catchment approach to combating soil erosion in Thailand" in 1999 under the umbrella of the Management of Soil Erosion Consortium (MSEC).

MSEC employs a new research paradigm based on a participatory, interdisciplinary catchment approach in mid- to long-term experiments (5–15 years) to assess the significance of sustainability factors on steeplands. Catchment studies will also be useful in quantifying the processes occurring within and the interactions among the different compartments of the ecosystems. The three key elements of this approach are: the focus on on- and off-site impacts, the provision of scientifically sound information for decision-makers, and the involvement of the whole range of stakeholders from land users to policy-makers.

This report presents the progress of the project as of September 2000. It highlights the biophysical and socioeconomic characteristics of the model catchment and the initial results of the hydrological measurement and analysis.

OBJECTIVES

1. To develop sustainable and acceptable community-based land management systems that are suitable for the entire catchment;
2. To quantify and evaluate the biophysical, environmental, and socioeconomic effects of soil erosion, both on- and off-site;
3. To generate reliable information and prepare scientifically based guidelines for improvement of catchment management policies; and
4. To enhance NARES capacity in research on integrated catchment management and soil erosion control.

METHODOLOGY

Site selection

Seven watersheds were pre-selected by the national authorities for consideration by the MSEC Mission. Based on the recommendations of the MSEC Cebu meeting in 1996, the selected catchments were evaluated for their suitability as follows:

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Step 1 Interviews and discussion with the local chiefs of relevant agencies or research stations, their personnel, and villagers, mainly based on questionnaires, open-ended interviews, and the examination of available reports.

Step 2 Field assessment and examination of: a) existing equipment; b) land use systems; c) soil conservation practices of the farmers; d) the degree of on- and off-site effects; e) related R&D activities; f) existing socioeconomic and cultural conditions of on- and off-site communities, and potential for their participation.

Step 3 A summary discussion involving all team members to evaluate the following issues: a) representativity of the catchment with respect to people, land use, hydrology, soil erosion, nutrients, and pollution; b) main problems and options; c) potential activities to be recommended.

Details of the model catchment selection for the MSEC were reported on the IBSRAM publication " Report on the Mission to Thailand and Indonesia (1–23 August 1996) and the Philippines (19–27 January 1997).

From the seven sites visited by the site selection mission, three watersheds, namely, Mae Chaem, Mae Yom, and Khun Sathan were identified as the most suitable for the project. Khun Sathan Watershed was recommended during the MSEC assembly in February 1997, but was changed later to Mae Yom after the Hanoi assembly in June 1998. A smaller catchment was further identified in Mae Yom for more detailed studies on erosion and hydrology. Activities in Khun Sathan have however continued with the work of the University of Bayreuth.

Biophysical and socioeconomic characterization

For comprehensive biophysical and socioeconomic characterization of the selected catchment, attributes were gathered using different tools and techniques (Table 1).

Evaluation of the on-site effects of soil erosion

The Huay Yai Catchment was selected for more detailed erosion and hydrological studies. It is within the Mae Thang subwatershed. Within Huay Yai, four microcatchments were further selected and characterized in more detail.

Weirs or flumes and sediment traps were constructed at the outlet of each microcatchment and automatic water level recorders were installed. An automatic weather station was installed within the catchment area and eight manual rain gauges were distributed at appropriate locations.

Biophysical and socioeconomic information was monitored to assess erosion and growth of crops or other vegetation in the different microcatchments. In addition, physical and chemical analysis of the soils was carried out together with preparing soil profile descriptions. Socioeconomic data monitoring was done by conducting interviews with farmers.

The effect of different land uses on soil erosion was evaluated by monitoring and analyzing soil loss, runoff, and discharge at the weirs constructed in the different microcatchments.

Evaluation of the off-site effects of soil erosion

Identification of potential off–site impact

Soil sediment may impair the ability of the water body to support any or a combination of these uses: irrigation, domestic and industrial water usage. The water bodies (e.g. a reservoir) where the runoff-carrying soil sediments from the study site drains, were identified. There is a need to identify the upstream watershed area that contributes sediments into this water body to determine the other sources of soil sediments from within the watershed.

Table 1. Information for biophysical and socioeconomic characterization.

Attribute	Possible use	Tools and techniques
Slope and elevation	Assessment of erosion potential suitability	Field measurements, existing topographic maps
Soil (texture, erosion potential, depth, N, P, K, organic matter content)	Assessment of fertility, productivity, land suitability	Soil survey/ analysis, existing information/maps
Climate (daily rainfall amount, maximum and minimum air temperature, velocity)	Assessment of erosion potential and assessment of future hydrologic events	Field measurement, records at nearby stations
Hydrology (quality and quantity of streamflow, surface runoff, evapotranspiration)	Appreciation of hydrologic behaviour of a catchment , of land suitability, erosion potential, impacts of proposed land uses and practices	Field measurement, existing records,
Land use (extent of existing and historical land uses, major practices, productivity)	Selection and design of appropriate biodiversity conservation measures and practices, assessment of impacts of proposed land uses and practices	Field measurement, existing maps
Water resources	Appreciation of hydraulic behaviour, Assessment of erosion potential and impacts of alternative land uses	Literature review, existing maps
Fauna/livestock	Assessment of land suitability and impacts on vegetation	Key informant interview, literature review
Population	Population pressure on resources, Availability of labour	Key informant interview
Settlement and land use history	Decision making support system	Key informant interview, Literature review
Composition of village population	Reaction to innovation representation	Key informant interview
Occupation	Investment potential Adoption of labour-intensive land management technologies	Key informant interview, Survey
Access to markets	Potential to agricultural management	Key informant interview
Access to information	Effectiveness of information dissemination	Key informant interview, Formal survey
Credit constraint	Availability of capital	Key informant interview
Local organization and functions	Effectiveness of project implementation, technology transfer	Key informant interview
Conflicts	Understanding behaviour Insight into off-site issues	Key informant interview Literature review
Land tenure	Decision on long-term investments	Key informant interview Formal survey
National policies	Policy formulation planning	Literature review

Off-site impact results in costs (or benefits) and can be negative or positive. The negative effect of soil erosion could include: a) loss of biodiversity; b) reduced water quality; c) reduced capacity of reservoirs to deliver water for irrigation; and d) increased flooding

Survey of the off-site economic activities affected by erosion

A survey in downstream communities and for other water users was carried out to gather information on the off-site water-based economic activities most vulnerable to the pollution of the water body affected by erosion. In this case, the water in the reservoir is primarily used for irrigation,

and therefore information from farmers living downstream and irrigation department personnel is most useful.

To support information from interviews, physical and chemical analyses of water draining to the reservoir sampled at different points were carried out. The sampling sites are shown in Figure 1.

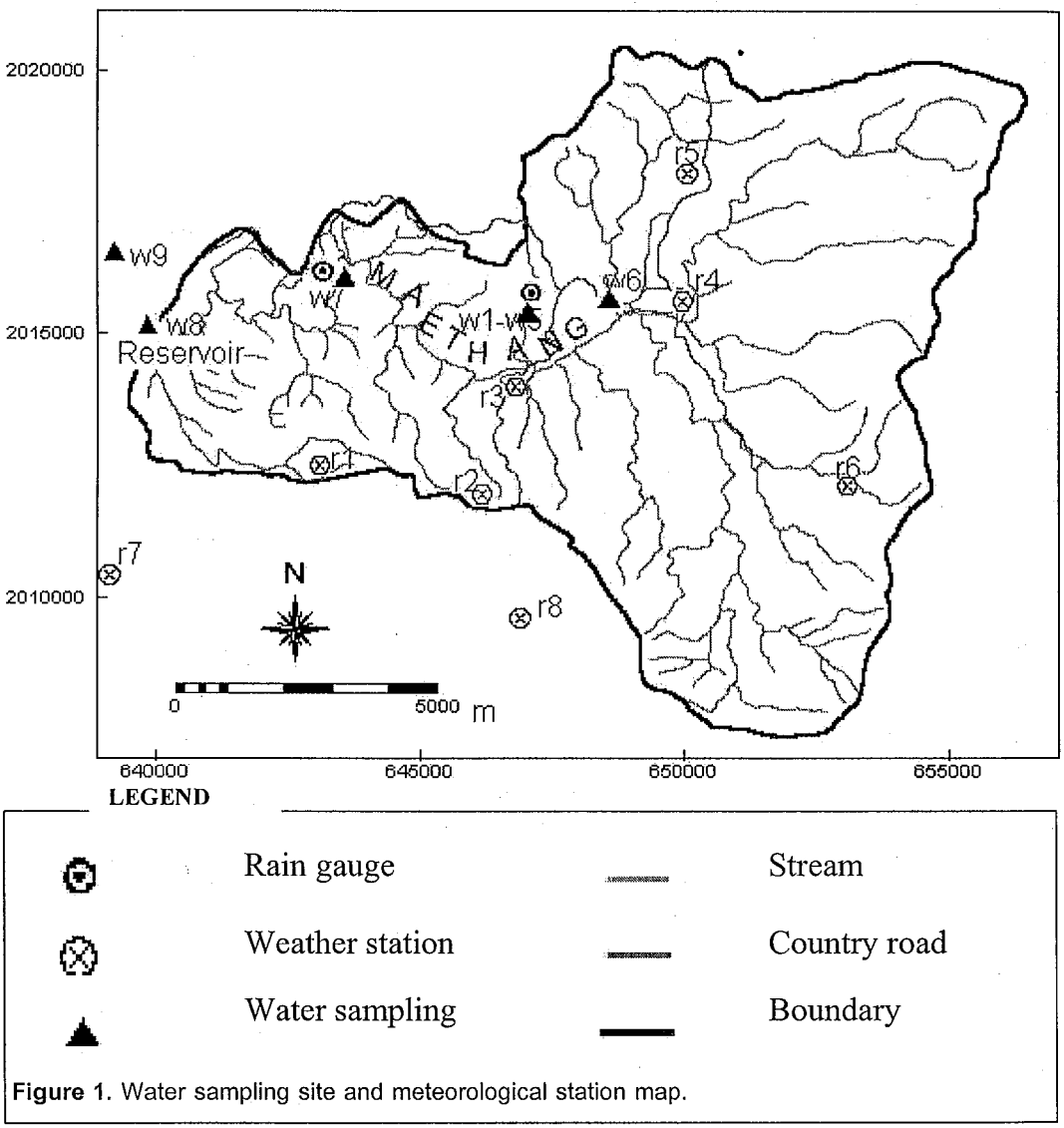


Figure 1. Water sampling site and meteorological station map.

RESULTS AND DISCUSSION

Site selection

As mentioned earlier, the MSEC work has finally concentrated its activities in the Mae Yom Watershed (Figure 2). The advantages of the Mae Yom Catchment as the representative MSEC catchment are: a) the area is predominantly agricultural with many kinds of land use or crop diversity, and b) the moderately steep topography represents the eroded steepland. A much smaller sub-watershed, Mae Thang, was still further selected

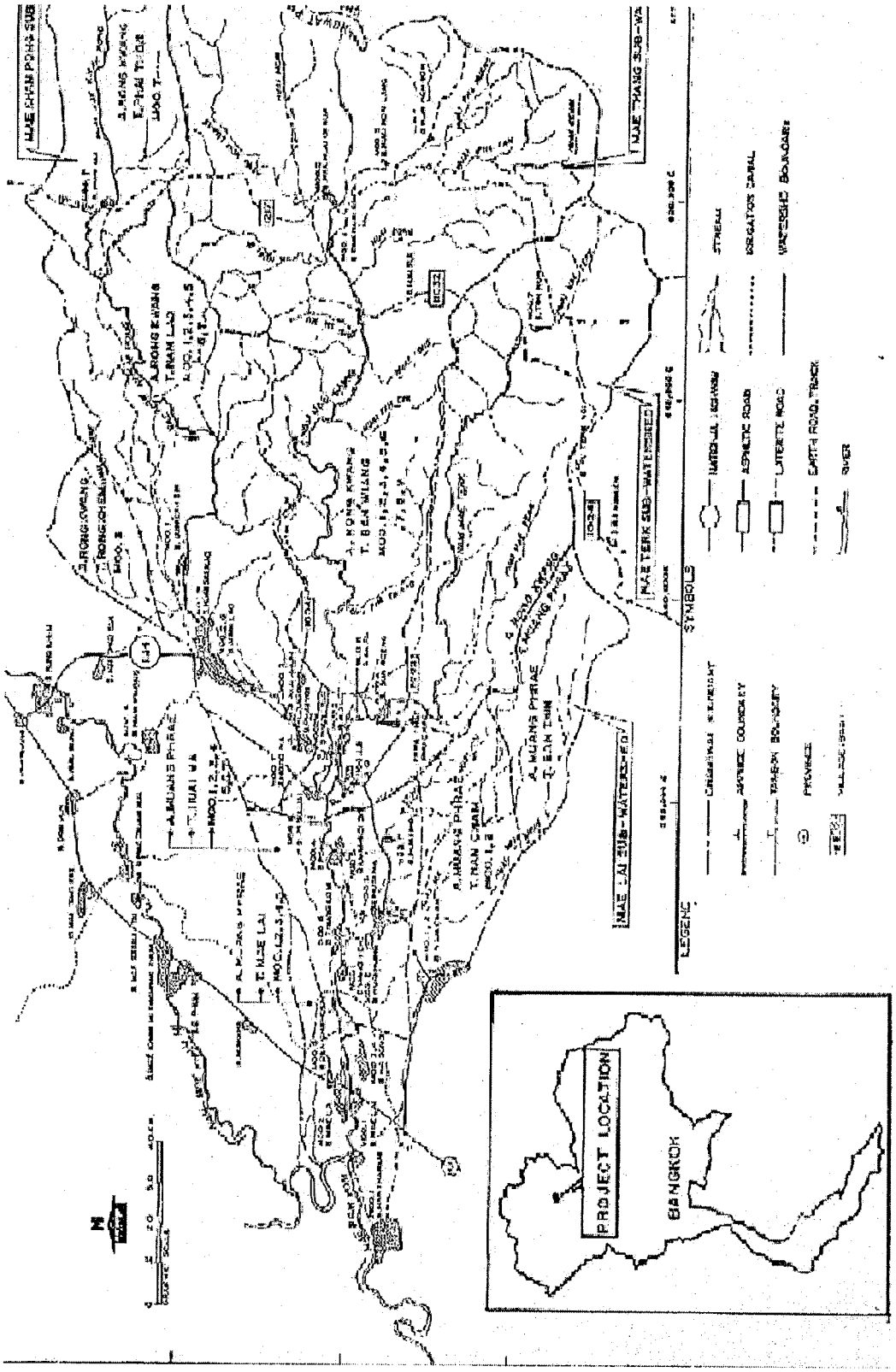


Figure 2. Mae Yom Catchment.

The Mae Thang Sub-watershed covers an area of 102.8 km^2 about 550 km north of Bangkok. Within the sub-watershed, a smaller catchment, Huay Yai, was delineated as the experimental site for the MSEC study. Huay Yai is located in Pak Huay Ooi village, Ban Wiang subdistrict, Rong Kwang District, Phrae Province at 18° 14' north latitude and 100° 24' east longitude and covers a total area of approximately 71 ha (Figure 3).

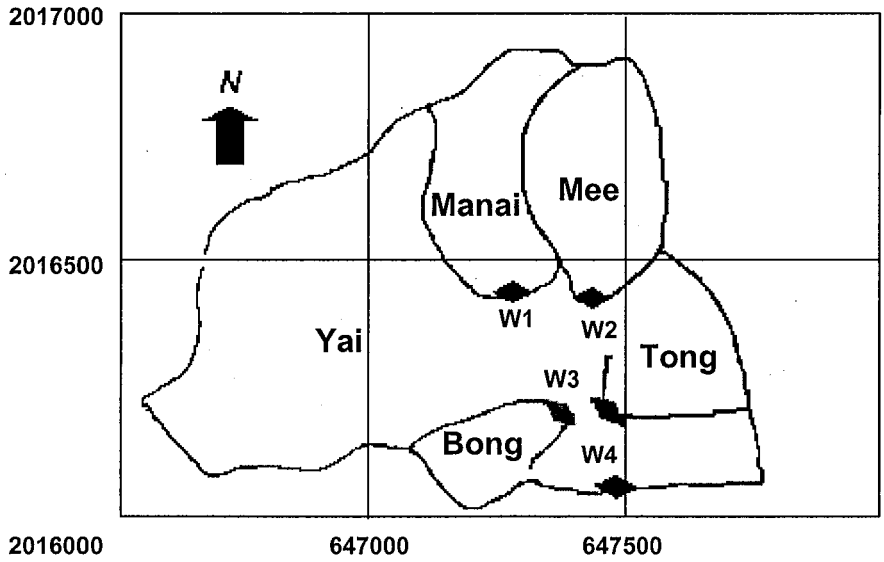


Figure 3. Huay Yai catchment and selected microcatchment (showing hydrological construction sites).

Biophysical and socioeconomic characterization

The topography of Mae Thang subwatershed is rolling to mountainous with slopes ranging from 12–50%. The elevation is about 400–480 m asl. It can be reached by travelling from Phrae along Highway no. 101 which links Phrae and Rong Kwang District and then by turning right on the provincial road no. 1134. The other biophysical and socioeconomic characteristics of the site are shown be[illegible]w.

Climate

The climate is influenced by two main monsoons causing rainy and cold seasons. The rainy season normally occurs between May to October. March and April is a transition period when the weather is hot and dry but in some years, unexpected rain occurs due to tropical depressions from the South China Sea. The cold season is from November to February.

Data recorded at the Phrae Meteorology station from 1974 to 1999 showed an average annual rainfall of 1,077 mm (Table 2). About 90% of the rainfall occurs during May to October with a peak in August or September. The distribution is considered sufficient relative to the evaporation rate (Figure 4). The temperature varies from a minimum of 15.3?C in December and January to a maximum of 37.5?C in April. The mean annual temperature is 26.8?C and relative humidity ranges from 82–95%.

Soil

The soils of the Mae Thang subwatershed are derived from siltstone, sandstone with intercalated limestone, shale, and phyllite (Figure 5). They vary from medium to fine texture, low to

médium fertility, high to medium organic matter content, shallow to moderately deep, moderately drained to well-drained. They have moderate permeability and available moisture content. Most of them are not very suitable for upland crops because of the topography and dominance of gravel. About 41% of the area is very well suited for fruit trees, although a large portion (about 53%) of the land still has shallow soil depth.

Table 2. Monthly rainfall and temperature from 1974–1999.

Month	Rainfall (mm)	Temperature °C		
		Maximum	minimum	Mean
January	7	30.9	15.3	23.1
February	12	33.5	16.9	25.2
March	23	36.3	20.9	28.6
April	83	37.5	24.0	30.8
May	167	35.3	24.5	29.9
June	121	33.6	24.5	29.1
July	148	32.4	23.8	28.1
August	209	32.1	24.4	28.3
September	186	32.3	23.8	28.1
October	90	31.9	22.6	27.3
November	23	31.1	19.4	25.3
December	8	30.5	15.3	22.9
Annual	1,077	30.8	22.9	26.8

Source: Phrae Meteorology Station.

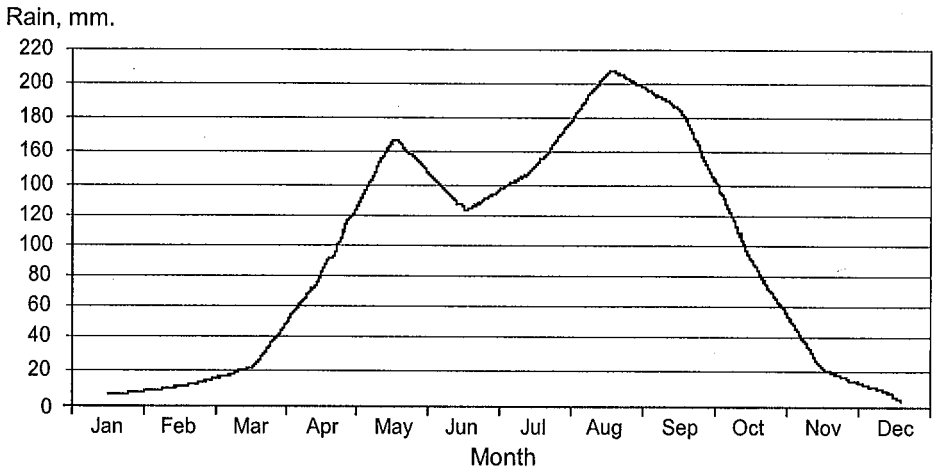


Figure 4 Average monthly rainfall from 1974–1999.

Water resources

Mae Yom Watershed is composed of four main streams They are a) Mae Thang, b) Mae Khum Pong, c) Mae Terk and d) Mae Lai (Figure 2). Mae Thang originates from the mountain range in the east and runs down to Huay Hom village. It then passes through Pak Huay Ooi village, and down to Mae Thang reservoir. Mae Khum Pong stream, which originates from many tributaries in Khun Sathan subdistrict in Nan Province runs down and joins the Mae Thang stream at Wiang village, Ban Wiang subdistrict, Rong Kwang District.

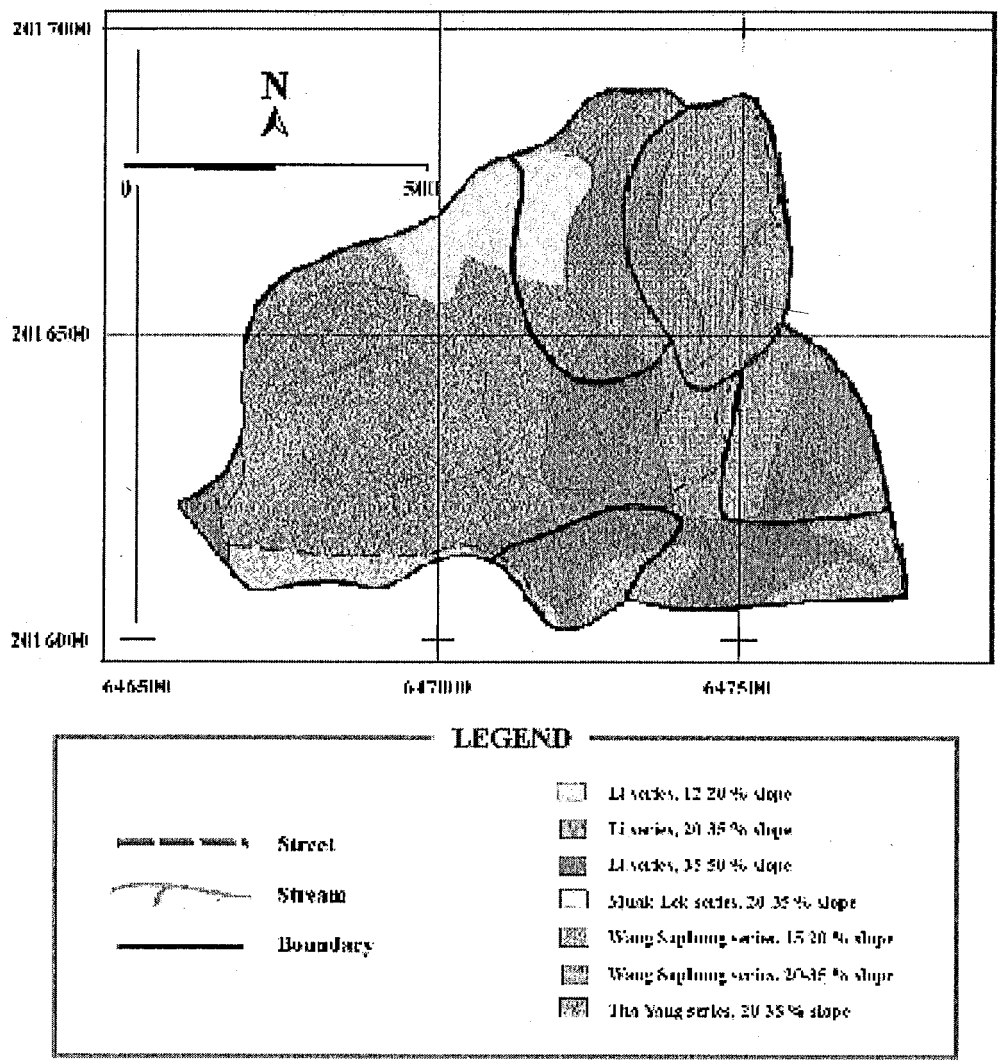


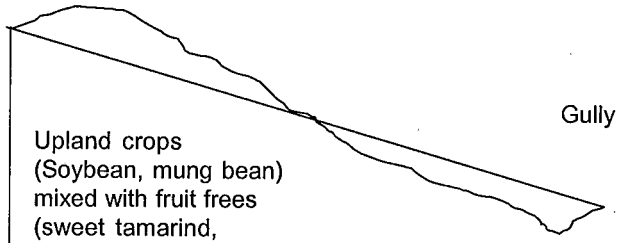
Figure 5 Soil map of Huay Yai Catchment.

Mae Terk stream originates from many tributaries in the southeast, passes through Mae Terk mountain and joins the Mae Thang stream at Ban Boon Roeng village, Wiang subdistrict, Rong Kwag District. The Mae Lai stream, which captures all the three streams at Ban Wiang subdistrict joins the Yom River at Ban Mae Lai subdistrict, Muang District.

The MSEC site in Huay Yai is within the Mae Thang subwatershed. Huay Yai tributary comprises five small tributaries with dendritic patterns. They are: a) Huay Mee, b) Huay Ma Nai, c) Huay Bong, d) Huay Tong and d) Huay Yai. Except for the Huay Yai, water is present only during the rainy season.

Vegetation and land use

Mae Thang subwatershed used to be covered by mixed deciduous forest, but is now a degraded area and more or less totally cultivated. Field crops such as soybean and mung bean are the important crops grown. Fruit trees such as sweet tamarind, mango, litchi, and longan are planted in patches. A transect of the area that shows the different land uses in the landscape is presented in Figure 6.



Land use	Upland crops (Soybean, mung bean) mixed with fruit frees (sweet tamarind, mango, longan)		Bamboo Nat. veg.
Soil	Very shallow, rocky, gravelly, clayey, low fertility, Severe erosion	Shallow, gravelly, clayey medium fertility moderate erosion	Shallow Bank erosion
Problems	1. Low soil fertility 2. Soil erosion 3. Drought 4. Insects, pests, and disease (stem rod, leaf worm, pod borers, snails, rast, rust, powdery mildew) 5. Low price of product (8–11 Bt. kg^{-1} of soybean, 9–12 Bt. kg^{-1} of mung bean, 40–50 Bt. kg^{-1} of sweet tamarind) 6. High input of agricultural materials 7. Big fruit trees shade annual crops		
Opportunities	1. Apply fertilizer (15–15–15), crop residue 2. Minimum tillage, contour ploughing, spraying herbicide, digging hillside ditches, leucaena hedgerow 3. Spray chemicals 4. Formation of farmers' group, seeking help from government 5. Formation of farmers' group, loan from Bank Agriculture 6. Pruning		

Figure 6. Transect diagram.

Soybean followed by mung bean is the common cropping pattern in the area. In some areas, fruit trees such as sweet tamarind, mango, litchi, and longan are grown with soybean and mung bean. At present, many farmers plough their land every other year to reduce soil erosion and use chemicals and labour to control the weeds.

In the lowlands, the cropping sequence is mung bean/paddy rice/soybean or corn. Farmers usually apply small amounts of chemical fertilizer. The rotation with soybean is to improve soil fertility. A crop calendar is shown in Figure 7.

Animal and fauna

Rabbits, rats, chickens, snakes, and wild birds are commonly seen in the area. Earthworms are found in places where the soil is moist and high in organic matter and in flat areas, gullies or streams.

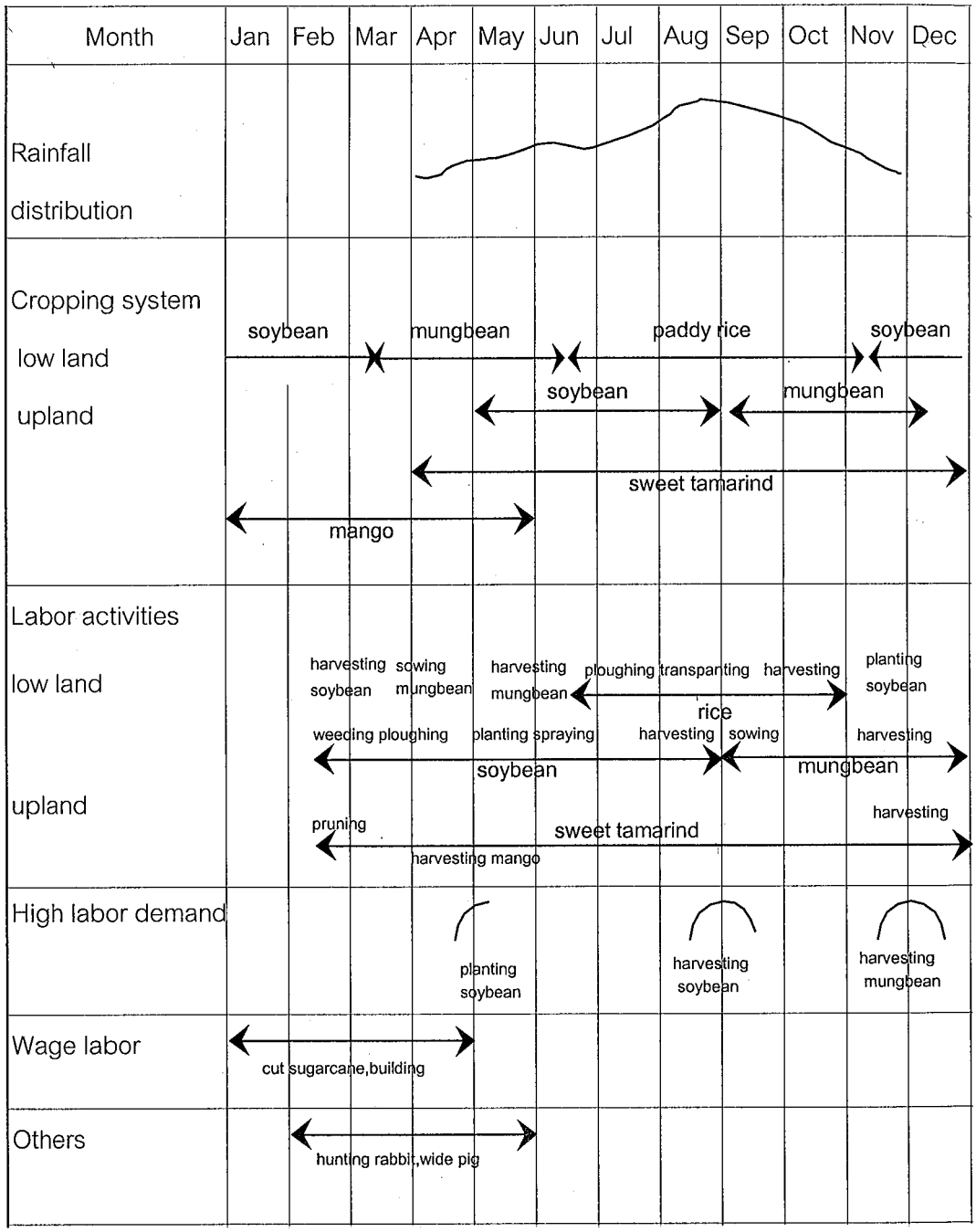


Figure 7. Crop calendar in Mae Thang subwatershed.

Insect pests and diseases

Insect pest and diseases cause problems to farmers. The main diseases found are fungal and bacterial diseases such as rust, stem rot disease. The main insects found in the catchment are leaf worms, stem borers, pod borers, lice. Farmers spray chemicals at least two times per cropping season to prevent damage caused by disease and insect invasion.

Population

The experimental site is currently farmed by 50 families, all of them living outside of the area. About 92% of them lives in Pong village, approximately 25 km from the site. Earlier, there were about 203 households in the village with 1,375 persons. At present, there are 489 households with 3,655 persons. Household size is from 3–11 persons with an almost equal ratio of male and female. The population density is about five persons ha^{-1}.

Settlement and land use history

Originally, Pong village consisted of two hamlets called sub-village no. 4 and sub-village no. 10. These two hamlets were founded a very long time ago. When the population increased, the villagers separated and built other hamlets called sub-village no.8 and sub-village no.12. However, they are located around the same area. At present, there is no more in-migration to the village because no more land is available.

Pong villagers have a very close relationship with the land use history of Mae Thang subwatershed which dates back before the 1970s. In the past, Mae Thang was a mix-deciduous forest primarily with teak. Then logging activities caused deforestation and changed land utilization. Villagers occupy sloping land for their cultivation. The significant events that occurred in the area are shown in Table 3.

Table 3 . Key events in the history of the Mae Thang subwatershed.

YEAR	KEY EVENT
<1970s	The catchment area had a mix-deciduous forest with teak as the major tree
1970	Private timber company was permitted to cut trees; a few farmers started growing upland rice, cotton, and corn on the deforested land; due to low productivity they stopped growing 1–2 years later.
1971–1972	A few farmers grew soybean on the deforested land.
1977	A gravelly earthen road was constructed downstream and passed through the site uphill.
1979	Many farmers cultivated upland rice because of lack of paddy fields to produce sufficient rice; some farmers grew soybean.
1980	More farmers occupied more land.
1982	High-yielding varieties and chemical fertilizers were introduced by credit personnel and middlemen.
1970s–1982s	The slash-and-burn technique was generally practiced for land preparation.
1983	Many farmers changed corn to soybean and grew mung bean as a second crop; small tractors and herbicides were used.
1989	All of the area was occupied; farmers grew fruit tree such as sweet tamarind, mango, and litchi.
1991–1992	2 small dams were constructed (Mae Thang and Mae Kum Pong dam).
1992	Local government officers established soil conservation demonstration plots and distributed sweet tamarind seedlings to farmers for planting as part of the conservation measures.
1995	Farmers observed topsoil loss and crop yield reduction; farmers improved their traditional land use practices by 1) ploughing across slope; 2) ploughing crop residues into the soil; 3) use of soybean trash to cover the soil; 4) minimum tillage and using herbicides in alternate years; soybean/mung bean were generally grown on upland areas.
1999–2000	Private company contracts farmers to grow a corn variety in the lowland area as part of its seed multiplication programme; some farmers abandoned their land in the upland area due to very poor soil conditions; some farmers stopped growing field crops because the fruit tree canopy shaded the annual crops below.

Composition of village population

About 90% of the Pong residents working in the site are 20–60 years old, compared to about 75% of the total population who are 16–65 years old. They are all farming households with minimal education reaching only the primary school level. Farmers cultivating the site have about 3–4 persons per household with 1–2 persons available for labour. About 70% of the farmers have upland farms of 0.96–3.2 ha. Almost all of the farmers have at least one piece of equipment such as small tractor and sprayer.

Farming is the main occupation and source of income of the people in the catchment. Others are engaged as hired labour, traders, weavers, or in bamboo handicrafts. Of the available labour, about 65% does not have not enough time to work off farm. The total annual family income of the 87% of the on-site farmers is less than US$857 per annum.

Access to markets, agricultural information and credit

The farmers sell their agricultural products in the nearby town about 19 km from the village. They use public transport to the market. About 50% of on-site farmers own a vehicle (motorcycle or car) which they also use to transport their products.

Agricultural information and knowledge mainly come from local agricultural extension workers. Farmers complain of the lack of technical knowledge on growing alternative crops. Extension services are virtually non-existent.

The Bank of Agriculture and Cooperatives primarily provides the credit services in agricultural activities. The bank provides not only agricultural loans but also the special financing schemes under the various government programmes. Because of the low agricultural income of the farmers, the bank suffers from low repayment.

Local organizations

The RFD operates 18 watershed research stations in Thailand. One of them is the Mae Yom Watershed Research Station in Phrae Province. It was established in 1982 in Rong Kwang District, near the experimental site. The area of responsibility covers the Mae Thang subwatershed. Its main functions are to carry out research related to watershed management and to identify the impact of human settlement and land use on water quality and quantity in the watershed area (Saifuk, 1998).

Land tenure and conflicts

Most of the catchment area lies within the boundary of Mae Khum Pong National Forest Reserve. Conflict over the land between the government and farmers who encroach on the forest was common more than 10 years ago for farmers who had occupied and cultivated land within the national forest reserve for a long time. As a result, the RFD has allocated certain areas for cultivation and granted land titles through the Land Reform Department. The problem has been minimized but encroachment still continues on a small scale.

Relevant policies

In 1996, the Thai government under pressure from farmer's organizations and NGOs, launched a countrywide programme to allocate land to landless people who had been living in state forests. As a result, parts of the research area in Mae Thang sub-watershed are used for cultivation. Only pockets of forests with compact poor soils remain scattered over the Mae Thang subwatershed. Farmers were granted a maximum of 2.2 ha per family. However, some families have more area as they are able to buy

the land allocated to others. Those who sold their land have start forest encroachment again with the speculation that the government will run a similar scheme some time in the future.

Evaluation of the on-site effects of erosion

Four microcatchments, namely, Huay Ma Nai (W1), Huay Mee (W2), Huay Bong (W3) and Huay Tong (W4), were delineated within the Huay Yai micro-catchment. They are approximately 10.4, 8.6, 3.7, and 6.5 ha, respectively. The total area of the microcatchment under study is about 71 ha.

There are four soil series identified in the microcatchments (Table 4 and Figure 5). They are primarily Alfisols and Ultisols with parent materials derived from shale or phyllite.

Table 4. Soils and slopes of the selected microcatchments.

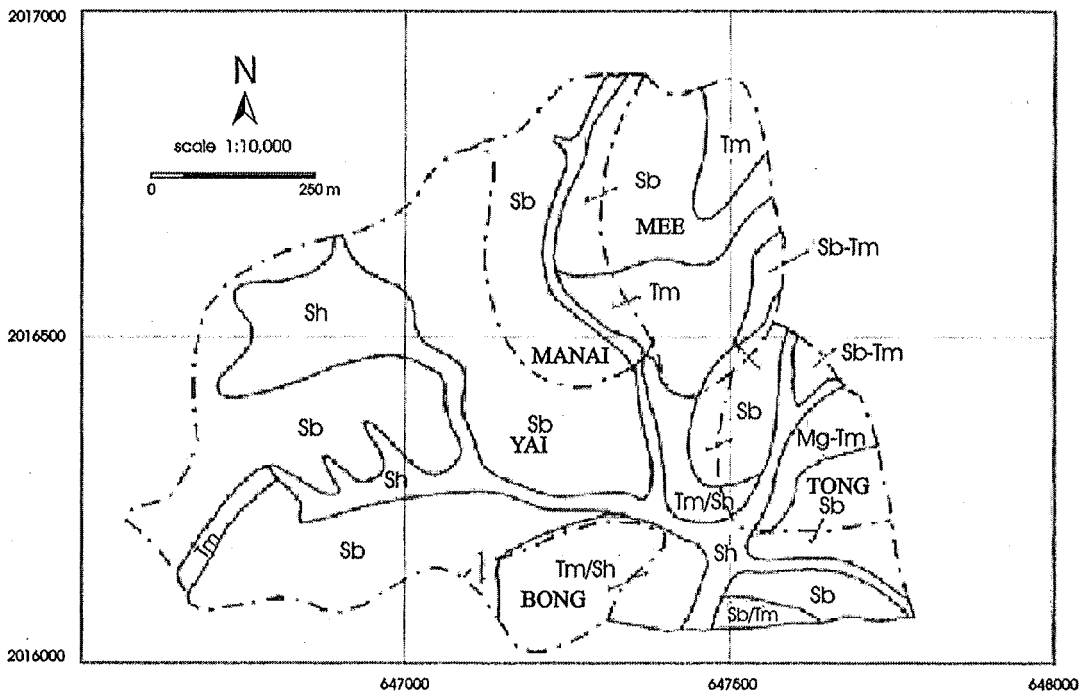
Soil series name	Slope (%)	Area (ha)				
		Mee	Manai	Bong	Tong	Yai
Li						
Clayey-skeletal, mixed,	12-20	–	–	–	–	2.3
semiactive, isohyperthemic,	20-35	3.1	3.5	–	–	7.6
shallow, Ulic haplustalfs	35-50	–	0.5	2.9	3.4	15.7
Muak Lek						
Clayey-skeletal, mixed, semiactive, isohyperthemic, shallow, Ultic Haplustalfs	20-35	–	2.2	–	–	3.7
Wang Saphung	15-20	–	–	0.8	0.6	5.2
Fine, mixed, active, isohyperthemic, Typic Haplustalfs	20-35	7.3	–	–	2.5	9.8
Tha Yang						
Loamy-skeletal, siliceous, isohyperthermic, Kanhaplic Haplustults	20-35	–	2.4	–	–	26.8
Total		**10.4**	**8.6**	**3.7**	**6.5**	**71.1**

Huay Yai has similar cropping systems as in the upland area of Mae Thang (Table 5 and Figure 8). Farmers at the site prefer growing soybean followed by mung bean because of the higher product price and easier farming practices. Fruit trees are also grown in patches.

Table 5. The present land use in the selected microcatchments.

Land use	Area (ha)				
	Manai	Mee	Bong	Tong	Yai
Soybean	4.9	6.8	0.3	3.3	43.4
Tamarind	4.9	0.8	-	-	6.6
Shrub	-	1.1	-	0.9	11.4
Tamarind and shrub	-	-	3.5	0.2	6.6
Mango and tamarind	-	-	-	1.5	1.6
Soybean and tamarind	0.6	-	-	0.5	1.6
Total	10.4	8.7	3.8	6.4	71.2

Source: Watershed Hydrology Sub-division, LDD (Aug, 2000).



Mapping unit	Description	Area ha	Area %
Sb	Soybean	43.45	61.1
Tm	Tamarind	6.55	9.2
Sh	Shrub	11.35	15.9
Tm/Sh*	Tamarind/Shrub	6.60	9.3
Mg/Tm*	Mango/Tamarind	1.55	2.2
Sb/Tm*	Soybean/Tamarind	1.60	2.3
* combination 70:30	Total	71.10	100.0

LEGEND

watershed

landuse

Figure 8. Land use map of Huay Yai Catchment.

Hydrological monitoring

In addition to a tipping bucket, rain gauges, and a set of other meteorological sensors, a chart-driven recorder and later a set of nine manual rain gauges were installed at Huay Yai study site. The rainfall total at the site up to the end of October 2000 was 1,230 mm (Table 6). The preliminary analysis of data from the microcatchments showed that the runoff from the five microcatchments ranged from 6.6 to 17.4% of the rainfall

Erosion and land use

The sediment trapped in W1, W2, W3, and W4 as of the end of September 2000, was measured at 510, 812, 223, and 508 kg ha^{-1}, respectively (Table 6). The results agreed well with the land use of the microcatchments shown in Table 5. The amount of sediment collected from W1, W2, and W4 was relatively more than that collected from W3. The catchment of W3 was dominated by tamarind and shrubs while cultivated soybeans dominated the catchments of W1, W2, and W4.

Table 6. Soil erosion and runoff measured at the Thailand site from April to October 2000.

Microcatchment	Size (ha)	Runoff (mm)	Soil loss (kg ha^{-1})
Mawai (w1)	10.4	207	510
Bee (w2)	8.7	214	812
Bong (w3)	3.7	81	223
Tong (w4)	6.5	133	508

Total rainfall – 1230 mm

Using the Universal Soil Loss Equation (USLE), the potential soil erosion from Huay Mee, Huay Manai, Huay Bong, and Huay Tong in 1999 was calculated and also showed the same pattern. Huay Bong (W3) had the lowest percentage of the catchment area that is severely eroded (Table 7 and Figure 9). It should be noted that W3 has a land use of tamarind and shrubs.

Table 7. Degree of soil erosion in the different microcatchments evaluated in 1999 using USLE

Level t ha^{-1} y^{-1}	Degree of soil erosion	Manai	Mee	Bong	Tong	Yai
				Areas (ha)		
0–10	Very slight	0.3	1	0.2	0.3	11
10.1–30	Slight	1	1	0.9	0.3	13
30.1–90	Moderate	2.1	2.4	1	2.5	19
90.1–120	Severe	0.5	0.5	0.8	0.2	4.6
>120	Very severe	6.5	3.7	0.8	3.2	23.4
Total		**10.4**	**8.6**	**3.7**	**6.5**	**71**

Evaluation of the off-site effects of soil erosion

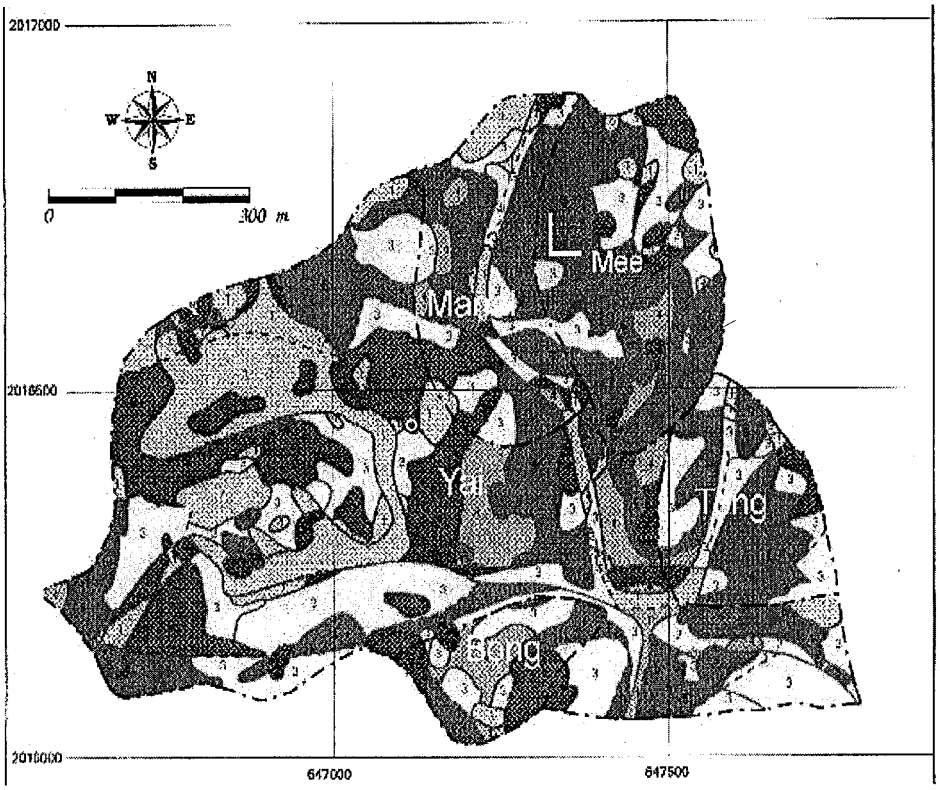
Potential off–site effects of soil erosion

The water body where the runoff carrying soil sediments from the study site drains, is the Mae Thang reservoir. It was constructed as a zoned earthfill dam from May 1992 to April 1995. It has a capacity of 30.6 million m^3 at normal storage level. The Mae Khum Pong and Mae Terk streams join the Mae Thang stream when it drains out of the Mae Thang reservoir. Since Mae Thang reservoir purpose is for irrigation, the potential off-site impact could be in terms of changes primarily in water quality and crop production.

Initial evaluation of the potential impact

Information from the Royal Irrigation Department showed that sediment deposition will not cause significant problems in the reservoir's operation. It was estimated that after 50, 100, and 500 years, the accumulated sediment volume would only be 0.67, 1.34, and 6.33 million m^3 or 1.311, 1.315, 1.326 t m^{-3}. This corresponds to a mean annual sedimentation load of 17,585 t (Royal Irrigation Department, 1996). The life of the reservoir could reach 100 years. The only problem foreseen is the reduction in active storage by about 2.2% and 4.4% after 50 and 100 years of operation. The agricultural area is therefore not expected to be reduced. In terms of water quality, initial analysis showed that the water is still within the range suitable for irrigation.

The effect on aquatic life may be difficult to quantify because aquaculture is not a major activity in the area. However, it can be roughly concluded that fish or other aquatic life is not affected by sedimentation or chemicals detected in the water. Based on the results of analyses during 1995, the level of herbicides detected in water samples was much lower than the limitation standard (Inthasothi, 1996).



LEGEND

Mapping unit	Level ton/ha/yr	Description	Areas (ha)				
			Mee	Manai	Bong	Tong	Yai
1	0 - 10	Very slight	0.3	1.0	0.2	0.3	11.0
2	10.1 – 30	Slight	1.0	1.0	0.9	0.3	13.0
3	30.1 – 90	Moderate	2.1	2.4	1.0	2.5	19.0
4	90.1 – 120	Severe	0.5	0.5	0.8	0.2	4.6
5	> 120	Very severe	6.5	3.7	0.8	3.2	23.4
Total			10.4	8.6	3.7	6.5	71.0

Microcatchment

Erosion Phase

Watershed Hydrology Subdivision, Soil and Water Conservation Division, Land Development Department Aug 2000.

Figure 9. Soil erosion in 1999 using the USLE.

SUMMARY AND CONCLUSION

Huay Yai Catchment, with an area of approximately 71 ha was selected within the Mae Yom Watershed. Four microcatchments, namely, Huay Manai, Huay Mee, Huay Bong, and Huay Tong were delineated and instrumented for erosion and hydrological measurements. The climate type in the area is tropical savannah 'Aw' and the average annual rainfall from 1974–1999 was 1,077 mm. The temperature ranges from 15.3–37.5?C. The topography is rolling to mountainous and the soils are medium to fine texture and low to medium fertility and mostly shallow. Its tributaries have flowing water only during the rainy season. The existing cropping pattern is soybean/mung bean.

Fifty farming families living mainly in Pong village, 25 km from the site, are presently cultivating the area. The total population of Pong village is about 3,655 persons with household size of 3–11 persons per household with 1–2 persons available for labour.

Initial results as of September 2000 showed that the sediment collected in W1, W2, W3 and W4 amounted to 510, 812, 223, and 508 kg ha^{-1}, respectively. The results agreed well with the land use of the microcatchments, that is soil loss was higher from the cultivated soybean catchments than the catchment of tamarind and shrubs. Estimates of soil erosion based on the Universal Soil Loss Equation (USLE) also showed the same trend.

Until the end of 2000, the on-site effect of soil erosion on crop growth cannot yet be evaluated. Additional data are still needed to verify and make firm conclusions on this aspect.

The off-site effect of soil erosion on reservoir life and water supply was evaluated and the only foreseen problem would be the reduction of active storage of about 2.2% and 4.4% after 50 and 100 years of operation. Surface water quality is still in the normal range for irrigation water and standard for drinking water.

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