The Management of Soil Erosion Consortium (MSEC): Linking Land and Water Management for Sustainable Upland Development in Asia

Progress Report of ADB-RETA 5803
Catchment Approach to Managing Soil Erosion in Asia

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INTRODUCTION

Continued land degradation brought by soil erosion in the sloping lands has been a major constraint in sustaining upland agriculture and food security in most of Asia. Farming and other economic activities have become environmentally unsustainable causing deleterious on-site and off-site effects. Quite a few studies on soil erosion and soil conservation have been undertaken, but results have not yielded sustainably adopted land management options that can provide reasonable returns without further degrading the resource, base and the environment. Greenland *et al* (1994) made a reexamination of approaches to research on sustainable land management and recommended a new research paradigm providing all organizational model that engages scientists and research institutions to tackle a common goal through a participatory, interdisciplinary, and community and catchment-based approach. This led to the establishment of the Management of Soil Erosion Consortium (MSEC) as one of the four consortia under the SWNM system-wide initiative of the CGIAR.

In 1998, MSEC initiated a research project on soil erosion management in six countries in Asia with support from the Asian Development Bank (ADB). The project aimed to develop and promote sustainable and socially acceptable community-based land management options for sloping uplands through a participatory and interdisciplinary approach at the level of a catchment. This paper presents an overview of the progress of the project in Indonesia, Laos, Nepal, Philippines, Thailand and Vietnam. It highlights the progress of the project in catchment research and summarizes its accomplishments in the other components of information dissemination and capacity building *vis a vis* the outputs expected. The more detailed discussions of the technical outputs are contained in the individual country reports and the technical papers presented in this assembly. It also discusses the project's strategy in governance and management.

PROGRAM OBJECTIVES AND EXPECTED OUTPUTS

The objectives of the program are to:

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

The program focuses on three major components to address the stated objectives. These are:

- catchment research to evaluate the effects of different land management practices on water and nutrient flows in selected representative catchments;
- capacity building of participating NARES in research on integrated catchment management and soil erosion; and
- dissemination of research results for enhanced adoption of land management technologies and for more accessible information as concrete basis for decision making

Outputs from its activities are expected to be generated in the first three 'years, but for some, a longer time frame is needed. In fact, the consortium is envisioned for a period of at least 10 years. The expected outputs are given in the project logical framework (Table 1a, 1b) and summarized as follows

- Decision support tools and guidelines based on a better understanding of the on- and off-site effects of soil erosion
- Alternative technologies and land management systems that are socially, and institutionally acceptable to the communities in the catchment areas
- Methodology for assessment of impacts and obtaining participation of farmers and other stakeholders in the management of catchments which includes policies that will improve the management of catchments by the local government and the communities
- Information and communication strategies to effectively disseminate the results of the research to the farmers

and other land users
- Enhanced NARES capacity in integrated catchment management research
- Improved program management for catchment management research

Table 1a. Logical Framework: Management of Soil Erosion Consortium (MSEC)

SUMMARY	OBJECTIVELY VERIFIABLE INDICATORS	MEANS/SOURCES OF VERIFICATION	IMPORTANT ASSUMPTIONS
OVERALL GOAL:			
To contribute to the long-term increases in agricultural productivity, poverty reduction, and conservation and enhancement of land and water resources	Reduction of soil erosion, nutrient losses and run-off and increase in agricultural production in benchmark sites; reduction of negative effects of erosion off-site	Community development plans and statistics; field survey	Participation of relevant stakeholders committed; policy environment supportive of natural resources management
PROJECT PURPOSE:			
To facilitate, enhance and sustain the adoption and use of land management systems that increase agricultural productivity and conserve soil and water resources	Number of stakeholders involved in project implementation	Progress reports-, publications, field surveys	Stakeholders continue to be committed to participate; commitment of NARES to implement research and disseminate results
RESULTS/OUTPUTS:			
1. Decision support tools and guidelines for improved soil erosion management in catchments	Number of programs/models (DSS) evaluated and applied; number of guidelines prepared and published	Progress reports; technical publications; field surveys	Programs/models available for evaluation
2. Improved technologies and land management systems that will address both increased productivity and resource conservation	Number of improved technologies and land management systems evaluated and used	Technical reports; field surveys	NARES implement the research; benchmark sites established and maintained
3. Methodology for assessment of impacts of improved practices on production, and environmental conditions	Adaptation of methodology in other environments	Technical reports	availability of expertise in the countries
4. Information and communication channels for improved dissemination and sharing of results	Number of communication channels developed and information materials produced	Technical reports; field surveys	Extension personnel participate
5. Enhanced capacity of the NARES in catchment research and subsequent dissemination of its results to farmers	Number of persons trained; quality and quantity of equipment provided, number of students assisted	Reports, list of training courses; training materials; list of equipment; thesis reports	Trained staff stay with project
6. Improved program management, monitoring and evaluation	Improved quality of outputs; less administrative problems; quality and quantity of collaboration	Progress reports	Project outputs made available; scientific committee starts to function

Table 1b. List of Activities for the Different Outputs

Output 1 Tools and Guidelines for Improved Soil Erosion Management	**Output 2** Improved Technologies and Land Management Systems	**Output 3** Methodology for Impact Assessment	**Output 4** Information and Communication Strategies	**Output 5** Enhanced Capacity of the NARES	**Output 6** Improved Program Management Monitoring and Evaluation
a. Adapting the methodologies for economic assessment of soil erosion and nutrient depletion	a. Quantification and evaluation of the biophysical, environmental, and socioeconomic effects of soil erosion, both on-	a. Assessment of resources including indigenous technical knowledge (ITK) and needs with key stakeholders	a. Presentation of technical papers in relevant seminars and conferences	a. Conduct of relevant training programs	a. Forging linkages and collaboration

	site and off-site				
b. Evaluation of models and decision support systems to explore consequences of erosion and loss of nutrients and organic matter	b. Development and evaluation of catchment-based land management options that will be sustainable and acceptable to various users	b. Analysis of impact of consortium model	b. Preparation of annual reports and related documents	b. Provision of needed equipment	b. Periodic visits to the MSEC sites in the participating countries
		c. Evaluation of policy and institutions and assessment of impact	c. Establishment of MSEC web page and data base and linked to SWNM web site	c. Provision of consultancy services	c. Conduct of monthly meetings, 2 SC meetings and 1 MSEC assembly
c. Exchange of approaches on catchment studies and standardization of methods, techniques and assuring quality			d. Establishment and operation of a list server for sustainable land management	d. Support for complementary researches of interested graduate students	

PROGRAM IMPLEMENTATION

MSEC uses a new approach to the organization and implementation of soil erosion management research. The approach provides a mechanism that engages different scientists and research institutions in a coordinated and participatory mode at the catchment scale. Research planning and implementation is undertaken through consultation among concerned NARES, IARCS, ARIs, NGOs, and farmers. The NARES play the central role in the consortium, particularly in the participatory research, but with a broad responsibility for underpinning applied and strategic research as well (Figure 1). IWMI serves as the consortium secretariat and facilitator. Project and institutional linkages are also established to effect this partnerships at the country level (Figure 2).

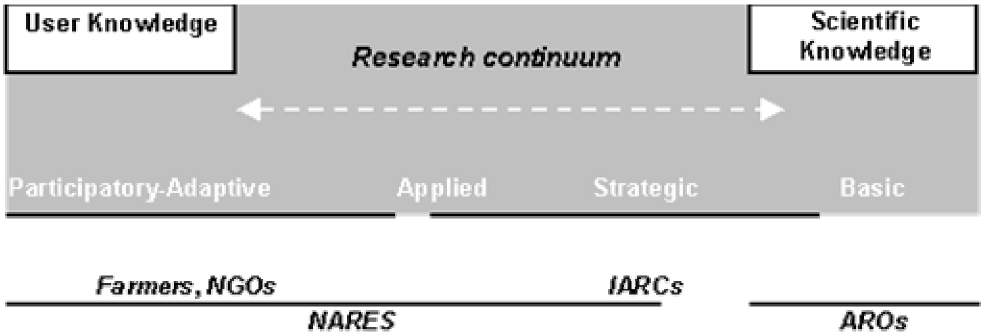

Figure 1: The research continuum showing the role of different groups in the implementation of MSEC MSEC research (Craswell and Maglinao, 2001)

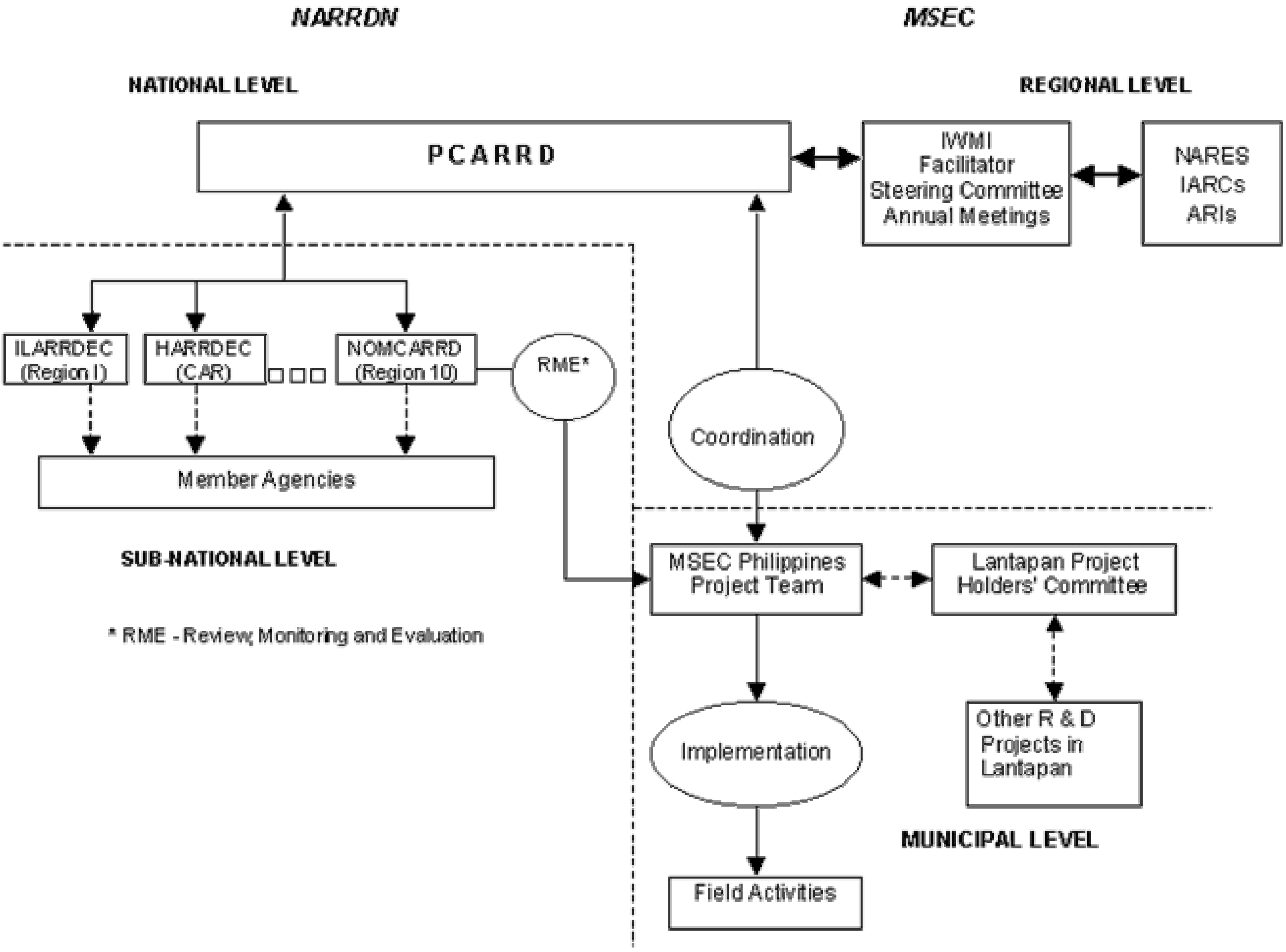

Figure 2: MSEC Philippines Project: Organization and Linkages

The study catchments were selected using carefully defined criteria and methodological guidelines developed for the purpose (IBSRAM, 1997). Monitoring stations equipped with automatic water level recorders, manual staff gauges, sediment traps, automatic weather stations, automatic sediment samplers, and manual rain gauges were installed in the catchments to collect hydrological and erosion data. In addition, monitoring of the socioeconomic parameters and the agricultural practices of the farmers was likewise undertaken. The detailed methodology used in carrying out the activities in the catchments are contained in the individual country reports presented in the 5th MSEC assembly (Maglinao and Leslie, 2001).

The best bet land management options were identified in consultation with the farmers. The information gathered from the monitoring of the biophysical and socioeconomic data were explained to the farmers during the discussion. The identified options were implemented by the farmers with the technical assistance from the researchers. Regular monitoring of the effect of file introduced options is underway. It is assumed that with the inputs of the farmers taken into consideration, any intervention would be adopted and sustained.

PROGRESS IN CATCHMENT RESEARCH

Catchment Profiles

The experimental catchments range from 67 ha in Laos to 139 ha in Indonesia with up to four smaller microcatchments representing different land uses delineated within (Maglinao *et al,* 2001). All catchments (except in India) have slopes ranging from 12 to 80%, and an average annual rainfall ranging from 1,080 to 2,500 mile (Table 2). In the Philippines and Thailand, water flows in the creeks only during the rainy season. The catchments are dominated by annual cash crops with some patches of perennials and are cultivated primarily by ethnic minorities. In general, the model catchments represent a resource management domain with common biophysical and socioeconomic characteristics common, to the marginal sloping uplands (Craswell and Maglinao, 2001).

Table 2: Profile description of the MSEC catchments in participating countries

General Description	Catchment name						
	Lalatola	Babon	Ban Lak Sip	Masrang Khola	Mapawa	Huay Yai	Dong Cao
Basic information							
Country	India	Indonesia	Laos	Nepal	Philippines	Thailand	Vietnam
Province	Bhopal	Semarang	L. Prabang	Chitwan	Bukidnon	Phrae	Hoa Binh
Latitude	24º16'N	07º20'S	19 º 51'10''N	27º49'N	08º02'50''N	18º13'20''	20º57'40''N
Longitude	77º30'E	110ºE	102º10'45''E	85º32'30''E	125º56'35''E	100º23'40''	105º29'10''E
Elevation (m)	415	390-510	400-700	650-1400	1080-1505	400-480	125-700
Catchment size (ha)	75	139	67	124	91	71	96
Biophysical attributes							
Slope (%)	<5	15-75	30-80	40-100	8-35	12-50	40-60
Geology and landform		Basaltic lava mudstone	Shale;	Gneiss; schist	Basalt, pyroclastics	Siltstone, sandstone	Schist
Rainfall (mm)	1,200	2,500	1,403	2,200	2,537	1,077	1,500
Soils	Vertisol	Inceptisol	Alfisol; Ultisol	Inceptisol; Alfisol	Ultisol, Inceptisol	Alfisol; Ultisol	Ultisol
Vegetation and land use	Degraded forest, soybean, wheat sorghum, maize	Rice, maize, rambutan	Forest, bush fallow; rice maize, job's tears	Forest, grasslands, rice maize, millet, potato	Forest plantation, open grassland, maize, potato, vegetables	Maize, soybean, mung bean, tamarind	Cassava, rice, maize, taro, peanut
Hydrology	Intermittent (water flows only during rainy round)	Permanent flow (water flows year round)	Permanent flow (water flows year round)	Permanent flow (water flows year round)	Intermittent flow (water flows only during rainy round)	Intermittent flow (water flows only during rainy round)	Permanent flow (water flows year round)
Socioeconomic attributes							
Population - household - persons		 405 1,812	 80 427	 54 354	 70 155	 489 3,655	 38 196
Ethnic group			Lao Theung (92%) Lao Lum (2%)	Gurung; Gharti; Brahmin, Chhetri/Thakuri,	Talaandig	Hmong, Thai	Kinh (40%); Muong
Land tenure		Owners, shareholders	State owned Land use right (28 HH)	With certificate of ownership Leased	Private owner	Land use title	Land use right
Income (100%)							
+ on farm - crop - animal + off farm		 46% 18% 36%	70% 30%	41% 59%			 57% 39% 4%
Dominant crops	Soybean, sorghum, wheat	Rambutan, lowland rice; upland crops	Maize, job's tears	Maize, rice, millet, mustard, legumes	Vegetables, maize	Maize, soybean, mungbean	Cassava, rice, maize, peanut
Agricultural Practices	Two crops in one year	Two crops in one year	One crop in one year	Two or three crops a year	Two crops in one year	Two crops in one year	Two-crops in one year

Relevant institutions	ICRISAT, CRIDA, JNKVV, IISS, BAIF	CSAR, CIRAD, BPTP; AIAT	NAFRI; IRD	NARC, Dept of Hydrology, ICIMOD	PCARRD, DA, DENR, NGO SANREM, CMU, ICRAF, SEARCA,	RFD, LDD, RID; ICRISAT; AIT	MARD, NISF, VASI; ICRISAT

In most catchments, the farmers who farm in the areas live in tile village outside of the catchment. It is only in the Philippines where most of the farmers settle within the catchment. Land use rights are provided to the Vietnamese and Lao farmers while the farmers in the other sites are either shareholders or owners. A number of research and development institutions have been collaborating with the project in all areas.

The sub-catchments range from a small of 0.9 ha in the Philippines to as large as 38.5 ha in Indonesia (Table 3). Those in Indonesia are primarily cropped either with upland annual crops or perennials, primarily rambutan. In the Philippines, the sub-catchments represent a combination of the area cultivated to maize, vegetables or potato and grasslands with a small settlement area in one of the sub-catchments. In Vietnam, the sub-catchments are cropped with either monoculture or intercropped cassava, but with areas of natural grass still present. In Laos, a large part of the area of the sub-catchments is under rotating cultivation or bush fallow. Annual upland crops also predominate in the catchments in Thailand and Nepal.

Table 3. Size and dominant land use of the micro-catchments in the different countries

Micro-catchment	**Area (ha)**	**Land use**	**Slope (%)**
Indonesia			15-75
MC-II	3.2	50% annual upland crops, coffee and nutmeg on the upper slopes	
MC-2I	2.0	Rambutan and some bare plots	
MC-3I	38.5	Rambutan	
Laos			30-80
MC-1L	1.2	69% rotating land, 31 % teak	
MC-2L	19.5	76% rotating land, 6% upland rice	
MC-3L	13.3	80% rotating land, 12% forest	
MC-4L	18.6	61% rotating land, 11% job tear, 10% forest, 7% upland rice	
MC-5L	8.8	53% rotating land, 35% forest, 8% upland rice	
MC-6L	1.7	56% rotating land, 13% forest, 31% teak	
Nepal	40-100		40-100
MC-1N	72.6	Mixed (45% upland, 5% lowland, 20% shrub, 30% forest)	
MC-2N	39.6	Mixed (60% upland, 10% shrub, 30% forest)	
MC-3N	11.5	Mixed (23% upland, 2% lowland, 35% shrub, 40% forest)	
MC-4N	1.6	Upland cultivated (100%)	
Philippines			8-35
MC- 1P	24.9	20% cultivated, 80% Falcata, grassland	
MC-2P	17.9	40% cultivated, 60% grassland/forest	
MC-3P	8.0	10% settlement, 15% cultivated, 17%, 75% natural grass	
MC-4P	0.9	40% cultivated, 60% grassland	
Thailand			12-50

MC-1T	11.6	47% soybean-mungbean, 47% tamarind	
MC-2T	9.8	78.2% soybean-mungbean, 13% shrub	
MC-3T	3.2	94% tamarind, shrub	
MC-4T	7.1	51% soybean-mungbean, 23% mango, tamarind	
Vietnam			40-60
MC-1V	4.8	67% monoculture cassava, 33% natural grass	
MC-2V	9.4	24% cassava intercrop, 59% cassava monoculture, 17% natural	
MC-3V	5.2	Cassava intercrop	
MC-4V	12.4	26% cassava intercrop, 74% natural grass	

Erosion and Land Use

The existing land management practices showed their effects on the degree of soil erosion in the different sub-catchments within each of the three catchments. Except for the results obtained in Nepal, the areas more intensively cultivated to upland crops produce more soil loss than those grown to perennials or left under grass cover (Table 4). This confirms the initial observations seen from the same catchments a year before (Maglinao *et al,* 2001). In Indonesia, sediment yield was highest in the sub-catchment (MC-1I) dominated by upland annual crops yielding a soil loss of 6.7 tons/ha in one year of observation. This is presumably because of minimal soil surface litter and little canopy cover of the catchment (Agus *et al,* 2001). On the other hand, the other sub-catchments (MC-2I and MC-3I) planted to perennials (primarily rambutan), lost relatively less amount of soil during the same period, only about 1 ton/ha and yielding considerable amount of sediment only during the middle part of the rainy season (January).

Table 4. Observed soil erosion in the different micro-catchments in the different countries

Micro-catchment	Area (ha)	Land use	Soil loss (t/ha)
Indonesia			
MC- 1I	3.2	50% annual upland crops, coffee and nutmeg on the upper slopes	6.7
MC-2I	2.0	Rambutan and some bare plots	0.8
MC-3I	38.5	Rambutan	1.0
Laos			
MC-1L	1.7	69% rotating land, 31% teak	0.5
MC-2L	29.3	76% rotating land, 6% upland rice	0.6
MC-3L	19.8	80% rotating land, 12% forest	0.0
MC-4L	27.7	61% rotating land, 11% job tear, 10% forest, 7% upland rice	2.1
MC-5L	13.1	53% rotating land, 35% forest, 8% upland rice	2.8
MC-6L	2.5	56% rotating land, 13% forest, 31 % teak	2.0
Nepal	40-100		
MC-1N	72.6	Mixed (45% upland, 5% lowland, 20% shrub, 30% forest)	0.08
MC-2N	39.6	Mixed (60% upland, 10% shrub, 30% forest)	0.14
MC-3N	11.5	Mixed (23% upland, 2% lowland, 35% shrub, 40% forest)	0.09
MC-4N	1.6	Upland cultivated (100%)	Traces

Philippines			
MC-1P	24.9	20% cultivated, 801/o Falcata, grassland	0.1
MC-2P	17.9	40% cultivated, 60% grassland/forest	0.7
MC-3P	8.0	10% settlement, 15% cultivated, 17%, 75% natural grass	1.0
MC-4P	0.9	40% cultivated, 60% grassland	53.9
Thailand			
MC-1T	11.6	47% soybean-mungbean, 47% tamarind	0.1
MC-2T	9.8	78.2% soybean-mungbean, 13% shrub	1.6
MC-3T	3.2	94% tamarind, shrub	1.0
MC-4T	7.1	51% soybean-mungbean, 23% mango, tamarind	0.4
Vietnam			
MC-1V	4.8	67% monoculture cassava, 33% natural grass	5.2
MC-2V	9.4	24% intercrop, 59% cassava monoculture, 17% natural grass	4.3
MC-3V	5.2	Cassava intercrop	3.9
MC-4V	12.4	26% cassava intercrop, 74% natural glass	2.0

Note: Period of observation:
Indonesia - March 2000 to February 2001
Laos - May to September 2001
Nepal - March to September-2001
Philippines - April 2000 to March 2001
Thailand - June to September 2001
Vietnam - January to August 2001

In the Philippines, observations conducted front April 2000 to March 2001 also showed the effect of land use on erosion. The smallest sub-catchment (MC - 4P) and which has a higher percentage of cultivated area gave the highest soil loss of 53.9 ton/ha. The lowest soil loss was in the sub-catchment (MC - 1P) which has a lower percentage of cultivated area and a larger area covered with grasses. The sub-catchment (MC-3P) which has the lowest percentage of cultivated area but with some settlement within yielded a higher soil loss. The relatively higher soil loss in this sub catchment which has 10% built up area may be attributed to erosion from the foot trails and road network (Duque *et al,* 2001). Using a simulation model, Ziegler *et al* (1999) showed that roads generate runoff sooner during an event, and hive greater discharge values than other surfaces. Sediment transport was also greater. Footpaths emerged as, important areas of accelerated runoff generation on agricultural fields that otherwise require large amount of rainfall to produce runoff.

In Vietnam, the data collected from January to October 2001 showed that among the sub-catchments, MC-1V (predominantly cassava monoculture with some natural grass) had the largest soil loss of about 5.2 ton/ha. The least was from MC-4V (predominantly natural grass and cassava intercropping) at 2.0 tons/ha. The larger soil loss from MC-1V (primarily cassava monoculture) than from MC-3V (all cassava intercropping) shows the effect of cassava intercropping system as opposed to a cassava monoculture. At its peak growth, cassava provides only about 47-56% soil cover and mixed cropping or intercropping can increase this protection (Toan *et al,* 2001). The effect of natural grass in the sub-catchments was also manifested. Natural grass enhances infiltration, reduces runoff and runoff velocity, and consequently reduces soil loss.

In Laos, observations made from May to October 2001 showed that the micro-catchment with the smallest proportion of rotating land and with some 8% of upland rice (MC-5L) gave the highest soil loss of 2.8 tons/ha (Phommassack *et al* 2001), No erosion was observed in the micro-catchment with the largest proportion of rotating land and about 12% forest (MC-3L). It is surprising to have a different observation in the site in Nepal. The sub-catchment which has been extensively cultivated yielded the lowest soil loss on a per hectare basis (Maskey *et al,* 2001).

Soil Erosion and Farming Operation

Farming operations in the field is very much related to how the land is managed and obviously can also affect soil erosion. Observations in Indonesia showed that at the time of planting the upland crops (November), a rainfall of nearly

600 mm produced sediment yield as high as about 2 tons/ha (Agus *et al.* 2001). It is to be noted that at this time, the soil surface very bare and the soil aggregates were loose because of tillage. With rainfall exceeding 400 mm in January, March and April, sediment yield was greater than 1 ton/ha. It appears that the soil has to reach a certain level of water saturation and the amount of rainfall should be high enough for erosion to occur in the relatively well-covered sub-catchments (MC-2I and MC-3I).

In Vietnam, it was also observed that at the start of the rainy season when the soil was still dry, there was not much runoff even during strong rains. The amount of rainfall could have just been enough to saturate the soil as a rainfall of more than 300 mm in May did not result in significant increase in runoff. Runoff sharply increased the following month (Toan *et al* 2001). Incidentally, the overall cover density of the area was also at its highest from June to August.

Soil Erosion and Catchment Size

In the Philippines, the smallest sub-catchment (MC-4P) which incidentally has a large proportion of cultivated area yielded the highest soil loss both in total amount and in tons per hectare. In Indonesia, most of the sediments measured from the trap in the smaller sub-catchments (MC-1I and MC-2I) were of the larger sized aggregates or particles (bed load) while for the larger sub-catchments (MC-1I), the finer sediment (suspended load) dominated (Figure 3). This reflects that during the erosion process, relatively small portion of soil aggregates was dispersed, especially for the MC-2I sub-catchment with no tillage and with ideal cover (Agus *et al,* 2001). This also reflects that the source of most sediment reaching the sediment trap was relatively close to the trap and the larger the catchment, the less the bed load contribution to sediment yield.

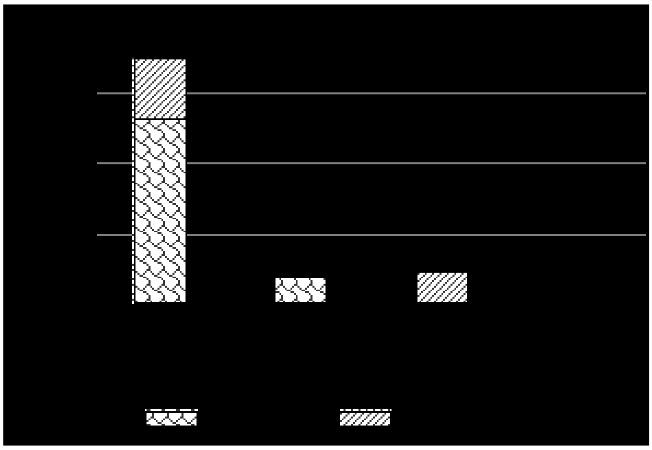

Figure 3: Sediment output from the different sub-catchments in Babon catchment, Indonesia, from March 2000 to February 2001 (Agus et al, 2001)

In Laos, the measured erosion from the microplots reached as high as 78 ton/ha compared with approximately 1-2 ton/ha at the microcatchment scale. These observations reconfirm earlier reports that direct extrapolation of soil loss data from plot scale to small catchments and from small catchments to bigger catchments will lead to overestimation.

Nutrient Depletion and Off-site Effects

The results of analysis of the soil eroded from the catchment in Vietnam clearly showed that much of the plant nutrients are carried away with the sediments (Toan *et al,* 2001). They showed that the catchment has lost a total of 740 kg OM, 39 kg N, 31 kg P_2O_5 and 80 kg K_2O. In the measurements conducted in one of the microcatchments in the Philippines, 3.4 tons OM, 0.1 kg extractable P, and 7.9 kg exchangeable K were lost with 62 tons of eroded soil measured from May 2000 to August 2001 (Duque *et al,* 2001). The data clearly show that farming without soil conservation results in soil and nutrient losses that could further result in lower crop yields and productivity. It is anticipated that with proper soil management and applying the appropriate land use, soil and nutrient losses could be minimized.

One visible effect of erosion off site is the sedimentation downstream due to the transport of soil from the uplands. An initial valuation of this effect at the Philippine site was done by valuing the cost of dredging the silted irrigation canals of the Manupali River Irrigation System (Carpina *et al.,* 2001). Since 1995, a total of 81,724 m^3 of sediments was estimated to have been transported to the system costing about US$49,000 for dredging. With the assumption that 0.5% comes from the Mapawa site, it was estimated to have contributed 409m^3 of sediments to the irrigation system or an equivalent of US$245 as cost for dredging (Duque *et al,* 2001).

While not all of the model catchments have nearby reservoirs where the effect of erosion on sedimentation can easily be assessed, initial attempts have identified economic activities and environmental effects that could be studied to evaluate the effect of soil erosion off-site. The effect of erosion on the quality of the water that flows downstream and on the production of crops in the lowlands could also be assessed and valued.

Related to the amount of soil loss, the amount of nutrients that are carried away is a reflection of the degrading effect of soil erosion. As the top soil is removed by water erosion, considerable amounts of plant nutrients are also lost. Obviously, this will reduce the soil fertility on the site and consequently result in the reduction in crop yields unless external nutrient inputs are provided back to the cultivated fields in the catchments. It becomes obvious, that the land management systems that must lie introduced should be able to restore the lost fertility and increase farmers' income.

Best Bet Land Management Options

In most instances, the land management options identified for introduction in the catchments were variants of the contour hedgerow farming in combination with soil fertility management and animal production. In the Philippines, the use of natural vegetative strips (NVS) is one technology that was identified by tile fat-fliers. This is done by using naturally-growing grasses and some agro-forestry crops as hedgerows. It is worth noting that several farmers have already made use of this technique as a result of the promotion activity by ICRAF in the area. Adoption seems to be affected by the tenure system of tile farmers. About half of the landowners have adopted some conservation measures but none from the tenants (Duque *et al,* 2001). For those who are interested but have not yet adopted, the major reason is the cost of establishment.

In Indonesia, the option identified is a combination of fodder grass planted oil alternate terraces of land currently used for annual upland crops and cattle fattening. In terms of seriousness of erosion, this area needs priority attention. The fodder grass is expected to reduce erosion and serve as feed for the livestock. The identification of the option was based on lessons learned from elsewhere in Indonesia that farmers' adoption and improvement of a conservation measure is determined by the economic contribution of the measure to the household economy. Farmers are attracted to a practice only if the practice promises economic benefit and this consideration must be put forward in the participatory technology selection. This will be introduced in late 2001 during the next cropping season.

Vetiver grass and *T. candida* are tile hedgerows in the alley cropping system introduced in the catchment in Vietnam. The technology intervention has just been started and so the effect of the intervention on crop growth and yield cannot still be evaluated. Possibly as a result of the demonstration site on alley cropping near the site, the farmers believe that the system will reduce runoff and soil loss, add organic matter and improve soil fertility by adding the hedgerow trimmings.

Other options that the farmers in the Philippines look at are the planting of pasture legumes during fallow after growing potato, corn or cabbage instead of grass fallow for 3-4 years and planting tiger grass and bamboo along the creek banks to serve as buffer. Tiger grass and bamboo are expected to provide additional income as tiger grass is used for soft broom and bamboo as props for the banana plantation.

It was observed that presentation and discussion of the results of monitoring in the catchments with the farmers helped very much in the identification of the land management options that are more appropriate in the particular area. While the farmers are aware of soil erosion and its negative effect, actual observations and the alarming figures presented increased their appreciation of looking at a longer time horizon. As they are aware of the declining productivity of their land, they were also interested in fertility management. Of course, their immediate concern are tile benefits that they will gain in the short term. These concerns should be given more emphasis in introducing any interventions in their farms.

Modeling and Extrapolation

The soil erosion and hydrology model (PCARES) developed by Dr. E. Paningbatan of UPLB was tested using MSEC data from the Philippines and found to need some modifications. ICRAF agreed that MSEC also looks at a similar model that they have developed. The model was found to work using the data inputs required by the other model. Dr. Apisit Eiumnoh of AIT was tapped to work on this particular model. The model was demonstrated during the MSEC assembly in Hanoi.

Further analysis of secondary data and complemented with the primary data collected from the different catchments was done to produce maps that would be needed in the application of the PCARES and ICRAF models. These were used during the follow up training conducted in Vientiane, Laos from 22-26 October 2001.

Other Strategic Research

Rainfall simulation studies in Thailand showed that infiltration rate tended to increase while runoff coefficient decreased with slope gradient (Janeau *et al,* 2001). Runoff volume decreased with increasing slope. These results suggest that for convex landforms, the steep midslope zone can play the role of infiltration trap for runoff water from upper gentler zone. This may have substantial impacts on flow volume generated from small watersheds and on water quality.

The work of the University of Bayreuth, also in northern Thailand showed that vegetation and land use influence the quality and rate of organic matter input into the mineral soil and is therefore one of the main factors controlling the composition of soil organic matter (Moller *et al.* 2001). The conversion of forests to cabbage cultivation resulted in enhanced breakdown or soil organic matters as indicated by the lower contents of OC and N in the mineral soil in the latter land use. Reforestation with Pinus did not lead to a significant build-up of organic matter in the mineral soil.

ACCOMPLISHMENTS WITH RESPECT TO OUTPUTS EXPECTED

As presented in the logical framework, the outputs expected from the project are: 1) decision support tools and guidelines for improved decision making and research implementation, 2) alternative technologies and land management systems, 3) alternative information and communication strategies, and 4) improved program management and governance. Table 5 shows the accomplishments of the project as of December 2001 *vis a vis* these expected outputs.

Table 5: The outputs expected from the project and the accomplishments as of December 2001

Outputs Expected	**Accomplishment as of December 2001**
Tools and guidelines for improved decision making and research implementation	Guidelines for site selection of MSEC catchments published Minimum data sets for biophysical and socioeconomic site characterization Protocols for biophysical data collection, storage and retrieval Modified decision support system for sustainable land management to consider nutrient losses during erosion events Procedure and guideline for rainfall simulation studies Use of ^{137}Cs as a method of measurement of past erosion Framework for assessment of impact of project prepared and presented in several conferences
Alternative technologies and land management systems	The best bet options introduced in the farming systems in the catchments were identified in consultation with the farmers. In general, the recommended interventions are variants of the hedgerow cropping technology with modifications considering the inputs from the farmers. In Indonesia, in the Tegalan micro-catchment which showed the highest rate of erosion, grass hedgerows and livestock production will be integrated in the system. The natural vegetative strips (NVS) technology being promoted by ICRAF was identified for introduction in the Philippines. It will also incorporate soil fertility management in enhancing the yield of crops. Variants of the SALT were introduced in Nepal and Vietnam. *Tephrosia candida* and vetiver grass were used as hedgerows in Vietnam
Improved information dissemination and communication strategies	Organized and conducted 19 workshops and meetings since 1998 (see Appendix 1) Presented 13 technical papers in international conferences and meeting organized by other organizations. Three papers are accepted for presentation at the ISCO conference in Beijing in May 2002 Published 4 proceedings and books, 6 articles in journals/proceedings Prepared 6 reports to donors Redesigned the web page to fit to the IWMI web site
Enhanced capacity of the NARES	At least 60 research partners trained on various areas in 11 programs conducted since 1998 Consultants are hired to assist in some special aspects of the project Ten (10) MS and PhD students are conducting their research in the catchments in Indonesia, Laos, Philippines, Thailand and Vietnam (see Appendix 2)
Improved program management, monitoring and evaluation	Regular visits to sites to monitor and evaluate progress of project Linkages and collaboration forged with IARCs and ARIs with similar activities Stronger complementation among related programs resulted from the integration of IBSRAM and IWMI programs under a focused theme of sustainable smallholder land and water management Strengthen role of SC by forming clusters to work on more specific assignments Good and fast exchange of communication still provides a good mechanism for managing the program. Commitment of continued support on the part of all partners appears to be a critical ingredient

	Eleven (11) MSEC monthly meetings were conducted from January to December 2001. These meetings provide a venue for discussion and updating of the progress of the project among IWMI staff and IRD scientists especially in Bangkok and Laos.

Tools and Guidelines for Improved Decision Making and Research Implementation

MSEC's emphasis not only on research but also on research methodology is expected to produce tools and guidelines to support decision making and improved implementation of MSEC research activities. One such output is an earlier publication by IBSRAM which provides the guidelines for model catchment selection for MSEC. The site selection was based on criteria agreed upon by the consortium partners.

The minimum data sets for biophysical and socioeconomic site characterization was prepared and employed. Protocols on the biophysical data collection, analysis, storage and retrieval have been discussed during the country visits of IWMI staff. The existing methodologies for the economic assessment or soil erosion and nutrient depletion and on-farm trials have been adapted and applied in the MSEC sites. Existing soil erosion and hydrology models are reviewed to identify appropriate models applicable to the MSEC work.

Alternative technologies and land management systems

In most instances, the land management options introduced in the catchments were variants of the contour hedgerow farming in combination with soil fertility management and animal production. In the Philippines, the, use of natural vegetative strips (NVS) is one technology that was identified by the farmers. In Indonesia, tile option identified is a combination of fodder grass planted oil alternate terraces of land currently used for annual upland crops and cattle fattening. Vetiver grass and *T. candida* are the hedgerows in the alley cropping system introduced in the catchment in Vietnam.

Other options that the farmers in the Philippines look at are the planting of pasture legumes during fallow after growing potato, com or cabbage, instead of grass fallow for 3-4 years and planting tiger grass and bamboo along the creek banks to serve as buffer. Tiger grass and bamboo are expected to provide additional income as tiger grass is used for soft broom and bamboo as props for tile banana plantation.

Methodology for impact assessment

Impact assessment is an important and integral part of research management. However, the methodology of doing such assessment particularly natural resources issues such as sustainable land management is still lacking or inadequate. With MSEC implementing a new research paradigm, it is most important to know the added value of its approach. Is the consortium model, or a participatory catchment-based approach to research on soil erosion the best alternative means of producing outputs that will have more impact? The project has already designed a framework for the assessment of its impact.

Improved information dissemination and communication strategies

To address this expected output, MSEC has continued to support activities such as participation to relevant seminars and meetings not only of the IWMI staff, but also of our national partners. More recently, three MSEC papers have been accepted for presentation at the ISCO meeting in Beijing. The list of publications, papers prepared for scientific conferences, and the workshops and conferences organized or attended by MSEC is shown in Appendix I.

In addition to preparation of regular reports to donors, MSEC is maintaining a web page and data base and have operated a list server called SLMNET. The usefulness of all these information dissemination mechanisms however depends on the cooperation of all involved.

Enhanced capacity of the NARES

As of present, MSEC has conducted 10 training programs oil topics such as, program management, participatory approaches, hydrology, GIS and modeling, rainfall simulation data analysis, etc. participated in by more 60 partners from 16 institutions. The list of training programs is also shown ill Appendix 1.

Ten graduate students have been involved with the project by conducting their research in the sites. Another aspect that has been put forward very much earlier is the involvement of graduate students in research work of MSEC. It is therefore necessary to have closer links with universities in the countries or in the region. Appendix 2 shows the list of students conducting research with MSEC. Consultants have also been tapped to provide assistance in addressing more specific research topics.

Improved program management, monitoring and evaluation

Improved program management, monitoring and evaluation could also be reflected on the quality of the other outputs mentioned above. A better management of the program is expected to yield more usable tools and guidelines, more relevant technologies, more effective information dissemination and more significant institution development. MSEC envisions to optimize the use of scarce research resources by strengthening linkages and collaboration with related projects and institutions. Regular visits to the MSEC sites are still a major activity to monitor progress and anticipate problems in implementation. The regular monthly meeting of the MSEC group at IBSRAM has provided better interaction and sharing of ideas within the organization. For the year 2001, 11 monthly meetings were held.

SUMMARY AND CONCLUSION

Past research and development efforts have not been able to provide sustainable solution to land degradation problems, and soil erosion has remained a major constraint in improving the living conditions of the people in the marginal and sloping uplands in Asia. The Management of Soil Erosion Consortium with the funding support from the Asian Development Bank (ADB) has implemented a research project to address such problem employing a new research paradigm.

Concrete outputs in terms of capacity building have been achieved. Complete instrumentation of the experimental catchments and training of NARES participants have been useful in initiating the research work ill the field. The initial results from different participating countries have shown some interesting observations on the erosion and hydrological processes occurring in the experimental catchments and the factors that may affect them.

The consortium approach and the participatory and interdisciplinary research methods could be a potential key to sustaining upland development in Asia. With stronger and continuing partnerships among stakeholders, it has in itself added a new dimension to soil erosion management, with the potential to enhance the adoption and sustainability of introduced interventions. MSEC will continue to employ this approach and the promising outputs will further be validated at different scales of application and expanded to a much wider area for greater impact.

Under IWMI's leadership, the integration of land and water issues results is expected to be highlighted. The follow up phase which is also planned will provide the needed push to pursue this objective.

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Appendix 1

Information Dissemination and Capacity Building Outputs of MSEC

A. Publications and Reports

A.1 Proceedings, Books

1. Maglinao, A.R. and R.N. Leslie (ed.) 2001. Soil erosion management research in Asian catchments: methodological approaches and initial results - Proceedings of the 5'h Management of Soil Erosion Consortium (MSEC) Assembly. Thailand: IWMI Southeast Asia Regional Office. 275 p. (This volume includes the country reports for 2000 and other related papers)

2. Maglinao, A. and R. Leslie. 1999. Site selection and characterization: Focus on biophysical and socioeconomic inventory. Papers presented at the assembly of the Management of Soil Erosion Consortium (Hanoi, Vietnam, 8-12 June 1998). Bangkok, Thailand: IBSRAM. 1999. Issues in Sustainable Land Management No 6.

3. Penning de Vries, F.W.T., F. Agus, and J. Kerr (eds.) 1998. Soil Erosion at Multiple Scales: Principles and Methods for Assessing Causes and Impacts. CABI Publishing, UK 390 p.

4. Pongsapich, A. and R. Leslie. 1998. Indigenous technical knowledge for land management in Asia: Papers presented at the assembly of the management of Soil Erosion consortium, (Nan, Thailand, 28-January - 2 February 1997. Bangkok, Thailand: IBSRAM, 1998. Issues in Sustainable land Management No. 3.

5. IBSRAM. 1997. Model catchment selection for the Management of Soil Erosion Consortium (MSEC) of IBSRAM. Report on the Mission to Thailand, Indonesia and tile Philippines. Bangkok,: IBSRAM.

A.2 Articles/Papers Published in Journals/Proceedings

1. Maglinao, A.R. and F. Penning de Vries. 2001. Participatory research on catchment management: the: IBSRAM experience in Asia. In: Thapa, G.B., Ganesh, P.S., Michael, Z. Giridhari, S.P., Ramji, P.N. (eds.) Integrated Watershed Development and Management in Asia: Training and Research Needs and Priorities, Thailand: AIT. pp. 49-60

2. Penning de Vries, F.W.T., C. Niamskul, H.D. Bechstedt, A. Maglinao and A., Sajjapongse. 2001. Participatory approaches for sustainable use of sloping land in Asia. In: Sustainability of Agricultural Systems in Transit. ASA Special Publication no.64. p. 131-141.

3. Maglinao, A.R. 2001. A framework for impact assessment: its application to evaluating IBSRAM programs. In: P. Cox and R. Chlay (eds.). The Impact of Agricultural Research for Development in Southeast Asia. Proceedings of an International Conference held at the Cambodia Agricultural Research and Development Institute, Phnom Penh, Cambodia, 24-26 October 2000.

4. Craswell, E.T. and A.R. Maglinao, 2001. A catchment approach to research on soil erosion in the marginal uplands of Asia. In: Suthipradit, S., C. Kuntha, S. Lorlowhakam and J. Rakngan (eds.). Sustainable Agriculture: Possibility and Direction, Proceedings of the 2nd Asia-Pacific Conference on Sustainable Agriculture. 18-20 October 1999, Phitsanulok, Thailand. p 151-162.

5. Craswell, and C. Niamskul. 1999. Watershed management for erosion control on sloping lands in Asia. In: R. La (ed) Integrated Watershed management in the Global ecosystem. CRC Press, Boca Raton, Florida, USA.

6. Craswell, E.T., C. Niamskul and F.W.T. Penning de Vries. 1998. Catchment approach to combating soil erosion in Asia - the Management Soil Erosion Consortium . In: Penning de Vries, F.W.T., F. Agus and J. Kerr (eds.) Soil Erosion at Multiple Scales: Principles and Methods for Assessing Causes and Impacts. CABI Publishing. Wallingford, UK.

A.3 Papers Presented at Scientific Conferences and Other Meetings

1. Maglinao, A.R. and F. Penning de Vries. 2001. Management of soil erosion for sustainable upland agriculture in Asia. Paper presented at the International Symposium on Sustainable Soil and Water Resources Management. 30-31 May 2001. Manila, Philippines.

2. Maglinao, A.R., J.P. Bricquet. 2001. Consortium approach to soil erosion management: A potential key in sustaining upland development in Asia. Paper presented At the International Conference on Sustaining Upland Development in Southeast Asia. 28-30 May 2001. Manila, Philippines.

3. Janeau, J.L., J.P. Bricquet, A. Boonsaner, A. Chanthavongsa and T.D. Toan. 2000. Soil erosion and land use change in Lao's, Thailand and Vietnam: A comparative study. Poster paper presented at the ISCO Conference, 22-27, October 2000 at Buenos Aires, Argentina.

4. Bricquet, J.P., T. Phien and T.D. -Toan. 2000. How agricultural practices are responsible for erosion? A case study in Vietnam. Poster paper presented at the ISCO Conference, 22- 27 October 2000 at Buenos Aires, Argentina.

5. Agus, F., J.P. Bricquet, Sukristiyonubowo, T. Vadari and T. Enters. 2000. Managing soil erosion in Kaligarang catchment in Java, Indonesia. Paper presented at the ISCO Conference, 22-27 October 2000 at Buenos Aires, Argentina.

6. Maglinao, A.R and F. Penning de Vries. 2000. Participatory research on catchment management: the IBSRAM experience in Asia. Paper presented at the Workshop on Watershed Development and Management. 7-8 August 2000, AIT, Bangkok, Thailand

7. Maglinao, A.R., J.P. Bricquet and F. Penning de Vries. 1999. MSEC: Building the foundation for integrated catchment management. Paper presented at the 4th MSEC assembly. 25-29 October 1999. Cagayan de Oro City, Philippines.

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11. Maglinao, A.R., J.P. Bricquet and P. Penning de Vries. 1999., An innovative approach to soil erosion management research. Poster paper presented at the Methodology Workshop on Environmental Services and land Use Change. Bridging the Gap between Policy and Research in Southeast Asia held at Chiang Mai, Thailand on 30 May to 2 June 1999.

12. Craswell, E.T. and M. Latliam. 1998. The soil, water and nutrient management programme - An overview. Paper presented at the 16th World Congress of Soil Science. 20-26 August 1998. Montpellier, France.

13. Niamskul, C and F. Penning de Vries 1998. The Management of Soil Erosion Consortium: participatory and interdisciplinary approach to research at a catchment scale. Paper presented at the 16th World Congress of Soil Science, 20-26 August 1998. Montpellier, France.

A.4 Brochures, Awareness Materials, Newsletters

1. MSEC brochure, April 1999, April 2001

2. MSEC News, a regular column in the IBSRAM Newsletter (Nos. 55, 56, 57, 58)

3. MSEC web page

A.5 Report to Donors, Other Papers

1. IWMI. 2001. Catchment Approach to Managing Soil Erosion in Asia (ADB-RETA NO. 5803) Semi-annual progress report (January to June 2001) submitted to ADB, July 2001

2. IWMI. 2001. Management of Soil Erosion Consortium (MSEC). Progress report submitted to the Bureau of Agricultural Research (PAR), Department of Agriculture (DA), Philippines. June 2001

3. IBSRAM 2001. Catchment Approach to Managing Soil Erosion in Asia (ADB-RETA No. 5803). Annual progress report (January to December 2000) submitted to ADB, January 2001

4. IBSRAM. 2000. Catchment Approach to Managing Soil Erosion in Asia (ADB-RETA No. 5803). Semi-annual progress report (January to-June 2000) submitted to ADB, July 2000.

5. IBSRAM. 2000. Catchment Approach to Managing Soil Erosion in Asia (ADB-RETA No. 5803), Annual progress report (January to December 1999) submitted to ADB, January 2000

6. IBSRAM. 1999. Catchment Approach to Managing Soil Erosion in Asia (ADB-RETA No. 5803). Semi-annual progress report (September 1998 to March 1999) submitted to ADB, May 1999

B. Workshops Conferences, and Meetings Conducted 2001

1. Integrated watershed management for land and water conservation and sustainable agricultural production in Asia (ADB-ICRISAT project annual meeting and 6th MSEC assembly). 10-14 December, Hanoi, Vietnam

2. 7th Consortium steering committee meeting, Hanoi, Vietnam. 14 December

3. MSEC project staff and stakeholders meeting, Lantapan, Bukdnon, Philippines. 1-2 June

4. MSEC-2 proposal preparation workshop, Bangkok, Thailand. 9-11 April

5. 6^{th} Consortium Steering Committee meeting, Bangkok, Thailand. 11 April

2000

1. 5^{th} Consortium steering committee meeting, Semarang, Indonesia. 9 November

2. 5^{th} MSEC assembly, Semarang, Indonesia. 7-11 November

3. 4^{th} Consortium steering committee meeting, Bangkok, Thailand. 13-15 June

4. MSEC workshop on socioeconomic survey and on-farm research, Bangkok, Thailand. 5-7 July

5. ADB project review, Bangkok, Thailand. 25-28 May

6. IBSRAM-NARES meeting, Bangkok, Thailand. 25 April

7. SWNM program review, Wageningen, Netherlands. 21-23 February

1999

1. Workshop on soil erosion and land use change. Luang Prabang, Lao PDR. 7-9 December

2. 4^{th} MSEC assembly, Cagayan de Oro, Philippines. 25-29 October

3. 3^{rd} Consortium steering committee meeting, Cagayan de Oro, Philippines. 28 October

4. ADB-IBSRAM-ICRISAT joint planning meeting. Bangkok, Thailand. 1-3 February

1998

1. 2^{nd} Consortium steering committee meeting, Hanoi, Vietnam, 11 June

2. 3^{rd} MSEC assembly, Hanoi, Vietnam. 8-12 June

1997

1. 1^{st} Consortium steering committee meeting, Nan, Thailand

2. 2^{nd} MSEC assembly, Nan, Thailand.

C. Capacity Building

2001

1. Training-workshop on Training-workshop on modeling the erosion at the catchment scale. Vientiane, Laos, 22-26 October 2001

2. Training-workshop on data analysis, interpretation and report writing for catchment research and management. Los Banos, Laguna, Philippines. 6-10 August 2001

3. Training-workshop on on-farm participatory research methodology. Khon Kaen, Thailand. 26-31 July 2001

2000

1. Training on rainfall simulation, Phrae, Thailand. 12-15 December

2. Training-workshop on modelling erosion at the catchment scale, Hanoi, Vietnam. 16-20 October

3. Training-workshop on socioeconomic site characterization and on-farm research, Bangkok, Thailand. 5-7 July

4. Training course on GIS, economic valuation of environmental impact, and statistical techniques, Bangkok, Thailand. 24-30 April