Soil Erosion Research in Catchments: Initial MSEC Results in Asia

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INTRODUCTION

Recognition of the inadequacies of earlier research on soil erosion led the International Board for Soil Research and Management (IBSRAM) to a re-examination of approaches to research on sustainable land management (Greenland *et al.,* 1994). As a result, a new research paradigm has evolved. The new paradigm provides an organizational arrangement that engages scientists and research institutions to tackle a common goal through a participatory, interdisciplinary, and community- and catchment-based framework. Craswell and Latham (1998) identified the key elements that must be considered in operationalizing the new research paradigm. These key elements relate to user orientation, policy, equity, landscape, research intensity, knowledge, and orientation/goals (Table 1).

Table 1. Key elements of the new paradigm for research on sustainable land management (Craswell and Latham, 1998).

Elements	Approaches
User orientation	Participatory, community-based at all stages from planning to implementation.
Policy	Focus on policy and institutional issues that influence farmer and community decisions.
Equity	Consideration of equity, including gender analysis, in research planning and implementation.
Landscape	Integration of people, soil, and water at every scale from plot to catchment.
Research intensity	Linking strategic, applied, and adaptive research with technology development and participatory dissemination.
Knowledge	Reliance on both indigenous and scientific sources.
Orientation/goals	Linking increased productivity with natural resource conservation.

With major funding support from the Asian Development Bank (ADB), IBSRAM initiated the operation of the Management of Soil Erosion Consortium (MSEC) which employs the principles advocated by the new research paradigm. Drawing on the comparative advantages offered by the NARES, IARCs, and ARIs, field activities have been ongoing for almost two years in six countries in Asia, namely, Indonesia, Laos, Nepal, Philippines, Thailand, and Vietnam. A strong collaboration with another ADB-funded project executed by the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT) has made possible additional work in India, Thailand, and Vietnam. Additional support for strategic research is provided by the Institute of Research for Development (IRD) in Laos, Thailand and Vietnam, by the University of Bayreuth in Thailand and by the International Center for Research in Agroforestry (ICRAF) in the Philippines. Through this consortium arrangement, research is conducted in the different catchments selected in the participating countries.

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This report highlights the technical accomplishments of the project over the last two years. It emphasizes the results of the catchment research component of the project and its progress in relation to the expected outputs. It should be noted, however, that the project also undertakes capacity building, information dissemination, and programme management and governance.

OBJECTIVES AND EXPECTED OUTPUTS OF THE PROGRAMME

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

The programme 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 a concrete basis for decision making.

In addition to addressing these three major components, the implementation mechanisms advocated by MSEC are also documented and evaluated. In essence, the project looks at both the identification and application of alternative erosion management systems in catchments and the effective methodology for faster and sustainable adoption of these management systems.

Outputs from its activities are expected to be forthcoming in the first three years, but for some, a longer time frame is needed. In fact, the project output is envisioned for a period of at least 10 years. Expected outputs include the following:

- 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 impact assessment and gaining the participation of farmers and other stakeholders in the management of catchments, including 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 programme management for catchment management research

IMPLEMENTING THE RESEARCH PROGRAMME

The implementation of the field research activities of MSEC follows an interdisciplinary, participatory, and community-based approach. It started with the selection of representative catchments in participating countries by an interdisciplinary team using carefully defined criteria and methodological guidelines (IBSRAM, 1997). Visits and dialogues with local institutions, scientists, and farmers were facilitated by the NARES. This ensures that all stakeholder groups in the landscape affected by soil erosion, including farmers and policy-makers, benefit from the knowledge generated, recognize the scope and severity of the problem, and make appropriate decisions about investments and land use policy in the sloping land areas.

After finally selecting the model catchments, more detailed characterization was done to establish the baseline information about the sites. Different tools and techniques for conducting both biophysical and socioeconomic surveys were employed. General information gathered, as agreed upon by all partners, is presented in Tables 2 and 3.

Table 2. Data and information needs for biophysical characterization.

Factors	Data/information needed	Relevance/importance	Tool/techniques
Location and area		Land use allocation	Field measurement, GIS, other map measurement techniques
Abiotic features			
1. Geology and physiography / landform	Parent material, rock formation, mineral resources, topography, landform/shape, altitude, slope, slope aspect	Soil classification, assessment of erosion potential suitability, selection, design and evaluation of alternative land uses and practices	Secondary data, field observation, map analysis
2. Climate	Rainfall, temperature, sunlight duration, wind velocity, and direction	Assessment of land suitability, erosion potential and land, productivity; prediction of future hydrologic events; impact assessment of alternative land uses and practices	Instrumentation, field measurement, records from nearest PAGASA station, literature review
3. Soil	Soil morphology, texture, structure, permeability, erosion condition, fertility, pH	Assessment of fertility/ productivity, land suitability, and erosion potential; selection, design and evaluation of alternative land uses and practices	Soil survey/analysis, literature review
4. Water resources	Hydrology, drainage pattern and density, stream order, channel gradient, stream length	Appreciation of hydrologic behaviour, assessment of land suitability, erosion potential and impacts of alternative land uses/ practices	Instrumentation/field measurement, literature review, map analysis
Biotic features:			
5. Vegetation	Farming systems, crops planted, species composition, type and structure of plant communities, plant and land use density, canopy and groundcover, existing land uses.	Assessment of land suitability, erosion potential and land productivity; prediction of future hydrologic events; impact assessment of alternative land uses and practices	Vegetation sampling assessment and analysis; land use assessment/mapping
6. Fauna/ livestock	Species/kinds, population/ distribution, management practices	Assessment of land suitability and impact on vegetation	Reconnaissance survey, key informant interview

Several microcatchments representing various land uses were further identified and delineated to conduct more detailed soil erosion and hydrological studies. Hydrological monitoring stations equipped with automatic water level recorders, manual staff gauges, sediment traps, automatic weather instrumentation, and manual rain gauges were installed (Table 4). Data collection, monitoring, and analysis followed the agreed upon protocol. Analysis initially looked at the relationship among the measured and derived parameters.

Table 3. Data and information needs for socioeconomic characterization.

Factor	Information	Importance/relevance	Tools/technique
Population	Total population Population density Population growth rate Age/class structure Gender Migration pattern	Population pressure Scarcity of land Pressure on resources Availability of labor Property rights' regimes	Key informant interview
Settlement and land use history	Historical events Villagers' origin Reasons for settlement	Planning horizon Decision making Information flow	Literature review Key informant interview PRA
Composition of village population	Ethnicity Religion Cultural practices/ rituals related to land use	Reaction to innovation Representation	Key informant interview
Predominant occupation and typology of farming enterprises	Predominant occupation On-farm income Non-farm income Main crops produced Extent of Commercialization Farming systems Degree of mechanization Hiring of farm laborers	Investment potential Adaptability of practices Recommendation domains Adoption of labour- intensive land management technologies Opportunity cost of labour	Key informant survey Direct observation Structured survey
Access to markets	Product flow Markets for inputs Road system Proximity to markets and roads Travel costs Transportation Trading centres Farm-gate prices History of commercialization	Availability of inputs Product distribution Profitability of alternative land management and crops Potential for agricultural development	Literature review (maps, aerial photographs) Direct observation Key informant interview
Access to information on agricultural innovation	Sources of information (e.g. extension workers, merchants/sales representatives, other farmers, radio, tv) Frequency of visit to area (of sources of information) Farmers' perceptions of soil erosion Level of education	Effectiveness of information dissemination	Formal (structured) survey Key informant interview Group discussion with farmers
Credit constraints	Sources of credit Lending activities Interest rates	Availability of capital	Key informant interview

Structure and functions of local organizations	Local organizations Characteristics of local organizations Linkages/collaboration among organizations	Effectiveness of project implementation Information dissemination Technology transfer	Key informant interview
Conflicts	Conflicts Causes of conflicts Insights into off-site issues	Understanding and explaining behaviour	Key informant survey Formal survey
Land tenure arrangement and presence of land markets	Land classification Tenurial arrangement Presence of land markets Prices of eroded land and land with soil conservation Legal status (e.g. crop land, forestland) Presence of long-term investments	Decisions for long-term investments	Cadastral maps Participatory mapping Key informant interview Direct observation Formal survey
Rural development	Previous and current interventions	Probability of getting support from relevant institutions	Literature review Key informant interview
Other support services	Extension support services (government, NGOs, other groups, private sector, other groups)	Technology transfer Technical assistance	
National, regional, and local policies	Development thrusts Prices for inputs and marketed produce Price support, subsidies, taxes Credit Land rights Conservation/watershed protection Irrigation Upland agricultural development Afforestation Resource utilization	Relevance of project to national and local goals Policy formulation Planning	Literature review

Table 4. Structures constructed and equipment installed in the different MSEC catchments.

Structure/equipment	Number provided and/or installed						
	Indon	Laos	Nepal	Phil	Thai	Viet	Total
Area of catchment (ha)	139	73	124	91	71	96	
No. of microcatchments	4	4	4	4	4	4	24
Weir	4	5	5	5	4	5	28
Flume	1				1		2
Automatic weather station	1	1	1	1	1	1	6
Automatic water level recorder	5	5	5	5	6	5	31
Manual rain gauge	7	8	8	5	8	8	44
Staff gauge	15	15	15	15	15	15	90

A preliminary evaluation of the off-site impacts of soil erosion was conducted by identifying potential economic activities downstream that could be affected by the erosion that occurs in the catchments. These potential effects could be measured in terms of changes in water quality in streams or reservoirs, rate of sedimentation, production of crops in the lowlands, etc. In some countries, surveys and interviews with some affected sectors were also conducted.

INITIAL RESULTS

Characterization of the catchments

The experimental catchments range from 71 to 139 ha with four smaller microcatchments representing different land uses delineated within. All catchments (except in India) have slopes ranging from 12 to 80%, and an average annual rainfall ranging from 1,080 to 2,500 mm (Table 5). In some catchments, 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[2] with common biophysical and socioeconomic characteristics as follows:

- The soils are generally acid with low inherent fertility that declines rapidly under continuous cultivation without external inputs.
- Slopes are steep and soil erosion is the major land degradation process.
- The climate is warm, humid or subhumid, and tropical or subtropical. Rainfall intensities in the wet season are generally high.
- The native vegetation is commonly rainforest, but large areas have been logged over, subject to shifting cultivation, and covered with pernicious weeds like *Imperata cylindrica*. The area cultivated every year to subsistence food crops such as rice and maize is increasing.
- Steepland areas are remote and have been bypassed by government development schemes.
- The shifting cultivators in many areas are ethnic minorities, but increasingly upper catchments are being inhabited by lowland people unable to find land to cultivate elsewhere
- Many governments now require the shifting cultivators to abandon their nomadic lives and settle in one place, but lack of land tenure remains a problem.
- Off-farm employment through migration to cities and to other countries in the region, is a major source of income (Renaud *et al.*, 1998).

Erosion and land use

Results from Indonesia showed that land use affects the amount of erosion measured at the gauging outlet (Agus *et al.*, 2000). Observations from three microcatchments, namely, Tegalan, Rambutan, and Kalisidi, within the Babon Catchment showed bedloads of 1,092, 179, and 7 kg ha^{-1} (Table 6). This was measured from 24 December 1999 to 30 April 2000, during which time the area received 2,048 mm of rainfall. This amount of rainfall represents about 65% of the mean annual rainfall in the area. The figures show that erosion does not seem to be very alarming in the catchments

[2] Dumanski and Craswell (1998) defined a resource management domain as a spatial unit encompassing the environmental and socioeconomic characteristics of a recognizable unit of land including the natural variability that is inherently characteristic of the area. An RMD can be defined at the field scale if the intent is to differentiate management practices employed by farmers, or at broad scales if the intent is to relate to management implications imposed through policies or programmes, or at any level in between, provided that the linkages among the levels are illustrated.

Table 5. Updated profiles of the MSEC catchments in collaborating 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	24°16'N	07°20'S	19°51'10"N	27°49'N	08°02'20"N	18°13'20"N	20°57'40"N
Longitude	77°30'E	110°E	102°10'45"E	85°32'30"E	125°56'35"E	100°23'40"E	105°29'10"E
Elevation (m)	415	390-510	400-700	650-1400	1080-1505	400-480	125-700
Catchment size (ha)	75	139	73	124	91	71	96
Biophysical Attributes							
Slop (%)	<5	15-75	30-80	40-60	8-35	12-50	40-60
Geology and Landform		Basaltic lava	Shale; mudstone	Gneiss; schist	Basalt, pyroclastics	Siltstone, sandstone	Schisl
Rainfall (m)	1,200	2,500	1,403	2,200	2,537	1,077	1,500
Soils	Vertisol	Inceptisol	Ultisol; Entisol	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 flow (water flows only during rainy season)	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 season)	Intermittent flow (water flows only during rainy season)	Permanent flow (water flows year round)

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General Description	Catchment name						
	Lalatola	Babon	Ban Lak Sip	Masrang Khola	Mapawa	Huay Yai	Dong Cao
Socioeconomic Attributes							
Population							
- Household (HH)		405	80	54	70	489	38
- persons		1,812	427	354	155	3,655	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 certificatie of ownership Leased	Private owner	Land use title	Land use right
Income (100%)							
- on farm			70%	41%			
- crop		46%					57%
- animal		18%					39%
- off farm		36%	30%	59%			4%
Dominant crops	Soybean, Sorghum, wheat	Rambutan, lowland rice; Upland crops	Maize, job's tears	Maize, rice, millet, mustard, legumes	Vegetables, maize	Maize, soybean, mung bean	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 NGO	CSAR, CIRAD, BPTP; AIAT	NAFRI; IRD	NARC, ICIMOD	PCARRD, DA, DENR, NGO SANREM, CMU ICRAF, SEARCA	RFD, LDD RID; ICRISAT; AIT; Bayreuth	MARD, NISF, VASI; ICRISAT

dominated by perennial tree crops. Moreover, in these catchments of similar land use, the Kalisidi Microcatchment which is 19 times larger than the Rambutan Microcatchment yielded only a small amount of bedload, about 26 times less than in the Rambutan Microcatchment.

Table 6. Soil erosion in three microcatchments in the Babon Catchment in Indonesia (December 1999 to April 2000).

Microcatchment (weir)	Area (ha) 15–75% slope	Land use	Bedload soil loss (kg ha^{-1})
Tegalan	3.2	Upland annual crop (covering about 50% of the area) near the sediment trap, coffee and nutmeg on the upper slopes	1,092
Rambutan	2.0	Rambutan (and some bare plots)	179
Kalisidi	38.5	Rambutan	7

Note: Observations made from 24 December 1999 to 30 April 2000.
Rainfall during the period was 2,048 mm which is about 65% of the average annual precipitation in the area.

The Tegalan Microcatchment, which is predominated by upland annual crops, had the highest bedload of 1,092 kg ha^{-1}. This amount is six times larger than that coming from the Rambutan Microcatchment which is a hectare less in size. This information shows that the Tegalan area could be an erosion hot spot and needs greater attention with respect to improving land management

In Vietnam, the data showed that more than 45 tons of sediment were measured from the total area of the catchment or a soil loss of 474 kg ha^{-1} (Toan *et al.*, 2000). Among the microcatchments, W1 (predominantly cassava monoculture with some natural grass) had the largest soil loss of about 0.9 t ha^{-1} and the least was W4 (predominantly natural grass and cassava intercropping) with about 0.2 ton ha^{-1} soil loss (Table 7). W1 is the smallest microcatchment, while W4 is the largest. While they have almost the same area under farming, the cultivation in W4 is *Acacia mangium* intercropped with cassava while cassava is the monoculture in W1. Moreover, W4 has a large area under natural grass. Comparing the soil loss from W1 and W3 (all cassava intercropping), which have relatively similar area, shows the effect of the cassava intercropping systems as opposed to a cassava monoculture. W1 had a larger soil loss per hectare than W3. The effect of the natural grass in the microcatchments was also manifested in the results. Natural grass enhances infiltration, reduces runoff and runoff velocity, and consequently reduces soil loss.

Table 7. Calculated soil loss from the different microcatchments in Dong Cao Catchment in Vietnam

Micro-catchment (weir)	Area (ha) 40–60% slope	Land use	Soil loss (kg ha^{-1})
W1	4.77	Monoculture cassava (3.21 ha); natural grass (1.56 ha)	941
W2	9.45	Cassava intercrop (2.25 ha); cassava monoculture (5.56 ha); natural grass (1.64 ha)	555
W3	5.19	Cassava intercrop	841
W4	12.36	Cassava intercrop (3.18 ha); natural grass (9.18 ha)	209
MW	96.00	Cassava intercrop (21.73 ha); cassava monoculture (38.54 ha); natural grass (15.01 ha); secondary forest (5.02); others (15.70 ha)	474

In the Mapawa Catchment in the Philippines, observations conducted from April to July 2000 also showed the effect of land use on soil erosion (Carpina *et al.*, 2000). The microcatchment (MC 4) showed the highest soil loss of about 24 t ha^{-1} (Table 8). It should be noted that MC4 is the smallest microcatchment and has the highest percentage of cultivated area. MC1 which has the lowest soil loss (per ha basis) is the biggest but with only 20% of its area is under cultivation. The relatively higher soil loss in MC3 which has 10% built up area may be attributed to erosion from the foot trails and road network.

Table 8. Drainage area, land use, and calculated soil loss from the different microcatchments of Mapawa Catchment in the Philippines (April to July 2000)

Microcatchment		Land use	Soil loss
No.	Area (ha) 8–35% slope		(kg ha^{-1})
MC 1	24.82	20% cultivated to vegetables and root crops, 80% Falcata, Eucalyptus, grassland	55
MC 2	17.9	40% cultivated, 60% grassland	689
MC 3	8.0	10% settlement and built up area, 90% grassland	865
MC 4	0.9	50% cultivated (14% is left bare), 50% grassland and trees	24,498

The results from Nepal (Maskey et al., 2000) showed that soil loss is significantly lower in the upland cultivated area (W5) (Table 9). Moreover, soil loss in the microcatchment is minimum in July due to standing crops and many times higher in August owing to harvesting and land preparation for the next crop.

Table 9. Calculated soil loss from the different microcatchments of Masrang Khola Catchment in Nepal (June to August 2000).

Microcatchment (weir)	Area (ha) 40-60% slope	Predominant land use	Soil loss (kg ha^{-1})
W2	72.6	Mixed	224
W3	39.6	Mixed	166
W4	11.5	Mixed	199
W5	1.6	Upland cultivated	70

In Thailand, the amount of sediment collected from W1, W2 and W4 by the end of September 2000 was relatively higher than W3. This is because of the different land use of the microcatchment (Table 10). In Laos, soil loss at stations S0, S2, and S4 (Table 11) was mainly due to the surface relief of the area and lack of appropriate agricultural practices (Phommasak et al., 2000).

Table 10. Calculated soil loss from the different microcatchments of Huay Yai Catchment in Thailand (April to October 2000)

Microcatchment	Area (ha) 12-50% slope	Predominant Land use	Area planted to soybean %	Soil loss (kg ha^{-1})
Manai (W1)	10.4	Soybean (4.9 ha); tamarind (4.9 ha)	47.1	510
Mee (W2)	8.7	Soybean (6.8 ha); shrub (1.1 ha)	78.2	812
Bong (W3)	3.7	Tamarind and shrub (3.5 ha)	4.1	223
Tong (W4)	6.5	Soybean (3.3 ha); mango and Tamarind (1.5 ha)	50.8	508
Main (W5)	71.1	Soybean (43.4 ha); shrub (11.3 ha)		

These initial results indicate that the degree of erosion varies within a catchment and the information could provide a good basis for prioritizing where soil conservation measures should be applied immediately. They also indicate that with appropriate land use, erosion can be minimized.

Table 11. Calculated soil loss from the different microcatchments in Ban Lak Sip in Laos (July to September 2000)

Microcatchment	Area Slope 30-80% (ha)	Land use	Soil loss (kg ha^{-1})
S_0	9.56	Forest (3.23 ha), Teak plantation (0.89 ha), Bush fallow (5.28 ha), Banana plantation (0.16 ha)	248
S_1	1.26	Teak plantation (0.28 ha), Bush fallow (0.99 ha)	7
S_2	20.16	Forest (2.25 ha), Bush fallow (12.8 ha), Upland rice (1.6 ha), Banana plantation (1.7 ha), Other (1.5 ha)	72
S_3	14.42	Forest (1.62 ha), Bush fallow (9.87 ha) Upland rice (1.78 ha), Other (1.16 ha)	9
S_4	21.28	Forest (4.49 ha) Bush fallow (11.71 ha), Upland rice (4.98 ha), Corn + banana plantation (0.11 ha)	96

Soil erosion and nutrient depletion

It has always been argued that the loss of topsoil by erosion will cause a decline in the fertility on site. The results of analysis of the soil eroded from the catchment in Vietnam clearly showed that many plant nutrients are carried in the sediments (Toan *et al.*,2000). 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 Philippine site, 2.6 t OM, 0.1 kg extractable P, and 5.7 kg extractable K were lost with 48 tons of eroded soil (Ilao, personal communication). The data clearly show that farming without soil conservation results in soil and nutrient losses which 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.

Soil erosion and catchment size

There were also some indications that the amount of erosion measured at the outlet is influenced by the size of the catchment. Again, in the case of Indonesia, the Kalisidi and Tegalan microcatchments have relatively similar land use, but the amount of erosion measured at the outlet was about 26 times larger at the Rambutan Catchment. Kalisidi is 19 times larger than Rambutan (Table 6). In the Philippines, the smallest microcatchment (MC 4) also yielded the highest soil loss (Table 8). This result is very important in extrapolating erosion results from small plots to larger catchments and will have a significant bearing on the scaling up issue.

Off-site effect of erosion

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 in the irrigation canals and diversion dam of the Manupali River Irrigation System (Carpina *et al.,* 2000). A total of 73,321 m^3 of sediments has been estimated to have been transported to the system since 1995. With the assumption that 0.5% comes from the Mapawa site, it was estimated to have contributed 366 m^3 of sediments to the irrigation system or an equivalent of PHP11,302 as cost for dredging.

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.

The participatory process

The participatory process in soil erosion management research on a catchment scale was employed since the establishment of the consortium and the design of the research programme that it would undertake. A series of consultation meetings and dialogues among various stakeholders including the NARES, IARCs, ARIs, NGOs, donors and even farmer representatives was undertaken to agree on the design of the research and the various partners that would be involved.

Furthermore, carrying on the principles of participation, interdisciplinarity, and collaboration, the NARES identified local institutions and project teams composed of researchers of different disciplines. Within the countries, collaboration among relevant partners has evolved. The organization of these teams from different institutions and disciplines has enhanced the participatory, interdisciplinary, and interinstitutional mechanism that the consortium advocates. Generally, this arrangement is committed through formal agreements signed between and among institutions. In the Philippines, the MSEC project agreed on organizational linkages allowing the coordination of activities down to the field level (Figure 1). Through this mechanism, the Lantapan Project Holders Committee serves as the integrating mechanism at the municipal level, NOMCARRD at the subnational level, and PCARRD at the national level (Ilao *et al.,* 2000). IBSRAM serves as the facilitator and link among the various NARES, international centres, and advanced research institutions. This arrangement hopes to optimize the use of scarce resources and enhance the synergy of different experts and institutions.

At the field level, the participation of farmers is stronger during surveys to further refine the characteristics of the sites and solicit farmers' input in identifying constraints and opportunities for tackling the problem of soil erosion and crop production. In most cases, the farmers appreciated their involvement in such activities and became more interested in the project (Agus *et al.,* 2000; Ilao *et al.,* 2000). They also appreciated the value of the equipment installed in the field and are interested in its care and protection. While the farmers did not consider soil erosion as their primary problem, indications at this stage show that they are willing to be actively involved in the project.

SUMMARY AND CONCLUSION

Soil erosion and land degradation have remained a major problem in the marginal uplands of Asia. Lessons learned from past R&D point to a need for a research orientation that will produce sustainable land management technologies and policies that are acceptable to the various users of the land. Discussions and consultations among various stakeholders concerned in natural resource management took some time before an agreement on the new research paradigm and the consortium model was arrived at.

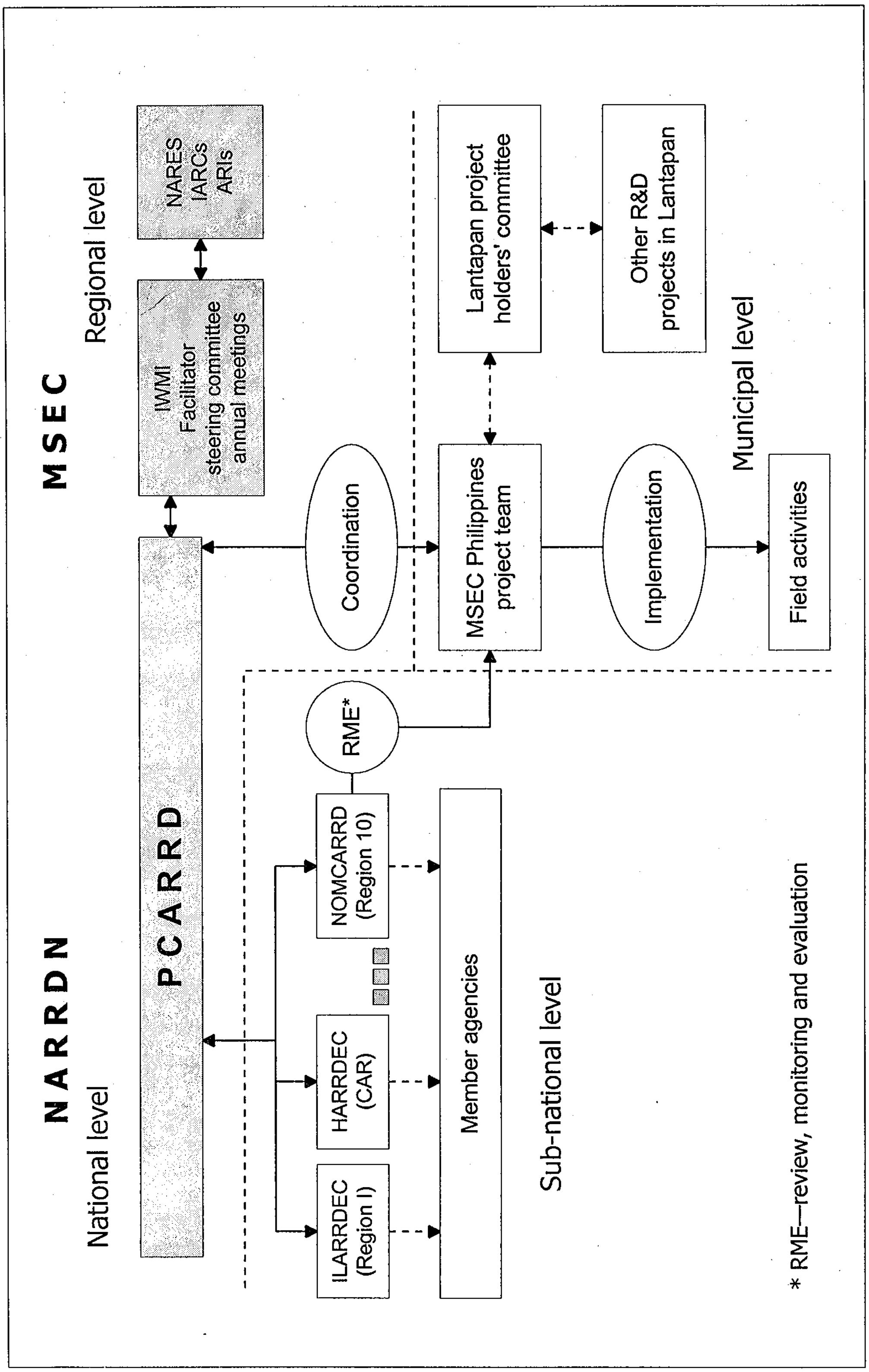

Figure 1. MSEC Philippines Project: Organization and Linkages.

The conduct of soil erosion research on a catchment scale is a new innovation in erosion management to capture both the on- and off-site effects of soil erosion. This activity aims to evaluate the effects of different land management practices on soil erosion and on water and nutrient flows in selected representative catchments. This is done by quantifying and evaluating the biophysical, environmental and socioeconomic effects of soil erosion.

The initial results from different participating countries have shown some interesting trends, although much more data and analysis have to be acquired and done before a final conclusion can be arrived at. Nevertheless, this information is expected to provide the scientific basis for the formulation of guidelines for improvement of catchment management policies. Furthermore, these policies will assist in the identification and development of alternative land management systems that are acceptable to various land users. In essence, catchment research is expected to produce tools and guidelines for improved decision making and project implementation and alternative land management systems that would be more sustainable.

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