

Integrated Natural Resource Management on the Poverty-Protection Interface in an Asian Watershed

KEY WORDS: integrated conservation-development projects, sustainable agriculture, agroforestry, soil conservation, buffer zone, protected national park, biodiversity, landcare, timber

ABSTRACT

There are serious methodological and policy hurdles to be overcome in effective integrated natural resource management that alleviates poverty while protecting environmental services in tropical watersheds. We review the development of an approach to integrate biodiversity conservation and agroforestry development through the active involvement of communities and their local governments. The work focused on the Kitanglad Range Nature Park in the upper reaches of the Manupali watershed in central Mindanao, Philippines. Agroforestry innovations were developed to suit the biophysical and socio-economic conditions of the buffer zone, including practices for tree farming and conservation farming with annual crops. Institutional innovations improved resource management, resulting in an effective social contract to protect the natural biodiversity of the Park. Natural vegetative contour strips were installed on several hundred sloping farms. Stream corridor vegetation was restored by the local Landcare groups. The practices decreased soil erosion and runoff, while the buffer strips increased maize yields by an average of 0.5 t/ha on hill slope farms. Fruit and timber tree production dramatically increased, re-establishing tree cover in the buffer zone. The scientific knowledge base guided the development and implementation of a natural resource management plan for the Municipality of Lantapan. A dynamic grassroots movement of farmer-led Landcare groups evolved in the villages near the park boundary. It has had significant impact on natural resource conservation in both the natural and managed ecosystems. Encroachment in the natural park has been reduced 95% in the past four years. This integrated approach has been recognized as a national model for local natural resource management planning and watershed management in the Philippines. Currently, the collaborating institutions are evolving a negotiation support system to resolve the interactions between the three management domains: The park: the ancestral domain claim, and the municipalities. The consortium that evolved this integrated systems approach operated effectively with highly constrained funding, suggesting that commitment and impact may best be stimulated by a "drip-feed" approach rather than by large, externally funded efforts.

INTRODUCTION

The classical method of preserving a natural area has always been to declare it off-limits and enforce exclusion. In tropical conditions, enforcement often was not successful because population pressure was intense, or the costs of enforcement were too high. The approach of integrating conservation and development attempts to link enforcement with compensation to the communities that are directly affected by the presence of the natural area (Wells and

Brandon, 1992). During the past decade there has been a rapid expansion in participatory watershed resource management projects and integrated conservation-development projects (ICDPs). However, the participatory mode is novel and complex, and such projects have little theory or experience to draw upon (Rhoades, 1998).

The Sustainable Agriculture and Natural Resources Management (SANREM) Program is a global research effort that aims to develop a new paradigm for research on sustainable agriculture and natural resources management (Hargrove et al, 2000). The program takes the whole landscape and lifescape of a watershed as the basis for formulating and resolving major management issues. It includes communities and local government bodies as reviewers, partners, and implementers of the research and development. The approach seems well suited to tackling some of the key methodological issues in protecting the natural habitats of unique tropical biodiversity encountering human pressure.

One of the three global sites where SANREM has been working is the Manupali watershed on the southern border of the Kitanglad Range Natural Park in central Mindanao, Philippines. The Biodiversity Consortium at the Philippine site is composed of collaborating organizations including a university, NGOs, and government agencies, convened by the International Centre for Research in Agroforestry (ICRAF). The work was also linked with the global program on Alternatives to Slash-and-Burn. The objective was to conduct research to develop tools and approaches that combined improved biodiversity conservation with the better livelihood opportunities through agroforestry for the communities that live near the Kitanglad Range Nature Park. This paper reviews that experience. It concludes by examining the implications of an integrated natural research management approach in this context.

The consortium began its work by drawing on the lessons learned from the global experience with ICDPs (Wells and Brandon, 1992; McNeely, 1995). One of the key lessons that has emerged is that the active leaderships of local people is the key. Communities near protected areas often bear substantial costs in foregone use or extraction from the protected area, yet may gain little in return. They are usually poor and quite remote to normal government services. There must be explicit linkages between project components. An integrated approach with balanced attention to both enforcement and development is necessary. To achieve the goals of protecting biological diversity and helping to improve the welfare of the people living near the protected area, it is necessary to pay explicit attention to how the rural development activities directly support the objective of protection. Some types of development initiatives may increase the pressure on the reserve. Road construction, or growth in agricultural productivity, may have this outcome under some circumstances. Introducing technologies that raise agricultural productivity may elevate land values, and may make it more attractive to encroach on to reserve land. Compensation to communities to promote local development may take many forms. This has often included agroforestry practices, crop intensification & irrigation, conservation farming practices, community forestry and others (Wells and Brandon, 1992). The objectives are to involve local people in natural resource management that empower them, increase their incomes, and shift their production systems in ways that better protect natural biodiversity in the agricultural landscape, and reduce their need to extract resources from the protected area. For sustained protection, in-migration must also be managed, and greater off-farm employment generated.

INTEGRATING CONSERVATION AND DEVELOPMENT IN THE MANUPALI WATERSHED

Biodiversity Value

The Kitanglad Range Nature Park is acknowledged as one of the most important biodiversity reserves in the Philippines. It supports the richest known vertebrate fauna (mammals and birds) in the country (Amoroso et al., 1996; Heaney, 1992, 1993 unpublished). It is the habitat of many endangered, endemic, rare and economically important species of animals and plants. Heaney (1992) observed thirteen of the fourteen species of birds endemic to Mindanao, including the critically endangered Philippine Eagle (*Pithecophaga jefferyi*). One genus of mammal is endemic to the park alone, the poorly known *Alionycteris paucidentata*. The park is a relatively small ecosystem of approximately 50,000 hectares, but is also of exceptionally high conservation value in terms of high endemism of the vascular flora (Amoroso et al. 1996; Pipoly and Masdulid, 1995 pers. com.). This includes the endangered rootless vascular plant (*Tmesipteris lanceolata* Dang.) (Amoroso et al, 1996). The park was recently found to have the highest tree density ever reported in a tropical forest (Pipoly and Masdulid, 1995 personal communication). This combination of a small, manageable size, and a rich, singular biodiversity, conforms to the type of protected ecosystem that Sayer (1995) proposes ought to receive the most determined attention in tropical biodiversity protection.

The Watershed

The people residing in the Manupali watershed, downslope from the Park, exert pressures on both the natural and managed ecosystems, particularly on the remaining protected forest. Amoroso (1997) noted an alarming rate of habitat destruction due to human activities, including illegal cutting of trees, over-harvesting of minor products, shifting cultivation, and conversion of forest lands to agricultural production. The present landscape of the upper reaches of the Manupali watershed consists of essentially three belts of land:

- 1) The national park, consisting mostly of pristine forested land existing at high altitudes (>1200 masl) with few current household land claims and National Park status.
- 2) A zone of land surrounding the park that is managed by the Department of Environment and Natural Resources (DENR) as production forest: this is the external buffer zone of the park. This is land on the fringe of the forest and has now been mainly converted to agricultural fields interspersed with imperata-dominated grassland. Encroachment here has been partly sanctioned through the expectation of social forestry stewardship contracts, with eviction no longer a tenable management option.
- 3) Privately-owned agricultural land that is further downslope from the public DENR lands. These landholdings comprise a mosaic of agroforest, crop, and fallowed fields, with remnant forest existing in the steep ravines, which border the streams that drain the national park.

The Participatory Learning Landscape Appraisal (PLLA), and our research during the initial years (1993-96), documented the land use practices (COPARD, 1996, Banaynal, 1996). This work highlighted the urgent need to develop an integrated and sustainable buffer zone management program. The indigenous Tala-andig people regard the public lands as their ancestral domain. Initial research indicated there was a strong self-perception among communities on the boundary of the Park that the protection of the natural biodiversity was in their own self-interest (Cairns, 1996). This somewhat contrasted with the concerns of the dominant in-migrant population, which tended to emphasize resource exploitation and

extraction for cash income. A major concern of the Tala-andig villagers was protection of the hydrological resources of the upper watershed for their water supplies. They were quite explicitly sensitive to spiritual and cultural values of the forest. They attributed the current failure to protect these resources to the lack of institutional mechanisms to manage the resources in a way that explicitly recognized local needs for more secure land tenure and alternative livelihoods. Lack of state recognition of secure tenure by the households residing in the buffer zone outside the park boundaries was a critical constraint that would need to be eventually addressed.

The Project Framework

The project goal was to elucidate a more fundamental understanding of people-ecosystem interactions to guide development of practicable natural resource management plans and processes. The research aimed to develop the elements of a workable social contract between buffer zone communities and the non-local stakeholders concerned with resource protection. We hypothesized that there were two essential conditions for sustainable buffer zone management and biodiversity conservation in the Kitanglad National Park:

- 1) Agricultural/agroforestry intensification in the buffer zone to enhance income growth, complemented by other forms of off-farm employment generation in the local and national economy, and
- 2) Community-supported enforcement of the boundaries of the park. Our work focused on both aspects. We investigated appropriate technical innovations suited to the biophysical and socio-economic conditions of the buffer zone, and we studied how to induce institutional innovations to enable better natural resource management. The social contract underlying the model links the provision of assistance in intensifying agriculture to local responsibility for park boundary protection.

ENHANCING AGRODIVERSITY

Agriculture is the dominant livelihood in the villages near the Park, as is the case with many other protected areas in the tropics. The boundary area of Kitanglad Park is located at an elevation of 600-1700 m, where temperate vegetable crops (including potatoes, cabbages, and tomatoes) are quite productive. Vegetable production is expected to further expand in the future. Our analysis indicated that the most likely future trajectory for farming systems in the buffer zone is toward continuous vegetable production on a portion of the farm (0.1-1.0 ha), with perennials (timber and fruit trees) grown on the remaining farm area, particularly on the steeper parts. A farm planning exercise with 67 families in three buffer zone villages (COPARD, 1996) found that the greatest interest was in establishing simple contour buffer strip systems on the annual crop areas of the farm, and increasing the area of fruit and timber tree crops on the remainder. The farmer-participatory research effort (described below) thus focused on enhancing the environment for smallholder tree production and contour buffer systems to sustain annual cropping. It involved numerous tests carried out by farmers independently, supplemented by experimental trials conducted by researchers on farmers' fields.

Smallholder Tree Production Systems

Prior attempts to reforest the buffer zones of deforested areas in the Philippines focused on the planting of large blocks of trees with local wage labor by the Department of Environment and Natural Resources (DENR). Such a project was implemented in the Manupali watershed during the late 1980s, prior to SANREM. Like many other such top-

down attempts, it failed. The plantations were burned out, often by local smallholders, across whose land the trees were planted. Only a few small remnant stands now remain in the 'reforested' buffer zone area.

Research in northern Mindanao documented a major transformation toward smallholder timber tree production in this region in response to market development (Garrity and Mercado, 1994). There is increasing evidence that smallholders are a key to future reforestation efforts in the tropics (Pasicolan, 1996; Garrity, 1994). Our approach was to ensure that improved germplasm was available for a variety of species to enhance income and reduce risk, and that best management practices suited to local farm circumstances were in place. The initial work focused on determining an appropriate mix of species of interest to farmers, and testing diffusion strategies to incorporate them into farming systems. A farming systems survey (COPARD, 1996) was conducted through open-ended interviews with farmers and neighborhood groups. Several training exercises (Koffa and Garrity, 2001) were also convened that fostered mutual learning between farm households and researchers. Farmers in the buffer zone and private lands related that they were very interested to expand the area of timber trees on their farms. The constraints to accelerating the process were a lack of seedling supply, knowledge of which species were most profitable, appropriate tree management, and availability of a wider range of tree germplasm to diversify risk. Subsequently, a detailed survey was undertaken as part of a graduate thesis. It developed a comprehensive knowledge base on multipurpose tree species performance at different elevations in the upper watershed (Glynn, 1996). The most common timber species planted in the upper watershed were found to be *Pereserianthes falcatera*, *Gmelina arborea*, and *Eucalytus camaldensis*. Farmers observed that the *Eucalytus* species perform particularly well at the buffer zone elevation levels (Glynn, 1996). Germplasm of a range of other fast-growing timber species, with emphasis on new accessions of *Eucalytus deglupta* and others. This was followed by a series of replicated on-farm experiments that evaluated the available commercial species for comparative performance by elevation. This work was complemented by investigations to domesticate a number of local species identified and used by farmers for timber (Palis, 1997). Experience was also obtained, through working with farmer groups, on the effectivity of three types of smallholder nursery systems. These activities resulted in a major acceleration of tree-production in the buffer zone (see section below on Landcare).

Enhancing Conservation Farming

Continuous crop production on steep slopes in Mindanao induces annual rates of soil loss often exceeding 100-200 t/ha (Garrity et al, 1993). The installation of contour buff strips reduces these losses by 50-99% and creates natural terraces that stabilize the landscape and facilitate further management intensification. These advantages have led to wide promotion of contour hedgerow systems by the DENR and the Department of Agriculture (DA). These systems are based on double rows of leguminous trees that are pruned periodically to provide green manure to the associated annual crops. Although the system has been shown to increase yields and better sustain soil fertility, adoption has been poor. Installed hedgerows were usually abandoned because farmers found that took too much labor to manage the tree hedgerows (ICRAF, 1997).

We had observed an indigenous buffer strip practice that had been evolved by a few farmers at another location in the Philippines. The practice, called natural vegetative strips (NVS), was introduced in the watershed as an alternative to the recommended system. NVS are

created by laying out the contour lines on sloping fields, and then allowing them to re-vegetate with the regrowth of natural grasses (Garrity et al, 1993). We found that NVS are exceptionally effective in soil conservation with minimal maintenance, and require no outside source of planting materials. Nelson et al (1998) modeled the long-term trends in maize yields, and found that yields increased after NVS were established. On fields with NVS maize production increased about 0.5 t/ha. This was further supported by the experience of many farmers who claimed that the buffer strips substantively increased their yields within a few years after installation.

Widespread popularization of the practice occurred through farmer-to-farmer knowledge sharing in the Landcare movement. Since 1996 it has led to about 300 farmers adopting the NVS practice on their farms in the upper watershed. In addition to the demonstrated effects on sustaining and increasing crop yields, farmers in the buffer zone also perceived that the practice would strengthen their tenurial claim to the land they were tilling.

The tree farming and contour buffer strips practices had immediate potential to help farmers in the buffer zone intensify land use and increase profitability, while sustaining land resources. Their widespread adoption is now backstopping the institutional innovations, and provides pragmatic alternatives to encroachment in the Park. Current research is estimating the aggregate effects of these vegetative buffers and filters on the hydrological functions at the landscape level (van Noordwijk et al, forthcoming). We now turn to the process of evolving participatory institutional innovations for local natural resource management.

ASSEMBLING THE ELEMENTS OF A SOCIAL CONTRACT

The foremost policy issue impinging on local natural resource management systems is the reality of overlapping land rights and management priorities. There are three sets of overlapping management claims and systems in the vicinity of the Park. These are: the Park and production forest land administered by the state (DENR), the ancestral domain claim of the Tala-andig people, and the jurisdictions of the six municipalities that surround the park. Figure 1 shows how these interact geographically. SANREM policy research focussed on understanding the ways in which the three overlapping jurisdictions can be reconciled, and in developing a scientific basis for management plans by the three sets of entities. The work aimed to provide options leading to a consensus that would meet the various stakeholders' concerns. We envision the development of a natural resource management system for the buffer zone of the Park that is based on a holistic Park management plan, coordinated with an ancestral domain management plan. These need to be supported by the municipal-level natural resource management plans. We are using an integrated natural resource management framework to evolve a negotiation support system to resolve the interactions between these three management domains (van Noordwijk et al, forthcoming). The following sections review the current status of that work.

Municipal Natural Resource Management Planning Model

In late 1995, the Mayor of the municipality of Lantapan committed human and financial resources to the development and implementation of such a plan, for which there was no precedent in the Philippines (Catacutan et.al. 1999, municipal natural resources management plan.). The municipal government created a multi-sectoral Natural Resources Management

Council made up of representatives of all the major sectors of the community, including smallholder farm households, church, civic, business and educational leaders, and others. The 25 members were appointed by the municipal mayor, who also established a local planning team that received support from the municipal environmental planning officer. The research team focussed on assembling the knowledge base for a scientifically-based local natural resource management plan. The draft plan was circulated, and subjected to a series of public hearings. Many changes were incorporated in the plan, and it was enacted by the Municipal Council in early 1998. The municipal government has currently allocated 5% of the municipal budget for implementation of the plan. In addition, ten villages within the municipality have, through their local elected bodies, allocated an average of 10% of their budgets for implementing activities to achieve objectives related to the plan. The initial impact of the plan has included a number of new policies and regulations related to resource conservation. These were proposed by the village representatives on the municipal council. Many on-the-ground activities have now been completed that enhanced the conservation of land, water, and biodiversity aspects of the plan. The research consortium's technical contributions to the plan stemmed from its research on agroforestry, conservation farming, and biodiversity conservation. For example, numerous steep ravines emanate from the Kitanglad range out into the agricultural landscape. These valleys are the least disturbed parts of the agricultural area, and they harbor diverse natural communities. They may be valuable in radiating strands of natural biodiversity outward from the protected area into the agricultural parts of the landscape. A strategy to enhance the biological integrity of the ravines was developed (Glynn, 1996). A methodology to survey and map the vegetative communities of major ravines of the Alanib River was evolved. The maps that were developed provided a basis for identifying the hot spots where change in land management practices was needed to protect stream water quality and riparian biodiversity. A local volunteer water watch organizations has been monitoring the water quality of the major streams. Their results pointed to serious biological contamination of several community's water supplies. Based on this information, a ravine habitat management component was incorporated into the municipal natural resource management plan. The communities have now been actively re-vegetating the degraded streambank areas with trees, through voluntary initiative and efforts.

The Lantapan experience is a significant advancement in municipality-led and participatory local NRM planning. In 1998, the DENR recognized the Lantapan experience as a national model for natural resource management planning in the Philippines Strategy for Improved Watershed Resources Management (DENR, 1998). The model is now being implemented in other municipalities in Bukidnon, and other provinces throughout the country. It is a significant step in the devolution of planning and management for natural resource protection to the local level, and a major shift from traditional top-down planning approaches towards participatory multi-sectoral planning and research-based decision-making.

The Landcare Movement Mobilizes Grassroots Conservation

The villages that immediately surround the protected area are on the conservation interface. They are embedded physically in the competing jurisdictions of the local municipality, the state forest land claimed by DENR, and the ancestral domain claim of the original inhabitants. Ultimately, the success of natural resource conservation depends on the initiative, active involvement, and support of the local residents. This requires a stronger conservation ethic at the community level, adaptation and adoption of conservation-

oriented and more productive farming practices, and collaboration between villagers and the Park administration in boundary enforcement (Garrity, 1995). Our hypothesis was that village-level knowledge-sharing community-action organizations are fundamental to addressing these natural resource management challenges.

A movement of self-governing farmer-led knowledge-sharing organizations had evolved in the nearby municipality of Claveria (located in a watershed in northern Mindanao). This Landcare movement was initiated by farmer groups to diffuse agroforestry practices among upland farming neighborhoods. It was started by small groups of farmers, and was based on their interest in learning and sharing experience with new technologies that increased income while conserving natural resources. These groups formed themselves at the neighborhood (sub-village) level. The agenda later expanded to many other aspects of community action for local natural resource management such as fire control, soil conservation policies, and riparian protection. The movement is composed of self-governing groups of people concerned about land degradation problems. Today, there are more than 2,000 households in Claveria who are members of the 145 chapters of the Landcare Association. They have initiated more than 300 fruit and timber tree nurseries, and are actively disseminating conservation farming technologies to fellow farmers via farmer-to-farmer contacts. More than 1500 farms in Claveria have adopted contour buffer strip systems on their sloping agricultural lands through these voluntary exchanges. As the movement grew, it began to attract strong support from the local government units at the village and municipal levels. It received technical backstopping from NGOs and the Department of Agriculture extension agents (Mercado et al, 2000). It is now active in 15 municipalities in five Philippines provinces.

The Landcare approach was introduced in Lantapan in 1998, through cross-visits by the numerous Lantapan farmers and civic leaders to Claveria. This was enhanced by networking with the local government, and with the municipal agricultural extension agents. The movement grew rapidly. Currently, there are more than 45 Landcare groups with a total of over 800 members, most living in the villages near the park boundary. The neighborhood groups coalesced into village chapters. Representatives of the chapters meet monthly as part of the municipal Landcare Federation. They share new information and ideas that have emerged in the various groups, and together they plan larger-scale community activities. The municipal and village governments actively support the Landcare groups through annual budgetary allocations.

The chapters have stimulated the development of over 40 nurseries for timber and fruit trees, and have fostered the adoption of contour buffer strips on several hundred farms. They have begun community-wide environmental protection by assisting in the planting of thousands of trees to protect the riparian buffer zone along the Kalasihan River. The Kalasihan was shown to be encountering the most severe pollution problems in the municipality by the local water watch monitoring group. Municipality-wide environmental awareness has increased during the past three years as a result of the intensified activities of the Landcare movement and the support of the municipal and village government units. The effects of these developments on the protection of the natural park are now clearly evident. Previously, the frequency of encroachment for extraction or slash-and-burn farming in the park were completely out of control, with hundreds per year. The annual number of park encroachment incidents during the past three years now declined by about 95% (F. Mirasol, Park Director, personal comm.). This was attributed to the enhanced collaboration between the villagers, the park administration, and the municipal, governments through the institutional innovations described above.

Instruments of secure land tenure for the farm populations inhabiting the buffer zone area have yet to be fully consummated. In the meantime, however, the Landcare experience indicates that the residents perceive that instruments that more formally recognize their local tenurial rights will be forthcoming. Evidence of this is abundant in the types of long term investments in soil conservation and tree production systems that are rapidly being adopted. The Landcare movement has significantly increased the social and political capital of the residents. It has been a contributing factor enabling positive developments in local natural resource management.

Douthwaite et al (forthcoming) has pointed out that in complex environments, integrated natural resource management (INRM) interventions must be able to foster and motivate the innovative potential of local people. They noted that a grassroots, community development model can lever enormous amounts of creative talent, and this has striking implications for INRM. Our ongoing evaluation of the Landcare experience in Mindanao, combined with locally-led natural resource management planning and implementation at the municipal level, suggests that it embodies the creation of these types of human and social capital.

DISCUSSION

This paper reviewed an approach to integrating conservation and development that links the protection of biodiversity with the development and adoption of improved agroforestry farming methods, and local institutional innovations by the communities that are directly affected by the presence of a natural park. The objectives were to conduct research to develop tools and approaches that combined improved biodiversity conservation with better livelihood opportunities, to increase local capacity to manage natural resources, and to apply the tools to solution of a set of complex natural resource management challenges. To achieve the goals of protecting biological diversity and helping to improve the welfare of the people living near the protected area, it was necessary to pay explicit attention to how the rural development activities directly supported the objective of protection.

Significant progress has now been achieved in assembling the elements for an effective social contract to protect the natural biodiversity of Kitanglad Range Natural Park while improving the livelihoods of the communities on the park boundary. Figure 2 presents the work in the context of an integrated natural resources management (INRM) framework (see the paper by Izac in this issue for further background). The framework is an intellectual and methodological successor to the farming systems research framework, but places more emphasis on the links and trade-offs between enhanced biological productivity, ecosystem integrity and resilience, and human well-being. There is significant evidence that the integrated approach created an effective linkage between development and conservation. Through strong initiative and support for natural resource management planning and implementation at the local level, and the efforts of the grassroots Landcare farmer groups, a conservation ethic has been spreading through all segments of the community. Stronger support for a wide range of environmental concerns is now common among migrant households, religious and educational leaders, local politicians, staff of the local government units, the commercial agribusiness community, in addition to the original Tala-andig inhabitants.

Sensitivity by the wider community for the environmental and religious values of the Tala-andig has broadened and deepened. Biodiversity protection is now owned as a local responsibility by a much broader segment of the local society beyond the ancestral communities. It is now pursued with a strong measure of civic pride. Some of the key success factors identified have been a strong consortium of both research and development institutions, and local government entities committed to an integrated systems approach. This group evolved with a common vision, and the patience to nurture that vision under highly constrained funding conditions. Indeed, the funding constraints experienced may have been a blessing. Increasingly, it is observed that higher levels of commitment and impact for integrated conservation-development may be stimulated by a 'drip-feed' approach rather than by large, externally-funded efforts.

The major challenge yet to be resolved is the reconciliation of the ancestral domain claim with the Park jurisdiction, and with the need for greater tenurial security among immigrant settlers in the buffer zone. Similar manifestations of these upland tenurial issues are observed in various forms throughout Southeast Asia. A negotiation support system is being developed to facilitate the resolution of such conflicts. This is described in a companion article in this volume (van Noordwijk et al, forthcoming). The components of the tools are being developed through work at three key watersheds in the region, including Sumberjaya, Indonesia, and Mae Chaem, Thailand, in addition to the work at Manupali, Philippines that was covered here.

LITERATURE CITED

- Amoroso, V.B. 1997. Pteridophyte diversity in the Philippines: Status, issues and conservation initiatives. Paper presented during the National Seminar-Workshop on Environmental Education and Management, July 2-3, 1997. Central Mindanao University, Bukidnon, Mindanao, Philippines.
- Amoroso, V.B., Acma, F., and Pava, H. 1996. Diversity, status and ecology of Pteridophytes in three forests in Mindanao. In: J.M. Camus & R.J. John (editors). *Pteridology in Perspective*, pp. 53-60. Royal Botanic Gardens. Kew.
- Banaynal, R.A. 1996. COPARD 2: NECI Annual Progress Report. Network for Environmental Concerns, Cagayan de Oro City, Philippines. 24 p. with annexes.
- Cairns, M.F. 1996. Ancestral domain and national park protection: A mutually supportive paradigm? A case study of the Mt. Kitanglad Range National Park, Bukidnon, Philippines. In: Garrity, D, Glynn, C, and Banaynal, R (eds) *Summary Report of a National Workshop on Buffer Zone Management and Agroforestry*. Central Mindanao University, Bukidnon. p. 15.
- Catacutan, D., Garrity, DP. and Mirasol, FS. 1999. *Reinventing Protected Area Management: From Curing to Preventing*. Working Paper. International Centre for Research in Agroforestry, Los Banos, Philippines. 9 p.
- COPARD. 1996. *Community Organizing Participatory Action Resource Development Research. Terminal Report (Cycle 1)*. Network for Environmental Concerns, Cagayan de Oro City. 30 p.
- DENR, (1998) *The Philippines Strategy for Improved Watershed Resources Management*. Forest Management Bureau, Dept of Environment and Natural Resources, Quezon City, Philippines. 102 p.

Douthwaite, B., de Hann, N, Manyong, V.M., Keatinge, D. Blending 'hard' and 'soft' science: The 'follow the technology' approach to catalysing and evaluating technology change. *J. Cons Ecol* (this issue).

Garrity, D.P. and Mercado, A. 1994. Reforestation through agroforestry: market-driver smallholder timber production on the frontier. In: Raintree, J.B. and Francisco, H.A. (eds), *Marketing of Multipurpose Tree Products in Asia*. Winrock International, Morrilton, AR, 265-268.

Garrity, D.P., Kummer, D.M. and Guiang, E.S. 1993. The Philippines: In: *Agricultural Sustainability and the Environment in the Humid Tropics*. Washington, D.C.: National Academy Press. Pp. 549-624.

Garrity, D.P. 1994. The importance of agroforestry and ICRAF's mission in Southeast Asia. *In: Present Situation, Problems, Prospects, and Practical Implementation Program of Education and Research on Forestry for Sustainable Agriculture and Natural Resource Conservation in Asia*. University of Tsukuba, Tsukuba, Japan. pp. 107-115.

Garrity, DP 1995. Improved agroforestry technologies for conservation farming: Pathways toward sustainability. In: *Proceedings International Workshop on Conservation Farming for Sloping Uplands in Southeast Asia: Challenges, Opportunities and Prospects*. International Board for Soils Research and Management, Bangkok, Thailand. Proceedings No 14, pp 145-168.

Glynn, C. 1996. Overcoming constraints to agroforestry adoption in tropical highlands: An investigation of performance by elevation patterns for some commonly grown timber species in the Manupali Watershed, Bukidnon, Philippines. M.Sc. Thesis, Tropical and Subtropical Horticulture and Crop Science, Wye College, University of London.

Hargrove, W., Garrity, DP., Rhoades, RE. and Nelly, CL. (2000). A Landscape/Lifescape approach to Sustainability in the Tropics: The Experience of the SANREM CRSP at Three Sites. In: R. Lal (Ed.). *Integrated Watershed Management in the Global Ecosystem*. CRC Press. Florida, USA. : pp. 209-222.

Heaney, L. 1993. Survey of vertebrate diversity in Mt. Kitanglad Nature Park. Unpubl. Manuscript, Philippine National Museum, Manila. Heaney, L. and Peterson, A.F. 1992. Inventory of the vertebrates of Mt. Kitanglad Nature Park. Final Report, 12 pp.

ICRAF. 1997. Annual Report for 1996. International Centre for Research in Agroforestry, Nairobi, Kenya.

Izac, A.M. What paradigm for linking poverty alleviation to natural resources management? *J Cons Ecol* (forthcoming, this issue).

Koffa, S.N. and Garrity, D. P (2001). Grassroots Empowerment and Sustainability in the Management of Critical Natural Resources: The agroforestry Tree Seed Association of Lantapan. In: I. Coxhead and G. Buenavista (Ed.). *Seeking Sustainability: Challenges of agricultural Development and environmental management in a Philippine watershed*. Philippine Council for Agriculture, Forestry, and Natural Resources Research and Development. Los Banos, Philippines. : pp.197-217 .

McNeely, J.A. 1995. Partnerships for conservation: An introduction In: McNeely, J.A. (ed) *Expanding Partnerships in Conservation*. Island Press, Washington, DC. Pp 1-12.

Mercado, AR Jr, Patindol, M, and Garrity, DP. 2000. The Landcare experience in the Philippines: Technical and institutional innovations for farming. In *Changing Landscapes --*

- Changing Futures. Proceedings of the International Landcare Conference, March 2000. Murray-Darling Basin Commission, Victoria, Australia. Pp 236-244.
- Nelson, R. A., Cramb, R. A., and Mamicpic, M. A., 1998, Erosion/ productivity modeling of maize farming in the Philippine uplands. Part III: Economic analysis of alternative farming methods, *Agricultural Systems*, 58:2, pp. 165-183.
- Palis, H. 1997. Domestication initiatives of indigenous tree species in Mt. Kitanglad. Final report of SANREM Phase 1. International Centre for Research in Agroforestry, Bogor, Indonesia.
- Pasicolan, P. 1996. Tree growing on different grounds: an analysis of local participation in contract reforestation in the Philippines. Centre for Environmental Science, Leiden, Netherlands.
- Pipoly, J. and Masdulid, D. 1995. The vegetation of a Philippine submontane forest, Kitanglad Range. Personal Communication.
- Rhoades, R. 1998. Participatory Watershed Research and Management: Where the Shadow Falls. Gatekeeper Series No 81, Int'l Institute for Environment and Development, UK. 20 p.
- Sayer, J.A. 1995. Science and international nature conservation. Occasional paper no. 4. Center for International Forestry Research. 14 p.
- Van Noordwijk, M., Tomich, T P, and Verbiest, B. Scaling, lateral flows, filters, sustainability, and negotiation support models for natural resource management in landscapes with trees. *J Cons Ecol* (forthcoming, this issue).
- Wells, M. and Brandon, K. 1992. People and Parks: Linking protected area management with local communities. World Bank/World Wildlife Fund/USAID. Washington, D.C.

Figure 1. Diagrammatic representation of the linkages between three types of natural resources management plans.

Figure 2. Elements of the approach in the Manupali watershed to alleviate poverty and protect environmental services in an integrated natural resource management research framework.