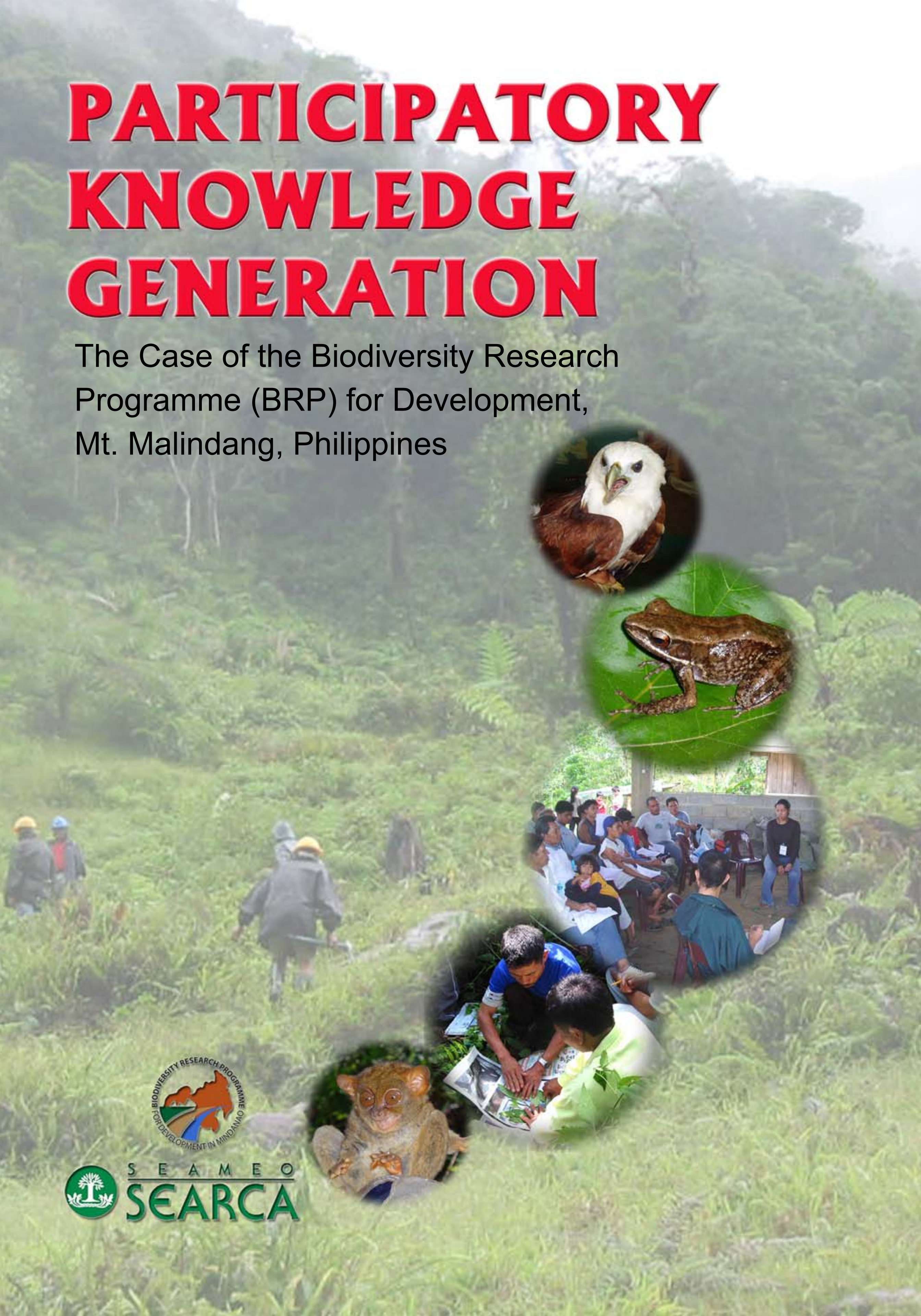
PARTICIPATORY KNOWLEDGE GENERATION

The Case of the Biodiversity Research Programme (BRP) for Development, Mt. Malindang, Philippines



BIODIVERSITY RESEARCH PROGRAMME FOR DEVELOPMENT IN MINDANAO

SEAMEO SEARCA

Compiled and edited by:
Paul J. Hillegers, Nicomedes D. Briones, Mariliza V. Ticsay, Carina S. Fule

With contributions from:
Cecilia B. Amoroso, Victor B. Amoroso, Myrna G. Ballentes, Della Grace G. Bacaltos, Renato D. Boniao, Francis Fletcher M. Freire, Aurelia Luzviminda V. Gomez, Annabella Gorospe-Villarino, Carmelita G. Hansel, Olga M. Nuñeza, Teresita O. Poblete, Emma M. Sabado, Luz C. Sevidal Castro, Alita T. Roxas, Wilfredo H. Uy

Language Editor and Desktop Artist:
Leah P. Arboleda

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Executive Summary

The Biodiversity Research Programme (BRP) for Development was designed and implemented by Filipino and Dutch researchers from 2001 to 2005. It aims to help address the research needs and questions relevant to biodiversity conservation in the Philippines. By utilizing the integrated ecosystems or landscape approach, BRP's research initiatives were location-derived and development-oriented, systems-oriented and interdisciplinary, and participated in by various stakeholders.

BRP's Filipino and Dutch partners chose Mt. Malindang because of its landscape and biodiversity conditions. It is nearly completely covered by the Province of Misamis Occidental on the Island of Mindanao. The Mt. Malindang Range Natural Park (MMRNP) has been identified as a biodiversity "hotspot" in the Philippines. It has been considered as a high priority area for protection and conservation because its watersheds provide for the needs of about a million people. At the time of program implementation, there were approximately 22,300 inhabitants in the MMRNP buffer zone, and 900 more were living in the limited portions of the park's core protected area. The inhabitants within the park and its environs were mainly Subanun whose livelihoods largely depended on the mountain's resources. The Subanun were the original settlers in the lower portions of Mt. Malindang but have since settled in its upland areas. A wedge in the northeastern part of the Mt. Malindang landscape, including two major river catchments, the Layawan and Langaran Rivers, were selected as BRP research sites.

Program phases. In the pre-implementation phase, the results of the participatory rapid appraisal (PRA) studies formed the base for BRP's research priorities. The first generation research, which started in 2001, further provided baseline studies that were critical in determining the research priorities of the last phase — the comprehensive and integrative second generation studies.

In the second generation phase, three master projects covered all aspects of the Mt. Malindang landscape: 1) the uplands, which included the undisturbed and disturbed forests, and semi-permanent agriculture on the higher elevated areas; 2) the lowlands, which included the remnant forest patches, grasslands, shrublands, and permanent agricultural lands; 3) the aquatic ecosystems, which consisted of the river systems and the coastal waters; and 4) the socioeconomic and policy studies.

The studies were implemented by researchers from academic institutions in Mindanao. The expertise of researchers from other

Philippine institutions was also tapped as needed. Likewise, the programme involved Dutch researchers in their areas of expertise.

Biodiversity profile. The BRP studies showed the presence of diverse flora, vertebrate fauna, and arthropods in the different subsystems of Mt. Malindang. The mountain is indeed a key conservation site due to its high number of endemic and threatened species. The most important and most diverse among the habitats for conservation were the mossy and montane forests, as well as the Almaciga and the submontane dipterocarp forests. Endangered species were found in all the forest types, but especially threatened were the Almaciga trees. The diversity of flora and faunal species, which contained a substantial number of endemic species, was very high, especially in the Almaciga forests. These forests contained many endangered species, and research results revealed high to extremely high endemism of tree species. Equally important were the other forest types that served as sanctuaries and sources of regenerating materials and species pool for the flora and fauna of the other vegetation types.

The second-growth forests in the midlands, meanwhile, showed high species richness and endemism. Together with the mixed lowland dipterocarp forests, these second-growth forests served as habitat corridors. The rivers' water quality was analyzed as good, and their riparian subsystems were found to harbor rich flora and faunal species. The coastal waters in the BRP research areas were also found to have poor fish stock. This could be attributed to overfishing and degradation of the fish habitats. Some mangrove and nipa patches were found scattered along the coastline since most of the vegetation systems were converted into built-up areas.

Poverty and increasing population were the main threats to the biodiversity conditions in the area. Although there were legal and sociocultural factors that regulated the use of natural resources, these resources were still critically needed by the people for their livelihood. Hence, despite environmental laws, trees were continuously being extracted from the forests of the core protected area and the buffer zones for timber and firewood.

Land use. Agriculture was found to be the major land use in Mt. Malindang. *Kaingin* or slash-and-burn farms, that were usually planted with corn, cassava, sweet potato, and rice, were found scattered in the logged-over areas. At the time of the studies, farmers were continuously expanding these areas. The cultivation of semi-temperate vegetables (cabbage, onion, sweet pepper, and chayote) was introduced due to the area's low temperatures and high precipitation. The high-input but financially rewarding semi-temperate vegetable farming in the upland barangays was thus considered a thriving livelihood for the residents, including the Subanun.

Some form of agroforestry (coconut intercropping with fruit trees and annual crops) was also being practiced in Mt. Malindang's midslopes. Irrigated rice farms were found in the lowlands with irrigation water being sourced from the Langaran and Layawan Rivers. Quarrying for sand and gravel in the riverbeds was a major livelihood for families in some riverside villages, while fishery was mostly relied on by families living in densely populated coastal zones.

The expansion of agriculture into the upper slopes of Mt. Malindang was another major concern. The gathering of wild plants and honey as well as the hunting of wildlife, were often done to supplement household income. However, inappropriate practices often lead to overexploitation such as the cutting of immature rattan or improper resin tapping of the Almaciga trees. Though wildlife hunting was not widespread anymore, the risk of losing the endemic and threatened species still remained high as people were continuously protecting their gardens/farms with traps and other hunting tools.

These land use practices, however, may lead to increased forest land conversion, cultivation of sloping areas, and the ensuing environmental problems associated with the use of chemical pesticides in controlling vegetable pests and diseases. In addition, quarrying activities and dams for irrigation increased the suspended load of soil particles that were continuously affecting water quality and aquatic habitats. The intensive use of fishery and other coastal resources were likewise exerting pressure on the natural resources. Environmental pollution from the coastal population centers was also extensive.

Socioeconomic profile. The upland population of Mt. Malindang was primarily dependent on the land and forest resources for survival. The rural lowland and coastal population relied heavily on agriculture and fishing. However, the average household income was generally below the poverty line. The cash needed to buy farm inputs or finance fishing operations were sourced from informal credit sources, and the backyard raising of poultry, pigs, goats and/or cattle. Although low human capital was found prevalent in all BRP research sites, this was augmented by training programs, seminars, and other information, education and communication (IEC) programs implemented by both national and local agencies, NGOs, and religious groups.

The studies also revealed a high membership in people's organizations formed by foreign-funded NGOs in the upland and interior lowland communities. There were also religious groups in the communities. Sociocultural capital across the landscape of Mt. Malindang was generated primarily from kinship ties, that is, people were related by blood or affinity thereby resulting to strong family ties. Sociocultural capital was also comparatively limited in the upland communities due to their inaccessibility. For their part, the Subanun have attained a sense of security in terms of their survival as they have successfully nurtured their intricate coexistence with the biophysical environment over the years.

Policy and governance. Several national and local laws, and policies cover biodiversity conservation in Mt. Malindang. For protected areas such as the MMRNP, there were legal provisions that prevented the extraction of forest resources and encroachment into forest lands. A major issue, however, was the non-compliance and defiance of prohibitions because of the people's more immediate concern for livelihood, and the general lack of understanding on the impacts of biodiversity conservation. Policy enforcement was also characterized by the apparent lack of local government commitment and weak political will.

Enhancing research capabilities. Aside from these studies, one of BRP's objectives was to strengthen the research capabilities of Mindanao-based researchers on biodiversity. The participation of the local researchers, particularly from the Subanun and coastal fishery communities, was BRP's significant contribution to the empowerment of the local stakeholders to ensure continuity of project activities.

The expertise of researchers from other Philippine institutions was also tapped to address the gaps in technical capability on the part of the Mindanao research partners. This strategy was used in areas where the Dutch researchers contributed their scientific and technical expertise on biodiversity research.

Recommendations. Based on the abovementioned findings, further research is needed to:1) lessen the dependence of communities on forest biodiversity resources by intensifying agricultural production outside MMRNP and its buffer zones, particularly in the coconut agroecosystems; 2) design and establish ecological networks and networking within the Mt. Malindang environment; 3) further develop the knowledge base for monitoring, conservation and livelihood development; and 4) continue the scientific network collaboration of the researchers and research institutions, including opportunities for international networking.

To practice and/or implement biodiversity research, the project thus recommends initiatives to: 1) further recognize and support the sustainability of the sociocultural heritage of the Subanun;
2) continue and intensify awareness campaigns on the values and participation of the stakeholders in the planning and decision-making processes required in the biodiversity conservation of MMRNP;
3) improve access to financial assistance and further develop infrastructure; and 4) identify the comparative advantages of the Mt. Malindang landscape that could be marketed locally and abroad.

With regards to policy, BRP recommends that efforts be initiated to: 1) intensify government efforts through the strict implementation and enforcement of all existing laws, regulations and ordinances related to the conservation and sustainable use of the Mt. Malindang landscape, particularly the strengthening of MMRNP organizations concerned with marine and coastal resources protection; 2) stimulate private investments and initiatives to protect and rehabilitate environmentally critical areas of Mt. Malindang; 3) promote livelihood opportunities that are compatible with the local and national thrusts on biodiversity conservation (e.g., ecotourism); and 4) implement zoning guidelines and regulations for the environmental impacts of semi-temperate vegetable farming in the uplands.

Contents

Acronyms and Abbreviations

AMP	Aquatic Ecosystem Master Project
AusAID	Australian Agency for International Development
bd ft	board feet
BIOMES	biodiversity monitoring and evaluation system
BRP	Biodiversity Research Programme for Development
CADC	Certificate of Ancestral Domain Claim
CADT	Certificate of Ancestral Domain Title
CBD	Convention on Biological Diversity
CEC	cation exchange capacity
CMT	community monitoring teams
DA	Department of Agriculture
DAR	Department of Agrarian Reform
dbh	diameter at breast height
DENR	Department of Environment and Natural Resources
FPIC	free and prior informed consent
GPA	Gandawan Planters Association
ICC	indigenous cultural communities
IEC	information, education and communication
IKS	indigenous knowledge systems
IP	indigenous people
IPRA	Indigenous People's Rights Act
IUCN	International Union for the Conservation of Nature
JPC	Joint Programme Committee
LAG	Local Advisory Group
LGUs	local government units
MAPDA	Mansawan Planters Development Association
masl	meters above sea level
MMRNP	Mt. Malindang Range Natural Park
NGOs	nongovernment organizations
NIA	National Irrigation Administration
NIPAP	National Integrated Protected Areas Programme
NIPAS	National Integrated Protected Areas System
NSS	National Support Secretariat
NTFP	nontimber forest products

OM	organic matter
PACBRMA	Protected Area Community-Based Resource Management
PALS	Philippines-Australia Local Sustainability Program
PAMB	Protected Area Management Board
PENRO	Provincial Environment and Natural Resources Office
PRA	participatory rapid appraisal
PWG	Philippine Working Group for Biodiversity Research
RA	Republic Act
RAWOO	The Netherlands Development Assistance Research Council
RC	relative dominance
RD	relative density
RF	relative frequency
SALT	sloping agricultural land technology
SCO	Site Coordinating Office
SEAMEO	Southeast Asian Ministers of Education Organizations
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
SEC	Socioeconomic and Cultural Studies Master Project
SI	Similarity Index
SIV	species importance value
SLO	Support and Liaison Office
SWOT	strengths, weaknesses, opportunities, and threats
TEMP	Terrestrial Ecosystem Master Project
TSS	total suspended solids

1

Recognizing Biodiversity's Role in Sustaining Human Survival

BIODIVERSITY LOSS: A GLOBAL CONCERN REQUIRING LOCAL ACTION

Several decades ago, more and more people realized that healthy and flourishing ecosystems were essential for us to survive. Biodiversity provides the raw materials, goods, and services that mankind need to live, work, produce and consume.

Loss of biodiversity became apparent in the middle of the last century. Large-scale industrialization and increased level of income of the people in the northern temperate regions required a growing demand for natural resources which created pollution problems and environmental degradation. More and more resources were needed for the growing northern economies, majority of which were coming from the less developed southern hemisphere.

In the humid tropics, the loss of biodiversity began when the markets for tropical timber changed from local into internationally oriented markets. Large timber concessions were granted for mechanized timber exploitation, changing untouched natural forests into logged-over, often much degraded forests.

The mechanized logging operations required an intensive network of primary truck roads and secondary hauling roads to access remote areas. This network of roads attracted landless local farmers and migrants from distant districts who were in search of new fertile land for shifting cultivation and other forms of subsistence agriculture.

Almost at the same time, the international demand for timber and agricultural products also increased sharply. The rich countries in the north and the developing countries in the south needed vast tracts of land to produce oil, rubber, coffee, pepper, and other products. These further intensified loss of biodiversity.

Parallel to this environmental degradation was a sharp increase in population that was unable to share in the profits from this resource exploitation. The local population thus had to struggle even harder for their subsistence and became more dependent on the decreasing natural resources. The situation was such that biodiversity conservation has now started competing with human development.

To fight the loss of global biodiversity, the United Nations Conference on Environment and Development in Rio de Janeiro in 1992 adopted the Convention on Biological Diversity (CBD). It emphasized North-South cooperation to conserve and sustain the use of biodiversity, and the fair sharing of benefits arising from their use.

The Philippines and The Netherlands were among the 154 signatory nations that committed to implement the resolutions of the convention. As a follow-up to the Rio de Janeiro summit, both countries started a wide range of activities. Among these were efforts to supplement existing environmental laws and regulations, develop new policies, and implement action and research programmes to conserve biodiversity and at the same time improve livelihood.

In the spirit of the Rio de Janeiro agreements, The Netherlands Minister for International Cooperation requested the Netherlands Development Assistance Research Council (RAWOO) to develop a number of long-term, pilot programs on biodiversity research for development. The Philippines and The Netherlands' academic communities were challenged to help address the problem and find added values in the combination of biodiversity and socioeconomic development.

This laid the grounds for the development and implementation of a research partnership between the two countries through the Philippines-Netherlands Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and its Environs (Figure 1).

THE BIODIVERSITY RESEARCH PROGRAMME (BRP) FOR DEVELOPMENT

Guiding Principles and Concepts

Through a series of consultations, joint meetings, and conferences between Filipino and Dutch proponents, a research agenda was designed based on needs and questions relevant to biodiversity conservation in the Philippines. It was through this agenda that the guiding concepts and principles of a research program were developed responsive to sustainable development needs.

BRP worked on the principles of:

1. steering biodiversity research through a society-driven approach;
2. developing a comprehensive approach that aims to integrate support for collaborative research, and build and strengthen national capacity for biodiversity research; and
3. promoting research cooperation on equal footing.

Fig. 1. The satellite image of the Northeastern part of the island of Mindanao, Philippines where Mt. Malindang is located.

From these working principles were concepts that guided the implementation of BRP: 1) location-derived and development-oriented, 2) promoted multi-stakeholder participation, 3) systems-oriented and participatory, and 4) used the landscape approach.

a. Location-Derived and Development-Oriented

The research agenda, priorities and methods in BRP were obtained from the needs expressed by the people in the research sites. People identified problems and potential solutions critical for their own development. Through this process, the relevance and usefulness of research was established at the onset.

b. Promoted Multi-Stakeholder Participation

Multi-stakeholder participation involved not only the research community but more importantly the local communities, local government units, nongovernment organizations (NGOs), and other stakeholders. Constant interaction and feedback among the stakeholders made research more responsive to local development needs. Their participation enhanced the mechanisms for the research to provide inputs into policy making, program implementation, and day-to-day practices that would help conserve biodiversity.

c. Systems-Oriented and Interdisciplinary

The conceptual framework of the research was holistic, i.e., it examined results to understand the interaction of the different elements of the system. To do this, BRP brought together the natural, socioeconomic, and cultural components, and their interactions which affected biodiversity in the area. This included researchers from various disciplines in the natural and social sciences, and those who were experienced in cross-cutting or multidisciplinary studies.

d. Used the Landscape Approach

The interactions of elements within an ecosystem are fundamental in studying biodiversity. Likewise, the interactions among the elements of contiguous ecosystems are equally important to provide holistic and integrated effects on biodiversity protection and conservation.

By using the landscape approach and its various methods of analysis, the ecosystem interactions within the watershed or catchment areas that span the uplands, lowlands, and coastal/marine ecosystems were assessed. The landscape approach directly involved all the stakeholders including the local government units (LGUs) for a holistic and integrated decision-making process.

Funding realities made the program implementers decide on Mt. Malindang, Mindanao as the pilot site. The site was largely viewed and intended as the possible springboard from which similar biodiversity conservation initiatives throughout the country could be launched.

Vision, Mission, Goal, and Objectives

BRP envisions economically and culturally prosperous communities living harmoniously in a sustainable environment where biodiversity conservation was founded on an integrative and participatory research model. This would require the undertaking of collaborative, participatory and interdisciplinary research that promoted the sustainable use of biological resources. Effective decision making is also needed on biodiversity conservation to improve livelihood and cultural opportunities. BRP emphasized innovative research to generate knowledge and insights that contributed to a better understanding of biodiversity issues in the Mt. Malindang landscape, better policy responses, improved management practices, possible redirection of people's livelihood activities, and increased opportunities that aligned with the goals of biodiversity conservation.

Hence, BRP aimed at:

1. making biodiversity research more responsive to real-life problems and development needs;
2. introducing a new mode of knowledge generation for biodiversity conservation that was interactive, participatory, multi/interdisciplinary, and learning-based;
3. strengthening national capacity for biodiversity research, and enhancing local ownership by empowering Philippine research partners and local stakeholders; and
4. promoting genuine research cooperation between researchers from the Philippines and the Netherlands.

Components

BRP has two major components: the Research Projects and Support Activities. In the Research Projects, themes linked questions to real problems and opportunities in the communities and ecosystems in the research sites. Research themes were organized into the following general categories: (1) methodology development, (2) knowledge expansion and improvement, and (3) policy-oriented research. A theme comprised a major research topic with several specific studies. This also worked on the premise that research should be a genuine collaboration between researchers from the Philippines and The Netherlands with joint responsibilities, mutual trust, free sharing of experiences and expertise, and working through a two-way learning process.

The Support component, meanwhile, consisted of organized activities that provided systematic support for the cross-cutting needs of the research activities. These activities boosted the relevance of the Research Projects to development problems in the research site, especially those that were expressed by the local stakeholders. The main activities in the Support component were grouped into the following categories:

1. Capability building and institutional strengthening;
2. Information, education and communication (IEC);
3. Knowledge management; and
4. Networking and alliance-building.

The research and support activities were very much interrelated as prescribed by the BRP principles and concepts. Hence, each research project contained support elements (e.g., capacity building), whereas support activities required research (e.g., presentation of thematic data through GIS).

Organization

a. Development and Implementation (1996-2005)

BRP was designed as a long-term North-South research partnership that was focused on Mt. Malindang and its environs. It was jointly conceived and designed by the Philippine Working Group (PWG) for Biodiversity Research and by RAWOO. RAWOO collaborated with the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) which was concerned with the promotion of sustainable agriculture through natural resource management and environmental protection in the Philippines and Southeast Asia.

The schematic diagram in Figure 2 depicts the project formulation and implementation process that started as early as 1996. RAWOO and SEARCA jointly prepared and marketed BRP for funding by the Dutch government and other possible donors. SEARCA facilitated and organized the activities in the Philippines. RAWOO, meanwhile, mobilized professional and material resources in The Netherlands, and advised the Dutch government on BRP's implementation.

BRP was approved by the Dutch government for implementation from July 2001 until June 2005 through a grant awarded to SEARCA. The programme was later extended until June 2006.

b. Stakeholders and Participants

Stakeholders. Different stakeholders first contributed to BRP's implementation when they participated in the National Consultation Meeting for Biodiversity Research Agenda Setting in July 1997. The participating stakeholders comprised of BRP researchers, and representatives from government and nongovernment institutions in the Philippines' three major island groups. A similar group from The Netherlands also participated in the consultation.

The consultation paved the way for continuous linkages and networking with key stakeholders as part of the pre-implementation plan. There were meetings with local government representatives that consisted of the Governor of the province of Misamis Occidental, the mayors of the municipalities of Aloran, Baliangao, Calamba, Concepcion, Don Victoriano, Lopez Jaena, Plaridel, and Sapang Dalaga, and the barangay captains and council members in the villages reached by the PRA. Consultations were also held with agencies concerned with biodiversity, environment, and natural resource management. These included the Department of Environment and Natural Resources (DENR), through the Protected Area Management Board (PAMB), and implementers of major programs in MMRNP and Misamis Occidental, such as the European Union, CARE-Philippines, and the University of the Philippines System. Close contacts with the stakeholders were maintained during program implementation.

Research participants. Numerous senior, assistant, and local researchers were involved in conducting the PRA during the pre-implementation phase or the first generation studies (Phase I), and the second generation studies (Phase II). Researchers came from Mindanao scientific institutions.

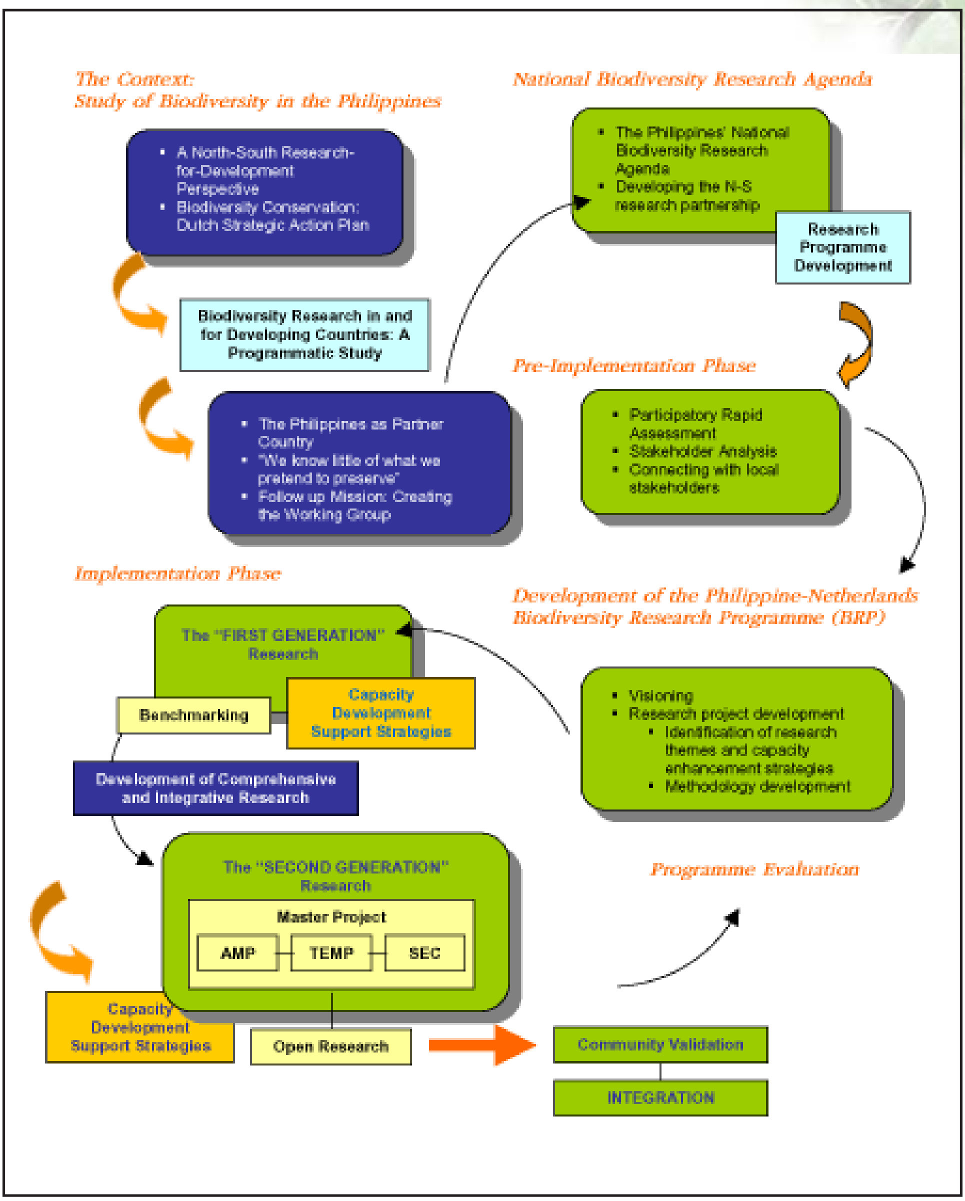

Fig. 2. BRP project formulation and implementation process (Calalo 2005).

Experts and other subject matter specialists from the country's other island groups were also tapped as research collaborators to help address the gaps in technical capabilities on the part of the Mindanao partners. The same strategy was applied for research areas where the Dutch were the acknowledged experts. This unique cross-cultural, cross-sectoral, and interdisciplinary partnership ensured that all concerns were covered.

Aside from the researchers, the Philippine Working Group (PWG) for Biodiversity Research, a collegial body of environmental advocates and practitioners established in 1997, was also tapped to improve program formulation and decide on the operational policies of the initial phases. The PWG helped formulate the selection procedure of the research studies for the Joint Programme Committee (JPC) and functioned as a scientific advisory council for the research teams.

Meanwhile, the JPC had the final decision on BRP's implementation process, including the selection of the research studies, and publication of research results.

The participating institutions in Philippines and The Netherlands, the members of the PWG, and the JPC are listed in Appendix 1. The research teams that conducted the different studies are given in Appendix 2.

c. Management

The highest policy and decision-making body of BRP was the JPC. It consisted of three members each from The Netherlands and the Philippines. The JPC reviewed work programs, endorsed the annual budget, and was responsible for the overall management of BRP. JPC was advised by the PWG and the Local Advisory Group (LAG). As a collegial body where decision making was a shared responsibility, JPC decisions were most often based on the views of the Philippine members because of the latter's familiarity with local context and issues.

Implementing the policies and plans made by JPC was SEARCA, serving as BRP's National Support Secretariat (NSS). The NSS managed and coordinated the overall implementation of BRP, and monitored its progress. It was also responsible for coordinating the Programme's multiple partners in the country.

NSS worked through a Site Coordinating Office (SCO) based at the research site. SCO was headed by a Site Coordinator who handled local and field-level implementation with three to four staff members. They handled the coordination of research and development activities in the study area which included, among others, provision of logistical support and monitoring of activities.

Meanwhile, a Support and Liaison Office (SLO) at the ETC Foundation based in The Netherlands, served as the secretariat which coordinated the Dutch partners' participation.

TOWARDS PARTICIPATORY KNOWLEDGE GENERATION IN BIODIVERSITY

Pre-Implementation Phase (PIP): The PRA Studies

Research questions on biodiversity and sustainable rural development, the research site, and the actual research studies were identified and formulated in the pre-implementation phase. PRAs were conducted during this phase for the coastal, lowland, and upland ecosystems.

The PRA studies were initiated by inviting scientific research institutions to submit preliminary research proposals related to biodiversity and development. Responding researchers were then invited to participate in a workshop to discuss and level-off on the PRA methodology to be used in the first major research activity in Mt. Malindang. The workshop formed three research groups that investigated the following areas in the upland, lowland, and the coastal areas:

a. Description of the biophysical, sociocultural and economic conditions and status of the ecosystems;
b. Assessment of the biodiversity conditions;
c. Identification of stakeholders and their needs;
d. Description of the strengths, weaknesses, opportunities, and threats (SWOT) to the communities in relation to biodiversity conservation; and
e. Identification of researchable areas in the Mt. Malindang area.

Results of the PRA studies have been published in the BRP Monograph Series (Appendix 3).

The results of the PRA studies served as the major inputs that finalized the BRP implementation plan. The results helped describe in detail the research thrusts of BRP, and the sub-landscapes and ecosystems of the Mt. Malindang research area.

Implementation Phase I: The First Generation Studies

Implemented in 2001, the first generation studies consisted of a study on methodology development and three studies on knowledge expansion and improvement. They were the following:

1. Development of a participatory methodology for the inventory and assessment of floral resources and their characterization in the montane forests of Mt. Malindang;
2. Participatory biodiversity inventory and assessment of Lake Duminagat in MMRNP;
3. Assessment of the diversity of selected arthropods in cabbage-growing areas in Mt. Malindang, Misamis Occidental; and
4. Community-based inventory and assessment of riverine and riparian ecosystems in the Northeastern part of Mt. Malindang.

Summaries of these studies are referred to in Appendix 4.

Implementation Phase II: Master and Open Research Projects

Preparation for the second implementation phase started in 2002 with the implementation of the master and open research projects. Whereas the first generation studies provided baseline information, the second generation studies were more comprehensive and integrative.

Three master projects were formulated to cover all the aspects of the Mt. Malindang landscape: the uplands, including the undisturbed and disturbed forests, and semi-permanent agriculture in the higher elevations; the lowlands, including the remnant forest patches, grasslands and shrublands, and permanent agricultural lands; the aquatic ecosystems, consisting of the river systems and the coastal waters; and the economic and sociocultural profile of the people who were using the mountain's resources.

a. Terrestrial Ecosystem Master Project (TEMP)

The studies gathered in this master project assessed the biodiversity richness, status and development trends of the flora, the vertebrate and the arthropod fauna, and the soil. They also focused on the mutual interrelationships and interrelations with human resource use and developments, and advised on the sustainable use and management of biodiversity.

TEMP included four studies, namely:

- Plant diversity and status in the northern landscape of Mt. Malindang range and its environs;
- Vertebrate faunal diversity and relevant interrelationships of critical resources;
- Arthropod faunal diversity and relevant interrelationships of critical resources; and
- Soil ecological diversity and relevant interrelationships of critical resources.

b. Aquatic Ecosystem Master Project (AMP)

In general, the research activities under AMP obtained valuable information for the development of the River Basin Management Plan, and the management strategies for biodiversity conservation in the aquatic ecosystems.

Three studies were conducted under AMP:

- Biodiversity and physicochemical profiling in the headwaters of Layawan River;
- Comparative assessment of Langaran and Layawan Rivers; and
- Comprehensive analysis of the ecological factors useful for the development of strategies to sustain coastal biodiversity and improve fish stock management.

Detailed assessments were made on the flora, fauna, macroinvertebrates, coliform, fish, coral, seagrass/seaweed, plankton, and physico-chemical factors. Summaries of the studies are given in Appendix 4.

c. Socioeconomic and Cultural Studies Master Project (SEC)

SEC examined the major patterns of resource use over time in the terrestrial and aquatic ecosystems, and described the potential of indigenous knowledge systems (IKS) for synergy with modern technology-based approaches to biodiversity resource management and conservation. It also evaluated certain policies that were relevant to biodiversity management and conservation.

The SEC studies focused on the following:

- Resource utilization patterns in the terrestrial and aquatic ecosystems of Mt. Malindang and its environs;

- IKS and modern technology-based approaches: opportunities for biodiversity management and conservation in Mt. Malindang and its immediate environs; and
- Policy analysis for biodiversity management and conservation in Mt. Malindang and its environs.

Summaries of these studies are referred to in Appendix 4.

d. Open Research Projects

Meanwhile, open research projects were intended to fill in the gaps of areas that were not covered by the master projects. These projects were more specific, and emphasized social and policy research including people/migration, labor and matter (products and sediments); policy and ecogovernance; and identification of sustainable livelihood strategies. Two studies were done under this category:

a. Conserving the diversity of selected arthropods in cabbage-growing areas in Mt. Malindang, Misamis Occidental through participatory integrated pest management; and
b. Conservation and utilization of endemic, rare, and economically important plants in three barangays of Don Victoriano, Misamis Occidental.

Appendix 4 also provides the summaries of these two studies.

Analytical Frameworks

To guide the individual studies, three analytical models were used during the implementation of the master projects as presented in Figures 3, 4 and 5.

Framework 1: Relationship Between Ecosystems and Resource Flows

BRP used the landscape approach to understand the interrelated factors and issues that affected biodiversity use and conservation in Mt. Malindang. The research studies on land, water, vegetation, wildlife, and socioeconomic environment from the top of Mt. Malindang down to the coastal zones improved the understanding of the relationships between human activities and the terrestrial- and aquatic-based natural and man-made ecosystems. Figure 3 shows that area-specific, ecological, and societal (human) values serve as the basis for analyzing the interactions as well as in coming up with biodiversity management goals. Ecological values were mainly related to the health of the specific ecosystems which were determined in terms of biological diversity, functional integrity, and nutrient and energy dynamics.

This approach emphasized individual ecosystem, and subecosystem use and management. Interactions of elements within an ecosystem were found fundamental in studying biodiversity. The interactions among the elements of contiguous ecosystems were likewise equally important as it provided a holistic and integrated analysis. The flows of materials, energy and people passing through the different ecosystems may yield positive and/or negative effects.

Through the landscape approach, various methods and analysis, associated with river systems and their catchment areas, spanning the upland, lowland, and coastal/marine ecosystems, were used. This broader and integrated analytical approach were indeed helpful in the decision making of the political-administrative units. Moreover, researchers were guided through the schematic representation of the linkages between sublandscapes and ecosystem, and the upstream and downstream resource flows.

This framework was based on the ecosystems that have been delineated and used in the TEMP and AMP biodiversity studies. This was also used by the SEC study to describe and analyze the resource flows in Mt. Malindang.

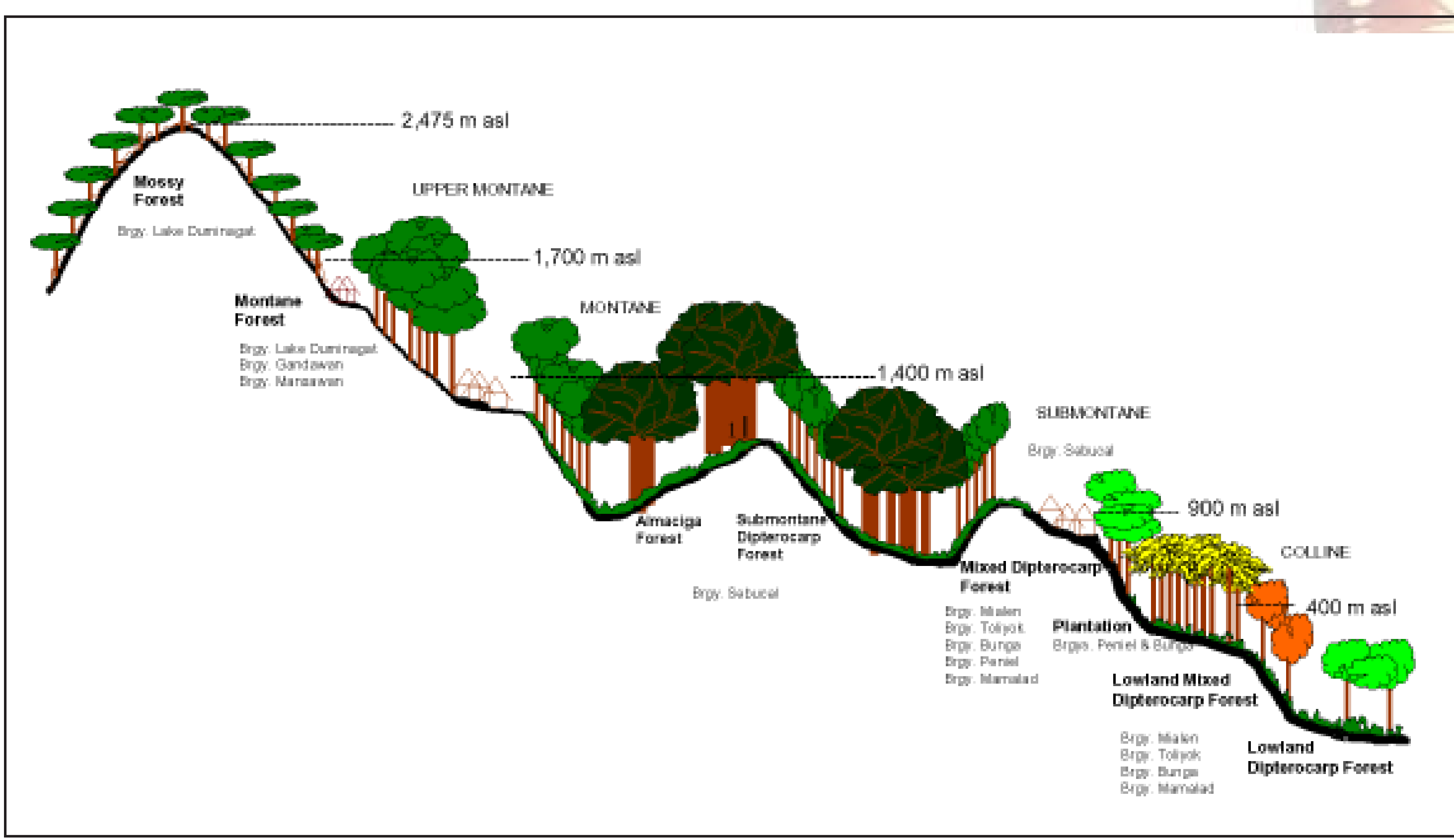

Fig. 3. Analytical framework showing the relationship between ecosystems and resource flows.

Framework 2: Relationship Between Livelihood and Biodiversity

Figure 4 illustrates the framework that presents the link between livelihood and biodiversity. This was used by the socioeconomic and sociocultural studies which assessed the assets that households own, control, claim, or have access to.

The assets were influenced by various socioeconomic and sociocultural characteristics (social relations, institutions and organizations) in the context of gradual developments (trends) or calamities (shocks). The livelihood strategies that resulted from the assets and mediating processes may be natural resource-based or non-natural resource-based. The former led to different land uses which were classified as either farm, or off-farm. The latter, on the other hand, pertained to such activities as self-employment or employment in the manufacturing, commercial, or services sectors. The outcome of the livelihood strategies that led to strategic goals was classified into human development and environmental sustainability goals.

Framework 3: The Integrative Framework

The integrative framework in Figure 5 is a model that describes the relationships and interactions between biodiversity losses and the underlying socioeconomic, political, and direct factors or pressures, and society's response. This model emphasized the importance of policies, laws, and regulations in the degradation processes of biodiversity loss. It also showed the positive societal responses that helped curb the negative developments in pursuing sustainable use and conservation of natural biodiversity. This framework was intensively used to guide study leaders in integrating their research activities.

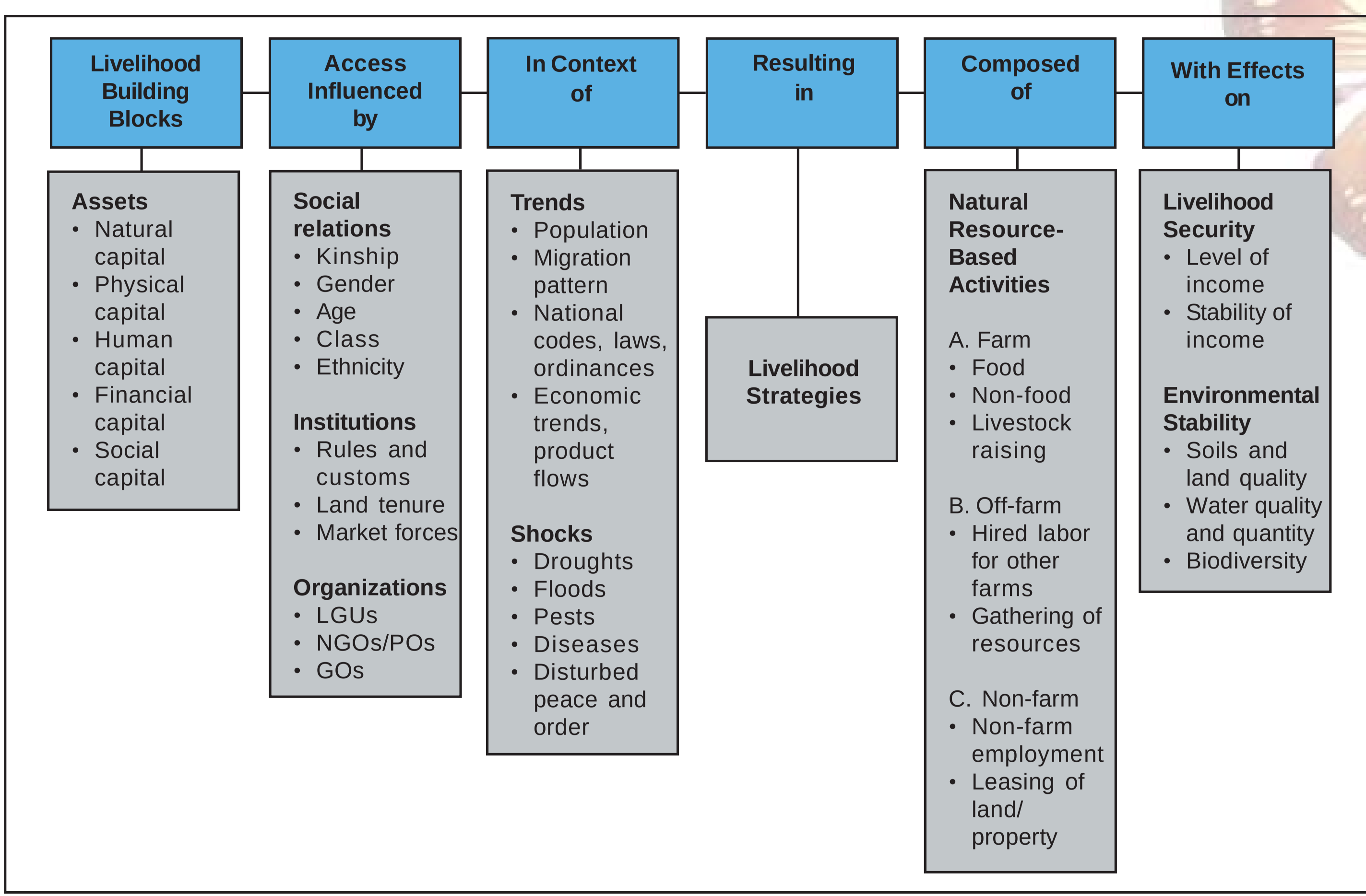

Fig. 4. Analytical framework showing the relationship between livelihood and biodiversity.

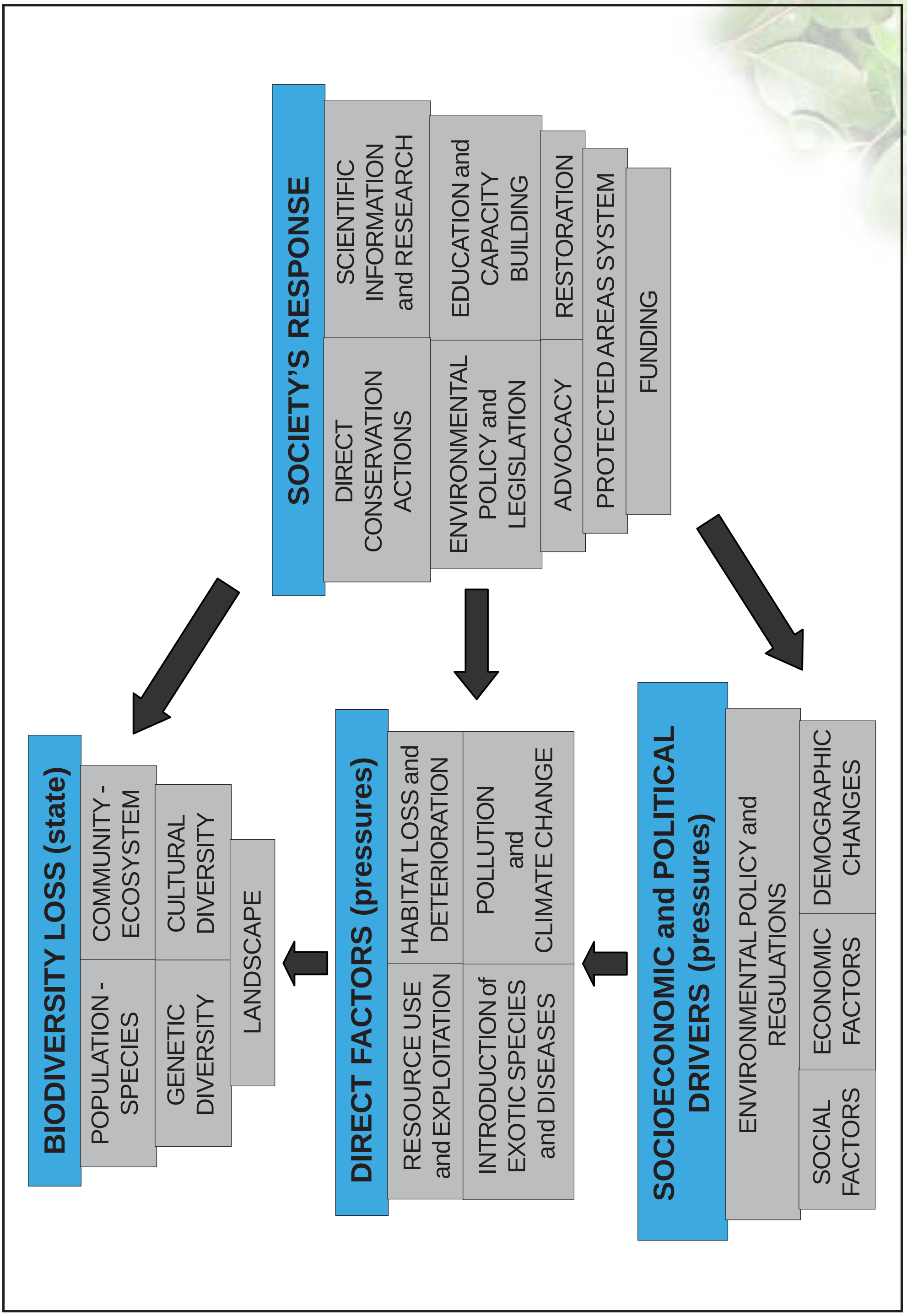

Fig. 5. The programme's integrated analytical framework (Ong, 2005).

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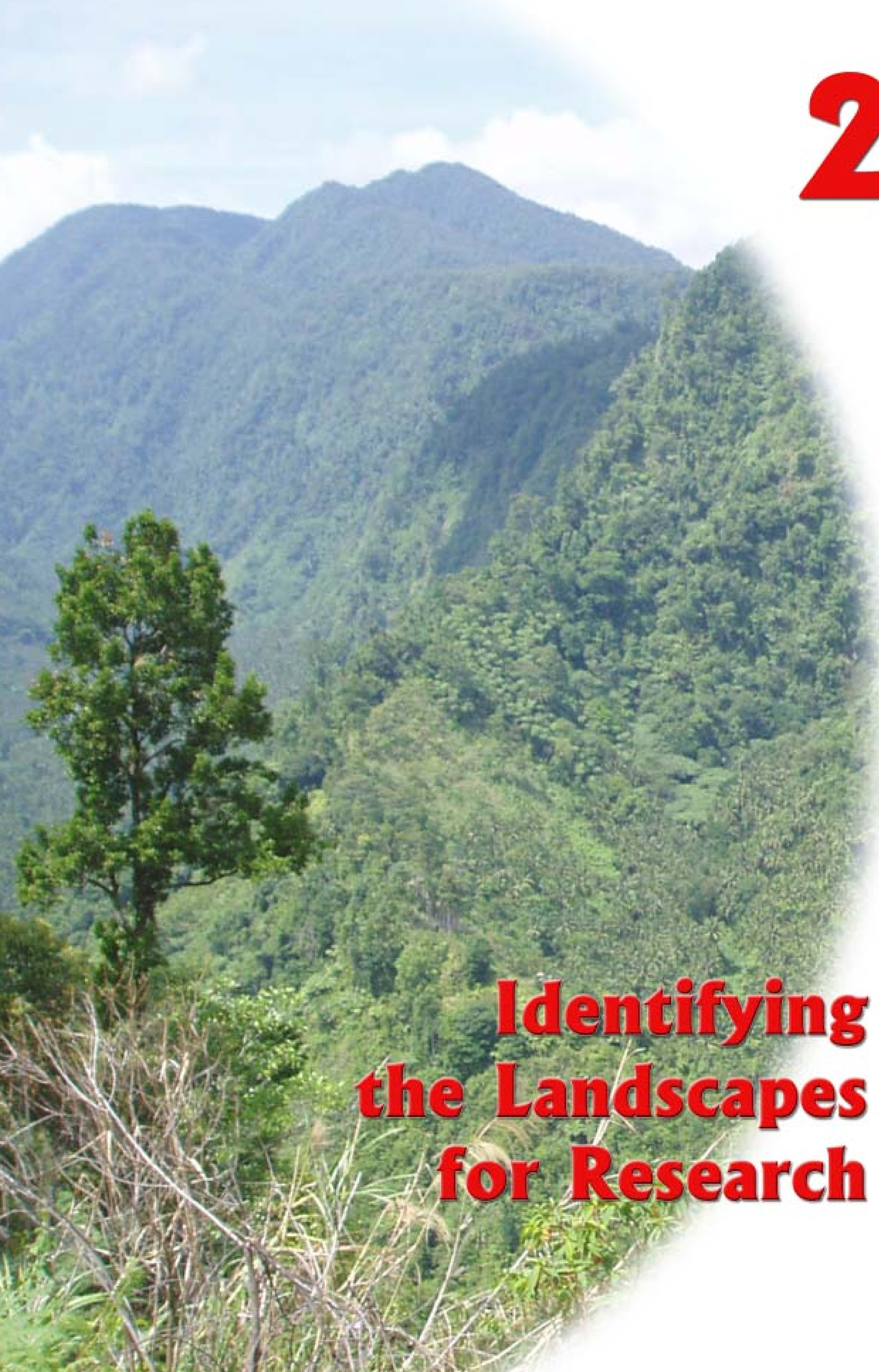


Identifying the Landscapes for Research

MISAMIS OCCIDENTAL:
INTERNAL AND EXTERNAL PERSPECTIVES

Misamis Occidental is located in the eastern part of Zamboanga Peninsula in Mindanao, southern Philippines. The province falls between 123^0 33' 00" to 123^0 51' 50" east longitude and 8^0 01' 00" to 8^0 40' 15" north latitude. It is bounded on the northeast by the Mindanao Sea, east by the Iligan Bay, southeast by the Panguil Bay, and the west by the provinces of Zamboanga Del Norte and Zamboanga Del Sur.

Alluvial plains could be found on the eastern side of the province which were mainly planted with rice and coconut. The western part is a mountainous belt with some forest cover. With a total land area of 1,939.32 km^2 (193,932 ha), Misamis Occidental represents 2.5 percent of the total land area of Mindanao (94,640 km^2), the second largest island in the Philippine archipelago that occupy 300,000 km^2. Mindanao boasts of a wide variety of terrestrial flora and fauna. It is thus known to have the highest tree density among tropical forests. Likewise, Mindanao has the richest known vertebrate fauna in the country. It is where the greatest diversity of Philippine mammals and birds can be found. In fact, Mindanao is home to 45 globally threatened species (Heaney 1993).

As in other parts of Mindanao, rugged topography also dominates Misamis Occidental but rises gently to Mt. Malindang. The highest elevation of the province is at 2,425 m. Climate belongs to the fourth type of the Corona Classification where rainfall is more or less fairly distributed throughout the year. November is usually the rainiest month while February is the driest. Although it lies outside the Philippine typhoon belt, the province is often frequented by storms. The province consisted of 14 municipalities and three cities. As of 2000, population was at 486,728 spread in 99,901 households. Population was set at 516,160 in 2005, representing just 0.006 percent of the total Philippine population of 84.5 million. At the time of the studies, the Subanun constituted about 4.38 percent of the total population. The Subanun originally inhabited the coastlines of Misamis Occidental but later retreated into the upper slopes of Mt. Malindang due to the intrusion of migrants. The Subanun are now mainly settled in the upland municipalities of Don Victoriano, Concepcion, and Tudela.

With its rich natural resources but increasing population, the province's main land uses were agriculture (60%), forest cover (18%), and grassland/brushland (20%). Coconut was the chief crop of the province, followed by corn and rice. More than 70 percent of the forest area had been declared as park and wildlife reserves. Fishing was the major industry along the coastal areas.

THE MT. MALINDANG LANDSCAPE

Mt. Malindang covers some areas of the provinces of Zamboanga del Sur and Zamboanga del Norte, both of Region IX, and much of Misamis Occidental in Region X, between 8’ 07" and 8’ 28" latitude and 123’ 32" and 123’ 45" longitude. The three major peaks of MMRNP are Mt. Malindang (2,425 masl), North Peak (2,183 masl), and South Peak or Salog Peak (1,850 masl). Figure 6 gives a three-dimensional satellite image of Mt. Malindang.

Mt. Malindang is the only representative natural forest from the Zamboanga Peninsula Biogeographic Zone (Myers 1988). The mountain’s flora and fauna exhibit a high degree of endemism (NIPAP 2000), hence its inclusion as one of the “biodiversity hotspots” in the Philippines that need high priority protection and conservation (Ong *et al*. 2002). There were 223 plant species in 89 plant families that have been recorded so far. A substantial number still requires scientific classification. Aside from the plant species, rare and endangered fauna that could be found were the Philippine eagle, flying lemur, Philippine deer, tarsier, Rufous Hornbill, and the Giant Scops Owl. Some 337 mammals, 158 birds, 11 reptiles, and 14 amphibians have also been recorded.

The watersheds of Mt. Malindang play a critical role in the survival of the population. Its watersheds affect about a million people in all municipalities and cities of Misamis Occidental, as well as six municipalities of Zamboanga del Norte, and five municipalities of Zamboanga del Sur. While the core protected area of Mt. Malindang was still covered with primary forests, the remainder of the watershed has been cleared and dominated by grasslands/shrublands, coconut farms, and agricultural lands.

Soil in the Mt. Malindang range was found to be sandy and clay loam, and moderately strong to very strongly acidic (pH 6 to as low as pH 4.6). It had a high organic matter content of up to 20.2 percent particularly in areas above 1,000 masl, and thus very conducive to agriculture. Hence, the total watershed area of 174,385 ha consisted of 36,621 ha of forests (21%), 67,000 ha (40%) of grasslands/ brushlands, and 46,000 ha (26%) of coconut farms.

The climate in Mt. Malindang belonged to Type II of the Modified Corona Classification. It has no dry season but has a very pronounced maximum rainfall from November to January. Annual rainfall ranges from 1,700 to 2,500 mm. Relative humidity was high, from 80 to 85 percent at sea level from November to January, and even higher in the mountains. Temperatures were found almost constant throughout the year, with a mean temperature of 26-28^{o}C on the coastal areas, and the hottest months from April to June. Temperatures were relatively low at higher altitudes with a daily mean temperature of 15°C in the highest areas.

There were 15 major sub-watersheds and 78 rivers emanating from Mt. Malindang's peaks and draining to the coastal zones of Misamis Occidental and partly of the Zamboanga provinces. Its rugged terrain and steep slopes indicated the mountain as being volcanic. The eight-hectare crater lake at Barangay Duminagat, the hot springs in Barangays Sebucal and Tuminawan as well as the extensive distribution of volcanic rocks and carbonized woods at Barangay Mansawan, also indicated the volcanic origin of Mt. Malindang. Lake Duminagat also continued to attract tourists despite being considered a sacred place by the Subanun.

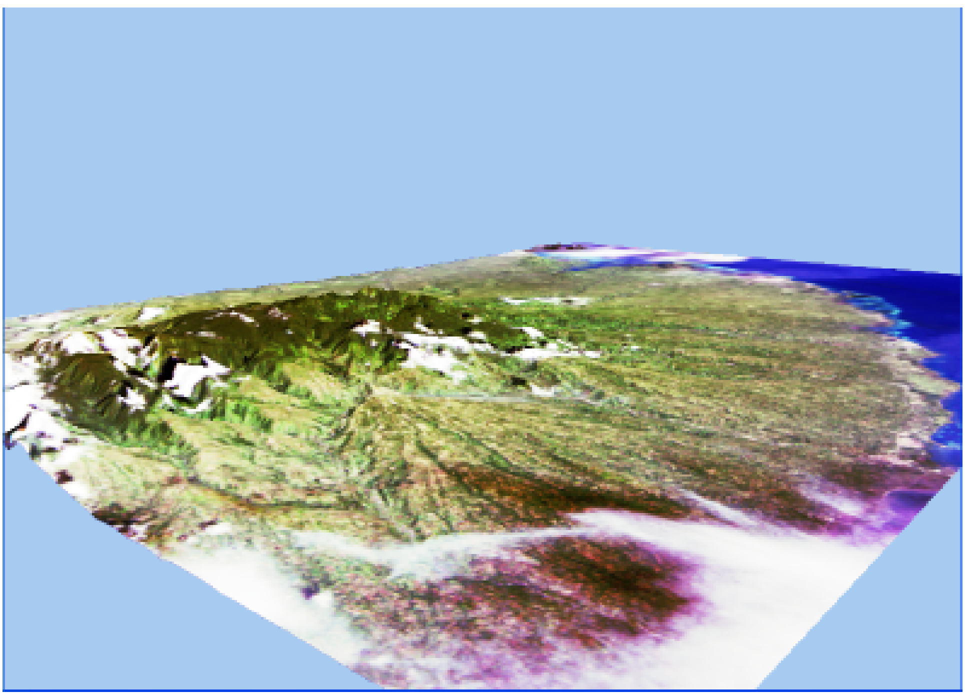


Fig. 6. Three-dimensional satellite image of Mt. Malindang.

THE MT. MALINDANG RANGE NATURAL PARK (MMRNP)

Located entirely within the province of Misamis Occidental, MMRNP covered 65 barangays in 16 municipalities. At the time of the studies, an estimated 18,000 people were living in the buffer zones, and about 900 people were living in the limited portions of the core protected area. The inhabitants in the close vicinity of the park mainly consisted of the Subanun (about 80%) whose livelihood largely depended on subsistence farming. The core protected area of the Park consisted only of four barangays which were found in the municipalities of Don Victoriano, Concepcion, and Lopez Jaena, in Oroquieta City. Two of the four barangays were BRP study sites: Barangay Lake Duminagat in Don Victoriano and Barangay Sebucal in Oroquieta City.

Mt. Malindang was declared a national park in 1971 by virtue of Republic Act (RA) 6266. It has a watershed area covering 53,262 ha. This declaration placed MMRNP under the National Integrated Protected Areas System (NIPAS) of 1992 (RA 7586). As required by NIPAS, the boundaries of the Park were re-surveyed and revised, in consultation with the communities therein.

Survey results found that the core protected area was reduced to 34,694 ha. The remaining 53,262 ha were re-designated as buffer zones. These revisions were embodied in Presidential Proclamation 28 which was issued on 2 August 2002. Included also in the proclamation was Mt. Malindang's re-classification into a natural park where extractive activities were not allowed in the core or strict protection zone. Mt. Malindang officially became a protected area with the passage of RA 9304 on 30 July 2004, otherwise known as the Mt. Malindang Act.

THE RESEARCH SITES

The interactions of elements within the landscape subsystems are critical in studying biodiversity. Likewise, the interactions among contiguous landscape subsystems are equally important to provide insights on biodiversity and human development processes.

Mt. Malindang was chosen by the Filipino and Dutch partners because of its unique landscape subsystems and biodiversity. The extensive and fairly well-defined water catchments emanating from Mt. Malindang to the coastal zones of Misamis Occidental provided spatial areas for integrating landscape-level analysis.

Two river catchments, the Layawan and Langaran Rivers, were selected for research. Moreover, local centers of biodiversity – Mt. Amparo and Lake Duminagat – and their associated landscape subsystems, were also identified. The Langaran River was the research site for the first generation river project. This river supplied irrigation water through three dams for rice cultivation in several barangays along the river. Quarrying and fishing by illegal fishing methods were also common practices along this river.

The catchment area is administratively part of the municipalities of Calamba, Baliangao, Lopez Jaena, and Plaridel. The Layawan River cuts across the barangays of Mialen, Toliyok, Bunga, and Villaflor. The barangays Taboc Sur and Taboc Norte in Oroquieta City are very near the mouth of Layawan River. The coastal areas investigated were limited within the two-kilometer radius from both sides of the river mouth and extending one kilometer offshore, thus enclosing a total of 4 km^2 for both rivers.

To establish the connection between TEMP and AMP, upstream study sites of the latter project were chosen to overlap with the former project's study sites, i.e., Barangays Mialen and Toliyok in the Layawan River and Barangay Mamalad in the Langaran River. Data collected from the same barangays for SEC were identified by the AMP studies. The Danlugan cove in Lopez Jaena, meanwhile, was added as an additional study site to address specific problems on water quality. Figure 7 shows the location of the research sites.

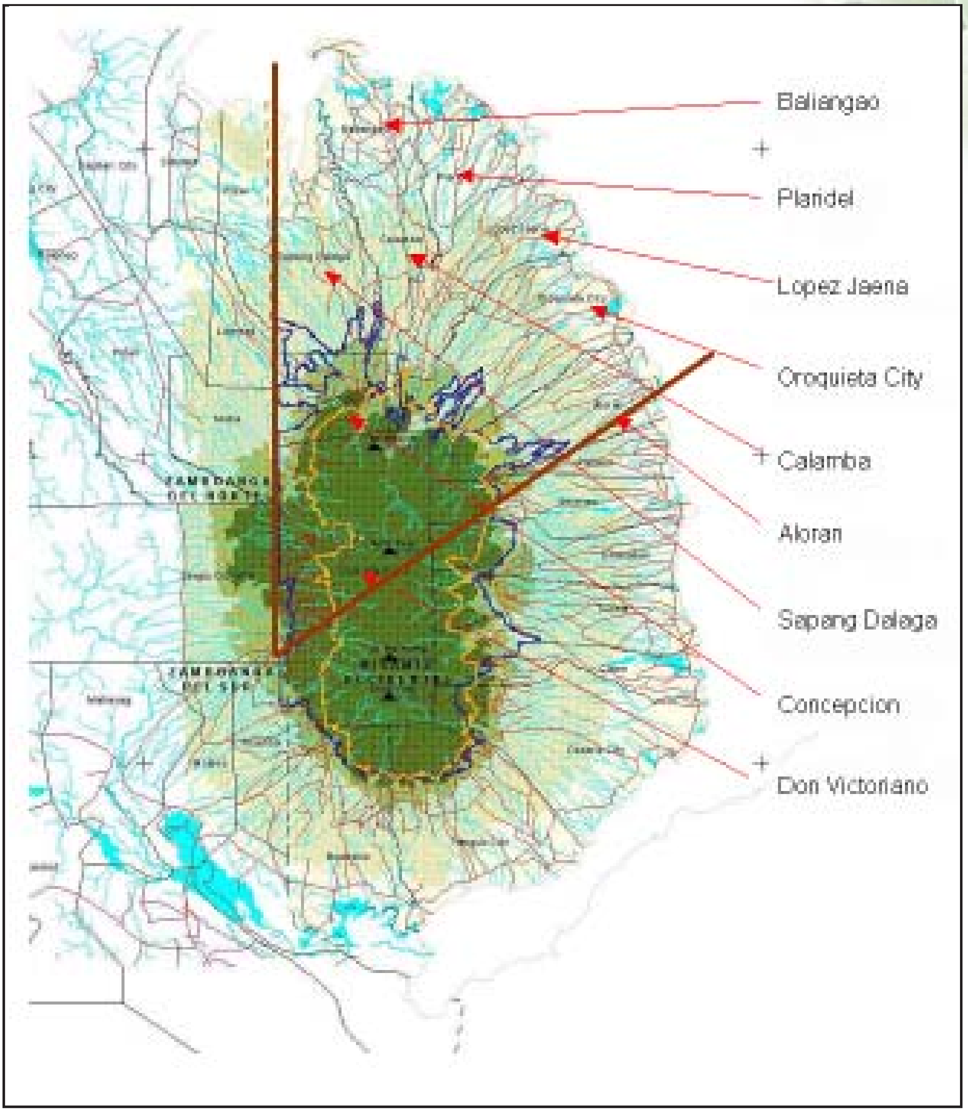


Fig. 7. Location of the BRP research sites.

3

Discovering Unity in Biodiversity

PHYSICAL DIVERSITY

Geomorphology

Mt. Malindang is a strato-volcano formed in the Holocene-Pleistocene period. It consists of a complex series of lava and ash build-up. The volcanic eruptions, followed by severe erosion, have created a deeply dissected mountain range with a rectangular shape that is generally North-South oriented. The highest peaks include Mt. Malindang itself (2,404 masl), North Peak (2,183 masl), South Peak (1,850 masl), Mt. Sumalarong (1,782), Mt. Ampiro (1,532 masl), and Mt. Labag (1,537 masl). The mountain slopes are steep and cut by ravines and gullies. A good impression of the rough uplands is shown in the three-dimensional satellite image of the Mt. Malindang Range (Figure 8).

Climate

Mt. Malindang has a tropical rainforest climate that has no distinct dry season. Rainy months are from November to January. Based on altitude and aspect, climate data from Oroquieta City at sea level, over a longer period of time, showed a constant daily temperature of about 27^{o}C and an annual rainfall range of 1,700-2,500 mm. Humidity ranges from 80 to 85 percent at sea level in November–January, and even higher up in the mountains.

Rainfall and temperature were measured within a five-month period from September 2004 to January 2005 in five barangays at different elevations. The total rainfall during this period ranged from 1,751 to 1,458 mm, whereas average daily rainfall ranged from 350 to 292 mm. Typhoons (southwest monsoons) visited the area from September to January. The average daily temperatures during these months were generally lower in the highland than in the lowland barangays. The temperature varies in the high-elevation communities. For example, the lowest temperature (20^{o}C) was recorded in Barangay Lake Duminagat while that of Barangay Toliyok, the temperature was 27^{o}C.

The climate plays an important role in the life of the indigenous Subanun people. Many of their subsistence activities, religious traditions, and cultural manifestations were found related to the different seasons and weather conditions (Figure 9).

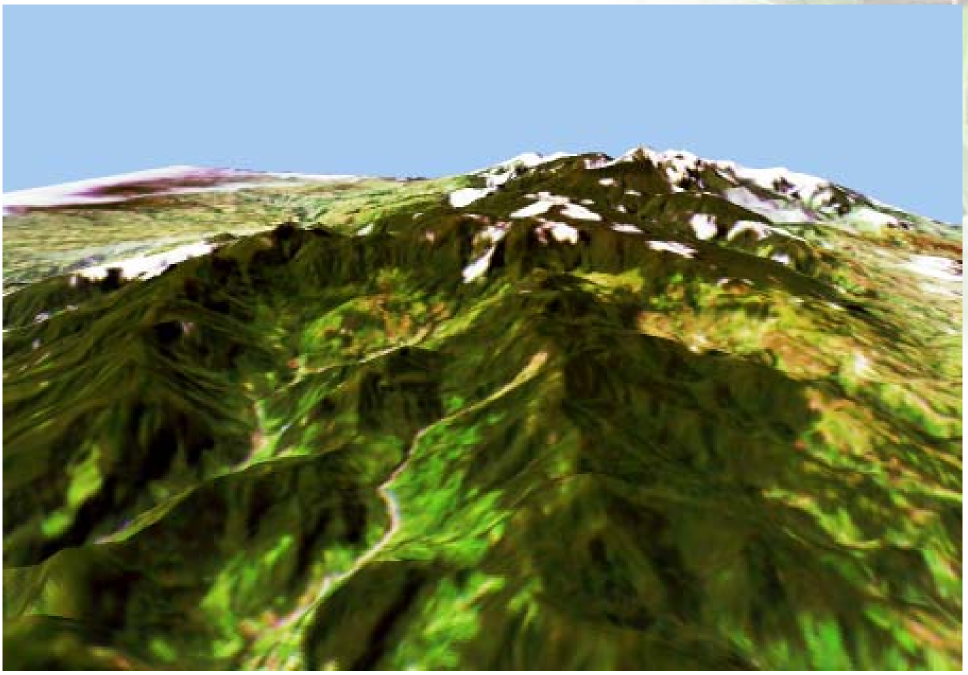


Fig. 8. Three-dimensional satellite image of the Mt. Malindang range.

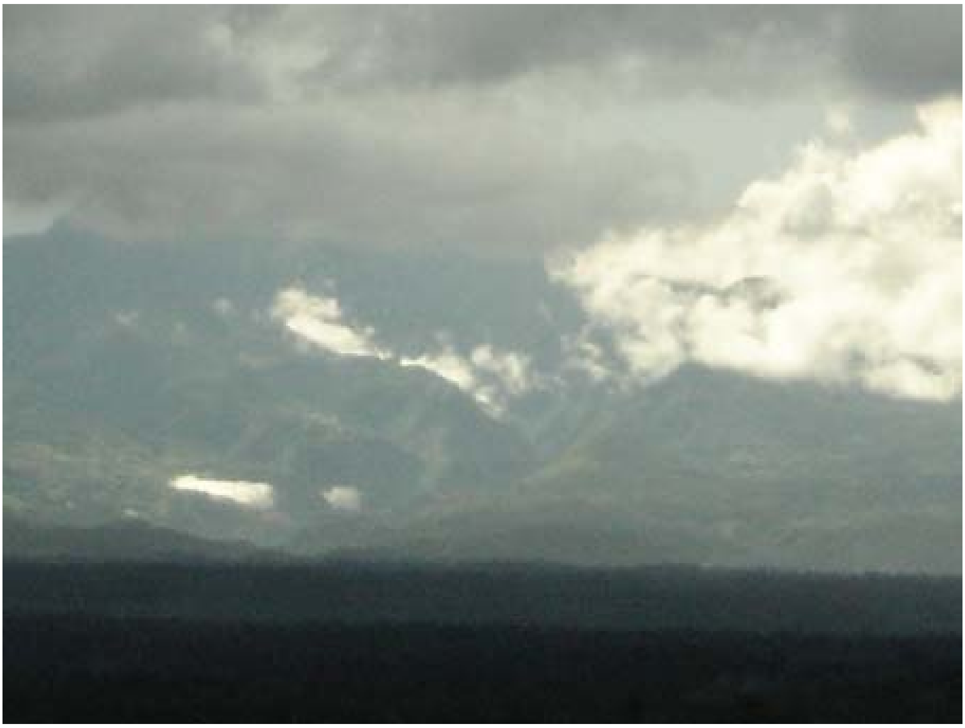


Fig. 9. Rain above Mt. Malindang.

Hydrology

The hydrology of Mt. Malindang was typical for a high volcano in the humid tropics. High precipitation caused continuous water runoff following a radial drainage pattern. The fast-flowing water caused by high stream slopes cut deep into the landscape, forming deep gullies. Although rainfall varies with seasons, the rivers were never dry. The numerous catchment areas formed were relatively narrow and small.

As a volcano, Mt. Malindang has numerous springs, several hot springs, and a crater lake, Lake Duminagat, which is located in the central part. It has an elevation of 1,560 masl with an area of 8.04 ha and a depth of about 20 m.

The hot springs, which were indicative of latent volcanic activity, were also located in the higher altitudes of Mt. Malindang. The numerous springs provided excellent water for the domestic use of the rural villages and cities along the coastal areas. The continuous water runoff also provided irrigation for the extensive rice fields in the coastal areas and the lowlands. River dams were even established in some areas to irrigate the fields with fresh water.

The northern central part of Mt. Malindang, meanwhile, coincided with the northern part of MMRNP. It consisted mainly of catchment areas for the headwaters of four rivers. The water basin of the headwaters of the Dapitan River was located in the west covering Barangays Mansawan, Gandawan, and Lake Duminagat. The basin then drained to the northeast to the province of Zamboanga del Norte. In the north were the basins of the headwaters of the Langaran and the Layawan Rivers. In the east, meanwhile, was the water basin for Palilan River (Figure 10). The Langaran River was included in the PRA studies during the pre-implementation phase of BRP. It was also included in the second generation studies together with the Layawan River.

Soil

Soils in Mt. Malindang were sandy and clay loam. They were found to be moderately strong to very strongly acidic (pH 4.6-6.0) and with high organic matter of up to 20.2 percent in areas above 1,000 masl.

Pedogenetically, soils in Mt. Malindang were young and shallow. Although two soil orders, inceptisols and entisols, could be found, the soil was composed mainly of inceptisols with acidic properties. They also contained a considerable amount of allophane. Allophanic soils have low bulk density, high cation exchange capacity, and high phosphate absorption. These denote the properties of amorphous

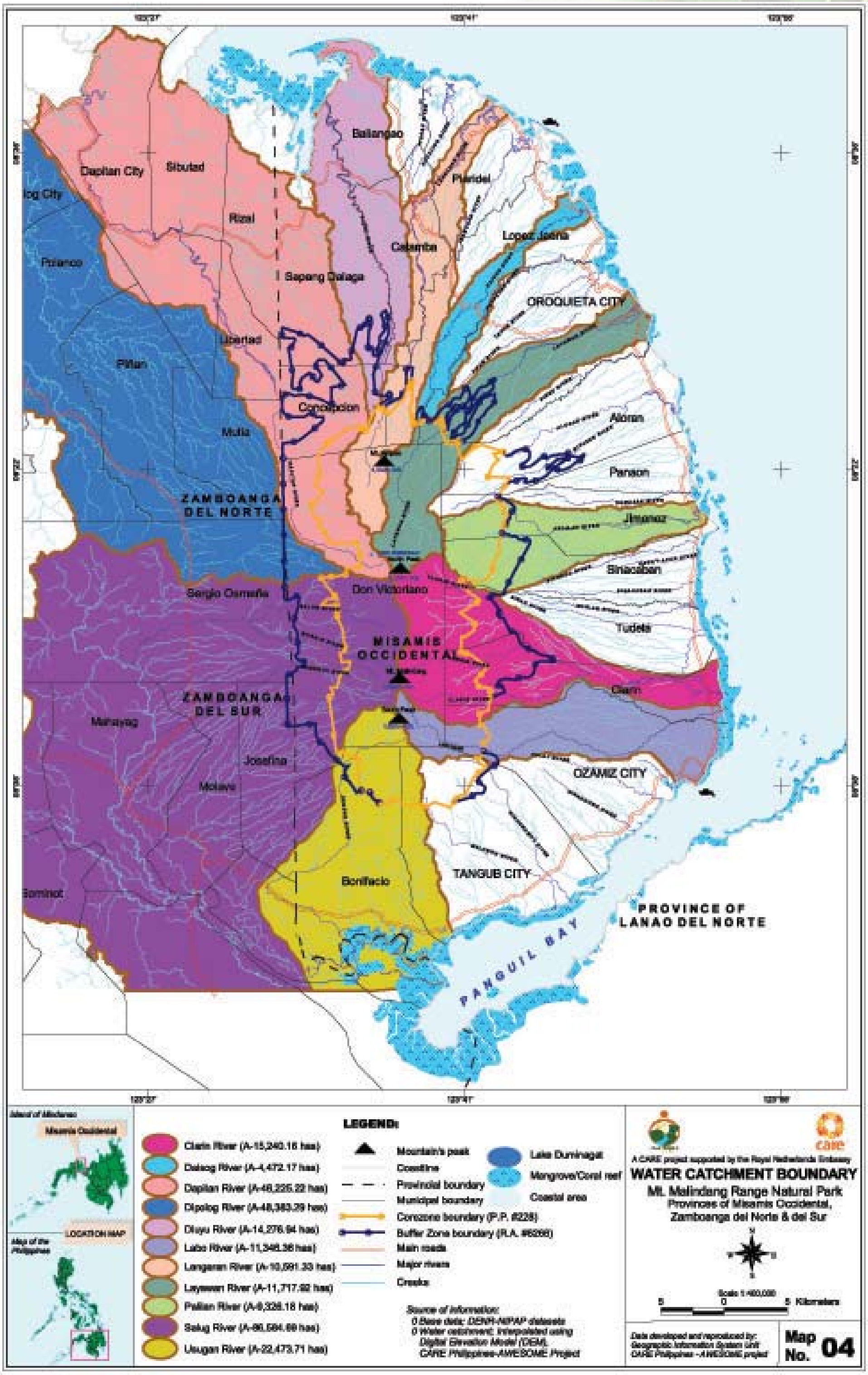


Fig. 10. Water catchments in the Mt. Malindang landscape.

clays which characterize volcanic ashes that weather rapidly in humid or perihumid climates. Such soils have good physical make-up and essentially fertile when first cleared for cultivation. However, they deteriorate rapidly with continued use over time, particularly in sloping areas.

The upper 0-20 cm surface of the soils, supported by nine pedons spread throughout the project site, showed that the undisturbed ecosystems were distinctly more fertile than either of the disturbed agro or the grassland ecosystems. Primary data on the chemical and physical properties of the soils are given in Table 1. The undisturbed ecosystem was clearly better off, at their present state, than the disturbed ecosystems based on organic matter (OM), cation exchange capacity (CEC), and bulk density (D_b).

OM contents of the soils in Mt. Malindang ranged from 8.5 to 20.2 percent (Table 1). These values were relatively higher than most of the soils across the Philippines. The undisturbed (primary) forests were also found to have high OM. Although OM increased with higher elevation, the dramatic change in OM content from primary forests to grasslands, both above and below 1,000 masl, was obviously not due to elevation differences only. Heavy erosion on bare steep slopes (Figure 11) and land conversion also caused the rapid loss of OM.

According to general soil respiration class ratings, soil has an ideal state of biological activity, adequate OM, and active populations of microorganisms only if its carbon dioxide (CO_2) production reaches a certain level. In general, the biological activity in the landscape subsystems that were studied was less than ideal probably because of the significant loss of OM. The presence of earthworms and nematodes found in the soil samples were described in detail in the succeeding sections.

Table 1. Soil chemical properties of the different ecosystems.

Ecosystems	OM (%)	pH (1:1 H_2O)	Avail P (ppm)	Total N (%)	Exch K ($cmol_c\ kg^{-1}$)	CEC ($cmol_c\ kg^{-1}$)	D_b ($Mg\ m^{-3}$)
Undisturbed forest	20.2	4.9	2.1	0.5	0.2	57.0	0.4
Disturbed forest	15.0	5.4	1.4	0.5	0.5	40.1	0.7
Agroecosystem	10.3	5.2	1.3	0.4	0.5	27.5	0.9
Grassland	8.5	5.3	1.0	0.3	0.3	23.6	1.1

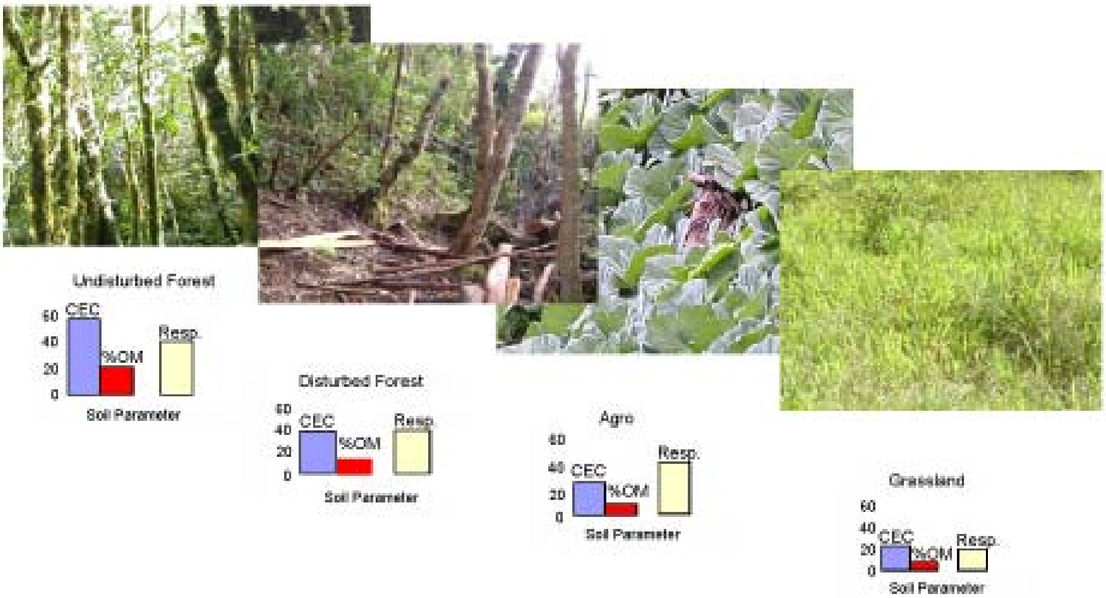


Fig. 11. Reduction of soil quality with the degradation of the landscape subsystems.

LANDSCAPE DIVERSITY

A traveller in Southeast Asia immediately recognized Mt. Malindang as one of the numerous volcanic mountains in the region that rises from the sea. Such volcanoes all have a more or less similar landscape profile.

When approaching Misamis Occidental from the air, the coastlines and lowlands bore all the features of human presence and activities — human settlements, roads, and permanent arable land. Light green or yellowish vegetation could be seen further up the mountain. These areas have lesser human settlements and agricultural farms. The top of the volcano was dark green, still untouched by human interference. Numerous river systems radiate from the top and deep gullies could be seen carved in the landscape. These differences in the landscape were even more visible if approached from the sea, or through a ferry ride from Mukas to Ozamiz. The horizontal and vertical segmentation of Mt. Malindang are shown in Figures 12 and 13.

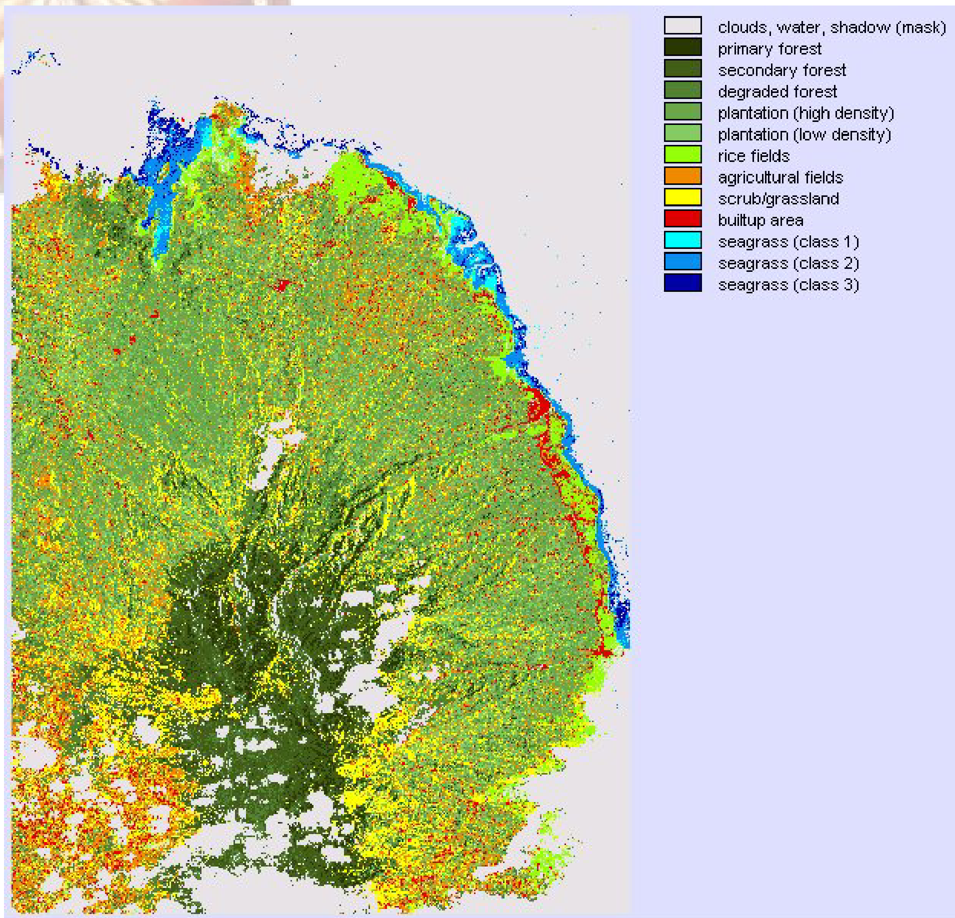


Fig. 12. Land cover map based on satellite images.

Fig. 13. A view of Mt. Malindang from the Mukas-Ozamiz ferry where the different landscape subsytems are clearly visible.

According to the landscape segmentation described, Mt. Malindang can thus be classified into different landscape subsystems. This classification was based on altitude (which determines temperature and rainfall), slope, hydrology, flora and fauna, land use and human population. In addition, the landscape subsystems were mainly based on floristic research which started as early as BRP's pre-implementation phase. Plant community research in the terrestrial studies, conducted in the latter phases of BRP implementation, presented the detailed description and nomenclature of the landscape subsystems.

Land satellite imagery maps were used to select a segment of the Mt. Malindang area, comprising the Langaran and Layawan Rivers. This "research pie" was delineated by drawing grids. The grids indicated the sampling sites of the research in the forest ecosystems, agroecosystems, and the grass-dominated fallow areas. Studies were also done on the recognized landscape subsystems to assess vertebrate and arthropod diversity. Moreover, soil studies in the different sample sites were done to obtain a more holistic description of the subsystems, including their mutual relationships and human influences.

Sample plots were then located in the forests and agroecosystems. Apart from the general plot information (ecosystem, plot code, date, altitude, location, aspect, slope, and soil), a general physiognomic description of the vegetation structure was also recorded in terms of different layers, height, and characteristic structural features. The names of species, density (number per area), and cover (diameter, basal area, crown cover, and cover-abundance values) were also specified. Diameter measurements, frequency, and cover percentage values were then integrated into a common simple ordinal scale to formulate a floristic classification.

The field data, which contained a complete list of flora in Mt. Malindang, were stored in a database. With the help of specialized software programs, TURBOVEG, TWINSPAN and MEGATAB, the rough data were processed into a detailed floristic classification. The whole process ended with synoptical tables for different plant communities that indicated exclusive, selective, and preferential species. This ecological information was also used as inputs to revise existing vegetation maps, which were based on land use and physiognomic characteristics, to reflect accurate biodiversity information.

The differences in the different land use subsystems are described as follows:

Landscape Subsystems of the Higher Elevations

The landscape subsystems of the higher elevations were found above 900 masl. Roughly coinciding with MMRNP, this was the focal area of most of BRP's second generation studies. Five important and relatively untouched natural landscape subsystems and one man-made agroecosystem could be found in these subsystems. They were the mossy forest, montane forest, submontane forest, Almaciga forest, the crater lake (Lake Duminagat), and the permanent and fallow agroecosystems. Administratively, the research areas belonged to three municipalities. Figures 14 and 15 show more detailed descriptions of this landscape and the research sites.

In the municipality of Don Victoriano, three barangays were chosen for the BRP studies. They were Barangays Mansawan, Gandawan, and Lake Duminagat.

Barangay Mansawan served as the gateway leading to the north peak portion of the mountain and Barangay Sebucal, while passing through Barangays Gandawan and Lake Duminagat, respectively. Located at 1,200-1,400 masl, Barangay Mansawan can be reached by vehicle. It is the center of trade and market for the neighboring barangays. The northwestern part of the barangay drains to the Dapitan River. Barangay Mansawan used to be forested but most areas have been converted into agriculture.

Barangay Gandawan has an altitude of 1,000-1,500 masl. It lies between Barangays Mansawan and Lake Duminagat and can only be reached by foot or riding a horse. Once covered by thick forests, rampant logging in the barangay resulted in the establishment of agricultural farms which dominated the area. Likewise, the nearby mountain peaks of Mt. Pongol and Mt. Ulohan sa Dapitan were also affected by logging and resource utilization.

Barangay Lake Duminagat, meanwhile, can be found at the base, bordering the north peak mountain range and rising at an elevation of 2,199 masl. The barangay is located in a crater valley with residential houses and a primary school, and dominated by farms and gardens (Figure 16). The 10-hectare crater lake, meanwhile, is located across the ridge and about one kilometer from the western part of the barangay at 1,560 masl. A shallow stream at the eastern side drains the surface water toward Kalilangan River and ultimately joins the Dapitan River.

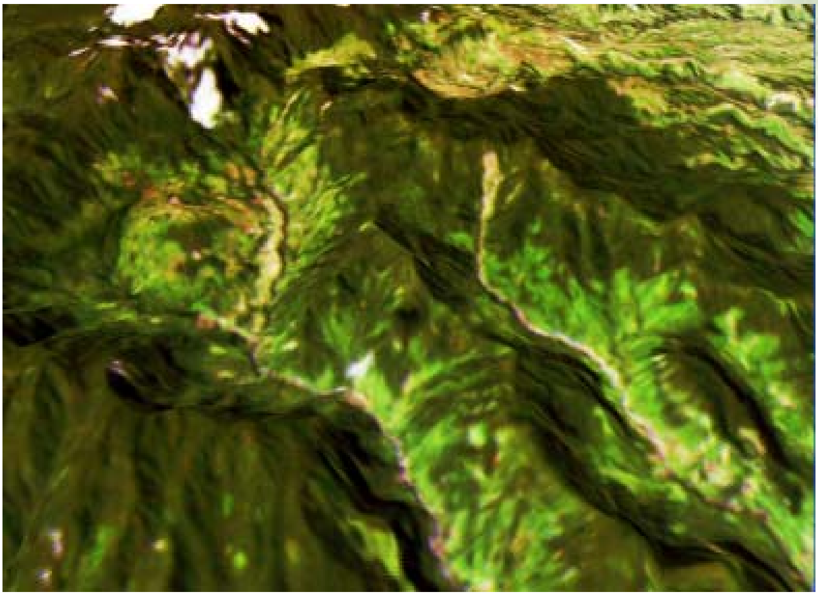


Fig. 14. Three-dimensional map showing the headwaters of the Dapitan, Langaran and Layawan Rivers.

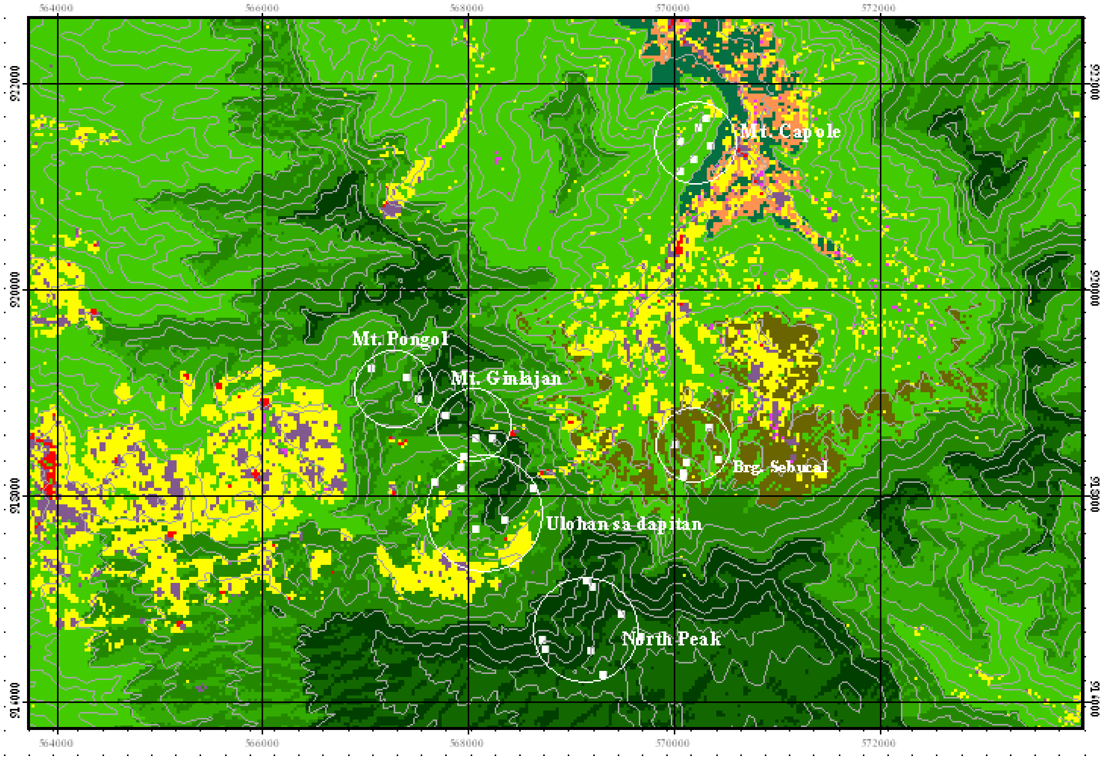


Fig. 15. Topographic map of the headwaters of the Dapitan, Langaran, and Layawan Rivers with the BRP sampling sites.

Fig. 16. Barangay Lake Duminagat.

The nearby Mt. Ulohan sa Dapitan peak has been affected by logging and resource utilization. Fortunately, the nearby Mt. Ginlajan peak has not been logged due to the protection efforts of the Subanun.
The Subanun considered this a sacred place for the burial of their leaders.

Another research site was Barangay Sebucal, the most remote area in Oroquieta City. Its elevation ranged from 700 to 1,400 masl. It was only accessible through a rough and winding foot trail with steep slopes from Barangay Lake Duminagat. It was surrounded by the catchment systems of the Layawan River in the northwest portion, and the Manimatay River in the northeast. These catchment systems merged at the lower portion of the barangay and drain into the mainstream of the Layawan River, cutting across Barangays Mialen, Toliyok, Bunga and Villaflor.

a. Mossy Forest (over 1,700 masl)

The mossy forest is the natural landscape subsystem dominating the highest elevations of Mt. Malindang (Figures 17 and 18). Found at altitudes ranging from 1,700 to 2,450 masl, the mossy forest is otherwise known as the cloud belt, due to the persistence of clouds in the area. The forest's relative moisture and rainfall were highest as compared with the other forest systems. Due to this high precipitation, the forest had acidic soils (pH 4.6-5.1) as a result of leaching. The slopes of the mossy forests were also quite steep, at

75 degrees. The branches and trunks of trees and the forest floor in this type of forest were largely covered with moss, thus the name mossy forest.

This type of forest was characterized by small trees with proproots and aerial roots that were evident from the crooked shapes of the trunks which were only one to a few meters high (10-20 m). Proproots enabled trees to adapt to the steep slopes which were prevalent in this zone. The proproots seek crevices in the soil for nutrients while the aerial roots provide extra support. Because mossy forests occurred at highly elevated areas, the trees were dwarfed and their trunks gnarled, especially towards the peak, due to strong winds.

Compared to the montane forests, the tree layer in mossy forests was relatively dense with 75-85 percent cover. The canopy layer consisted of two dominant plant species: *Ascarina philippinensis* (endemic) and *Xanthomyrtus diplycosiifolia*.

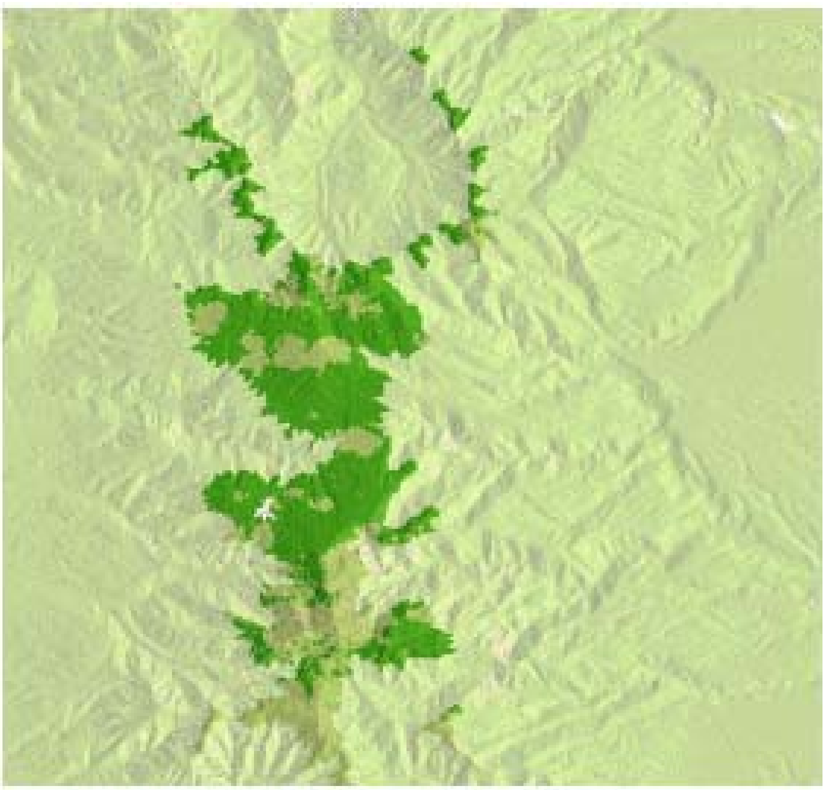


Fig. 17. Extent of Mt. Malindang's mossy forests.

Fig. 18. Inside Mt. Malindang's mossy forest.

b. Montane Forest (1,400-1,700 masl)

Montane forests were found in the Mt. Ulohan sa Dapitan peak in Barangay Lake Duminagat at 1,450-1,700 masl, and in the Mt. Pongol peak in Barangay Gandawan at 1,400-1,600 masl. Like the mossy forests, relative moisture and rainfall were also found high in montane forests. However, the slopes were considerably less steep than in the mossy forest with an average of 30 degrees. Soil pH was also somewhat higher or less acidic.

This type of forest is characterized by trees that are generally taller than in the mossy forest. Trees reached 30-35 m high, and had 90 percent cover. The trees were characterized by big trunks. Tree species that occupied the largest canopy cover in the montane forests were the endemic species of *Lithocarpus philippinensis, L. mindanensis,* and *Mastixia premnoides.* The shrub layer, meanwhile, was found to reach 5 m only and was open (covering 10-15%). The moss layer was less conspicuous in the montane forest as compared with the mossy forest.

c. Submontane Dipterocarp Forest (900-1400 masl)

The submontane dipterocarp forest can be found at an altitude ranging from 900 to 1,400 masl. Moisture and rainfall in this type of forest were less high than in the mossy and montane forests.
This type of forest thrived on very steep slopes: 50 degrees on the average with sandy loam soil and andesite type of rocks. Soil acidity averaged at pH 6, which was less acidic than in the Almaciga forests. This type of forest was observed only in Mt. Capole in Barangay Sebucal, Oroquieta City.

The submontane dipterocarp forest was found to have distinct layers. There was a canopy layer consisting of tall trees with big buttresses like *Shorea polysperma*, *S. mindanensis,* and *Ficus* sp. (covering 60-75%). These buttresses may extend about a meter from the ground and help to support the tree itself. The other layers consisted of smaller trees, shrubs, climbing bamboo, palms, vines, and several species of *Freycinetia* twining around the tree branches.
A representative example of the forest structure is depicted in Figure 19. Forest profiles are often used to visualize the forest structure.

d. Almaciga Forest (1,200–1,400 masl)

The Almaciga forest occurred in patches in the submontane dipterocarp forest at an elevation of 1,200-1,400 masl. The forest sites studied were located at Old Liboron, the southeastern side of Barangay Sebucal. Moisture and rainfall were relatively high in this type of forest. The slopes (20 degrees on the average) were less steep as compared to the submontane dipterocarp forests and lowland forests with slopes of almost 50-65 degrees, respectively. In addition, the Almaciga forest occurred on different rock types: andesite, porphyritic andesite, and scoria. Soil acidity was low averaging at pH 4.7. Soil was clay loam and thus always moist.

This type of forest was observed in Barangay Sebucal. It was characterized by the dominant tree species, *Agathis philippinensis*, which were endemic and threatened. These trees had the largest diameter at 180-230 cm, were the tallest at 35-45 m, and had the biggest canopy cover (Figure 20). The other species that was frequently observed was *Syzygium* sp*.* The shrub layer, which was not much higher than 3 m, had a cover of only about 5 percent, whereas the herb layer was far more dense with a cover of about 30-60 percent.

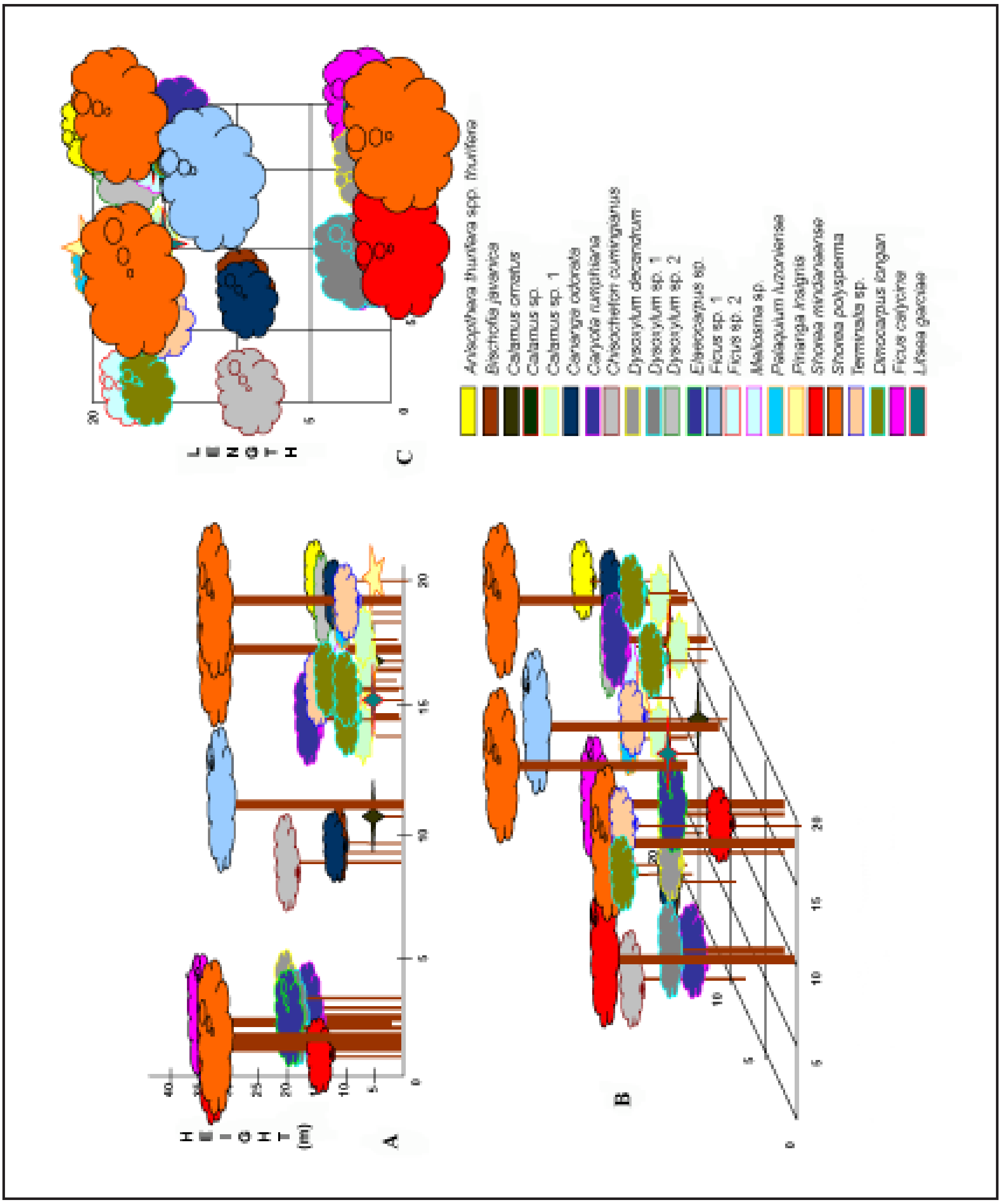


Fig. 19. Tree profile of the submontane dipterocarp forest.

Fig. 20. Almaciga tree (Agathis philippinensis).

Fig. 21. Lake Duminagat.

e. Lake Duminagat

Lake Duminagat is located in Barangay Lake Duminagat, Don Victoriano in the center of MMRNP at an elevation of 1,560 masl (Figure 21). It is an old, almost circular crater lake with a surface area of 8.04 ha and a maximum depth of 21 m. The limited littoral zone substrate bed was found to be soft and muddy.

Lake Duminagat is surrounded by mountains at all sides, except the opening in the western side. The catchment basin has a total area of 52 ha. It has no inlet streams but has a small outlet stream located at the southwestern part, which drains towards the Kalilangan River and ultimately joins the Dapitan River.

Although the lake area had no pronounced maximum wet and dry seasons, it had an annual rainfall of about 2,100 mm. Temperatures from March to October 2002 ranged from 15 to 23°C. At the time of the studies, the lake was not accessible to motor vehicles but could be reached by two trails, one from Centro, the main settlement of Barangay Lake Duminagat, and one from Barangay Gandawan. The lake is considered sacred by the Subanun residents of these barangays as their source of healing water.

f. Agricultural Systems

The agricultural systems in the higher elevations consisted mainly of traditional shifting cultivation. Cultivation of subsistence crops (like corn, cassava, and rice) was started a few years ago followed by a longer fallow period to rebuild the nutrient levels. Shifting cultivation farms under fallow would regenerate over time (provided there is no burning of the vegetation cover). Depending on the fallow age, vegetation of these agricultural systems gradually changed from grasses and weeds into woody seedlings, saplings, shrubs, poles, and young trees. Cultivation of semi-temperate vegetable crops was established as a permanent agricultural system so that residents could sell their produce to the local markets.

Temperatures in Barangays Mansawan, Gandawan, Lake Duminagat, Sebucal, and Mialen were found to be lower at 20.62-22.75°C, but have higher precipitation at 87.5 mm/day. Climate in these barangays were found favorable for growing cabbage, onion, sweet pepper, and chayote. Residents preferred the planting of cabbage because of its high economic value. However, production was constrained by pest infestation. Hence, two studies were conducted to help address this problem while protecting biodiversity. These were "Conserving the diversity of selected arthropods in cabbage growing areas through participatory integrated pest management" which concentrated on horticultural problems, and the "Conservation and utilization of endemic, rare and economically important plants."

Landscape Subsystems of the Lowlands

The lowland research areas of BRP ranged from about 100 to 900 masl. These areas consisted of complex mosaic land cover based on the 2000 satellite imagery of the land cover map. The main land cover was formed by coconut groves, shifting cultivation areas, secondary forest in different stages of regeneration, patches of remnant mixed dipterocarp forests, and plantation forests. These areas are easily distinguished in Figures 12 and 22.

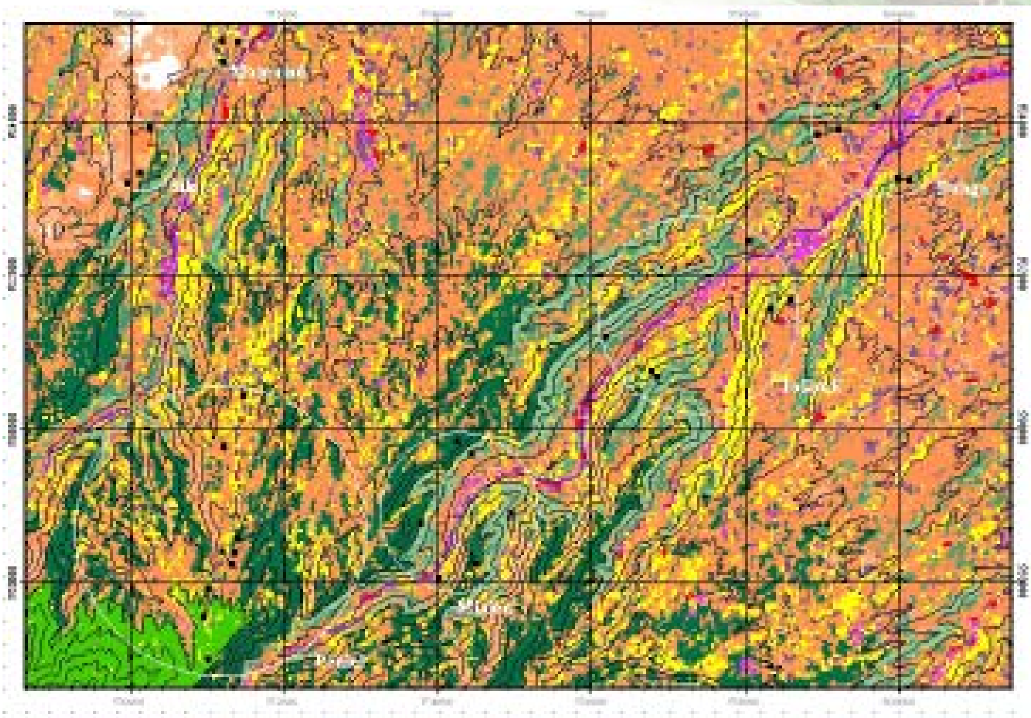


Fig. 22. Detail of land cover mosaic.

a. Mixed Dipterocarp Forest (450-900 masl)

The mixed dipterocarp forest in Mt. Malindang was found located at an altitude ranging from 450 to 900 masl, in Barangays Bunga, Oroquieta City, Peniel, Lopez Jaena (Figure 23), and Mamalad, Calamba in Misamis Occidental. Moisture and rainfall were found to be lower as compared to the other forest types. Slopes, however, were quite steep at 40 degrees on the average. Soil consisted of sandy loam and acidic at pH 4.5 on the average.

The mixed dipterocarp forests were the only forests that remained from the original natural forests of Mt. Malindang. Buttresses and prop roots were evident in the trees along the steep slopes, characteristic of *Syzygium*. The height of the tree layer ranged from 25 to 30 m, with a canopy cover of about 70 percent. The canopy species included *Lithocarpus* sp., the endemic and threatened *Shorea palosapis,* and the endemic *Caryota cumingii.* The fern *Sticherus laevigata* comprised the herb layer which was found growing in the open areas.
This species was found effective in preventing soil erosion because of its long creeping rhizomes and extensive root system.

Because of logging, this type of forest could only be found in patches in the Mt. Malindang range. Although cultivation was not practiced in the steep slopes, continuous cutting of trees for firewood, building materials, and timber further reduced the area covered by the mixed dipterocarp forests.

Fig. 23. Mixed dipterocarp forest.

b. Lowland Dipterocarp Forest (220-500 masl)

The lowland dipterocarp forest is a secondary forest type. Because of logging, its stands were found to occur in patches in areas with altitudes ranging from 220 to 500 masl. These areas were in Barangays Mialen (Figure 24), Oroquieta City and Mamalad in Calamba. Moisture and rainfall were lower than in the submontane dipterocarp forest.

Both forests types were found on slopes adjacent to the Layawan River. The slope of the lowland forest was less steep at an average of 25 degrees, and the soil consisted mainly of sandy loam. Soil was also moderately acidic at an average of pH 5.5, which was more or less equal to the acidity of the soils in the submontane dipterocarp forest.

The lowland dipterocarp forest is characterized by tall dipterocarp trees, which also occur in the submontane dipterocarp and mixed dipterocarp forests. Trees in this type of forest were found to be 20-25 m high with 60 percent cover. Shifting cultivation and extraction of resources for firewood, timber, and building materials, however, further reduced the area occupied by this type of forest.

Fig. 24. Lowland dipterocarp forest.

c. Mixed Lowland Dipterocarp Forest (220-450 masl)

This lowland forest type was found to occur on steep slopes located at an altitude ranging from 220 to 450 masl. The slopes were very steep and rocky at an average of 65 degrees with the parent material mainly consisting of sandy loam. Moisture and rainfall were found lower than in the other forest communities.

This type of forest was observed in Barangay Toliyok (Figure 25), Oroquieta City.
It consisted of patches from the remaining natural forest with a low tree layer of 20-25 m high, covering about 55-60 percent of the area. Canopy species found were *Lithocarpus* spp., *Shorea* sp., and *Lygodium auriculatum. Homalomena philippinensis*, meanwhile, dominated the herb layer.

Fig. 25. Mixed lowland dipterocarp forest.

Like the other types of forests, the mixed lowland dipterocarp forests also sufferred from shifting cultivation and the cutting of trees for firewood, building materials, and timber, especially in the less steep areas.

d. Plantation and Degraded Forests (120-900 masl)

Plantation and degraded forests were characterized by the cultivation of trees like *Acacia mangium* and *Cocos nucifera,* and weeds like *Imperata cylindrica* and *Chromolaena odorata*. They were found in areas with low rainfall and an altitude ranging from 120 to 900 masl.

The slopes were about 30 degrees on the average and soil was found acidic averaging at pH 4.5. These types of forests were located in Barangays Peniel, Calamba, and Bunga (Figure 26) in Oroquieta City. The plantation forest was characterized by a tree layer of planted species, which were 15-20 m tall, covering 75-80 percent of the area. The estimated area planted with *Acacia mangium* was 300-400 ha. This plantation forest was about five years old, and established by military officials and personnel as part of their civic action program. Further development of these forests had been delegated to the barangay officials.

Fig. 26. Plantations.

e. Agroecosystems on Lower Altitudes

The climate in the areas where the agroecosystems have been established was warmer at 27^{o}C. The areas also have lower precipitation at 40.9 mm/day especially in Barangays Toliyok, Bunga, Peniel, and Mamalad. The slopes ranged from 5 to 30 degrees. The parent soil material was predominantly sandy loam, while soil was quite acidic at an average of pH 5.

The agroecosystems were dominated by coconut groves and home gardens. These systems consisted mainly of coconut trees as the main tree component. Most of the coconut groves have been planted about

50 years ago, hence their 15-20 m height. They were often interplanted with fruit trees such as lanzones *(Lansium domesticum)*, rambutan *(Nephelium lappaceum),* and durian *(Durio zibethinus)*, especially near the villages (home gardens). Rice, corn, cassava, and sweet potatoes were planted underneath (Figure 27).

In agroecosystems, fallow cultivation was being practiced in the areas between the coconut groves, and the remaining forest areas located at the higher altitude areas. Extensive areas of *Imperata cylindrica* grass, shrubs and young regenerating secondary forests were found around the forests of MMRNP (Figure 28). These badly degenerated areas were often located in the designated buffer zones of the park. Encroachment into the forests, however, continued.

Fig. 27. Agrosystems at the lower altitude areas of Mt. Malindang.

Fig. 28. Shifting cultivation or fallow cultivation.

Landscape Subsystems of the Rivers

a. River System Elements

Several landscape elements have been observed in the river systems. The first element was the stream flowing in a river bed, consisting of rocks and gravel, which were found in the mountainous areas. The second element was the vegetated islands which could be found in the river bed, and were easily submerged during high tide. The third element was the riparian zones which most often consisted of forests that formed the interface between the water bed and the dry land. The last major element was the sandbar or sand island that was not vegetated and usually formed in downstream and low-lying areas.

When the typical concave profile of the upstream area changed progressively into a more flattening profile, the body of water and the waterbed changed as well. As a result, the riverbed consisted of smaller granular gravel and sand, whereas near the river mouth, soil consisted mainly of silt and clay fractions. Human settlements and resource utilization (water for domestic use, irrigation, gravel and sand, fish, and macroinvertebrates) integrated the landscape elements. All these landscape elements or sub-ecosystems served as habitats to numerous flora and faunal species.

The Langaran and the Layawan Rivers were chosen as the research sites because of their biotic and abiotic characteristics (Figures 10 and 29). The Langaran River was already studied in the "Community-based inventory and assessment of riverine and riparian ecosystems in the northeastern part of Mt. Malindang." Two river studies were also conducted as part of the aquatic ecosystem master project:
1) "Comparative assessment of the Langaran and Layawan Rivers," and
2) "Assessment of the headwaters of the Layawan River: linkage between the terrestrial and aquatic ecosystems in the Oroquieta watershed of Mt. Malindang" (Appendix 4). These studies included assessments of aquatic macroinvertebrates, riparian invertebrates (butterflies, moths, and dragonflies), birds, and mammals. It also included river water quantity and quality, the latter, of which, was influenced by alkalinity, total hardness, and the presence of dissolved and suspended solids.

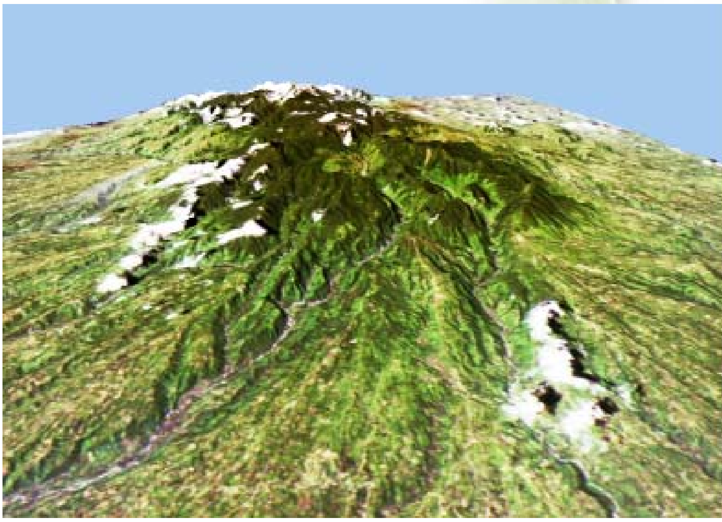


Fig. 29. Three-dimensional image of the Layawan (left) and Langaran (right) Rivers.

b. The Langaran River

The Langaran River originates from the slopes of Mt. Ampiro and Mt. Balabag. It runs from the foot of Mt. Ampiro, in the Municipality of Concepcion, crosses the Municipality of Calamba, and courses through and empties into the Municipality of Plaridel. Catchment area measured 10,591 ha.

There were three big dams in the river. The first dam was located in Napisik-Sipukat in the municipality of Calamba. The second dam and the biggest among the three dams was built in Nazareno in Barangay Tipolo. The third dam was located one kilometer downstream into Barangay Tipolo.

The sample research sites were located in five barangays along the Langaran River — Singalat, Mamalad, Bonifacio, Tipolo, and Catarman. Soil (pH, organic materials, and bulk density), vascular flora, and vertebrate and macroinvertebrate river and riparian fauna were assessed in these areas.

In addition, the socioeconomic characteristics of the communities along the river were obtained through interviews.

c. The Layawan River

The Layawan River was found a bit shorter than the Langaran River but had a slightly larger catchment area of 11,717 ha. The basin of its headwaters was located at the center of the northern part of MMRNP.

Meanwhile, the headwater basin of the Layawan River consisted of three sub-catchments, occupying a total of 1,189 ha. These were the Layawan Gamay (787 ha), Manimatay (981 ha), and Panubigon (121 ha). The mountains and ridges that formed the watersheds of the headwaters ranged from 760 to 2,183 masl. These included the peaks of Mt. Apo and North peak. The terrain was heavily dissected with steep slopes at the devices and less steep slopes in the middle of the basin. The three main headwater streams converged near the village of Barangay Sebucal at an elevation of about 960 masl. Hereafter, water ran down through Barangays Mialen, Toliyok, Bunga Buntawan, Vilaflor, and Taboc Norte towards Oroquieta City.

The headwater basin of Layawan River was located in Barangay Sebucal, within the core protected area of MMRNP, inside the municipality of Don Victoriano, and administratively under Oroquieta City. At the time of the study, Barangay Sebucal was accessible only by motorcycle, horse or foot even though roads were passable by vehicles through Barangays Mansawan and Toliyok.

BRP conducted an inventory of aquatic macroinvertebrates, measured the physicochemical factors, and analyzed the water samples in four sites along the three major headwater streams. Rapid appraisal of riparian flora was done in six plots, along the accessible sides of the various headwater streams. Inventory of the terrestrial/riparian invertebrates was also done in the four sites.

Landscape Subsystems of the Coastal Areas

The coastal zone, including the shallow marine waters, harbored a number of important subsystems (Figure 30). The coastal areas were highly valued by the population of Misamis Occidental as evidenced by the extensive human settlements and natural resource use. In fact, 87 percent of the population were found living within 50 km from the shorelines.

Fig. 30. Important landscape sub-systems of the coastal areas.

A continuous line of city and village settlements could be seen along the coastal road, which was also the only provincial road. Interspersed between the cities and villages were extensive irrigated rice fields, and settlements of farmers and fishermen with home gardens.

Numerous rivers and smaller creeks flowing into the sea could also be seen in the coastal areas. The river mouths often have some remaining original vegetation of mangrove and/or nipa palms. The shoreline consisted mainly of coral gravel and mud banks. The permanent submerged sea bottom, meanwhile, had been covered by different abiotic and biotic benthic catagories, including sand, silt, dead coral or rubles, live corals, seagrass, seaweeds, and algae.

The state of the coastal resources within the Mt. Malindang research wedge was already addressed in several BRP studies. These included the pre-implementation phase study on “Participatory rapid appraisal in the coastal ecosystem of Mt. Malindang, Misamis Occidental, Philippines,” the first generation study on “Participatory biodiversity assessment in the coastal areas of Northern Mt. Malindang,” and the second generation study regarding the “Comprehensive analysis of the ecological factors for the development of strategies to sustain coastal biodiversity and to improve fish stock management.” The last study consisted of sub-studies on some physicochemical factors, plankton, coral, seagrass, and seaweeds. The consecutive studies were built on the results and recommendations of preceding studies as summarized in Appendix 4.

Aside from these studies, PRA was also conducted in six different coastal barangays located in the three selected municipalities of Misamis Occidental. These were Barangays Manla and Caluya, in the municipality of Sapang Dalaga, Barangays Punta Sulong and Punta Miray, in the municipality of Baliangao, and Barangays Danao and Panalsalan, in the municipality of Plaridel. The first generation biodiversity assessment, meanwhile, was done in Barangays Mansabay Bajo, in the municipality of Lopez Jaena, Tuburan in the municipality of Aloran, Mobod in the municipality of Oroquieta, and Panalsalan in the municipality of Plaridel. The second generation study focused only on areas within the two-kilometer radius, from the mouth of the Langaran and Layawan Rivers, to determine the possible impacts of upland and river activities on coastal resources. The reef areas, and sampling sites of the PRA, first and second generation studies are given in Figure 31.

Fig. 31. Location of reefs and sampling sites of PRA, and the first and second generation studies.

a. Mangrove

Mangroves occurred in patches along the coastlines of Misamis Occidental. They were dominated by species belonging to the families Rhizophoraceae and Avicenniaceae. PRA research covered 3-140 ha of the mangrove areas, with Barangay Manla having the smallest research area, and Barangay Danao with the largest. These mangrove areas were mainly composed of secondary-growth forests. Sparse primary-growth forests remained in Barangays Punta Sulong, Punta Miray, and Panalsalan. Barangay Danao was unique because of the presence of a dense primary-growth forest.

Results of the studies revealed that the original mangrove area in the province decreased considerably because of land use conversion and exploitation of its wood resources. Large tracts of mangrove were transformed into rice paddies, saltbeds and fishponds. The wood of the mangrove tree species was continuously being extracted as fuel wood and high quality charcoal. Mangrove trees and branches were also being utilized as poles, fences, and fishing gear. Prunings and cuttings were being used to build houses. In addition, mangrove trees were being used to shield houses against strong winds. To help replenish the trees in the mangrove areas, research results also revealed that some abandoned fishponds have been replanted, and reforestation have been initiated by some municipalities and barangays (Figure 32).

Fig. 32. Mangrove restoration project.

b. Seagrass Beds and Seaweeds

PRA studies revealed that seagrass cover, ranging from 20 to 80 percent, was observed along the coastlines and in the island fringing reefs (Figure 33). Dense seagrass beds of mixed *Enhalus acoroides* and *Thalassia hemprichii* were found in all the barangays although the largest seagrass bed was found in Barangay Punta Sulong. These beds were found disturbed as evidenced by the dense epibionts on the leaf blades. Meanwhile, *T. hemprichii* beds were found in Barangays Punta Miray, Danao, and Panalsalan.

The people identified siganids (*Siganus fuscescens* or *danggit*) as the dominant fish that feed on and inhabit the seagrass beds.

The results of the second generation study showed that the average seagrass cover was generally higher in Barangay Plaridel (27.7%) than in Oroquieta City (15.9%). The estimated seagrass areas within the two-kilometer radius from the river mouth were 31.3 ha for Barangay Plaridel and 15.1 ha for Oroquieta City. These values were small compared to some areas with extensive seagrass beds such as in the Bolinao Bay in the province of Pangasinan (3,700 ha), Pagbilao Bay (189 ha) in the province of Quezon, Puerto Galera (114 ha) in the province of Mindoro Oriental, Iligan Bay (297 ha) in the province of Misamis Oriental in Northern Mindanao, and Murcielagos Bay (3,610 ha) in the province of Misamis Occidental.

Seagrass vegetation in Oroquieta City began at approximately a kilometer from both sides of the river mouth. Patches of the brown seaweed algae, *Sargassum* spp. and *Padina* spp. were found immediately in front of the Layawan River mouth at approximately one kilometer from both sides.

The generally low seagrass cover in Oroquieta City could be attributed to the substrates type, which was generally sandy along the beach and stony (fist-size to head-size) from the midreef towards the deeper end. The stony substrates were generally covered by the brown algae *Padina* and *Sargassum*. Although conditions may favor the growth of seagrass along sandy areas near the river, this was not validated by research data.

Fig. 33. Boat survey.

Meanwhile, the brown seaweed *Sargassum* was found in most of the reef areas, along the reef crest. Considering the presence of seagrasses near the river mouth, there appeared to be no pattern in the seagrass vegetation in Barangay Plaridel, unlike those in Oroquieta City. This may indicate the seemingly minimal influence of the river outflows to the vegetation.

c. Coral Reefs

PRA studies revealed that coral communities in Barangays Manla, Caluya, and Punta Sulong were in poor condition, except for the shoal (*takot*) shared by the coral communities in Barangays Manla and Caluya, which may be ranked as fair. Other areas were poor to fair in status, but small patches in Barangays Punta Miray and Panalsalan were good, and those in Barangay Danao were excellent.

The studies also revealed the major threats to coral communities: the dense crown-of-thorns sea star, and suspended silt in overlying waters. Degeneration of the coral reefs could be further attributed to the use of coral for the construction of pathways, houses, repropping of reclamation sites, use of damaging fishing gear, blast fishing, and harvesting of large shells.

A general boat survey (Manta Tow Survey) that was conducted as part of the first generation studies, revealed that 73 percent of the coral reefs were in poor condition, and only 2.4 percent were in very good condition. These results were reinforced by values obtained from the Condition Index, a measure of disturbance-related factors, as well as from the percentage of dead and live coral cover using the line intercept sampling method (Figure 34).

Results of the Manta Tow Survey from the second generation coastal study indicated that coral reef areas in the Langaran and Layawan Rivers were generally in poor condition.

Approximately 10 percent of the live corals covered the otherwise sandy-silty substrate of the areas. From the 19 sampling stations visited, only 12 stations contained live corals. Live corals were not found in stations fronting the river mouth, but were found in the shallow waters of the reefs at approximately 3-m deep. Corals apparently could not survive at a depth of 10 m or more as these areas were mostly covered with sand/silt due to low light intensities, and high amounts of suspended solids in the water column.

Unfortunately, shallow corals found in some stations were severely threatened and would probably be eventually covered by silt with the continuous increase of total suspended solids (TSS) due to river runoff. In addition, the lack of hard river bottom, unstable substrate, which was particularly evident in the deep water transects in the Layawan River, would also limit coral growth. Increased sedimentation, where hard substrates were eventually covered with sand/silt components, was also considered secondary causes to limited coral growth.

Fig. 34. The line intercept sampling method to measure disturbance-related factors, and percentage of dead and live coral cover.

FLORA AND FAUNAL DIVERSITY

Species Diversity in Terrestrial Subsystems

a. Flora

The plants in the subsystems were studied from sample plots, measuring 100 m^2, and in smaller subplots (Figure 35). The assessments listed species according to richness, number per area, basal area, crown cover, frequency, height and position of the crown in the different vegetation layers, and other aut-ecological properties (different uses). Computerized and manual analyses of all the ecological information resulted in a wide variety of categories, values and indicators that indicated the extent of species diversity.

Fig. 35. Species collection and identification by local researchers.

Fig. 35. Species collection and identification by local researchers.

One measurement of the extent of diversity was the scope of the species' habitats. Many species occurred in a wide variety of communities or subcommunities. Species were classified as diagnostic if their presence was very specific such that communities or subcommunities were easily distinguished. Species were also classified as exclusive, selective, and preferential according to their phytosociological descriptions.

Aside from the habitats, a second group of values was used to express species diversity. These included relative density (RD), relative dominance (RC), and relative frequency (RF). These values indicated the number of individuals per area, the cover of the (tree) crowns or the basal area of (tree) stems per area, and the number of times a species occurred in a set of sample plots. When combined, these three values resulted to the species importance value (SIV). The Shannon Index of General Diversity (H') and the Similarity Index (SI) were also used to compare biodiversity values, and indicate the mathematical functions of the number of individual species, and the number of total species in one or more sample sites.

A third group of species descriptive values indicated the natural distribution range of the species, the conservation status, possibilities for (economic) use, and sociocultural importance. The different categories used were adopted from the definitions and listings of the IUCN Red List of Threatened Species, the Statistics on Philippine Protected Areas and Wildlife Resources, and results of the BRP studies. These categories are shown in Table 2.

Table 2. Categories of species according to natural distribution, range of species, conservation status, possibilities for economic use, and sociocultural importance.*

Categories	Description
Endemic species	Species that are confined to a certain geographical region or its parts.
Rare species	Species that are not under immediate threats of extinction but occurring in such small numbers or in such localized or specialized habitats that it could quickly disappear if the environment worsens. These species needs watching.
Endangered species	Species that are actively threatened with extinction and its survival is unlikely without protective measures.
Depleted species	Although sufficiently abundant for survival, these species have been nearly depleted and are declining as a result of natural causes or human activities.
Economically important species	These species are based on known uses.

*Based on IUCN Red List Categories (http://www.redlist.org)

b. Species Richness

Results of the inventory of plant species in all the research sites, conducted by sampling plots and transect walks, revealed a total of 1,284 species, 472 genera and 187 families. Of these figures, 873 species were angiosperms, 20 gymnosperms, 280 pteridophytes, 85 bryophytes, and 26 species were lichens. Details of the total species richness of plants in MMRNP is shown in Table 3.

c. Vertebrates

Fourteen sampling sites were assessed for vertebrate faunal diversity. Five sites were assessed in terms of agroecosystem, two sites in terms of plantation forests, and one site each in terms of the different forest vegetation types.

The sample sites used were the same as those used in the flora study. Six sampling sites were subdivided into two subsites to study the effect of the north versus the south exposure on species composition.

Table 3. Plant species richness and endemism in the Mt. Malindang Range Natural Park based on transect and plot sampling.

Plant Groups	Total Number of		
	Family	Genera	Species
Angiosperms	114	307	873 (107)*
Gymnosperms	4	7	20 (3)
Pteridophytes	32	96	280 (28)
Bryophytes	32	55	85 (0)
Lichens	5	7	26 (0)
Total	**187**	**472**	**1,284 (138)**

* number of endemic species between brackets

Standard sampling techniques, meanwhile, were used to count and capture reptiles and amphibians (visual encounter or opportunistic search), birds (mistnet, line sampling in transects), and volant and non-volant mammals (traps, mistnet, direct systematic observation in transects or encounters).

Research results recorded 257 species of vertebrate fauna in Mt. Malindang which comprised 48 percent of the 536 species occurring in the island of Mindanao, and 23 percent of the 1,114 species recorded in the Philippines. High endemism was also observed, especially among volant mammals. These figures were generally higher compared with Mt. Kitanglad and Mt. Apo which have a fewer number of recorded vertebrate faunal species. Table 4 compares the vertebrate species in Mt. Malindang, Mindanao, and the Philippines.

Table 4. Vertebrate faunal species in Mt. Malindang.

	Mt. Malindang	**Mt. Malindang (Don Victoriano)** (Tabaranza *et al.* 2001)	**Mindanao**	**Philippines** (Sodhi *et al.* 2004)
Amphibians	26 (11)	16	35 (Crombie 1994)	101 (79)
Reptiles	33 (16)	10	92 (Crombie 1994)	258 (170)
Birds	162 (66)	147	325 (Kennedy *et al.* 2000)	576 (195)
Mammals	36 (21)	37	84 (PAWB 2002)	179 (111)
Total Number of Species	**257 (111)**	**210**	**536**	**1,114**

* number of endemic species between brackets

d. Arthropods

In studying the arthropod diversity in Mt. Malindang, research sites have been spread across the 10 barangays in the municipalities of Oroquieta City, Don Victoriano, Lopez Jaena, and Calamba. Majority of these sites were used in studying the flora of the forest and agroecosystems.

The sampling method used included visual and sweepnet sampling in 1x1 m plots in the forest vegetation sites, and systematic sweepnet strip sampling in the agroecosystem sites (Figure 36). Biodiversity indices (species richness, species diversity, Shannon's index, and Pearson's index of similarity) were calculated from the sampling results.

Results of the inventory in Mt. Malindang showed 741 species of arthropods in 340 genera, 135 families, 21 orders, and 5 classes. Table 5 presents the arthropod species composition in MMRNP which shows that the orders Coleoptera, Hemiptera, Hymenoptera, Diptera, and Araneida account for 78.37 percent of all the species found.

Species richness and diversity depended on a wide of variety of factors which included climate, geology, topography, aspect, soil, hydrology, the development stage of vegetation (climax or regenerating), natural dynamics (fire, flood, volcanic eruptions), human disturbances and use (logging, mining, NTFP exploitation, shifting cultivation, agriculture), and the presence of food species and shelter. Aside from these external factors, ecological interactions between the species in the system were also considered.

In general, tropical rainforest ecosystems were found to have the highest species richness. The tropical lowland forests of the Amazon, Congo Basin, and Southeast Asia have been competing for the record number of flora and faunal species.

Fig. 36. Sweepnet sampling.

Table 5. Arthropod compostion of the Mt. Malindang Range Natural Park.

Group	Families	Genera	Species	%
Beetles and weevils (Coleoptera)	22	86	258 (44)*	35
Bugs (Hemiptera)	30	64	156 (4)	21
Ants, bees, and wasps (Hymenoptera)	23	47	62 (0)	8
True flies (Diptera)	11	12	53 (0)	7
Grasshoppers (Orthoptera)	7	33	38 (10)	5
Other insects	31	76	117 (49)	16
Spiders + associates (Arachnida)	8	19	54 (0)	8
Crabs (Crustacea)	1	1	1 (0)	0
Centipedes (Chilopoda)	1	1	1 (0)	0
Millepedes (Diplopoda)	1	1	1 (0)	0
Total insects (Insecta)	**135**	**340**	**741 (107)**	**100**

* number of endemic species between brackets

If Mt. Malindang remained undisturbed, species richness would have decreased with increasing elevation, except for the coastal formations (mangrove and nipa), and some very special formations, such as the Almaciga forests. Angiosperms (873 species), birds (162 species), and beetles (258 species) were considered the most important species groups in Mt. Malindang (Figure 37).

In reality, however, human influences have indeed altered the natural situation of Mt. Malindang as shown in Table 6. Although species assessments have been influenced by the methods, structure and density of the vegetation and the terrain conditions, the accuracy of research results have been ensured. Canopy sampling could have resulted in more small epiphytic plants, possibly some smaller vertebrate species and certainly more arthropods. In certain areas, the density of the vegetation and the extreme steep slopes influenced the wildlife sighting and assessment techniques.

In areas above 1,000 masl, research results generally showed high plant and vertebrate species richness and diversity in the forest systems. However, the Almaciga forests showed decreasing plant and vertebrate species richness with increasing altitude. Species richness and diversity were thus low in this type of forest but did not necessarily indicate low biodiversity if high endemism had been observed. In fact, the highest values for arthropod species richness and diversity were obtained from the mossy forests that were located above 1,000 masl.

Meanwhile, the forest systems located below 1,000 masl, were found to be moderately to heavily disturbed. These forests contained mixed original forest (tree) species of low timber value, secondary species, and wild cultivated species. The forests showed a decreasing number of plant species in the lower elevations. This trend was not detected, however, for the vertebrate and invertebrate faunal species that lived in these habitats. The high number of arthropod species in the mixed dipterocarp forest was also noted. The 355 species recorded more than doubled the amount of species found in the second richest habitat — the mossy forest. This could be explained by the low number of vertebrates in this habitat, especially birds.

Fig. 37. Two of the three most important species groups identified in the Mt. Malindang landscape: birds and beetles.

The habitat structure and species composition of the vegetation types in the plantation and degraded forest and agroecosystems, at altitudes ranging from 120 to 1,300 masl, were found to be very broad and varied. Therefore, general conclusions have not been made.

Table 6. Species richness and diversity of plants, vertebrates, and arthropods in the different vegetation types of Mt. Malindang Natural Park.

Vegetation Types	Plants		Vertebrates		Arthropods	
	Richness	Diversity	Richness	Diversity	Richness	Diversity
Mossy Forest (>1,700 masl)	256.000	1.850	84.000	1.403	169.000	2.015
Montane Forest (1,400-1,700 masl)	263.000	2.036	102.000	1.687	122.000	1.857
Almaciga Forest (1,200-1,400 masl)	157.000	1.970	96.000	1.602	54.000	1.529
Submontane Dipterocarp Forest (900-1,100 masl)	219.000	1.920	132.000	1.621	108.000	1.569
Mixed Dipterocarp Forest (450-900 masl)	181.000	1.960	73.000	1.408	355.000	2.397
Lowland Dipterocarp Forest (220-500 masl)	144.000	1.880	100.000	1.402	138.000	1.726
Mixed Lowland Dipterocarp Forest (220-450 masl)	97.000		73.000	1.145	115.000	1.910
Plantation and Degraded Forest (120-900 masl)	61.000		102.00	1.245	136.000	2.002
Agroecosystem (150-1,400 masl)	127.000		144.000	1.476		
Vegetable					97.000	1.483
Cereals					30.000	1.252
Agroforestry					40.000	1.497
Grass-dominated fallow					81.000	1.626
Total number of species in all samples	**1,284**		**257**		**741**	

Water Quality and Species Diversity in Aquatic Subsystems

a. Lake Duminagat

Lake Duminagat is an oligotrophic lake. The water has low transparency, low alkalinity, and very soft. The water at the middle of the lake was found potable enough for drinking most of the time. Its various morphometric and physicochemical characteristics, such as low surface area to volume ratio, low lake area to watershed area ratio, low alkalinity, and low amount of dissolved solids, all contributed to its low productivity. In addition, the lake was found to have a low population and limited species number of macrophytes (representing one component of primary productivity), zooplanktons (representing secondary productivity), and phytoplanktons. The lake had a total zooplankton abundance of only 1.3 percent per liter. Consequently, the fish population, which should be at the top of the aquatic food chain, was also found to be low in kind, number, and biomass.

Five fish species were reported to be living in the lake. These included tilapia (*Oreochromis* sp), carp (*Cyprinus* sp.), *paitan* (*Barbodes binotatus*), *kasili* (*Anguilla* sp.), and *pargo*. Local residents only used indigenous hook and line, and fish traps thus obtaining a very low catch.

In the littoral zone, meanwhile, three submerged aquatic macrophytes were found prominent. These consisted of *lusay* (*Sagittaria cristata*, Alismaceae), *dagum sa tubig* (*Eleocharis acicularis*, Cyperaceae) and *busikad sa tubig* (*Ericaulon* sp., Eriocaulaceae). The lake supported a high diversity of indigenous shoreline fauna and flora, which were all included in the species lists of the flora, and vertebrate and invertebrate fauna studies of BRP.

Although coliforms were found through bacteriological analysis of the water samples taken from the middle of the lake, *Escherichia coli* could not be detected to check if the water has human fecal matter contamination. In fact, the water samples obtained from the lake met the Philippine National Standards for Drinking Water.

b. Rivers

The state of the Langaran and the Layawan Rivers were described by their levels of physicochemical parameters or the presence and abundance of flora and fauna, as well as the aquatic macroinvertebrates. In general, research results, specifically the physicochemical and macroinvertebrates parameters, indicated a relatively healthy Langaran and Layawan Rivers. The levels of physicochemical parameters (i.e., total suspended solids, dissolved oxygen, and nutrients) were found to be within the standards set by the Department of Environment and Natural Resources (DENR) through its Philippine National Standards for Class B River Systems. In fact, the presence of microorganisms and macroinvertebrates can be used to monitor the anthropogenic activities of the rivers and its surrounding terrestrial environment.

E. coli was found in the two rivers (in both the upstream and downstream sampling sites) but the highest concentration was measured in the Langaran River before the Tipolo Dam. The values measured for *E. coli* were below the standards set for bathing and swimming but exceeded the level for safe drinking water.

Macroinvertebrates are also very good indicators of water quality and diversity of aquatic life. Samples from six sites each in the Langaran and the Layawan Rivers, during the dry and wet seasons, showed that the number of taxon groups among the macroinvertebrates varied from upstream to downstream although there were no significant differences observed. There were at most 24 taxa obtained from the Langaran River, during the wet and dry seasons, including 19 taxa for excellent water quality indicators, 26 taxa for good water quality indicators, and 3 taxa for poor water quality indicators. For the Layawan River, on the other hand, 29, 21, and 2 taxa were obtained for excellent water quality indicators, good water quality indicators, and poor water quality indicators, respectively. Figure 38 provides an example of some excellent water quality indicators.

For the riparian flora along the riverbanks, tree species richness was found greater in the more upstream barangays, but decreased as the river flowed to the lowland areas. This was significantly true for the Layawan River but not for the Langaran River. One factor might be the less heavy settlements in the upstream than in the downstream barangays, the latter of which were more accessible to settlers. It was also observed that the flat riparian areas were usually cultivated. Only a single line of native trees at the immediate edge of the riverbank remained. Another explanation may be the rivers' channel morphology and topography.

The sampled riparian area of the Layawan River recorded 105 morpho-species of trees and about 111 species of shrubs, herbs, and weeds. The first generation data gathered from the Langaran River revealed a total of 251 species of vascular plants. Of the total 118 tree species (from both plot and rapid appraisals), about 62 tree species were collectively found in the Layawan River that were not found in the Langaran River. There were, however, 58 tree species commonly found

Fig. 38. Some macroinvertebrates considered as indicators of excellent water quality.

in both rivers. This implies either a less degraded condition for the riparian areas or a development of distinctive tree flora in the Layawan River corridor because of its high elevation.

In the Layawan River, a total of 60 species of birds, 12 species of mammals, 17 species of reptiles, and 13 species of fish were recorded as compared to the 52 species of birds, 11 species of mammals, 11 species of reptiles, and 25 species of fish found in the Langaran River.

Since avifauna are good indicators of the health of a river system, the BRP river studies focused on birds. Species richness of birds increased downstream to the Layawan River, while it decreased towards the river mouth of the Langaran River. This trend can be possibly attributed to a variety of bird habitats. Out of the 60 species of birds recorded in the Layawan River, 19 species were found endemic to the Philippines, and six species were found endemic to Mindanao. These were the: Writhed Hornbill (*Aceros leucocephalus*), Mindanao Tarictic (*Penelopides affinis*), Silvery Kingfisher (*Alcedo argentata*), and Brown Tit-Babbler (*Macronus striaticeps*).
Two migratory species, the Grey Wagtail (*Motacilla cinerea*) and the Brown Shrike (*Lannius cristatus*), were also recorded. Endemism was high at 39 percent compared to the national figure of 33 percent.

In the Langaran River, a total of nine endemic species were recorded in the four barangays studied. This represented about 17 percent of the total observed species in the stretch of the river, which was lower than the typical bird endemism of 33 percent in the country.
The endemic species included *Phapitreron leucotis, Loriculus philippinensis, Centropus viridis, Penelopides panini affinis,*

Rhipidura superciliaris, Aethopyga shelleyi, Dicaeum australe, Alcedo argentata, and *Dicaeum pygmeum*.

The most abundant species in the study sites were the Purple-Throated Sunbird (*Nectarinia sperata)* at 9.1 percent, Glossy Swiftlet (*Collocalia esculenta)* at 7.9 percent, and the Yellow-Vented Bulbul (*Pycnonotus goiavier)* at 7.1 percent. These three species also dominated the three study sites in Barangays Mialen, Toliyok, and Bunga. The lowermost study site, Barangay Villaflor, was dominated by the Little Egret (*Egretta garzetta)* at 17.8 percent, the Yellow-Vented Bulbul (*P. goiavier*) at 9.8 percent, and the Glossy Swiftlet (*C. esculenta*) at 8.4 percent. These four species were found dominant in the area.

Communities with high evenness tend to have low diversity. Mist-netting results showed that diversity was lowest in Barangay Villaflor but relatively higher in Barangays Mialen, Toliyok, and Bunga. In general, habitat complexity would result to an increase in faunal species. More niches become available to accommodate more species. On the other hand, a decrease in habitat complexity may result to higher evenness as lesser number of species will be accommodated.

c. Coastal Waters

Water quality. Water quality in the two research sites of the second generation studies determined dissolved oxygen, the presence and quantity of nutrients, the salinity profile, water transparency, TSS, sedimentation rate, and the presence of pesticides.

The values of most physical and chemical parameters monitored in the coastal waters of Langaran, Layawan, and Danlugan Rivers in April-May 2004 and September-October 2004 were within the DENR (1990) standards. Similar dissolved oxygen levels were observed in the research stations in the Layawan and Langaran Rivers. The presence of the harmful algal bloom in Langaran, Layawan, and Danlugan Rivers may have caused the water to become turbid as shown by the lower transparency values during the dry season. Among the three coastal areas investigated, the Danlugan River research station exhibited the lowest transparency values during the dry sampling period. But the relatively clear water and light penetration characteristics were not considered problems.

TSS levels were expected to increase with the increasing trend of transparency values during the dry to wet seasons. However, TSS levels significantly increased during the wet sampling period which coincided with the increasing sedimentation rate in the wet season. Despite the increasing pattern, the range of sedimentation rate was very much lower than what was observed in the outflow of the other rivers, e.g., the Agusan and Tubay Rivers in Butuan Bay. The TSS levels in the Langaran and Layawan Rivers have relatively very low concentrations from the maximum concentration required for growing and propagating fish. The sedimentation rate observed in the Langaran River significantly increased during the wet season. This could be the cause of the sediments transported from the river outflow as well as the materials brought in through wave action and water currents.

The sedimentation rate in these areas had been dictated by season and operations of the irrigation dam situated in the upstream of both rivers. More sediment load will be carried by water runoff when the dam opens. Despite the low TSS levels and low sedimentation rates, the study still recommends that quarrying activities in the river upstream be reduced if not eliminated.

Data also showed that pesticide pollution was not significantly pervasive. Results of the analysis agreed with the socioeconomic survey that showed the use of pesticides recommended by the Department of Agriculture (DA). These pesticides are safe to use for aquatic environments as they are transformed to less harmful substances when applied unlike the banned pesticides which are very persistent and remain in the environment. Although the water quality parameters that were investigated in the coastal areas of the Langaran and Layawan Rivers have shown variations, they were within the tolerable limits for marine waters and thus fit for fish growth and propagation.

Plankton. These consisted of microscopic flora organisms (phytoplanktons) and faunal organisms (zooplanktons) that were transported by water currents. There were more microscopic plants, represented by the phytoplanktons, recorded in Oroquieta City (47) as compared to Plaridel (40). A total of 45 species was also recorded in one sampling area in Barangay Danlugan, Lopez Jaena. Among these phytoplanktons, the diatoms were the most dominant group, followed by the dinoflagellates. The flagellates were the least dominant microscopic plants.

Meanwhile, the zooplanktons were classified up to genera level and specific groups. There were 44 identified species in Oroquieta City, 46 species in Plaridel, and 43 species in Barangay Danlugan. Overall, the zooplanktons were dominated by Crustacea.

Among the 87 phytoplankton taxa identified in the coastal waters surrounding Mt. Malindang, the diatoms, specifically the *Chaetoceros* spp., were the most dominant. In general, phytoplanktons and zooplanktons were abundant in Plaridel and Oroquieta City during the wet season. Barangay Danlugan, however, had a high level of phytoplanktons (red-tide causing organisms and other taxa) and zooplanktons during the dry season. The red and blue tide-causing organism was dominated by *Ceratium* spp. and *Trichodesmium* spp.

Studies also showed that the coastal waters in all the sampling areas harbored six genera of red-tide causing organisms, namely, Ceratium, Dinophysis, Gambierdiscus, Gonyaulax, Noctiluca, and Peridinium. In the Danlugan Cove, Lopez Jaena, five genera of red-tide causing organisms were observed with an aggregate relative abundance of 44.2 percent. *Ceratium* spp. (44.04%) formed the maximum relative abundance with the species *Ceratium lineatum* dominating the entire bulk of the population (43.7%). During field collection, water was observed to be red for sometime because of the increased presence of *C. lineatum* resulting from eutrophication on algae bloom due to high nutrient input.

d. Mangrove

In all the six PRA study sites in the north-northeastern part of Misamis Occidental, 19 mangrove tree species were recorded. Among them were *Avicennia* (with the typical pencil roots), and *Rhizophora* (with prop roots). Table 7 gives an overview of the mangrove tree species and their importance value found in the different barangays.

Studies have identified 12 species of shellfish, 12 species of birds, 4 species of reptiles, 10 species of plants, and 12 species of fish associated with mangroves. Flying foxes (*Pteropus vampyrus*) were also recorded in four barangays, while a crocodile was spotted in Barangay Danao.

e. Seagrass Beds and Seaweeds

Studies have recorded 59 species of seaweeds represented by 16 green algae, 24 red algae, 15 brown algae, and 4 blue green algae. Reports during the first generation studies have also revealed 20 new species of seaweeds in Mt. Malindang. The brown algae, *Sargassum* spp. (at least six species), dominated the seaweeds, followed by *Padina* spp. (at least four species). A commercially important agarophyte, the *Gelidiella acerosa*, was observed at 10 percent cover.

A total of seven species of seagrasses were also identified along the mouth of the Layawan River in Oroquieta City, and eight species along the mouth of the Langaran River in Plaridel. The *dugong* grass, *Thalassia hemprichii* (42-49% cover), was found dominant in both sites, followed by *Cymodocea rotundata* (12-26%). The tropical eel

Table 7. Occurrence and importance value of mangrove tree species in six barangays in North-Northeastern part of Misamis Occidental.

Mangrove Tree Species	Occurrence and Importance Value (%) of Mangrove in the Barangays					
	Manla	Caluya	P. Sulong	P. Miray	Danao	Panalsalan
Aegiceres corniculatum			+			+
Avicennia alba				+		
Avicennia marina	+		+	+	73	56
Avicennia officinalis	+	+	58	61	90	54
Bruguiera sexangula		+		+		
Bruguiera parviflora		+				
Bruguiera spp.			+	+		+
Ceriops decandra					+	
Ceriops tagal					+	
Ceriops spp.	+	+	+	+		+
Excoecaria agalocha				+	+	+
Lumnitzera littorea					+	
Lumnitzera racemosa	48		25	+	31	+
Rhizophora apiculata	52	65	67	55	+	35
Rhizophora mucronata	91	130	25	74	+	27
Rhizophora stylosa	25		+	27	+	26
Scyphiphora hydrophyllacea			+	+		+
Sonneratia alba	51		51	+	+	102
Sonneratia caseolaris		106	+	82	+	
Sonneratia spp.					107	
Xylocarpus granatum	33	+	74		+	+
Xylocarpus moluccensis				+		+

grass, *Enhalus acoroides,* was not recorded in all the quadrats sampled at Oroquieta City. The species, however, was observed in small patches in the area.

The small spoon grass, *Halophila ovalis*, ranked second in terms of sightings in the research stations in Oroquieta City (25%). Two of the relatively rare species reported in Mt. Malindang (*Halophila decipiens* and *Halophila spinulosa*) were not recorded within the two-kilometer radius from the river mouth of the study sites. Instead, they were reported only in Barangay Aloran, Tuburan.

Species composition of the area was comparable to Panguil Bay (eight species), Bolinao Bay (seven species), and Sulawan Point (seven species). In most tropical regions, a mixed seagrass bed has five to eight species that are normally occurring in a certain area.

f. Fish

From interviews, local residents identified 142 kinds of fish belonging to 52 families. The residents of the coastal communities in Barangays Manla, Caluya, Punta Sulong, and Punta Miray, along the Mucielagos Bay, identified the dominant fish species as those belonging to the family Siganidae. There were 16 species of reef fish recorded, four of which were indicators of the reef's good health.

Small and large offshore pelagic species and demersal species were likewise mentioned by the residents of Barangays Punta Miray, Danao, and Panalsalan. Unique to Barangay Danao was the bangus (*Chanos chanos*) fry collection in the Ducaling estuary. Up to 52 species of shellfish were collected in areas with extensive reef flats in Barangays Punta Sulong, Punta Miray, Danao, and Panalsalan.

However, studies have shown that reef fish biomass was low with average values ranging from 3.5 to 13.3 kg ha^{-1} in both the Layawan and Langaran Rivers. Reef fish consisted mainly of small individuals dominated by the pomacentrids like the damsel fish. Species richness of fish, however, was higher in the Layawan River (83-123 species) as compared to the Langaran River (63-65 species) for shallow and deep stations, respectively. Species composition of reef fish comprised mainly of the common types, like wrasses and damsels, which were not commercially important. Size structure of these reef fish were found to be mostly below 5 cm, particularly in the coastlines of the Layawan River.

Parallel to the poor coral reef condition found during the first generation study, was the low standing stock (biomass) of the reef fish (8.8+5.7 mt/km^2) when compared to the benchmark estimates. The catch per unit effort (CPUE) values were relatively low for all gear types in the four sampling sites. The estimated exploitation rate for siganids was 0.4, suggesting optimal exploitation. The seagrass beds in the study sites may have contributed to the increased presence of siganids in Barangays Panalsan and Mobod. The siganids was one of the five most abundant species groups in Barangays Tuburan and Mansabay.

In the shallow transects during dry sampling, 56 species, belonging to 16 families, were recorded in the Langaran River, Plaridel, and 82 species, belonging to 22 families, were found in the Layawan River, Oroquieta City. There were generally 158 species of coral reef fish recorded in Plaridel, while 162 species were found in Oroquieta City. In the deep transects, 68 species belonging to 20 families were recorded in Barangay Langaran, Plaridel, while 69 species belonging to 19 families were observed in Layawan River, Oroquieta City.

Results of this study complemented the results of the various studies done by other researchers in the country where the Pomacentrids were found dominant over other coral reef species regardless of depth. The relative abundance of this species may be due to its omnivorous characteristic or being able to feed on zoobenthos, coral, and algae. Hence, Pomacentrids were considered strict residents of the reef as they provide stability to the fish communities in the reef biotope.

When comparing the size frequency of the fish in both the shallow and deep transects of the Langaran River, Barangay Plaridel, studies showed that more small-sized individuals were found in the deeper part of the reef. A reverse condition was observed, however, in the southern portion from the river mouth as small-sized individuals were more abundant in the shallower portion of the reef.

When fish size frequency distribution in the shallow transects was compared, small-sized individuals were found more abundant in the Layawan River than in the Langaran River. Big-sized individuals were only found in the Langaran River. The deeper transects showed the same conditions. These figures implied increased fishing in the area as there were more small-sized fish than the larger ones.

The results of this study complemented the results of the first generation studies. Having more small-sized fish suggested a poor condition of fishery resources in the study sites and consequently implied overfishing.

The mean fish biomass in the shallow transects was 1.46 kg/500m^2 in Plaridel and 0.73 kg/500m^2 in Oroquieta City. Whereas in the deep transects, mean fish biomass was at 1.84 kg/500m^2 in Plaridel and 0.48 kg/500m^2 in Oroquieta City.

The overall mean fish biomass, regardless of depth and season, was 1.71 kg/500m^2 in Plaridel and 0.60 kg/500m^2 in Oroquieta City. Generally, the mean fish biomass in both sampling sites ranged from very much lower to slightly lower as compared to the fish biomass recorded in many other coastal areas in the Philippines. Although it was slightly higher than the mean fish biomass reported by the Save Nature Society, Inc. (SNSI) at 1.70 mt/km^2, the classification made by Hilomen *et al.* (2000) affirmed that these values fall under the very low category.

Special Groups of Species

a. Endemic Species

Plants. Studies have recorded 138 endemic species. The angiosperms had 107 endemic species, while the gymnosperms had three endemic species. Although this was the case, the gymnosperms obtained a high percentage of endemism ranging from 24 to 41 percent, while the pteridophytes had 11 percent endemism. Of the 59 (47%) endemic species of pteridophyte, studies have recorded 28 of these species present in Mt. Malindang (Amoroso 2000). Aside from being endemic, some of these were also threatened species.

One species, *Medenilla malindangensis,* was found endemic to the site (Figure 39), while 10 species were found endemic to the Mindanao island. These included *Saurauia involucrata, Saurauia fasciculiflora, Saurauia glabrifolia, Cinnamomum mindanaense*. Fifteen species, meanwhile, were found endemic to the Philippines.

Fig. 39. The site-specific species Medenilla malindangensis (Latepo).

Vertebrates. Like the plants, the vertebrate fauna in Mt. Malindang had a high number of endemic species. Out of the total species found in Mt. Malindang, 111 (43%) were endemic (Figure 40). Of the 17 non-volant mammals, 12 species (71%) were endemic.

Fig. 40. The site-specific species Malindang Tree Frog (Philautus surrufus).

Of these endemic species was the amphibian *Philautus surrufus*, otherwise known as the Malindang Tree Frog, which preferred arboreal microhabitats in the mossy and montane rainforests of Mt. Malindang. This amphibian had not been previously found outside the forest. Studies revealed that *P. surrufus* was found to inhabit all the different types of forests in Mt. Malindang except the mixed dipterocarp, mixed lowland dipterocarp, and plantation forests. It was surprisingly observed in the agroecosystem sites. *P. surrufus* breeds by direct development and has been listed as endangered in the IUCN 2004 Red List of Endangered Species. It is continuously being threatened by habitat conversion, agriculture, and human encroachment. Figure 41 also shows the other endemic reptiles found in Mt. Malindang.

Fig. 41. Some of the endemic reptiles found in Mt. Malindang were: (clockwise from top) Calamaria gervaisi, Cyrtodactylus annulatus, Rhabdophis auriculata, Sphenomorphus fasciatus, and Tropidophorus misaminus.

Arthropods. There were 67 arthropod species found endemic to Mt. Malindang, 23 species found endemic to the Mindanao island, and 17 species found endemic to the Philippines. Of these, 41 species were weevils (obtaining the highest endemism), 24 species were stick and leaf insects, and 2 species were butterflies (Figure 42). At least 21 species were found associated with endemic host plants, thus urging immediate conservation efforts.

Two butterfly subspecies (Nymphalidae) were also found endemic only to Mt. Malindang, one of which, *Parantica dannatti malindangensis* (Hudepohl), was observed only in the montane forest of Barangay Lake Duminagat. The other MMRNP endemic subspecies found was *Delias diaphana basilisae* (Pieridae). In addition, at least 21 species of endemic arthropods (mostly curculinoid beetles) were found associated with 18 host plants endemic to Mt. Malindang.

Fig. 42. One of the species of butterflies found endemic to Mt. Malindang was the Parantica dannatti malindangensis.

b. Threatened Species

Plants. Assessment on the threatened plant species in Mt. Malindang revealed 56 threatened species, 138 endemic species, and 289 species that were economically important. Of the 56 threatened species, 10 species were found critically endangered, 9 species were considered endangered, 13 species were considered vulnerable, 30 species were found endemic to the Philippines, and 2 species were considered threatened for extinction in the wild.

Majority of the threatened species were trees being extracted for their timber. Of the 10 critically endangered species listed in the National Threatened Species List, eight were dipterocarp tree species which have high timber value (Figure 43). Luckily, not all these species were locally threatened. *Hopea acuminata* and three Shorea species were found still abundant in Mt. Malindang. Based on vegetation types, the Almaciga, submontane dipterocarp, and lowland dipterocarp forests obtained the highest number of threatened species with 6, 6, and 4 species (per plot), respectively.

The use of *Lithocarpus* spp. (*Gulayan*), *Syzygium* spp. (*Pulayo*), and *Veburnum odoratissimum* (*Baho-baho*) as firewood resulted in the depletion of these species and its classification as being locally

Fig. 43. Some of the critically endangered tree species in Mt. Malindang were (clockwise from the top) the Dipterocarpus validus, Hopea acuminata, and Shorea palosapis.

threatened. Almaciga trees (*Agathis philippinensis*) were being protected by DENR with resin tapping permitted only under license. However, communities in Barangays Sebucal and Lake Duminagat illegally and improperly tap Almaciga resin as illuminant in their households.

Rattan (*Calamus* spp.) or "climbing palms," mostly belonging to the genus Calamus, were also found abundant in Barangay Sebucal, and fairly abundant in Barangays Peniel, Lopez Jaena, and Toliyok in Oroquieta City. In Barangay Sebucal, rattan was being collected from nearby Almaciga and dipterocarp forests by pulling down the whole cane thus killing the plant. Rattan in these areas was thus considered threatened.

Vertebrates. As shown in Figure 44, 27 (10%) of the vertebrate species recorded were considered threatened, 2 species were found critically endangered, 2 species were found endangered, and 21 species were found vulnerable. Of the threatened species, 27 were found to be locally threatened by the residents.

Of the 19 locally threatened bird species, 12 species were not in the IUCN list of threatened species (2004). Two Philippine endemic species on this list, however, the *Agila* (*Pithecophaga jefferyi*) and the *Tabantis* (*Alcedo argentata*), and the Mindanao endemic, *Bukla* (*Actenoides hombroni*) were found locally threatened.



Fig. 44. Some of the endangered mammal and bird species in Mt. Malindang were (clockwise from the top left): Urogale everetti, Acerodon jubatus, Rhinolophus subrufus, Otus mirus, Alcedo argentata, and Actenoides hombroni.



One of the threats identified was the continuous hunting of these species by villagers for food. Among the volant mammals, only the Philippine endemic *Kabog* or Golden-Capped Fruitbat (*Acerodon jubatus*) was in the IUCN list and also found to be locally threatened. For the non-volant mammals, the Mindanao endemic *Mugsaw* or Mindanao Tree Shrew (*Urogale everetti*) and the Philippine endemic *Kagwang* or Flying Lemur (*Cynocephalus volans*) were considered vulnerable and locally threatened.

Arthropods. Initial assessment showed a total of 17 species found endemic to the Philippines, 23 species found endemic to Mindanao, and 67 species found endemic only to MMRNP. There were 41 beetles found to obtain the highest endemism.

Endemism was assessed only for Odonata, Orthoptera, Phasmatodea, Hemiptera, Coleoptera, and Lepidoptera. Additional endemic and new species, particularly for Coleoptera, still await confirmation. Due to the high endemism of the arthropod fauna, threats to their biodiversity existed mainly due to the ignorance of the stakeholders in their role in the web of life.

c. Economically Important Species

Studies have identified 289 plant species in MMRNP that were economically important as food, medicine, ornamentals, building materials, handicraft, and forage. If properly managed and utilized, these plants could help sustain the livelihood of the residents (Figure 45).

Interviews also revealed 2 species of amphibians, 1 species of reptile, 16 species of birds, and 6 species of mammals that were being hunted and/or consumed by the local people. The Giant Philippine Frog (*Limnonectes magnus*) and the Variable Backed-Frog (*Rana grandocula*), both locally called *baki* and *bak-bak,* were considered edible. The *Ibid* or Sailfin lizard (*Hydrosaurus postulatus*) was the only known reptilian species being hunted as food in Mt. Malindang.

In addition, birds that were being hunted as food included the *Manok Ilahas* or Red Jungle Fowl (*Gallus gallus*), *Alimukon* or White-Eared Brown Dove (*Phapitreron leucotis*), *Kalaw* or Rufous Hornbill (*Buceros hydocorax*), *Tagiptip* or Tarictic Hornbill (*Penelopides affinis*), and *Manatad* or Common Emerald Dove (*Chalcophaps indica*).

Mammals that were hunted, meanwhile, were the *Baboy Ilahas* (*Sus philippensis*), *Unggoy* or Long-Tailed Macaque (*Macaca fascicularis*), *Tinggalong* or Malay Civet (*Viverra tangalunga*), *Binaw* or Philippine Brown Deer (*Cervus mariannus*), *Laksoy* or Philippine Tree Squirrel (*Sundasciurus philippinensis*), and certain species of mice/rats or what was locally called as *Ilaga.* Aside from being hunted for food, *Baboy ihalas* and *Unggoy* were also being kept as pets in farms.

The hives of the honeybee, *Apis cerana,* were being sourced for honey. Other invertebrates that provided direct benefits included the larvae and adults of the coconut beetle, termites, and *kalong* (crabs) as food; termites and naiads as fish baits; and ants and wasps as "biocontrol agents" against cabbage worms.

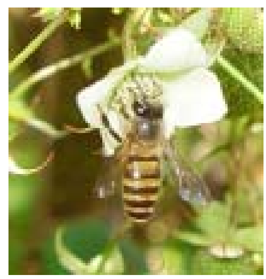


Fig. 45. Some economically important plant and animal species found in Mt. Malindang include (from the top): Agathis philippinensis, Phaius tankervilleae Blume, Apis cerana, and Rana grandocula.

Discussion

a. Flora

In general, the results of the flora, vertebrate fauna, and arthropod research indicated that Mt. Malindang had a high number of endemic and threatened species and thus considered a key conservation site. The most important and most diverse among the habitats for conservation, based on the results of the TWINSPAN analysis, were the mossy and montane forests in Barangay Lake Duminagat, and the Almaciga and the submontane dipterocarp forests in Barangay Sebucal. These areas were found to have 14 endangered species, and high to extremely high endemism.

Likewise, the other forest types were considered important and should be given equal attention for they also served as sanctuaries, sources of regenerating materials, and species pool for flora and fauna for the other vegetation types. The plantation/degraded and the mixed lowland dipterocarp forests, which showed high species richness and endemism, affirmed that forest patches within predominantly agricultural areas were also worth conserving, protecting, and even expanding. If properly managed, these areas, along with the habitat corridors, would effectively conserve biodiversity and endemism in the lowlands.

A series of flora thematic maps, resulting from the TWINSPAN flora analyses, showed that the Almaciga forest obtained the highest number of flora species, thereby earning Category V (Extremely High) classification. This was followed by the cluster of northern and southern montane forests, the mossy forest in the south, and the submontane forest which obtained a rating of Category IV (Very High). The lowland dipterocarp, mixed dipterocarp, and mossy forests in the north were clustered together in Category III (High). The lowland mixed dipterocarp forest was classified under Category II (Moderate). Plantation and degraded forests was Category I (Low).

b. Vertebrates

The findings in the vertebrate faunal study, meanwhile, indicated that Mt. Malindang supported the findings that endemic species thrived in intact forests. This demonstrated the importance of older forests to terrestrial vertebrates, and affirmed Mt. Malindang's rich biodiversity and urgency for conservation efforts. Although this was the finding, local residents admitted that the abundance of fauna had become lower compared to what they observed in the 1940s. During that time, animals could easily be seen roaming around residential areas.

Since then, animals have fled to the forests and became scattered due to increased disturbance of their habitats.

The vertebrate faunal analyses also led to a color-coded thematic map to indicate the biodiversity index classification (Figure 46). This was not used, however, for the arthropod analysis wherein the Shannon-Weiner classification scale was used instead.

Findings of moderately high species richness in the submontane dipterocarp, Almaciga, and mossy forests demonstrated the importance of older forests to terrestrial vertebrates. The tree profile of these forest types was found favorable habitats for terrestrial vertebrates and microorganisms.

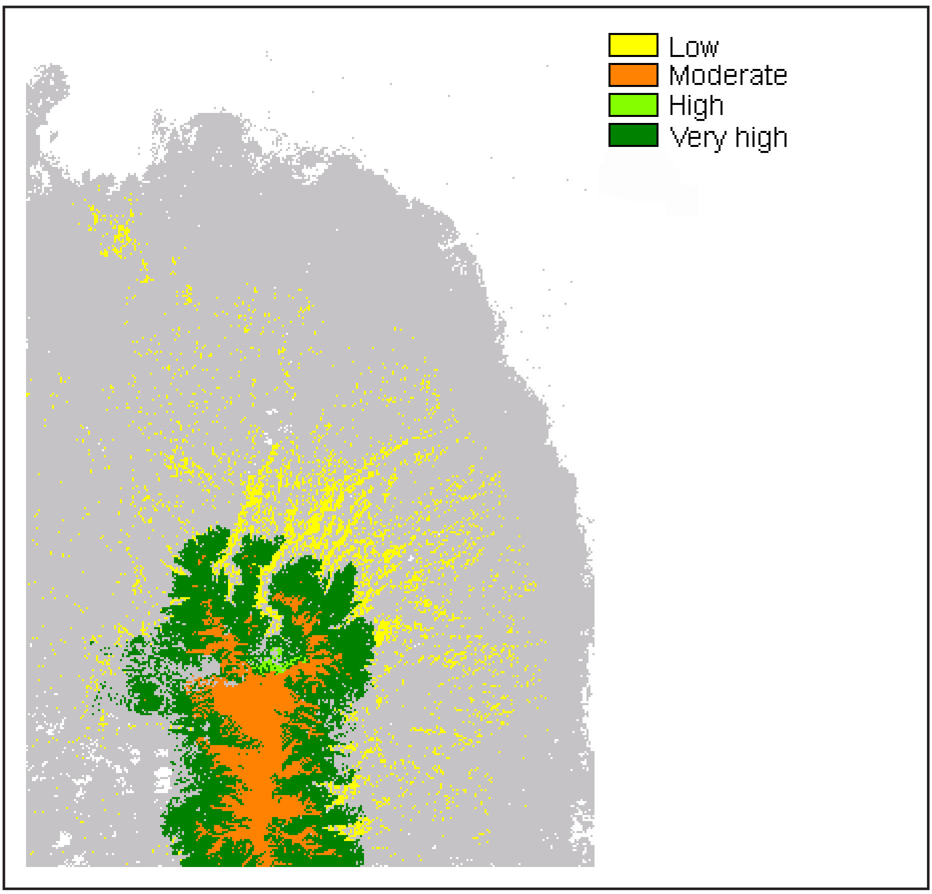


Fig. 46. Cluster data translated into a biodiversity map showing biodiversity value which is low in agroecosystems, moderate in lowland dipterocarp, mixed dipterocarp, and mossy forests, high in Almaciga forests, and very high in montane and submontane dipterocarp forests.

c. Arthropods

The studies have shown that arthropods have variable responses to weather conditions, and were often highly seasonal. It was thus difficult to determine if population differed because of sampling variations or just normal fluctuations. Nonetheless, methodologies were revised/improved as the studies were being conducted to obtain accurate and unbiased data on arthropod composition and population.

Results also showed that arthropod species diversity was found generally higher in the forest than in the agroecosystems. In terms of species composition, three major clusters of similarity among vegetation types were discernible as follows:

- similar arthropod species were found in five agroecosystem sites in Barangays Gandawan, Mansawan, Lake Duminagat, Mamalad, and Mialen with almost similar species found in Barangays Gandawan and Mansawan;
- similar arthropod species were found in the montane-mossy, the agrocereal grass-dominated, and the Almaciga forests in Barangay Sebucal; and
- similar arthropod species were found in the mixed lowland dipterocarp-plantation forests, agrocereal, agroforest, and mixed dipterocarp forests.

Three vegetation types showed little species similarities among each other or with any of the three clusters. These were the lowland dipterocarp forests in Barangay Mialen, the submontane dipterocarp forests in Mt. Capole, and the agrocereal grass-dominated systems in Barangay Peniel. The trophic guilds of the selected taxa indicated the biggest proportional representation of phytophagous, followed by the predaceous, pollinators, parasitic, scavengers, xyloborous, and ant species.

d. Coastal Studies

Coastal studies revealed the poor state of Mt. Malindang's fish stock. This should indeed be addressed as the proportion of people vis-à-vis the economically important fish in the research area was found to be lopsided.

Poor fish stock resulted from coastal resources degradation, especially the coral reefs, seagrass beds, and mangroves. Resource degradation may be due to the destructive anthropogenic activities in the coastal areas or through rivers which transported sediments. Direct reef destruction was caused by the mining of coral stones and coral sand for trade, and destructive fishing methods such as dynamite blasting and reef-front or reef-bottom trawling. Sedimentation was also caused by inappropriate agricultural and forestry practices, mismanagement of watersheds, exploitation of mangroves, and earth movements for the construction and dumping of terrestrial mine tailings and effluents.

Meanwhile, sedimentation, TSS and pesticide quantities were found to be within limits for fish growth. The direct relationship between poor fish stock and these pollutants have not been proven by the BRP studies.

CULTURAL DIVERSITY

Ethnicity

More than a million people currently depend on Mt. Malindang's watersheds, half of whom lived in the province of Misamis Occidental, while the rest lived in nine municipalities in the province of Zamboanga del Norte, and five municipalities in the province of Zamboanga del Sur. Population densities for the research wedge and the province of Misamis Occidental are given in Table 8.

Most of the people living in the coastal villages originated from various provinces in Luzon, Visayas, and Mindanao. The dominant ethnic groups were from the provinces of Bohol and Cebu. The Boholano and Siquijor migrants came in search of land, while the Cebuanos sought abundant fishing grounds.

The Subanun (also called Subanen, Subano, Suban'n) was the main ethnic group living in Misamis Occidental. They were the indigenous people who first occupied the Zamboanga Peninsula and Misamis Occidental. The *Piksalabukan Banwà Nak Subanun sak Misamis Occidental* (Organization of Subanun in Misamis Occidental) classified the Subanun into eight territorial divisions or *banwà* named after rivers or river systems which separated them geographically.

The Subanun were primarily farmers, although they also fished along the rivers and shores using their bare hands or spears, a fishing method called *manikop*. When migrants came, the Subanun bartered or exchanged their lands for axes, *sundang* (machete), and *tinaro nga ginamos* (salted fish stored in used gasoline containers).

The Subanun have nurtured their intricate coexistence with the forests and other ecosystems as these continue to provide them with the necessary resources for survival. Despite this, however, their resource

Table 8. Population, area and income classes of the municipalities and cities of the research wedge and the whole province of Misamis Occidental (2000).

Municipality/City	Population	Households	Area (ha)	Population Density (ha)	Barangays	Income Class
Research Wedge	199,356	41,910	111,149	1.79	237	
Sapang Dalaga	17,794	3,774	14,328	1.24	28	5th Class
Baliangao	14,552	3,255	7,705	1.89	15	5th Class
Plaridel	29,279	6,423	6,993	4.19	33	4th Class
Calamba	17,594	3,665	5,809	3.03	19	5th Class
Lopez Jaena	20,948	4,308	8,206	2.55	28	4th Class
Oroquieta City	59,843	12,417	17,576	3.4	47	3rd Class
Concepcion	6,900	1,487	7,318	0.94	18	3rd Class
Don Victoriano	9,319	1,815	31,455	0.3	11	5th Class
Aloran	23,127	4,766	11,759	1.97	38	4th Class
Bonifacio	27,810	5,502	13,109	2.12	28	4th Class
Clarin	29,712	6,094	8,262	3.6	29	
Jimenez	23,212	4,997	10,035	2.31	24	4th Class
Panaon	7,441	1,645	4,028	1.85	16	5th Class
Sinacaban	16,030	3,486	5,504	2.91	17	5th Class
Tudela	23,047	4,617	8,025	2.87	33	4th Class
Ozamiz City	110,420	22,170	16,407	6.73	51	
Tangub City	49,695	9,480	17,413	2.85	55	
Misamis Occidental	486,723	99,901	193,932	2.51	490	

* Municipalities were classified according to annual income (in millions of Philippine Peso) during the last three calendar years: 1st class > 35; 27<2nd class<35; 21<3rd class<27; 21<4th class<13; 13<5th class<7; 6th class<7.

utilization activities have been limited. They have a sense of security in maintaining their subsistence survival. Their coexistence with the forest environment has been marked by intensive farm work, but poor harvests, lack of social services, and poor health conditions.
This situation indeed renders them vulnerable to various problems.

At the time of the studies, the Subanun lived within and in the vicinities of MMRNP. Population consisted only of 4.38 percent of the total population of Misamis Occidental. The increasing number of migrants from the Visayas and other areas of Mindanao, that have established settlements along the coastal areas, forced the Subanun to retreat to the uplands of Mt. Malindang. About 900 Subanun were found living within the borders of MMRNP. Their livelihood largely depended on subsistence shifting cultivation and the collection of nontimber forest products.

Studies have revealed generally high population within and around MMRNP as compared to the rest of Misamis Occidental. However, the municipality of Don Victoriano experienced a rapid increase in population from 1990 to 1995. Plaridel, Lopez Jaena, and Calamba showed a very minimal increase of less than one percent during the five-year period. This could be attributed to the establishment of Don Victoriano as a new municipality during which migration was encouraged.

As a result, population growth rate in the municipalities of Jimenez and Tudela, during the period of 1980-1990, decreased as majority of the upland settlers migrated to Don Victoriano. This rapid migration contributed to rapid biodiversity loss because of encroachment into the forests for the cultivation of subsistence crops and subsequently the production of commercial crops.

Although this was the case, low population densities and high growth rates have been registered in the municipalities of Concepcion (94 persons/km^2) and Don Victoriano (30 persons/km^2). In reality, most of the human settlements in both municipalities were virtually located in the protected areas of the Park.

Most of the upland rural populations in Misamis Occidental were found dependent on the land and forests for their survival, while the rural lowland and coastal populations relied heavily on farm lands and fishing grounds. This dependency created serious implications to biodiversity conservation efforts but also presented opportunities for sustainable land and coastal resource management.

Settlement Patterns

Most of the pioneer settlers in the uplands of Mt. Malindang came from the lowlands of Misamis Occidental, and from the nearby provinces of Zamboanga del Norte and Zamboanga del Sur. The abundance of land and the invitation of religious sects, anchored on a promise of eternal salvation in what was then a frontier area. These were the factors that motivated migration to Barangays Lake Duminagat, Gandawan, and Mansawan.

Meanwhile, the rebel-military conflicts in the 1980s served as the main factor for in-migration to Small Potongan. Some of the major characteristics of these communities are listed as follows:

Uplands (with submontane dipterocarp forests)

- Mainly consisted of Subanun settlements, and clustered settlements on top of ridges or within valleys
- Were practicing subsistence farming (*kaingin* or shifting cultivation)
- Have established small-scale production of semi-temperate vegetables (cabbage, carrot, onions)
- Have limited accessibility although former logging roads have been converted to access roads

Lowlands (with riverine communities)

- Could be easily accessed by land transport
- Were producing rice and corn for home consumption in the upper slopes
- Have irrigated the rice fields in communities within 50-75 masl elevation
- Have planted coconut and fruit trees as major agricultural crops
- Undertook commercial quarrying of the Layawan River in Barangay Villaflor and the Langaran River in Barangay Tipolo

Coastal (with estuarine communities) Areas

- Could be accessed by any land transport or small sea vessels
- Have irrigated rice fields and coconut farms in Barangays Taboc Sur and Kauswagan
- Have established fishery, fishponds
- Were provided with basic services

Human, Social, and Financial Resources

a. Human Resources

The socioeconomic analysis of livelihood patterns in Mt. Malindang revealed that natural resources were still available and abundant in the uplands at the time of the studies. Physical infrastructure, government services, and financial assets or resources were also found accessible in the lowland and coastal areas. Lack of education and technical training (human resources) were observed in all the BRP research sites.

Educational levels appeared to be higher in the uplands than in the lowlands. This gap, however, was being addressed in the lowlands and coastal areas through training, seminars, and exposure trips. Residents in the lowland and coastal areas, however, have better media exposure and access to the capability building programs and health services of government agencies and NGOs.

Labor for hire (*panungha*) had become a good source of supplementary income for those with small farm plots or landless laborers. Hired labor and involvement in microeconomic enterprises indicated a strong trend towards diversification of income sources to meet the cash needs of households.

b. Social Resources

Social resources are also considered important assets, especially when livelihood conditions are poor, harmonious interactions are not present, and labor exchanges are constrained. Social assets are expressed when rituals are being valued and farming and hunting norms are widely practiced.

Social assets or resources across the landscape have been primarily generated through extensive kinship ties, either by blood or affinity. This was also referred to as bonding social capital. In the uplands, good relationships with government services were difficult to establish because of the relative inaccessibility of the communities. In contrast, enhanced social services were found in the lowland BRP research sites as these areas were near centers of governance. Hence, farm accessibility, availability of hired labor, and mechanization of some production activities were not considered problems.

Studies have also revealed that most of the residents of the upland and interior lowland communities were members of people's organizations that have been formed by foreign-funded NGOs in partnership with LGUs and government agencies, as compared to those which were organized solely by locally funded organizations or government agencies. A reason may be the relatively larger funding support that the former can command to support livelihood and infrastructure development.

Some people's organizations were found active in enhancing livelihood opportunities such as the two water users associations in Barangay Tipolo. The camaraderie shared by the members facilitated the exchange of learnings in agricultural technology, as well as the collective effort required in maintaining the irrigation canals. The associations purchased tractors and threshers through loans, that were being repaid from the proceeds of equipment rental by the members. The organization of the Subanun, the *Pie'k Salabukan Banwa Na'k Suban'n Sa'k Misamis Occidental, Inc., Banwa Langaran* (The United Territories of the Suban'n People in Misamis Occidental, Banwa Langaran) even went beyond livelihood concerns. They were also advocating the cause of the Subanun's right to self-determination and to its ancestral domain.

Religious groups have proliferated in the various BRP research sites. Affiliation with religious groups added security among the households. Trust in an omnipotent God balances the uncertainties of living under harsh weather conditions, possible crop failures, and other unpleasant circumstances. In the uplands, the more popular religious groups were the Rock Christ, *Piniling Nasud* ("Chosen People"), and *Katolikano*. In the lowlands and coastal areas, common religious affiliations were the Roman Catholic Church, the Philippine Independent Church, the United Church of Christ in the Philippines, and Iglesia ni Cristo, among others.

c. Financial Resources

The generally low income from farming, fishing, or non-farm and off-farm activities in all the research sites constrained the generation of savings. Credit to finance production, and emergency needs in the uplands and interior communities largely came from the informal sector or local middlemen as formal financial institutions were absent and interest rates were generally high. Residents in the lowland communities, near the town centers, and in the coastal communities, however, have access to formal credit sources that charge lower interest rates. Proceeds from the raising of backyard poultry, hogs, or cattle served as buffer against financial crises.

By using the 2002 annual per capita poverty threshold of PHP11,390 (NSO 2003) for the country's rural areas as benchmark, the households living in Mt. Malindang were found to be living below the poverty line as average per capita income was only PHP7,200/month. Funds to purchase fertilizers and pesticides for the vegetable plots, or to establish fishing operations could only come from loans. The problem of high interest rates of credits from informal sources necessitated the need to establish credit assistance to meet the financial needs of the communities.

Farmers in Barangays Villaflor and Tipolo, and the fishers in Barangays Taboc and Kauswagan have access to formal credit from the Paglaum Cooperative founded in their respective barangays. Financial support, in the form of remittances from migrants, played a key role in the mechanization of farming in Barangay Villaflor. The tractor and thresher were investments funded by the dollar earnings of kinsmen of a farmer-landowner. These equipment were being rented out to other rice farmers in the community. In the case of Barangay Villaflor, the tractors and threshers were purchased by the farmers through their respective cooperatives.

Foreign assistance programs with LGUs, such as the Philippines-Australia Local Sustainability (PALS) Program, funded by the Australian Agency for International Development (AusAID), and the former CARE-AWESOME Program (which ended in December 2004) were good sources of financial support for the upland barangays. PALS provided PHP1 M to impoverished barangays in Misamis Occidental, PHP300,000 of which were intended for infrastructure development, and PHP700,000 were aimed at supporting livelihood projects.

CARE-AWESOME, meanwhile, supported livelihood alternatives, capability building programs, infrastructure development, and forest protection. The agency distributed domestic animals and provided investments and training for abaca, coffee and fruit tree planting in support of the livelihood programs. CARE-AWESOME had been funding most of the activities related to the implementation of the National Integrated Protected Areas System (NIPAS) Act after the National Integrated Protected Areas Programme (NIPAP) ended in 2000.

Discussion

Studies have shown that the diversity of Mt. Malindang's socioeconomic environment have generally low or poor state of human, social, and financial assets or resources. These indeed pose serious threats to the sustainability of the natural resources and ultimately the biodiversity of Mt. Malindang.

The continuous increase in the population of Mt. Malindang required a proportionate increase in basic needs (food, shelter, and clothing) and services (education, health, livelihood, training). Hence, the inhabitants of Mt. Malindang's watersheds were constantly searching for ways to meet these basic needs. Inevitably, trees were being cut for firewood, construction materials, farming and shifting cultivation (*kaingin*), boat making, and commercial lumber. Resources in the lake and river systems were being used for irrigation, fishing, and quarrying. Coastal waters were being used for fishing, sea transport, and dumping areas for human garbage.

The mountain's upper slopes were slowly being converted into agricultural farms and human settlements that would definitely redefine the existing ecosystem. The cultivation of commercially viable crops, such as the semi-temperate vegetables, was found to be a financially viable livelihood for the upland communities. This would encourage the further clearing of the remaining forests for farm expansion. Although beneficial in the short run, the conversion of land into agricultural farms was found labor-intensive, and required high inputs of fertilizers and pesticides which could damage the environment in the long run.

On the other hand, rice farming had become widespread among the lowland communities. This livelihood undertaking provided people with additional rice supply. However, the high demand for rice resulted to an increase in the number of cropping cycles, from two to three crops a year, thus degrading soil fertility.

Also a major concern in Misamis Occidental was the poor state of fish stock in the coastal waters. This situation may be the result of biophysical and human developments in the Mt. Malindang landscape, and the degradation of its upper slopes that adversely affected the downstream areas, and ultimately the coastal ecosystems.

Unless the human, social, and financial needs of the population in Mt. Malindang are addressed simultaneously, the serious threats to biodiversity resources will be magnified in the next few years. Government and private programs, and project investments may help improve the livelihood conditions of the people in Mt. Malindang and indirectly halt the rapid loss of biodiversity and degradation of the whole landscape. These programs may focus on environmental awareness, information, education and communication (IEC), livelihood alternatives, credit facilities, and infrastructure development, among other areas.

4

Competing for Development and Survival

NATURAL RESOURCES

Land Use

Mt. Malindang's core area still has some intact forest cover. However, the rest of its watersheds have been cleared and dominated by grasslands, shrublands, coconut groves, and agricultural lands in the lower elevations. Of the total Mt. Malindang area of 193,932 ha, forests covered only 36,600 ha (21%). Open and deforested areas accounted for over 67,000 ha (40%), while the coconut groves covered over 46,000 ha (26%).

Shifting cultivation continued in the remaining forests. There were also extensive areas that formed a belt of *Imperata cylindrica* grass, shrubs, and young and regenerating secondary forest in the buffer zones. Since the lowland forests of Mt. Malindang have largely disappeared, the lower montane forests served as important sources of nontimber forest products such as food, firewood, building materials, round wood, and medicine. The lower slopes were rapidly being converted into agricultural farms and human settlements.

While laws and regulations have been formulated to protect and conserve Mt. Malindang, residents have ignored and avoided the laws to use and extract more resources. In the coastal study sites, population growth had intensified fishing. Mangrove forests in Barangays Taboc and Kauswagan have also been converted to residential and agricultural areas, clearly violating the Fisheries Code. Moreover, nipa swamps have also been converted either into fishponds or dwelling lots, especially in Barangay Taboc where high population density compelled some settlers to reside very near the shoreline. This situation further exposed the sea to the discards and debris from the people's livelihood and domestic activities.

These conversions have not only reduced coastal biodiversity but also permanently destroyed important coastal ecosystem functions, including the nursery grounds for juvenile fish, filtration of sediments and pollutants, and the protection of coastal land from erosion.

Forest Resources

ALTERRA's satellite image analysis of Mt. Malindang for the 1992-2000 period showed a deforested area of about 12,651 ha or 46.52 percent loss of forest cover. This implied a deforestation rate of 1,405 ha per year. Considering the 65 barangays located within and in the vicinities of MMRNP, deforestation occurs at an annual rate of 24 ha of forest per barangay. This means the disappearance of 33,700 ha of forests in

Mt. Malindang within 21 years. Using the DENR-PENRO's (Oroquieta City Office) recorded rate of deforestation of 667 ha per year in 1971-1996, it will take 51 years for the forests in Mt. Malindang to disappear. Figures 47 and 48 show the dramatic decrease of Mt. Malindang's forested area during the period of 1950-2000.

The plants and animals in the mossy forest provide food and medicine. Fortunately, these areas have remained relatively intact except on the mountain peaks where the occasional camping of mountaineers damaged ground cover vegetation. Some sites in the mossy forest of Mt. Ginlajan were considered sacred for the religious ceremonies of the Subanun.

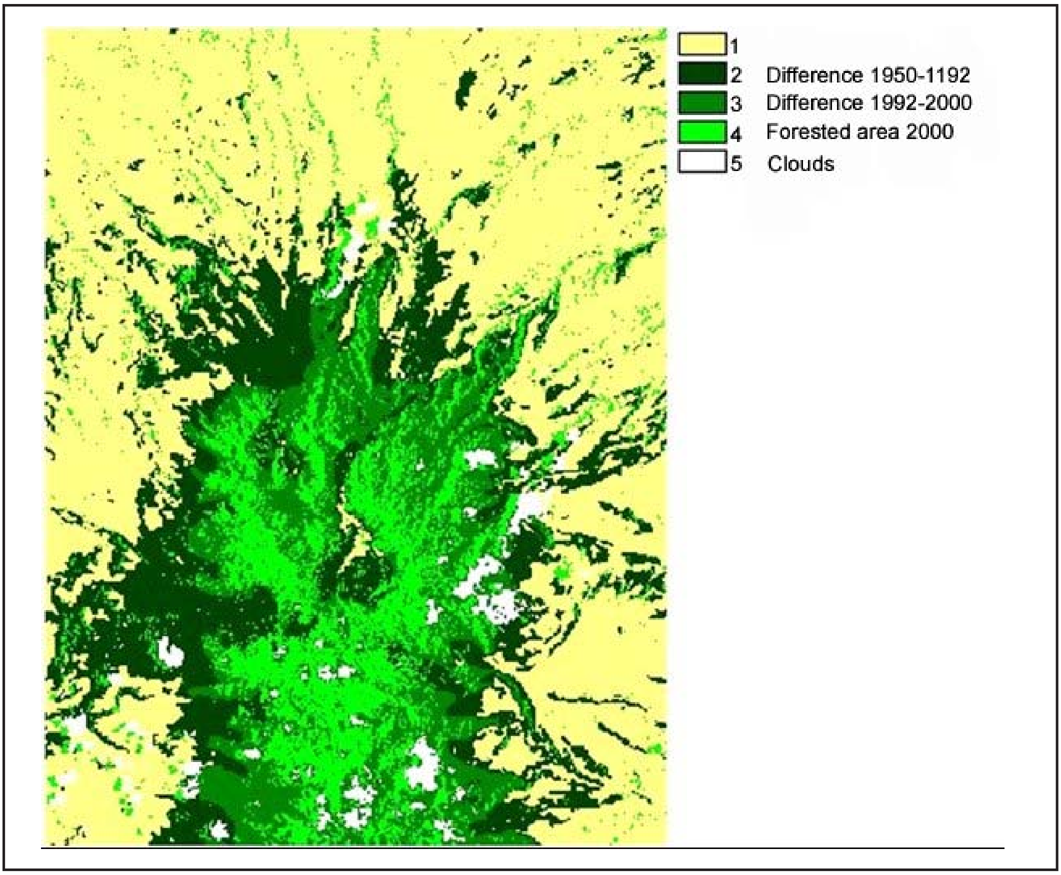


Fig. 47. Forest decline during the 1950-2000 period based on the 1950 topographic maps, and 1992 and 2000 satellite images.

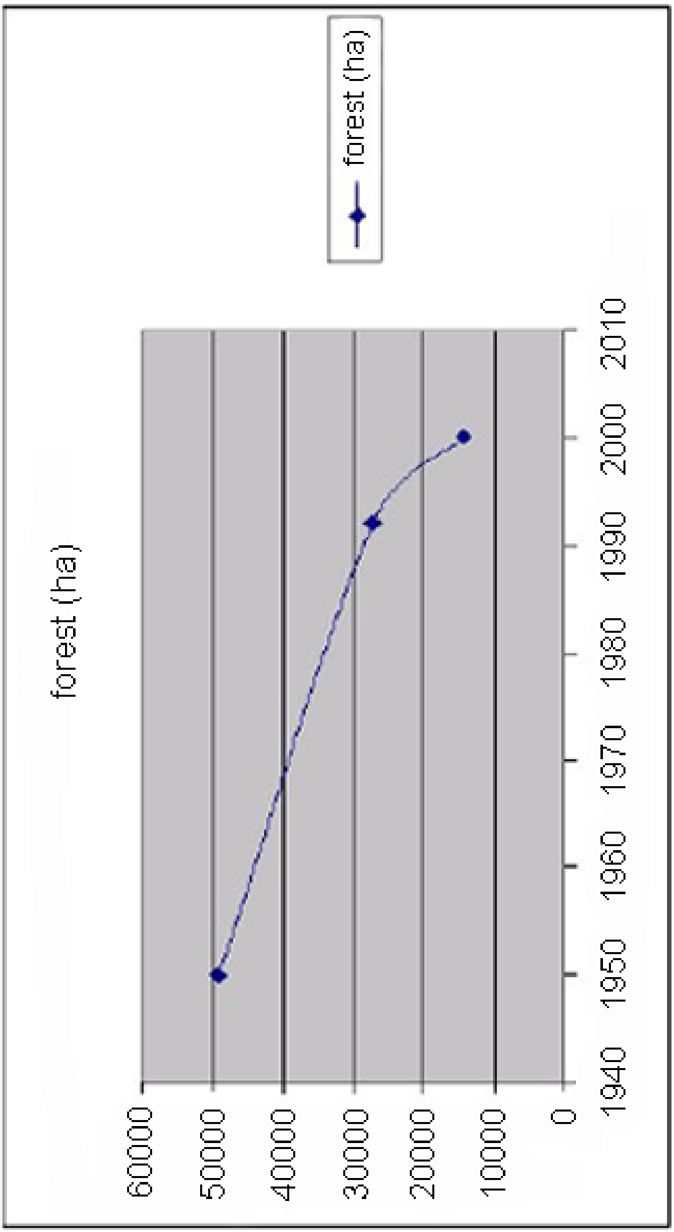


Fig. 48. Forest area decline (in ha) from 1950 to 2000.

The lower montane forest was now the most important source of nontimber forest products such as wild edible plants, firewood, building materials, round wood, and medicine. The Almaciga forests were important sources of building materials, firewood, and most importantly resin from the bark of *Agathis philippinensis*. The Almaciga forests were in great danger of disappearing because of continuous extraction of timber building materials (Figure 49), and intensive collection of resin. Likewise, the submontane dipterocarp forests were also important sources of food, firewood, building materials, timber, and medicine. The lower parts of the submontane dipterocarp forests have been logged and converted into agricultural farms.

Fig. 49. Old-growth Almaciga wood for house construction.

a. Local Demand of Wood for House Construction

The remaining forest cover was still the most important source of timber in building houses. Lumber estimates for household construction ranged from 37 to 67 bd ft, extracted at 15-20 cm diameter at breast height (dbh), and 5 m long. The number of trees being cut averaged from 15 to 26 trees per household.

Considering the total number of households in Barangays Gandawan, Lake Duminagat, and Mansawan, the consumption of wood for house construction would be 1,168.5-5,658 trees per barangay. These figures exceeded the forest stand in Barangays Gandawan (504 trees/ha), Lake Duminagat (877 trees/ha), and Mansawan (1,000 trees/ha) based on the flora study. This means that the rate of deforestation in the three barangays was between 1.5 and 7 ha per year for house construction alone.

b. Firewood Needs

Almost all tree species were being extracted for firewood. The average number of trees extracted weekly for fuelwood in the three barangays was 295 trees, with 15-20 cm dbh and a length of 5 m. This figure covered 38 percent of the average total number of trees per hectare (781-794 trees). Thus, the fuelwood needs of the three barangays were clearing one-third of trees per hectare every week and about one hectare every month. This rate will indeed decrease biodiversity in these areas.

The greatest fuelwood need was observed in Barangay Mansawan with a total extraction of 607 trees for its 276 households. This comprised 61-63 percent of the trees in one hectare. However, since the forests in this barangay have been degraded, the adjacent Barangay Palo, New Liboron became the main fuelwood source.

The use of *Lithocarpus* spp. (*Gulayan*), *Syzygium* spp. (*Pulayo*), and *Veburnum odoratissimum* (*Baho-baho*) for firewood caused the depletion of the population of these tree species. These species have now been classified as locally threatened. The SEC study indicated that the average extraction rate per week for every household was estimated at 0.192 m^3 or 2.20 trees (at 15-20 dbh and 5 m high).

Fig. 50. Rattan used for furniture, mats, and baskets.

c. Collection of Nontimber Forest Products

Traditional crude extraction practices did not consider the diameters of the trees to be tapped, and used horizontal cutting without a prescribed trunk thickness instead. Nontimber products extracted from the forests included rattan (*Calamus usithatus*) (Figure 50), nito (*Lygodium* sp.), and romblon (*Pandanus* sp.). Rattan was used for making basket strips and ropes. All the three species were being used to build furniture, and made into baskets and mats.

Medicinal herbs were also gathered from the forests. These included *busikad* (*Cyperus brevifolius*) and *bila-bila* (*Eleucine indica*), which were commonly administered for cough and fever, and *gabon* (*Blumea* sp.) which was administered for cough and flatulence.

d. Use of Wildlife Resources

A few of the residents were still found practicing wildlife hunting. Vertebrate fauna like the edible frogs, big birds, some volant and non-volant mammals, were being hunted as food or sold. Wildlife were being hunted mainly in the grasslands and farms near the forest fringes. Wild pigs, birds, and deer were usually trapped by the hunters and farmers.

Meanwhile, honey collection was also being done by the male household members in Barangays Lake Duminagat, Mansawan, Sebucal, and Peniel for family consumption. Some beehives, containing the larvae of the honey bees, were also collected for food or sold.

Likewise, the larvae and adults of the coconut beetle were used as protein source in Barangay Burgos, Lopez Jaena. Termites and *kalong* (crabs) were also being eaten. The naiads of the Odonata, called *kadang-kadang*, and termites were used as fish baits.

Agricultural Resources

Many upland communities were continuously planting cabbage (*Brassica oleracea* and *Brassica pekinensis*), green onions (*Allium fistulusum*), *sayote* (*Sechium edule*), carrots (*Daucus carota*), and root crops like yam, sweet potato (*Ipomea batatas*), and ginger. In fact, Barangays Lake Duminagat, Gandawan, and Mansawan could be considered farming communities that have upscaled into commercial production as early as the 1960s from the subsistence farming of root crops (Figure 51).

Traditional crops, such as sweet potato, *kanaka* (*Xanthosoma* sp.), and *gabi* (*Colocassia esculenta*) were also being eaten by the residents. In 2000, coffee and abaca have been introduced and sold to local markets. Backyard poultry and hog raising were also being done by several households, some of which even have a few heads of cattle obtained from a dispersal project of an NGO. In Small Potongan, fruits such as *marang (Artocarpus odoratissimus*), jackfruit (*Artocarpus heterophylla*), lanzones (*Lansium domesticum*), and banana were planted for seasonal sources of cash.

Fig. 51. Crops ready for transport to markets in the lowland communities.

The lowland/riverine communities depended primarily on farming with rice, corn, and coconuts as major crops. Coconut was found to be the main cash crop supplemented by fruits (jackfruit, banana, marang, and lanzones) and vegetables. Backyard poultry, goat and hog raising were other sources of income.

Copra from the interior communities of Barangays Peniel, Mialen, and Mamalad was usually sold to the middlemen (*compradors*) in the nearest towns. Spin-off livelihoods from coconut farming were coco-lumber trading, charcoal making, *tuba* (a local wine made from coconut juice) making, vinegar processing, broom making, and firewood gathering.

Farmers in Barangay Villaflor grew rice in commercial quantities that were being irrigated by brush dams, locally called *bati-bati* or *prensa*, that were established by assembling rocks across some areas of the Layawan River to channel irrigation water into the canals. The dam that was constructed by the National Irrigation Administration (NIA) in Barangay Tipolo in 1992, increased rice production and widened trade even as far as the provinces of Siquijor and Cebu through the port in Plaridel.

In the headwater areas, farms of corn, cassava, sweet potato, and *gabi* were located at the less steep downslopes. The steep slopes still have primary forest cover.

Freshwater Resources

The Langaran and the Layawan Rivers were being utilized as irrigation source and for quarrying. A gravel and sand quarry site in the Langaran River near Purok 4 in Barangay Villaflor provided off-farm income to all its 107 households. Quarrying was a major activity in the Langaran River in Barangay Tipolo with two concessionaires extracting sand and gravel of about 5,000 m^3 per year. It had been providing income to the residents since the 1970s, although the yield had been declining. The *quaristas* (quarry operators) now have to dig deeper into the river to get sand and gravel. In Barangay Tipolo, quarrying had already seriously affected the foundations of a bridge. Residents have been urgently requesting for the immediate regulation of quarrying activities from municipal officials.

Three big dams were constructed along the Langaran River. The first dam, which was built in Napisik-Sipukat, municipality of Calamba, were irrigating the rice fields of Baliangao (1,000 ha) and Calamba (300 ha). The second dam, which served as the communal irrigation system, was built in Nazareno in Barangay Tipolo by the

Association of Farmers. It had been irrigating more than a thousand hectares of rice fields in Calamba and Plaridel. The third dam, which was relatively small and located also in Barangay Tipolo, was irrigating the rice fields in the remaining parts of Plaridel towards the municipality of Lopez Jaena. The NIA dam remained as the only dam utilizing the waters of the Layawan River found directly at Purok 2 of Barangay Villaflor. Although the dam did not benefit the farmers of Barangay Villaflor, it provided irrigation to five other barangays in Oroquieta City.

At the time of the studies, tension was growing between the *quaristas* and the irrigators, the latter claiming that quarrying was adversely affecting brush dams and weakening the foundation of the concrete irrigation dams.

Coastal and Marine Resources

A major concern in Misamis Occidental was the poor state of fish stock in its coastal waters. This poor coastal biodiversity may be the result of biophysical and human developments, and degradation in the upper slopes of the mountain that were affecting the downstream areas and ultimately the coastal ecosystems.

Although considered as fishing communities, residents of Barangays Taboc Norte, Taboc Sur, and Kauswagan have also established irrigated rice fields and coconut farms. In the coastal study sites, the mangrove forests and nipa swamps, that used to serve as sanctuaries for fish and nurseries for their young, were converted into residential areas, coconut farms, and rice fields. The growing population, use of prohibited fishing gears, and encroachment by commercial fishers contributed to the continuous depletion of fish stock.

In the coastal community of Barangay Kauswagan, for example, there were about 44 ha of rice fields, and 25 ha of coconut lands. These lands were mostly being managed by tenants. The landowners living in the neighboring barangays either inherited or purchased these farms. Residential lots in the coastal barangays that were studied were either owned or rented. Lot sizes ranged from about 100-200 m^2, allowing very little or no space for gardens at all.

Most coastal communities of northern Mt. Malindang depended mainly on fishing as the major livelihood. The fishers were faced with the problem of dwindling fish catch which forced some to resort to blast fishing, fish poisoning with derris root and cyanide, compressor fishing, and use of fine-mesh net. These practices degraded the coastal ecosystems and caused resource depletion.

The state of coral reef and seagrass habitats, that partly contributed to the poor state of fish stock in terms of biomass, size, and species richness, may also be affected by human destructive activities especially blast fishing. The reef fish profile, being generally small-sized, can indicate overfishing, as noted in the SEC studies. Increased river discharge and transport of poor quality water (e.g., with higher TSS), with destructive human activities both upstream and in the coastal zones, will surely widen impact areas thereby degrading more coastal biota and depleting fish resources.

Most of the reefs within the two-kilometer radius from the river mouth were generally in poor to fair conditions with less than 50 percent live coral cover. Reef fish biomass was also generally low and composed of small individuals dominated by the damsel fish. Seagrass vegetation occurred about a kilometer from the river mouth in Oroquieta City but less than a hundred meters from Barangay Plaridel.

HUMAN RESOURCES

Demographic Changes

Because most of the rural populations in Misamis Occidental were dependent on the land, forests, and coastal resources for survival, biodiversity conservation will require sustainable land and coastal resource management.

In 2000, population density in Misamis Occidental was 2.51 persons per hectare which was lower than the national average of 3.07 persons per hectare, but higher than the regional average of 1.65 persons per hectare. The lowest population densities were found in Concepcion (0.94 persons per square kilometer) and Don Victoriano (0.3 persons per hectare). These were located in the Park's core protected area.

The province's population had continually increased, almost doubling in the last 40 years (1960-2000), due to the in-migration of people from the Visayan islands of Siquijor, Bohol and Cebu. On the other hand, there was a rapid out-migration in 1980-1990 in Tudela, Jimenez, and Sinacaban due to peace and order conditions.

Except for the municipality of Don Victoriano, which experienced rapid increase in population in 1990-1995, other BRP municipal sites, like Plaridel, Lopez Jaena, and Calamba, had a very minimal increase of less than one percent. The rapid increase in the population of the municipality of Don Victoriano contributed to the fast rate of biodiversity loss because of encroachment and subsistence farming cultivation.

Population growth was generally higher within and in the vicinities of MMRNP buffer zones like Barangays Mansawan and Gandawan in the municipality of Don Victoriano and Barangays Peniel in the municipality of Lopez Jaena. High population growth within MMRNP and its environs continued to put pressure on the natural resources (forests, river and springs, agricultural and coastal resources). At the time of the studies, there were 4,000 families living in the core protection zone, and 15,000 households around the Park that depended on its watershed resources (MMRNP-PAO 2004).

The upland Subanun communities in the core protection zone were faced with restrictions on resource utilization. The inappropriate application of cabbage farming techniques in the sloping areas, small-scale timber poaching in Barangays Mialen and Mamalad, and shortening of the fallow period for shifting cultivation were continuously depleting forest resources.

The increase in population also resulted in the intense competition for agricultural land, causing more and more marginal lands to be cultivated. In the upland study sites, the increase in the number of farmers shortened the fallow period and forced the farmers to work on infertile land. Legislations have also curtailed the further opening of forests for cultivation. In the lowland study sites of Barangays Villaflor and Tipolo, and the coastal communities of Barangays Kauswagan and Taboc Sur, cropping cycles of rice increased from two to three croppings per year to provide for the growing population, thus depleting soil fertility.

Likewise, the rising need for freshwater for domestic and agricultural use was continuously putting more pressure on natural springs and rivers. The irrigation waters of the rice fields in Barangays Mialen, Villaflor, Taboc Sur, Mamalad, Tipolo, and Kauswagan drain into the rivers and coastal areas carrying with them the residues of pesticides and inorganic fertilizers.

The harsh conditions in the upland barangays also forced women to migrate to the lowlands and work as domestic helpers either within the province or in the provinces of Cebu, Dumaguete, or even Manila. Remittances from the earnings of the migrants were seldom received and if so were reportedly low. Some off-farm income was also earned through hired labor and gathering of forest products.

Cultural / Social Resources

Biodiversity conservation cannot be dissociated from gender relations as this integrates the physical, biological, and the sociocultural environments. Gender indicates differences in access to and control of resources. Certain tasks in the livelihood activities were differentiated in terms of gender. For example, women did not engage in the heavy tasks of clearing and preparing (*pagsilab*) the farms. They were instead engaged in weeding, considered as a lighter farming activity.

The Subanun women in Mt. Malindang play secondary roles in farming, fishing, and hunting. Studies have shown that women in all the research sites helped only in seed preparation, planting, weeding, harvesting, marketing of produce, and in the performance of rituals. Land preparation, which involved clearing, burning or decomposing, and digging, was mainly undertaken by men as these activities were viewed as heavy tasks for women. Although planting was commonly participated in by both men and women, wetland rice planting in Barangays Mamalad and Small Potongan was scarcely done by women. Application of fertilizer or pesticide was likewise the task of the men as this was considered harmful for women.

Men and women shared in the weeding of the farms, although the men in Small Potongan finished it faster than the women. Harvesting was also shared among the men and women. However, hunting and fishing were done exclusively by men, except in Barangay Peniel where women also fish. Studies have shown that women were generally viewed as deficient in both the knowledge and skill that these activities required.

Although this was the case, the women have the sole responsibility of nurturing the family. They were also recognized to play critical roles as managers and protectors of the environment, and organizers of associations advocating environmental protection. A clear example of this role was seen in the provincial federation of the Subanun people's organizations where women leaders were elected by the members.

Among the Subanun, the role of women in productive activities or economy was found less visible than that of men. However, their role in performing religious rituals was valued in much the same way as the role of the men. While this dimension of life may not carry as much quantitative or monetary value as that of the economic dimension, it served as foundations for the strength and integrity of both individual and group life. Thus, the competence of women could indeed be tapped for leadership, advocacy, and the establishment of sustainable programs for resource management and conservation.

However, this primordial position of women in rituals was only observed in the upland communities of Barangays Lake Duminagat and Small Potongan. Because of distance from the lowlands, these communities were less exposed and therefore had minimal influence of other people and cultures.

Financial Resources

The generally low income obtained from farming, fishing or non-farm and off-farm activities in all the research sites constrained people from generating savings. Financial assistance for farm production and emergency needs in the uplands and interior communities largely came from private lenders because of lack of formal credit facilities in the areas. Residents in the lowland communities, near the town centers and along the coastlines, however, have access to formal credit sources that charged lower interest rates. As additional sources of income, the raising of backyard poultry and hogs, goats or cattle was found to be widely practiced.

High-value fruit crops such as pomelo, mangosteen, durian, marang, mangoes, and lanzones were commonly found in Mt. Malindang. Fruit tree farming was encouraged by the Department of Agriculture (DA) through its CARE-AWESOME project in 2000 to augment farmers' income and enhance the vegetation of the Mt. Malindang watersheds. However, the lack of tenurial security had been discouraging people from planting fruit trees due to the precariousness of user-rights over land as a result of the NIPAS Act.

To help gain tenurial security, several settlers in Barangays Mansawan and Gandawan, who were classified by NIPAS as tenured migrants or those who have resided in MMRNP five years prior to the passage of the NIPAS Act, have formed organizations which filed for certificates of stewardship under the Protected Area Community Based Resource Management (PACBRM). These organizations were the Mansawan Planters Development Association (MAPDA) and the Gandawan Planters Association (GPA).

In Barangay Mialen, large farmlands already have land titles but these were generally owned by non-residents or those living outside the communities. Absentee landlords were found prevalent in Barangay Mialen, and about a fourth of the farmer-respondents were tenants. Barangay Mialen is an agrarian reform community and has about 15 ha of land for redistribution. However, land reform has yet to be implemented in the area.

The practice of having tenants oversee the land of the absentee landlords was also widespread in Barangay Mamalad. The number of tenant-respondents were increasing among lowland riparian communities of Barangays Villaflor (a land reform community with around 30 ha of land for redistribution) and Tipolo.

In the coastal community of Barangay Kauswagan, where about 44 ha of land were rice fields and 25 ha were coconut lands, the number of tenants was found to be even higher. Again, the absentee landlords were either from neighboring barangays who inherited or purchased the farms. Meanwhile, the residential lots in the coastal barangays studied were either owned or rented with lot sizes ranging from 100 to 200 m^2, allowing very little space for gardens.

DISCUSSION

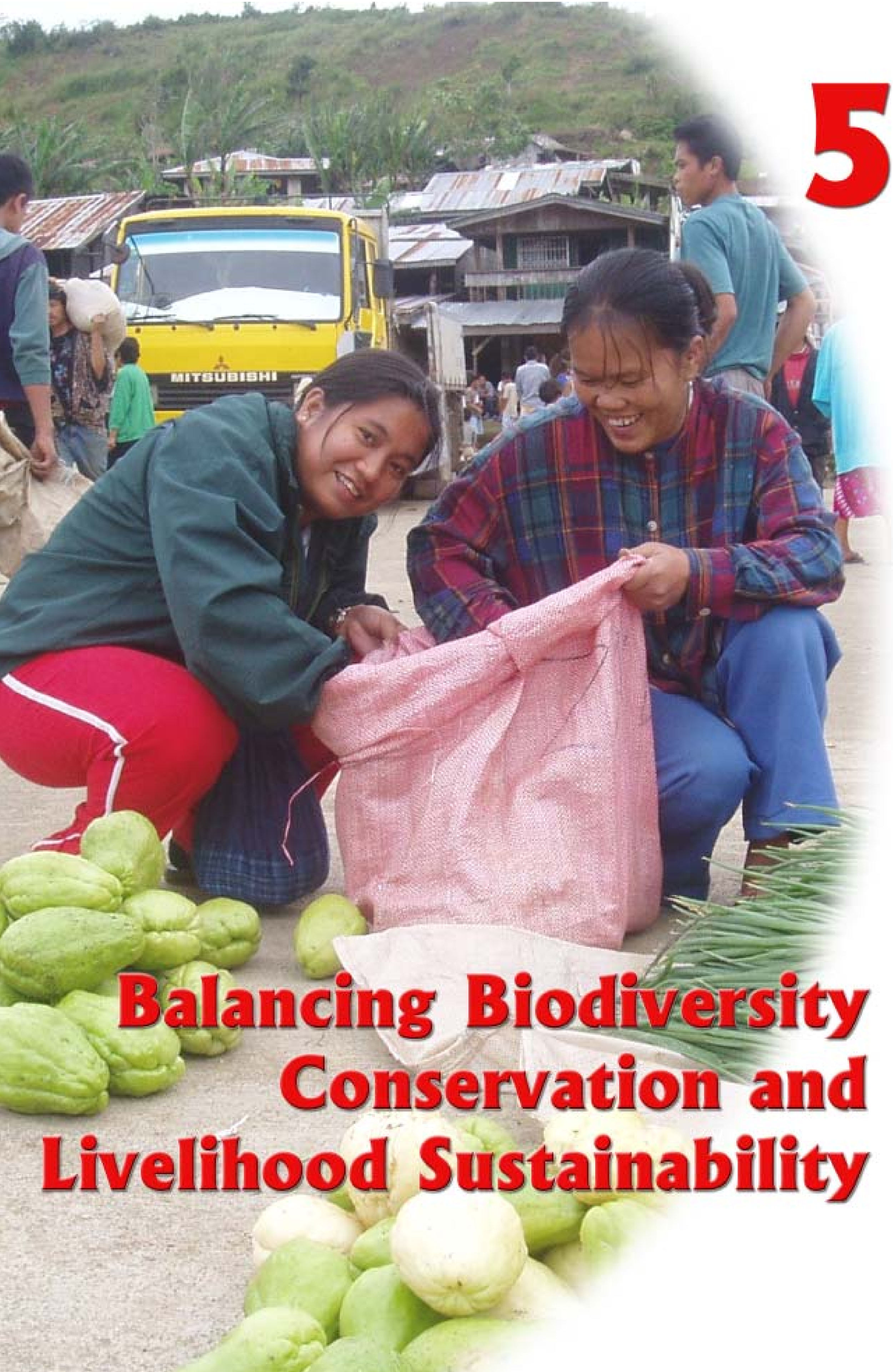
The commercialization of agriculture, forest products, fishery and other aquatic resources largely characterized the livelihood activities in Mt. Malindang. More competing uses of environmental resources have emerged to meet the challenges of development. Trees were continuously being extracted from the forests of the core protected area and the buffer zones, despite the implementation of the NIPAS Act. Rivers which were being used to irrigate farms have become quarry sites. Mangrove forests and nipa swamps were being converted into residential areas, coconut farms, and rice fields. Only plantation forests, planted mainly to monocrops, were found in the outer lowlands. Although the more interior communities still have forest patches, these were dwindling rapidly due to uncontrolled human encroachment. The forests in the uplands remained intact and have become the focus of protection efforts, laws and regulations both at the national and local levels.

Poverty and the ready accessibility of resources for timber, firewood, medicine, resin, rattan, wildlife, and other uses were continuously depleting the remaining resources of Mt. Malindang. The people's need for these resources for their survival could not be discounted amidst cultural and religious constraints which regulated the consumption and the encroachment of tilled lands into the forest, as well as the laws and regulations (e.g., RA 9147 NIPAS Law and RA NCIP Law) which further put legal barriers to the overexploitation of resources.

For example, to augment household incomes, rattan gathering can deplete the natural regenerative capacity of the stands by cutting even the immature stands. Improper collection of resin may kill the remaining Almaciga trees in the long run. Even the gathering of wild ornamental plants, medicinal plants, orchids, and epiphytes to supplement income could also pose danger to their biodiversity.

Most of the probable sources of overexploitation, as evidenced by the patches of sparse forests in most of the buffer zones, were the harvesting of round timber and lumber for household construction and repairs, and the collection of firewood for domestic uses. According to the SEC study, the average extraction rate of trees for fuelwood was estimated at 2.20 trees per week, per household at 15-20 cm dbh and 5 m high. This will surely exacerbate the present rate of forest degradation as population and human settlements continue to increase, and reforestation efforts continue be very limited.

Although, faunal extraction was not practiced as widely as before, the risk of losing the endemic and threatened species in MMRNP remains, as people continue to protect their gardens/farms with traps and other hunting paraphernalia. Hence, species and genetic loss, as well as habitat loss, for the flora and faunal resources will surely continue in the coming years.



5

Balancing Biodiversity Conservation and Livelihood Sustainability

POLICY CONTEXT

The declaration of Mt. Malindang as a protected area under the NIPAS Act certainly sets limits on human activities that could be done within and in its environs. It has inhibited the extraction of forest resources and expansion of cultivated lands. However, the efforts toward environmental protection and biodiversity conservation have consequently hampered people's livelihood. It is thus critical to find ways of balancing biodiversity conservation and livelihood sustainability in Mt. Malindang and its environs.

National Policies

Aside from the NIPAS Act (RA 7586), the national policies that also have direct concerns on Mt. Malindang were the Indigenous People's Rights Act or IPRA (RA 8371) and the Fisheries Code (RA 8550). As early as 1971, RA 6266 declared the Mt. Malindang range as a watershed and reservation area, and became a component of the NIPAS Act in 1992. Through Presidential Proclamation 228, the strict protection and buffer zones in Mt. Malindang were delineated in 2002. With this delineation, Barangay Lake Duminagat belonged to the core protection zone, while Barangays Gandawan, Mansawan, and Peniel were considered buffer zones. At the local level, some ordinances were formulated that may also have direct influence on the implementation of these national policies.

The NIPAS Act and IPRA are both very significant legislations to the terrestrial and riverine communities of MMRNP. The implementation of the NIPAS Act yielded significant accomplishments which included the formulation of a general management plan and the declaration of MMRNP as a full-fledged natural park by virtue of RA 9304 in 2004, among others.

While the NIPAS Act recognized the ancestral domain of the indigenous cultural communities (ICC) or indigenous people (IP), it was actually the IPRA that embodied the full recognition of ICC/IP rights and responsibilities. The implementation of IPRA hoped to assure the non-eviction of the Subanun from Mt. Malindang through some form of land ownership instruments, which they perceived as included in the implementation of the NIPAS Act. Unfortunately, there were no Certificates of Ancestral Domain Claims (CADC) granted in Misamis Occidental. The CADCs that were given prior to IPRA still have to be converted to Certificate of Ancestral Domain Titles (CADT).

Studies have shown the low level of awareness among the terrestrial and riverine communities regarding the provisions of the NIPAS Act. Majority of the population were aware that Mt. Malindang had been declared a protected area and with this, the cutting of trees was prohibited. Only a few thought that such areas protect and preserve the co-existence of both people and the natural resources therein. Most of the residents in the uplands and riverine areas where the Subanun mostly settled were also unfamiliar with IPRA and its provisions. This extremely low level of policy awareness could be attributed to the minimal and ineffective information dissemination campaign on the NIPAS Act and IPRA.

Regarding coastal resource management policies, municipal fishers were aware of some illegal fishing activities and gears that have been prohibited by the Fisheries Code. These included dynamite fishing (Figure 52), use of commercial vessels, encroachment into municipal waters, and use of fine mesh nets, among others. However, while the fishers acknowledged the positive impacts of complying with the prohibitions, some of them admitted involvement in such illegal activities.

Fig. 52. A blast fishing device found unexploded in the coastal waters of Oroquieta City.

Policy enforcement largely depended on the availability of manpower and logistics, as well as the effective implementation of concerned agencies and organizations. A major issue in policy enforcement was the non-compliance and defiance of prohibitions because of the general lack of understanding on the long-term negative consequences of illegal activities, and the people's more immediate concern for livelihood. Policy enforcement also suffered because of lack of local government commitment and weak political will.

The NIPAS Act ceased commercial logging in MMRNP. However, some data indicated the destruction of some forested areas in Mt. Malindang. Deforestation continued in various parts of MMRNP because of timber poaching and the sale of timber to lowland buyers, shifting cultivation, firewood collection, and tree cutting for house construction and boat making.

The formation of the Multi-Sectoral Misamis Occidental Anti-Illegal Logging Task Force on 10 September 2004 confirmed the existence of rampant illegal logging in MMRNP. Hence, the full potential of both the NIPAS Act and IPRA in conserving and maintaining biodiversity in Mt. Malindang has yet to be realized.

Policy Awareness on the Core Protection Zone

Studies have affirmed the low level of awareness regarding environmental policies and their positive impacts on the environment. Because of this, residents were having difficulties in complying with the policies particularly if they have immediate adverse effects on their livelihood.

In Barangay Lake Duminagat, majority of those who were aware of Mt. Malindang as a protected area were mostly the vegetable farmers. The NIPAS Act reduced their farm areas with the delineation of MMRNP's core protection zone. Some residents claimed that they have been occupying the area long before the passage of the NIPAS Act and the boundary delineation. To avoid conflict, DENR allowed the cultivation of some areas as long as they were within the demarcation boundaries. However, the expansion of vegetable farms was not allowed.

In the buffer zones, Barangay Gandawan residents indicated that the declaration of MMRNP as a protected area did not affect their livelihood as their communities and vegetable farms were far from the demarcation line of the core protection zone. On the other hand, the respondents from the riverine communities indicated that their livelihood was negatively affected by the declaration of the protected area mainly because of the prohibition on the cutting of trees.

In Barangay Mialen, the cutting of trees for timber was the main source of livelihood of some residents who were paid by contractors from Oroquieta City. The inaccessibility of the barangay did not deter illegal logging since timber was being transported through the river.

Although people were aware of the penalties for cutting trees, results of the policy study indicated minimal compliance if not outright defiance of this prohibition. This could be explained by the people's continued dependence on wood as fuelwood for home consumption, their belief that cutting of trees for house construction and repair was allowed, and the lack of alternative livelihood. The residents also believed that expansion of their vegetable farms could only be done by cutting trees.

Another reason for the non-compliance or defiance of the policies was the available market for wood and wood products. The riverine communities were found supplying wood for the downstream barangays. The case of Barangay Nueva Vista was different, however, because the market for fuelwood was high within the community itself.

Armed violators that threatened the forest guards, and involvement of the protectors or implementers of the policies in illegal activities were also some of the reasons for non-compliance of the policies.

Local Ordinances and Regulations

National policies normally provide the general framework, which may not necessarily conform to what are actually happening at the local level. The operationalization of national policies necessitated the formulation of ordinances at the local level.

a. Provincial Ordinances

The Local Government Code of 1991 served as the basis in formulating the provincial ordinances in Misamis Occidental. An example would be the Misamis Occidental Environment Code (Provincial Ordinance No. 001-2000) which recognized the NIPAS Act as among the governing laws of its forestry provisions. The ordinances also addressed certain provisions of the NIPAS Act, particularly the prohibition clauses. They explicitly prohibited the hunting and killing of birds and wild animals, as well as the use of power chain saws, within the barangays inside MMRNP (Municipal Ordinance No. 08-03 and 16-02, respectively).

Most of the local ordinances highlighted the penalties for violators. These included fines, imprisonment or both. The ordinances also imposed penalties on officers who refused to apprehend violators. There was one particular ordinance that provided incentives to the barangay personnel (officials or volunteers) who were directly involved in the arrest of violators (Municipal Ordinance 16-02).

b. City and Municipal Ordinances

Unlike provincial ordinances, municipal and city resolutions only served as recommendations and thus were not binding. Nonetheless, the number of resolutions passed indicated the intent of the local government to address biodiversity concerns in Mt. Malindang.

Among the municipalities, Lopez Jaena had the most number of resolutions and/or ordinances formulated concerning the environment. The municipality of Don Victoriano, on the other hand, passed one resolution because it was only established in 1990. Understandably, coastal municipalities have more resolutions and/or ordinances that addressed environmental issues in their respective areas.

For Oroquieta City, 13 resolutions that created impacts on Mt. Malindang were adopted by the local government from 2 July 2001 to 11 August 2003. The resolutions covered information dissemination initiatives on the prohibition of certain activities, from the catching of spiders to deep-sea fishing within municipal waters.

Among the different municipalities, Calamba had the least number of resolutions and/or ordinances that created impacts on Mt. Malindang. Between August 1999 and July 2003, the municipal government of Calamba approved four resolutions and one ordinance. One interesting resolution that was approved in 2003 was the voluntary payment of PHP10 from heads of offices, and PHP5 from regular employees for the protection and maintenance of MMRNP (Municipal Resolution No. 84, Series of 2003).

As for the municipality of Lopez Jaena, almost all the ordinances that were formulated addressed the protection of coastal and marine resources. Furthermore, all ordinances carried penal provisions for offenders, usually a fine of not less than PHP100 and/or imprisonment not exceeding a year.

The recommendatory nature of the resolutions made it difficult to determine their impacts on the environment. Likewise, the local ordinances were not that effective because there was no specific unit in the local government who was directly responsible for their implementation. Although the ordinances were basically punitive in nature, they nevertheless indicated the LGUs' recognition on the importance of protecting MMRNP.

BIOPHYSICAL MANAGEMENT

Practical Applications

Indigenous agroforestry practices are considered products of experiences, problems, and solutions. They evolved as a strategy for people to adapt to existing biophysical and socioeconomic conditions in the uplands. In Mt. Malindang, the following agroforestry systems were being practiced:

a. Slash-and-Burn / Swidden Farming

Locally called *kaingin*, this type of agroforestry system raises crops by using decomposed plant residues. This type of farming was usually done on logged-over or fallowed areas located in highly elevated or sloping lands. Hence, these farms were very susceptible to surface runoff and erosion, further aggravated by the clean cultural practice of totally removing the trees in the plot, and the planting of cabbage and onions on newly opened sites. Root crops, such as sweet potato, were also planted in this type of agroforestry system to help offset decline in soil fertility. The Subanun farmers, meanwhile, practiced long fallow periods of three to four years to restore soil fertility.

b. Cultivation in Rolling Areas

Subanun farmers in the uplands were found to prefer the cultivation of vegetables and corn in rolling areas. They found it easier to work standing across the slope than bending over as what lowland farmers do.

c. Performance of Rituals

Most farmers in Don Victoriano still believed in performing rituals and paying homage to the mountain spirits prior to farming.

d. Crop Rotation

Locally called *sal-ang*, crop rotation was being done by some farmers in Barangay Gandawan when soil fertility was perceived to be declining, as indicated by the poor quality and low yield of the current crop. Some farmers in this barangay would alternately plant *kamote*, cabbage, or Chinese cabbage in plots that formerly yielded poor quality or low volume of green onions.

e. Construction of Rock Walls

Locally called *balabag*, this system made use of decomposing logs to minimize soil erosion.

f. Soil Erosion Measure

Sweet potato was found planted at the lower portions of the farms to trap eroded soil.

g. Use of Supporting Technologies

Some lowland farming technologies were modified to adapt to upland conditions. These included the application of fertilizers to cash crops, such as cabbage and green onions, the construction of diversion ditches or dikes, the non-burning of uprooted weeds, multiple cropping, and the use of some ants as biological control agents in cabbage production.

In general, farmers did not practice contour farming techniques such as the sloping agricultural land technology (SALT). SALT is a popular agroforestry system being established with the use of contour strips of legume trees or hedgerows. The spaces in-between hedgerows were planted with annual crops. Farmers complained of the huge investments in time and labor required by this type of agroforestry system.

In addition, studies have revealed very few capacity enhancement training courses on contour farming, although training on the proper application of fertilizers and integrated pest management have been provided by DA, DENR, and the CARE-AWESOME project. DENR and CARE were reportedly active sponsors of seminars on the planting of fruit trees and abaca. CARE even funded projects on fruit tree and abaca planting from 2000 to 2004. Seminars on livelihood and access of formal credit, meanwhile, were found common in the coastal communities.

The use of crude and old resin extraction practices by residents of Barangays Sebucal and Lake Duminagat have extremely threatened the survival of the Almaciga trees. Hence, training programs on correct and scientific resin tapping procedures are urgently needed.

Coconut farmers, meanwhile, were practicing the girdling of the coconut stem on the first one meter above the ground to remove dead adventitious roots which they believed could induce fruiting. This belief was found to conform to scientific findings that tapping/creating

bark injuries would induce the release of the stress hormone ethylene. Ethylene is being developed within the plant system. As it enters into the plant stomata, it can induce maturity and fruiting of the coconut trees. The farmers were also found to practice the wrapping of the coconut stem with galvanized iron and plastic floor mats to prevent rats from climbing and eating the young coconut fruits.
For its part, mangrove reforestation, the first management intervention implemented in Barangays Panalsalan and Mobod, was found to be the major factor that contributed to high fish yield in these sites.

Indigenous Knowledge Systems (IKS)

While relatively high in population, the Subanun did not develop into a unified political force due to the dispersed location of their communities. The Subanun's villages were situated atop ridges or within valleys, and their houses were basically clustered at the center of the community. Most of the farms (*ba-úl*) ranged from one to three hectares in size that were located approximately one to two kilometers away from the houses. In Barangay Lake Duminagat, the farm lots were located on the eastern side of the community where the sun rises (*sidlakanan sa adlaw*).

The Subanun believe in a supreme being, referred to as *Apo Gumulang*. They invoked the spirits for various reasons: a) to seek the cure for illness and the restoration of one's health, protection against harm wrought by evil spirits, b) to appeal for a successful marriage, assured food supply from plants and animals, or successful assembly and meetings, and (c) to thank for bountiful harvests or good fortune.

a. Fauna

This has a role in the culture of the Subanun. The call of the *alimukon* or dove warned them not to leave the area thus resulting to postponements in scheduled travel arrangements on that day. The call of *pungak* or the Giant Scops Owl (*Mimizuki gurneyi*), as shown in Figure 53, or from the Grass Owl (*Tyto capensis*), indicated the presence of a wild pig in the farm. The call of *pisupit* or Plaintive Cuckoo (*Cacomantis merulinus*), Brush Cuckoo (*C. variolosus*), or the Oriental Cuckoo (*Cuculus micropterus*) signaled the start of farming or what was locally termed

Fig. 53. The call of the Giant Scops Owl (Mimizuki gurneyi) indicates the presence of a wild boar.

as *ting baul na*. In the absence of a clock, communities relied on the *kalaw* to tell the time. Calls of *bakbak* indicated a full moon or the coming of rain. In the past, the Subanun also believed that monkeys should not be hunted and eaten as they were also believed to be like humans.

Indigenous knowledge on arthropod species was very little and limited only to the common uses of honey, butterfly color symbols, weather forecasting by *kalong*, ritual for tree blooms, and for honey foraging and predation of a vespid wasp, *Ropalidia* sp. on the larvae of diamondback moth. The presence of butterflies in their houses was also considered signs. The red butterfly meant war or trouble, a white butterfly symbolized an upcoming wedding, a brown butterfly symbolized money, and a black butterfly meant death.

b. The Subanun's Seasonal Calendar

The seasonal variations in MMRNP could be attributed to its physiogeographic characteristics. These variations dictated the Subanun's activities as they interacted with the environment as depicted in their own calendar. Their calendar consisted of two general seasons over a one-year cycle — the *tindupî*, or rainy/wet season and the *p'ras*, or the sunny/dry season. There were also five intermittent seasons, namely: *samalunâ, gan'us dupî, p'ras gan'us, gan'us,* and *p'ras gilat/lugong*, described as follows:

- ***Samalunâ*** – occurs when the rainy and sunny periods happen in succession, usually lasting only for a month;
- ***Gan'us dupî*** – occurs when frequent rains are accompanied by occasional winds/storms which are common to upland barangays;
- ***P'ras gan'us*** – occurs when sunny periods are accompanied by winds/storms which are peculiar to the upland barangay of Small Potongan;
- ***Gan'us*** – occurs when there are storms with strong winds which are very particular in the upland barangays of Lake Duminagat and Mansawan, and the lowland barangay of Peniel; and
- ***P'ras gilat/lugong*** – occurs when there are storms during sunny periods which usually happen in the lowland barangay of Mamalad.

The type of season also dictated the appropriateness of agricultural activities being undertaken by the Subanun. In planting wetland rice, the cropping season was patterned after the *tindupi,* since rice fields were heavily dependent on rain. Farm preparation, like the cutting of grass, shrubs and small trees (*bunglay*), was also done during this season. In the succeeding season (*p'ras*), the cuttings were then set and dried for burning (*silab*) to be easier.

Fig. 54. One of the Subanun customs involves the brushing of leaves of the mayana plant that were dipped in chicken blood across the palms of the Subanun tribal leaders.

The season of *p'ras* was found to be the most appropriate for upland crops like corn and root crops. Fishing activities were also undertaken during *p'ras.* While hunting may be done at any time, many Subanun, however, regarded *p'ras* as the season most suitable for hunting.

The early Subanun settlers used to plant root crops (*kamote, gabi, kanaka*), corn, and upland rice during *p'ras.* Lately, the seasons have become unpredictable due to environmental changes. This compelled farmers to plant such crops even in other seasons.

c. Traditional Resource Use Patterns

Many Subanun customs were closely related to the belief in spirits that govern or own (*guipanag-iya*) the environmental resources (Figure 54). These beliefs somehow restrained the open access and control over such resources. Areas that were believed to be either not guarded or owned by the spirits were thus not over utilized.

d. Farming

The traditional farming practices of the Subanun were conservation-oriented. Rituals were performed before (*pailis*) and after (*liso-batang/ pahabog*) planting, and during harvesting (*pasungkò*). A traditional practice, *palihí* involved the periodic planting of kamote and gabi during the new or full moon. They also used *balabag* for soil conservation, and awaited the opening of the flower of a particular orchid, *ting-ulan*, to indicate the coming of rain.

e. Hunting

The Subanun hunted for home consumption and pest management. Although disallowed by existing environmental laws, the Subanun still continued hunting although they practiced: a) extra care in hunting for dogs, b) the construction of warning or danger signs for their traps, and c) the performance of rituals. They believed that wildlife were being guarded and controlled by the spirits, and could be effective restraints or regulatory mechanisms for biodiversity conservation.

Hunting was also patterned after the seasonal variations in the area. When hunters were not busy in their farms, they hunted for wild pigs and deer as frequently as three times a day especially during the season of *samalunâ* (when rainy and sunny periods occurred interchangeably), and during *ganus dupì* (rainy with occasional winds or storms). The Subanun believed that the flowering and fruiting of *gulayan* (*Lithocarpus* spp.) indicated hunting time for wild pigs.

In some areas, however, there were very little or no hunting at all during rainy days as this was believed to be the mating period of wild pigs. Hunting resumed during the cropping season. In Barangay Lake Duminagat, hunting was not done during *dugmon* (dormancy) and *ting-anak* (birthing) in the month of December.

Farmers were found to use traditional traps to control animals which they considered pests, like rats, monkeys, and wild boar.
These traditional traps were made of local materials, e.g., *gahong, balatik, lit-ag,* and *suyak*. The less dangerous traps or *lit-ag,* such as *giman, kilat,* and *gahong,* were still used to ensnare wild animals, although some hunters used the *pali-untod* (homemade shotgun).

The Subanun performed rituals (*apal*) prior to hunting to request the blessings of the deities whom they considered as guardians of wildlife. The rituals set the rules and guidelines for the Subanun to hunt or not to hunt in specific areas. However, deforestation and the wildlife's loss of habitats discouraged hunting among the Subanun. They instead resorted to the backyard raising of pigs, chicken, cows, and goats.

Wildlife was being hunted in the forest or along the banks of rivers, creeks or streams. In the case of game birds, only the small ones, such as the *kulasisi* (parakeet) were being hunted. Hunting for game birds was timed when they were feeding on the fruits of the forest trees. Birds were found abundant in the months of March to April, and August to September when trees were in their fruiting stage.
Wild pigs and monkeys were found more abundant from July to August, during the harvesting of corn.

f. Fishing

Fishing by the Subanun in the rivers and creeks helped to support for their subsistence. The most common fish caught were *paitan* or *pait-pait* and *kasili* (eel). Because fish had become scarce, fishing was only done when the farmers were not busy in their farms. When *kalongs* (crabs) were found in the areas, local people believed this to be a sign of coming rain.

Integrated Pest Management

From 2004 to early 2005, BRP promoted farming technologies among the cabbage growers in Barangay Gandawan. The technologies demonstrated lesser chemical farm inputs and integrated pest management approaches.

According to key informants who have adopted the technologies, organic pesticides using *tubli* (*Derris* sp.), hot pepper, tobacco, and horse manure were found effective. Concoctions, made out of pounded leaves of tobacco, *madre de cacao* (*Glerecidia* sp.), and *tubli*, were also made and mixed in water to control vegetables pests. However, the lack of tobacco supply in the area ceased the preparation of these concoctions.

The ants were likewise utilized as biological control agents against the worms (*bitay-bitay*) attacking the cabbage. Coconut *sapal* was spread on the cabbage plants to attract the ants.

Ex situ Biodiversity Conservation

The establishment of a nursery (Figure 55) and a community economic garden did not serve as livelihood projects but also *ex situ* strategies in conserving the remaining biodiversity in the forest. This *ex situ* conservation technique allowed the use of plant resources without depleting its natural population in the wild.

Fig. 55. Nursery for ex situ raising of endemic, rare and economically important plants.

Local researchers helped select and collect priority endemic and economically important species. Hence, 16 species of wildlings and 40 species of ornamental plants were propagated in the established nursery and greenhouse, respectively.

The outplanted hardened wildlings along the roads and trails of Barangay Mansawan showed a high percentage of survival. As a participatory project, the research results have helped draft a barangay resolution in Barangay Mansawan that would segregate an area for rainforestation where tree planting would be done by the local residents. Another barangay resolution was also drafted that prohibited animals from grazing along the trails and roads where the wildlings have been outplanted.

HUMAN RESOURCE DEVELOPMENT IN RESEARCH

Involvement of Researchers

The participatory nature of conducting the various studies made BRP’s implementation unique. It involved the participation of researchers from the different research institutes in Mindanao and the Netherlands. The researchers, especially the local researchers, were continuously informed of the needs of the local residents and the actual problems regarding the communities’ biophysical conditions, including the various sociocultural customs.

Stakeholder Involvement at the Grassroots

During the initial phase of BRP’s implementation, free and prior informed consents (FPIC) of the communities in the study areas were obtained according to standard protocols. The studies were also discussed first with the local leaders and key persons of the NGOs, national government agencies, and other government organizations in the barangays through consultative assemblies. Scheduled by the barangay leaders, these assemblies discussed the BRP objectives, principles, vision, and goals. It was also during these activities that the research objectives were enriched through the suggestions of the local residents, and local research partners were identified.

Aside from these assemblies, TEMP also conducted community information drives that increased community awareness on BRP while eliciting the residents' cooperation and participation. Leveling-off activities among researchers and research assistants were also done to facilitate consensus-building on sampling methodology and data gathering procedures.

Capacity Building in Research

To enhance the capabilities of the local researchers, training programs, workshops, information dissemination drives, meetings, and consultations were conducted particularly on the various research methods, techniques, data collection procedures, and field sampling techniques. These activities made use of lecture-discussions, hands-on sessions, field exercises, and consultations regarding possible modifications to commonly used data gathering techniques.
The capacity building exercises focused on the collection and preservation of flora and fauna specimens, collection and analysis of field data, plant taxonomy, herbarium processing and management, gender sensitivity, plant propagation, nursery operations, silviculture and horticultural practices, and sampling techniques for marine resources.

To maximize stakeholder participation, the training sessions also served as venues for program staff and local researchers to get acquainted and be comfortable as co-researchers. At the same time, these sessions provided them with opportunities to brainstorm and strategize to facilitate the implementation of the various BRP studies.

a. Biodiversity Monitoring and Evaluation System (BIOMES)

Developed by Central Mindanao University (CMU) and the Bukidnon Resource Foundation, Inc., this instrument was introduced to the members of the community monitoring teams (CMTs), and TEMP researchers and participants through a training-workshop in December 2004. The workshop helped improve the biodiversity monitoring and evaluation (BIOME) system, and developed corresponding 10-module training manuals.

b. Training-Workshop on Taxonomic Techniques

Meanwhile, the training on taxonomic techniques and the subsequent involvement of local researchers in conducting research inventory enhanced their skills on the various inventory techniques, and grouping of plants by habits (tree, shrub, herb, vine), and taxonomy (bryophytes, lichens, ferns and fern allies, gymnosperms, and angiosperms).

In addition, they also developed skills on proper documentation, collection and pressing of specimens for herbarium vouchers, proper plant collection, bagging of plants, and the use of some instruments for ecological data monitoring.

c. Community Validation

In maintaining the participatory nature of BRP, community validations were implemented towards the end of the research studies (Figure 56). Preliminary research results were presented to the residents of the various research sites for validation and/or clarification. Present in these meetings were the barangay captains, other members of the barangay council, representatives of people's organizations, key informants, and local research partners. Moreover, livelihood security, environmental sustainability, and relevant recommendations were discussed that further enriched the research findings and made them more accurate.

Fig. 56. Community validation.

The indigenous knowledge shared by the Subanun researchers likewise enriched the scientific identification of plants, and supported the establishment of a nursery of fast-growing trees and a community economic garden as potential livelihood projects for biodiversity conservation. The local researchers likewise contributed a lot in identifying medicinal plants that further enhanced the use of the research results.

Awareness Raising

To sustain the initiatives of TEMP, the flora researchers planned to continue the activities of the CMTs so changes and trends in species biodiversity and landscapes could be monitored. The results of these BIOME activities would indeed be useful inputs in formulating policies and ordinances by the PAMB or the local government units to conserve the remaining biodiversity in MMRNP. In addition, these BIOME activities could monitor the changes occurring in the biological and economic resources being managed, while identifying and formulating timely and appropriate conservation and management interventions. These activities could also serve as IEC strategies to increase people's awareness on threatened and endemic plant species in MMRNP.

As envisioned, BRP strived to develop the research capabilities of its Mindanao-based researchers on biodiversity. Their inputs on the improvement of research questions, identification of research sites, and the implementation of the actual studies were considered critical especially during the planning phase of BRP. The participation of the Subanun as local researchers also demonstrated the participatory nature of BRP and its efforts to encourage stakeholder empowerment. These are indeed critical requirements in sustaining the activities initiated by BRP.

6

Recognizing Challenges and Future Actions

REFLECTING ON THE FINDINGS

The original landscape of Mt. Malindang had a very high physical and biological diversity. Large-scale forest exploitation combined with shifting cultivation and conversion of forest into agriculture, especially in the last 60 years, had considerably diminished terrestrial biodiversity.

In the lowlands, below 1,000 masl, and in the coastal areas, various extremely rich forest ecosystems have nearly completely disappeared. The coastal marine resources have become endangered as well. The fish stock in the coastal waters was found to be very low and now a major concern for the population largely dependent on it. Fortunately, the total landscape was still very valuable and contained a multitude of natural as well as socioeconomic assets or capital that could be used to sustain human development. The greatest challenge for biodiversity for development, however, was livelihood improvement in the lowland rural areas and the reduced pressure on coastal and marine resources.

Natural Capital

a. Physical Environment

Of strato-volcanic origin, Mt. Malindang has steep dissected uplands with deep backward eroding gullies, and relatively flat to rolling lowlands. At the time of the studies, the soils were generally fertile although there were high risks for landslides and heavy erosion with continued forest degradation and planting of annual crops in the sloping areas without proper soil conservation measures. With a tropical rainforest climate, Mt. Malindang was found favorable for many rich ecosystems, including the man-made agroecosystems.

In terms of land use, agriculture in small, relatively flat areas in the uplands was found suitable for temperate vegetable crops, and other forms of permanent agriculture with annual crops. The lowland areas were better suited for agricultural purposes and offered excellent possibilities for increasing biodiversity through ecological networks. The resources in the coastal zones, meanwhile, were highly vulnerable with continued rise in population, establishment of rich housing estates, and intensive agriculture and fish farming. The coastal marine ecosystems, especially the coral reefs, were in great danger of disappearing due to pollution and mining.

b. Forest Resources

Primary and secondary forests could still be found in areas above 1,000 masl, particularly on the mountain peaks, steep slopes and river banks in the steep gullies. Forest ecosystem diversity was found rapidly disappearing with continued illegal logging, shifting cultivation and semi-temperate vegetable farming.

A time series study, based on old topographic maps and satellite imagery, made by the ALTERRA Green World Research of Wageningen University and Research (WUR) Centre, one of the partners in BRP, revealed that within a 50-year period (1950-2000), forest cover in Mt. Malindang will be reduced from 50,000 to 14,000 ha. Especially threatened were the Almaciga forests which could soon be dominated by Imperata grass and brushlands which have very low biodiversity value. The coastal and lowland areas (with mangrove and nipa swamps, and mixed dipterocarp formations) have long been converted into farming and built-up areas.

Diversity of flora and faunal species, containing a substantial number of endemic species, was still very high especially in the Almaciga forests. Forest products, such as lumber, firewood, charcoal, rattan, resin, tubers, fruits, medicinal plants, ornamental plants, wildlife, and honey were being used by the inhabitants of Mt. Malindang. Endangered species were also found in all the different forest types, with the Almaciga trees most specially threatened.

c. Agricultural Resources

Agriculture was the major land use in Mt. Malindang with the different agroecosystems exhibiting their own unique biodiversity profiles.

Kaingin (shifting cultivation) farms were found scattered in the logged-over areas and were still expanding even up to the steep slopes of Mt. Malindang. Coconut farms were the most extensive agricultural system found in Mt. Malindang. Coconuts were intercropped with some fruit trees and annual crops. This type of farming system provided livelihood to most of the rural population.

Meanwhile, the high-input, semi-temperate vegetable farming in the upland barangays was considered a thriving livelihood for the upland residents, including the Subanun. This relatively new cropping system was developed from the concomitant need for more forest conversion and cultivation of sloping forestlands that adversely affected biodiversity, and created environmental problems associated with pesticide application, the introduction of exotic vegetable species, and its accompanying pests and diseases.

Irrigated rice farming in the lowlands and coastal areas contributed substantially to the increase of social and financial capital. Irrigation water was sourced from the Layawan and Langaran Rivers.
Home gardens and areas around the houses in rural villages were usually planted with different fruit trees, shrubs, herbs, and ornamentals. Biodiversity in the irrigated rice fields, however, was low. But the biodiversity in the home gardens was found higher than in the coconut groves and rice fields.

d. Fresh Water Resources

Aside from serving as source of water, Lake Duminagat was considered sacred and a religious icon among the Subanun.
Quarrying for sand and gravel in the riverbeds was a major livelihood among the households in some riverside villages. Quarrying, however, increased river sedimentation and adversely affected water quality and downstream infrastructure.

In general, research findings revealed that the rivers' water quality was still very high based on the physicochemical parameters and the presence of macroinvertebrates. However, analysis of the river water indicated the presence of coliform bacteria throughout the year, as a result of fecal matter contamination.

e. Marine and Coastal Resources

At the time of the studies, poor fish stock was found in the coastal waters due to overfishing and degradation of fish habitats.
Moreover, the establishment of built-up areas have continuously destroyed mangrove and nipa swamps.

Environmental pollution from the coastal villages also contributed to low water quality. Most of the reefs within the two-kilometer radius from the river mouths of BRP's two research sites were generally in poor to fair conditions. Reef fish biomass was also generally low and composed of small individuals dominated by damsel fish.
Seagrass vegetation occurred in sites with variable sizes at different distances from the coast. The poor condition of the coral reefs and the seagrass beds could also be attributed to the water quality of the rivers that adversely affected the fish habitats.

Socioeconomic Capital

a. Social Capital

Social capital across the landscape of Mt. Malindang was primarily built on kinship or affinity. Social capital was found to be comparatively limited in the upland communities due to inaccessibility. Communities in the lowlands, on the other hand, have higher social capital due to their proximity to centers of governance, education, commerce, and sources of production inputs.

As the original settlers of Mt. Malindang, the Subanun were found to have successfully nurtured their coexistence with the biophysical environment.

b. Financial Capital

The household incomes in the Mt. Malindang landscape were found to be generally below the poverty line. Cash for the purchase of fertilizers and pesticides, or finance fishing operations could only come from informal credit sources in the communities. In addition, the generally low income obtained from farming, fishing or from non-farm and off-farm activities in all the research sites constrained the households from generating savings.

Studies have also shown that financial assistance for production and emergency needs in the upland and coastal communities largely came from private lenders (usually middlemen) because of lack of formal credit facilities. Residents in the lowland communities, near the town centers and in the coastal communities, however, have access to formal credit sources that charged lower interest rates. The raising of backyard poultry, pigs, goats and/or cattle was thus practiced in all communities as ready sources of cash.

Foreign-assisted programs with local government unit linkages, such as the PALS Program, funded by AusAID, CARE-AWESOME, and BRP also served as good sources of financial support to some barangays.

c. Human Capital

Although low human capital was found prevalent in all the BRP research sites, this was augmented by the training programs, seminars, and other IEC programs provided by national and local government agencies, NGOs and religious groups. Residents in the lowland and coastal areas, however, have better media exposure and better access to capability building programs, and health and educational services. Educational facilities in the upland barangays were not sufficient in meeting the needs of the increasing population.

In the upland and interior lowland communities, a lot of people were found to be members of people's organizations formed by foreign-funded NGOs. There were also religious groups in communities across the landscape. Affiliation with religious groups provided the households a sense of security in terms of spiritual upliftment.

d. Livelihood

More than a million people depended on the watersheds of Mt. Malindang, half of whom lived in Misamis Occidental. At the time of the studies, an estimated 18,000 people were inhabitants of Mt. Malindang's buffer zone areas, while 900 people were living in the limited portions of the core protected area. These inhabitants were mainly Subanun, whose livelihood largely depended on shifting cultivation.

Most upland communities depended on the forest lands and resources for their livelihood. The lowland and coastal communities, meanwhile, relied heavily on farming and fishing. The main livelihood activities of the communities according to elevation were:

Uplands (with submontane dipterocarp forests):

- *Kaingin* farming, firewood gathering;
- Hunting and gathering of nontimber forest products; and
- Small-scale production of semi-temperate vegetables (cabbage, carrot, onions).

Midlands to lowlands (including the riverine communities):

- *Kaingin* farming and firewood gathering;
- Upland rice and corn farming;
- Hunting and gathering of nontimber forest products;
- Irrigated rice fields;
- Coconut and fruit trees; and
- Quarrying in the Layawan riverbed along Barangay Villaflor, and the Langaran River along Barangay Tipolo.

Coastal communities:

- Irrigated rice fields and coconut farms in Barangays Taboc Sur and Kauswagan;
- Fishing in the municipal waters; and
- Small-scale enterprises (retailing, buy-and-sell, transport, etc.).

Indigenous Knowledge

The Subanun's traditional belief system was found closely tied to their concept of nature. For example, the Subanun developed their own calendar based on seasonal variations in the area that in turn, dictated their agricultural activities and other interactions with the environment.

RECOMMENDING FUTURE ACTIONS

From the abovementioned findings and challenges, BRP thus presents the following recommendations in terms of knowledge/research, practice/implementation, and policy that may be viewed as opportunities requiring future collective actions of the stakeholders:

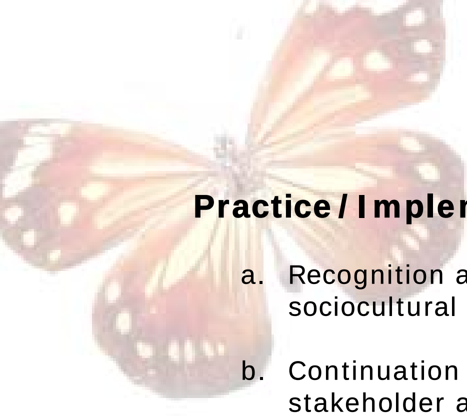
Knowledge / Research

a. Further research on agricultural production and coconut agroecosystems to help lessen the dependence of the communities on forest biodiversity resources within and in the vicinities of MMRNP;

b. Additional research in the design and establishment of ecological networks and networking within Mt. Malindang;

c. Further development of the knowledge base for the monitoring and conservation of biodiversity, and development of various livelihood undertakings; and

d. Continuation of the scientific network collaboration of researchers and research institutions including the establishment of international networks.



Practice / Implementation

a. Recognition and support of initiatives that sustain the sociocultural heritage of the Subanun;

b. Continuation and strengthening of initiatives that will intensify stakeholder awareness on the values and their participation in the planning and decision-making on biodiversity conservation efforts in MMRNP;

c. Improvement of means to access to financial assistance and further development of infrastructure services; and

d. Identification of the comparative advantages of the Mt. Malindang landscape that could be marketed locally and abroad.

Policy

a. Strengthening of government efforts in the strict implementation and enforcement of all existing laws, regulations and ordinances related to the conservation and sustainable use of Mt. Malindang's terrestrial, marine and coastal resources, including the sustainability of people's organizations;

b. Stimulation of private investments and initiatives in the protection and/or rehabilitation of environmentally critical areas in MMRNP;

c. Promotion of livelihood opportunities that are compatible with local and national thrusts on biodiversity conservation (e.g., ecotourism); and

d. Implementation of zoning guidelines and regulations to monitor the environmental impacts of the semi-temperate vegetable farming in the uplands.

Literature Cited

Amoroso, V.B. 2000. Status, Species Richness and Ecosystem Diversity in Mindanao Island. Pages 17-23 in Proceedings of the National Biodiversity Conservation Priority-Setting Workshop: Mindanao Regional Consultation. Davao City, Philippines.

Calalo, F.C. 2005. Participatory Biodiversity Research for Development in Mindanao: A Process Documentation Report. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna. Unpublished.

Crombie, R.I. 1994. A Working List of Currently Recognized Species of Amphibians and Reptiles Recorded in the Philippines. Unpublished Manuscript.

DENR (Department of Environment and Natural Resources). 1990. Administrative Order No. 34 Revised Water Usage and Classification: Water Quality Criteria Amending Section Nos. 68 and 69, Chapter III of the 1978 NPCC Rules and Regulations (corrected version). DENR Environmental Management Bureau, Quezon City, Philippines.

Heaney, L.R. 1993. Biodiversity Patterns and the Conservation of Mammals in the Philippines. Asia Life Sciences, 2:261-274.

Hilomen, V.V., C.L. Nañola Jr., and A.L. Dantis. 2000. Status of Philippine Reef Fishes. Pp. 131-138 In: Marine science: Living coastal resources. 3rd ASEAN Technology Week, 21-23 September 1992. Department of Zoology, National University of Singapore, Lower Kent Ridge, Singapore.

Kennedy, R.S., P.C. Gonzales, E.C. Dickinson, H.C. Miranda and T.H. Fisher. 2000. A Guide to the Birds of the Philippines. Oxford University Press Inc., New York.

IUCN. 2004. IUCN Red List of Threatened Species. http://www.iucnredlist.org.

Mt. Malindang Range Natural Park - Protected Area Office. 2004. Ang Kahimtang sa Mt. Malindang Range Natural Park (unpublished). Oroquieta City.

Myers, N. 1998. Threatened BIOTAS: Hotspots in Tropical Forests. Environmentalists. 8 (3): 1-20.

NIPAP (National Integrated Protected Areas Programme). 2000. Mt. Malindang Natural Park: General Management Plan, Description, Analysis and Prescription. Vol. I. DENR, Quezon City.

NSO (National Statistics Office). 2003. National Statistical and Census Bulletin. Sta. Mesa, Manila.

Ong, P.S. 2005. Bridging GAPs and Changing MAPs for a Better and Sustainable Philippine Environment. Paper presented at the National Multisectoral Policy Forum, Heritage Hotel, Pasay City, Philippines, on March 14-15, 2005, Philippine Legislators' Committee on Population and Development Foundation, Inc.

Ong. P.S., L.E. Afuang and R.G. Rosell-Ambal (Eds). 2002. Philippine Biodiversity Conservation Priorities: A Second Interaction of the National Biodiversity Strategy and Action Plan. Department of Environment and Natural Resources-Protected Areas and Wildlife Bureau-CI-UP-FPE, Quezon City, Philippines.

PAWB (Protected Areas and Wildlife Bureau). 2002. http://www.pawb.gov.ph/mammals.

Sodhi, N.S., L.P. Koh, B.W. Brook, and P.L.L. Ng. 2004. Southeast Asian Biodiversity: An Impending Disaster. Trends in Ecology and Evoloution, Vol. 19 No. 12.

Tabaranza, B.R., A.C.E. Tabaranza, A.P. Bagaloyos, and A. Dimapilis. 2001. Flora and Fauna of Mt. Malindang Natural Park, Don Victoriano and Lopez Jaena, Misamis Occidental (Final Report). Haribon Foundation for the Conservation of Natural REsources, Inc., Diliman, Quezon City.

Appendices

Appendix 1

Joint Programme Committee

Perry S. Ong, Chairperson (2003-2006)
Delfin J. Ganapin, Jr., Chairperson (2000-2003)
Marc Lammerink, Co-chairperson (2000-2006)
Leontine Visser, member (2000-2006)
Lijbert Brussaard, member (2000-2003)
Victor B. Amoroso, member (2000-2006)
Gil C. Saguiguit, Jr., member (2000-2006)
Abraham Huijsman, member (2004-2006)

Philippine Working Group

Ruth Grace Rosell-Ambal
Laksambuhay/Wildlife Conservation Society of the Philippines
Danilo S. Balete
Laksambuhay/Wildlife Conservation Society of the Philippines
Rowena R. Boquiren
University of the Philippines Baguio
Nicomedes D. Briones
School of Environmental Science and Management (SESAM), University of the Philippines Los Baños
Levita A. Duhaylungsod
University of the Philippines Los Baños/De La Salle University
Victor P. Gapud
College of Agriculture, University of the Philippines Los Baños
Arnulfo G. Garcia
SEARCA
William Sm. Gruezo
Institute of Biological Sciences, University of the Philippines Los Baños
Vincent V. Hilomen
Institute of Biological Sciences, University of the Philippines Los Baños
Daniel A. Lagunzad
Institute of Biology, University of the Philippines Diliman
Arturo Pacificador, Jr.
University of the Philippines Los Baños/De La Salle University
Maripaz L. Perez
Department of Science and Technology (DOST) - Philippines
Rene N. Rollon
University of the Philippines Marine Science Institute
Catherine B. Lagunzad
Ateneo de Manila University

Partner Institutions

Bukidnon State College (BSC), Malaybalay City, Bukidnon
Central Mindanao University (CMU), Musuan, Bukidnon
Davao Oriental State College of Science and Technology (DOSCST), Mati, Davao Oriental
Mindanao Polytechnic State College (MPSC), Cagayan de Oro City
Mindanao State University-Iligan Institute of Technology (MSU-IIT), Iligan City
Mindanao State University-Marawi, Marawi City
Mindanao State University-Naawan, Misamis Oriental
Misamis University (MU), Ozamiz City
Northern Mindanao State Institute of Science and Technology (NORMISIST), Butuan City
Research Institute for Mindanao Culture (RIMCU), Xavier University, Cagayan de Oro City
Southern Philippines Agribusiness, Marine and Aquatic School of Technology (SPAMAST), Malita, Davao del Sur
Sultan Kudarat Polytechnic State College (SKPSC), Tacurong, Sultan Kudarat
University of Southeastern Philippines (USeP), Davao City
University of the Philippines-Mindanao (UP-Min), Davao City
Alterra, Wageningen
Centre of Environmental Science (CML), Leiden
ETC/SLO, Leusden
Forestry Manpower Development (FMD) Consultants, Haarlem, The Netherlands
International Institute for Infrastructural, Hydraulic and Environmental Engineering (IHE), Delft
National Herbarium of the Netherlands, Leiden
National Museum of Natural History (Naturalis), Leiden
The Netherlands Development Assistance Research Council (RAWOO)
Wageningen University and Research Centre
Department of Agriculture (DA)
Department of Environment and Natural Resources (DENR), Central and Regional Offices
DENR-Protected Areas and Wildlife Bureau (PAWB)
National Commission for Indigenous Peoples (NCIP)
National Mapping and Resource Information Authority (NAMRIA)
Municipal and Barangay Local Government Units of:

Baliangao	Sapang Dalaga	Oroquieta City
Lopez Jaena	Don Victoriano	Aloran
Calamba	Plaridel	Concepcion

Provincial Government of Misamis Occidental
Subanun Indigenous People of Mt. Malindang

Appendix 2

BRP Researchers and Research Staff

Participatory Biodiversity Assessment in the Coastal Areas of Northern Mt. Malindang, Misamis Occidental

Project Leader
Dr. Della Grace G. Bacaltos
Southern Philippines Agribusiness, Marine and Aquatic School of Technology (SPAMAST), Malita, Davao del Sur

Study Leaders/Collaborators
Dr. Lea A. Jimenez
Davao Oriental State College of Science and Technology (DOSCST), Mati, Davao Oriental
Dr. Patria Rosales Baumstark
Mindanao State University-Iligan Institute of Technology (MSU-IIT), Iligan City
Dr. Erik de Ruyter van Steveninck
UNESCO-IHE/Delft, The Netherlands
Pedro M. Avenido
SPAMAST
Ruby Uy
Glee Tacang
Leon'e Mikael Lluch

Research Assistant
Ms. Rea Malou Coronado

Development of Participatory Methodology for Inventory and Assessment of Floral Resources and their Characterization in the Montane Forests of Mt. Malindang

Project Leader
Dr. Jose B. Arances
Central Mindanao University (CMU), Musuan, Bukidnon

Study Leaders/Collaborators
Dr. Victor B. Amoroso
CMU, Musuan, Bukidnon
Dr. William Sm. Gruezo
UP Los Baños (UPLB), Laguna
Dr. Colin Ridsdale
National Herbarium of the Netherlands, Leiden, The Netherlands

Dr. Leontine Visser
Wageningen University and Research Centre, The Netherlands
Dr. Benito C. Tan
University of Singapore

Research Assistants
Ms. Lilibeth V. Rufila
Ms. Jennifer B. Galvezo
Mr. Guiller S. Opiso

Biodiversity Assessment of Arthropods in Upland Vegetable Growing Areas in Mt. Malindang

Project Leader
Dr. Emma M. Sabado
Mindanao State University (MSU), Marawi City

Study Leader
Dr. Stephen G. Reyes
UP Los Baños, Laguna

Research Assistant
Mr. Esteban T. Padogdog, Jr.

Participatory Biodiversity Inventory and Assessment of Lake Duminagat, Mt. Malindang Natural Park

Project Leader
Dr. Carmelita G. Hansel
Mindanao State University (MSU), Marawi City

Study Leaders
Prof. Victoria T. Quimpang
CMU, Musuan, Bukidnon
Dr. Teresita O. Poblete
MSU, Marawi City

Research Assistant
Ms. Rhea Amor C. Lumactud

Community-Based Inventory and Assessment of Riverine and Riparian Ecosystems in the Northeastern Part of Mt. Malindang

Project Leader
Dr. Proserpina Gomez-Roxas
Mindanao State University (MSU), Naawan, Misamis Oriental

Study Leaders
Dr. Renato D. Boniao
MSU, Naawan, Misamis Oriental
Prof. Annabella Gorospe-Villarino
MSU, Marawi City
Prof. Sherwin S. Nacua
MSU, Marawi City
Dr. Erlinda Burton
Research Institute for Mindanao Culture (RIMCU), Xavier University, Cagayan de Oro City

Development of Delivery Systems for Biodiversity Conservation and Research in Mt. Malindang

Project Leader
Dr. Emmanuel A. Lariosa
CMU, Musuan, Bukidnon

Study Leader
Prof. Lucy B. Ledres
CMU, Musuan, Bukidnon

Comprehensive Assessment of Policies Affecting Biodiversity in Mt. Malindang and its Environs

Project Leader
Dr. Oliva P. Canencia
Mindanao Polytechnic State College (MPSC), Cagayan de Oro City

Study Leaders
Prof. Edgardo C. Aranico
MSU-IIT, Iligan City
Prof. Marina J. Segumpan
CMU, Musuan, Bukidnon

TEMP: Plant Diversity and Status in the Northern Landscape of Malindang Range and Environs, Misamis Occidental, Philippines

Project Leader
Prof. Edgardo C. Aranico
MSU-IIT
Dr. Jose B. Arances, *Ex-officio*

Study Leader
Dr. Victor B. Amoroso
CMU

Researchers
Mr. Nello D. Gorne
Northern Mindanao State Institute of Science and Technology (NORMISIST), Butuan City
Mr. Reymon P. Ruba
CMU

Research Collaborators
Dr. Brigida A. Roscom
MSU-IIT
Dr. Corazon G. Alava
Bukidnon State College (BSC), Malaybalay, Bukidnon
Dr. William Sm. Gruezo
UPLB
Dr. Daniel A. Lagunzad
UP Diliman
Dr. Benito C. Tan
University of Singapore
Leonardo L. Co
UP Diliman
Dr. Aart van den Berg
Alterra Green World Research
Dr. Anton Stortelder
Alterra Green World Research
Dr. Paul J.A. Kessler
National Herbarium of the Netherlands-Leiden Branch

Research Assistants
Ms. Lilibeth V. Rufila
Mr. Guiller S. Opiso
Mr. Meljan T. Demetillo

Project Assistant
Ms. Keith G. Noval

TEMP: Vertebrate Faunal Diversity and Relevant Interrelationships of Critical Resources in Mt. Malindang

Project Leader
Prof. Edgardo C. Aranico
MSU-IIT
Dr. Jose B. Arances, *Ex-officio*

Study Leader
Dr. Olga M. Nuñeza
MSU-IIT

Researchers
Dr. Apolinario A. Alicante
MSU, Marawi City
Ms. Marie Rosellyn C. Enguito
CMU
Ms. Fritzie B. Ates
UP Mindanao

Research Collaborators
Ms. Angela Grace Toledo- Bruno
CMU
Mr. Francis Fletcher M. Freire
University of Southeastern Philippines (USEP), Davao City
Dr. Merlijn van Weerd
Centre of Environmental Science (CML), The Netherlands
Dr. J.W. Pim Arntzen
National Museum of Natural History (Naturalis), The Netherlands
Dr. Aart van den Berg
Alterra Green World Research

Research Assistants
Ms. Yunalyn I. Labajo
Ms. Sharon M. Dejarme

TEMP: Arthropod Faunal Diversity and Relevant Interrelationships of Critical Resources in Mt. Malindang

Project Leader
Prof. Edgardo C. Aranico
MSU-IIT
Dr. Jose B. Arances, *Ex-officio*

Study Leader
Dr. Myrna G. Ballentes
CMU

Researcher
Ms. Alma B. Mohagan
CMU

Resource Person
Dr. Victor P. Gapud
UPLB

Research Assistant
Ms. Maria Catherine P. Espallardo

Research Aide
Ms. Myrna O. Zarcilla

TEMP: Soil Ecological Diversity and Relevant Interrelationships of Critical Resources in Mt. Malindang

Project Leader
Prof. Edgardo C. Aranico
Dr. Jose B. Arances, *Ex-officio*

Study Leader
Dr. Renato D. Boniao
MSU, Naawan

Researcher
Dr. Rosa Villa B. Estoista
MSU, Marawi City

Research Collaborators
Dr. Ron de Goede
Wageningen University and Research Centre, The Netherlands
Dr. Carmelita G. Hansel
MSU, Marawi City
Dr. Olga M. Nuñeza
MSU-IIT
Dr. Brigida A. Roscom
MSU-IIT
Dr. Sam James
Kansas University

Graduate Student
Nonillon M. Aspe
MSU-IIT

Research Assistant
Ms. Rhea Amor C. Lumactud

Research Aide
Ms. Mae Yen O. Poblete

AMP: Comparative Assessment of Langaran and Layawan Rivers

Project Leader
Dr. Della Grace G. Bacaltos
SPAMAST
Dr. Proserpina Gomez-Roxas, *Ex-officio*
MSU, Naawan

Study Leader
Ms. Annabella G. Villarino
MSU, Marawi City

Researchers
Ms. Elnor C. Roa
MSU, Naawan
Dr. Carmelita G. Hansel
MSU, Marawi City
Mr. Sherwin Nacua
MSU, Marawi City
Mr. Romell Seronay
NORMISIST

Research Collaborators
Mr. Francis Fletcher M. Freire
USEP
Dr. Brigida A. Roscom
MSU-IIT
Dr. Jan van Tol
National Museum of Natural History (Naturalis), The Netherlands
Dr. Erik de Ruyter van Steveninck
UNESCO-IHE/Delft
Dr. Aart van den Berg
Alterra Greenworld Research
Mr. Vincent Kalkman
National Museum of Natural History (Naturalis), The Netherlands

Research Assistants
Ms. Sarah France Edubos
Mr. Jayrald R. Santamina

Project Assistant
Ms. Mary Jane Castro

AMP: A Comprehensive Analysis of the Ecological Factors for the Development of Strategies to Sustain Coastal Biodiversity and to Improve Fish Stock Management

Project Leader
Dr. Della Grace G. Bacaltos
SPAMAST
Dr. Proserpina Gomez-Roxas, *Ex-officio*
MSU, Naawan

Study Leader
Dr. Wilfredo H. Uy
MSU, Naawan

Researchers
Mr. Pedro M. Avenido
SPAMAST
Ms. Elnor C. Roa
MSU, Naawan
Mr. Romell A. Seronay
NORMISIST

Research Collaborators
Dr. Dorothy G. Lacuna
MSU-IIT
Mr. Francis Fletcher M. Freire
USEP
Dr. Rene Rollon
UP Diliman
Dr. Erik de Ruyter van Steveninck
UNESCO-IHE/Delft

Research Assistant
Ms. Rea Malou Coronado

AMP: Assessment of the Headwaters of Layawan River: Linkage Between the Terrestrial and Aquatic Ecosystems in the Oroquieta Watershed of Mt. Malindang

Project Leader
Dr. Della Grace G. Bacaltos
SPAMAST
Dr. Proserpina Gomez-Roxas, *Ex-officio*
MSU, Naawan

Study Leader
Dr. Carmelita G. Hansel
MSU, Marawi City

Researchers
Ms. Annabella G. Villarino
MSU, Marawi City
Ms. Alma B. Mohagan
CMU
Mr. Sherwin S. Nacua
MSU, Marawi City
Dr. Teresita O. Poblete
MSU, Marawi City
Ms. Elnor C. Roa
MSU, Naawan
Mr. Romell A. Seronay
NORMISIST

Research Collaborators
Mr. Francis Fletcher M. Freire
USEP
Dr. Brigida A. Roscom
MSU-IIT

Research Assistant
Mr. Mitchel Gorospe

Research Aides
Ms. Karen P. Culminas
Mr. Wilson Hew C. Gay

SEC: Resource Utilization Patterns in the Aquatic and Terrestrial Ecosystems of Mt. Malindang and its Environs

Project Leader
Dr. Alita T. Roxas
MSU-IIT

Study Leader
Dr. Teresita O. Poblete
MSU-Marawi City

Researcher
Ms. Nelieta Arnejo Bedoya
MSU-IIT

Research Collaborators
Dr. Elvira Y. Adan
MSU-IIT
Mr. Rodger Dennis M. Valientes
UPLB
Dr. Leontine Visser
Wageningen University and Research Centre, The Netherlands

Research Assistant
Ms. Abegail V. Apalit

Research Aide
Ms. Siegrid C. Macas

Project Assistant
Ms. Audrey Marie G. Galindo

SEC: Indigenous Knowledge Systems (IKS) and Modern Technology-based Approaches: Opportunities for Biodiversity Management and Conservation in Mt. Malindang and its Environs

Project Leader
Dr. Alita T. Roxas
MSU-IIT

Study Leader
Dr. Luz C. Sevidal Castro
MSU-IIT

Researcher
Ms. Liwayway S. Viloria
MSU-IIT

Research Assistant
Ms. Johanna E. Hanasan

Research Aide
Mr. Reymund T. Bago

SEC: Policy Analysis for Biodiversity Management and Conservation in Mt. Malindang and its Environs

Project Leader
Dr. Alita T. Roxas
MSU-IIT

Study Leader
Ms. Aurelia Luzviminda V. Gomez
UP Mindanao

Researcher
Ms. Grace V. Villanueva
Misamis University (MU), Ozamiz City

Research Collaborators
Dr. Isabelita M. Pabuayon
UPLB
Dr. Leontine Visser
Wageningen University and Research Centre, The Netherlands

Research Assistant
Mr. Jerick T. Axalan

Research Aide
Ms. Zella Amor A. Orcullo

Conserving the Diversity of Selected Arthropods in Cabbage-Growing Areas in Mt. Malindang, Misamis Occidental through Participatory Integrated Pest Management

Project Leader
Dr. Emma M. Sabado
MSU, Marawi City

Study Leader
Dr. Lucy B. Ledres
CMU

Researchers
Ms. Bernadita C. Gutos
MSU, Marawi City
Mr. Roland C. Almorado
MSU, Marawi City

Research Collaborators
Ms. Virginia Cagas
Municipal Agriculture Office, Don Victoriano, Misamis Occidental
Ms. Ronelyn Tautuan
Municipal Agriculture Office, Don Victoriano, Misamis Occidental
Mr. Renato D. Boniao
MSU, Naawan
Dr. Brigida A. Roscom
MSU-IIT

Resource Person
Dr. Victor P. Gapud
UPLB

Research Assistant
Ms. Maricyl P. Dahug

Conservation and Utilization of Endemic, Rare and Economically Important Plants in Three Barangays of Don Victoriano, Misamis Occidental

Project Leader
Dr. Cecilia B. Amoroso
CMU

Study Leader
Mr. Emmanuel P. Leaño
CMU

Research Collaborators
Mr. Rico A. Marin
CMU
Ms. Reggie Y. dela Cruz
CMU
Dr. Thomas W. Kuyper
Wageningen University and Research Centre, The Netherlands

Research Assistant
Mr. Chris Rey M. Lituañas

Project Assistant
Mr. Jess H. Jumawan

Appendix 3

List of BRP publications (Monograph Series)

Amoroso, V.B., A.T. Roxas, E.A. Lariosa, R.V.B. Estoista, O.P. Canencia, D.C. Mero, G.R. Arreza, R.G. Bornales, Jr., and T.L. Cambel. 2004. **Participatory Rural Appraisal in the Lowland Ecosystem of Mt. Malindang, Misamis Occidental, Philippines.** BRP Monograph Series No. 1. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs. SEARCA, College, Laguna.

Cali, C.A., J.B. Arances, E.G. Tobias, E.M. Sabado, A.A. Alicante, L.B. Ledres, O.M. Nuñeza, and D.S. Ramirez. 2004. **Participatory Rural Appraisal in the Upland Ecosystem of Mt. Malindang, Misamis Occidental, Philippines.** BRP Monograph Series No. 2. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs. SEARCA, College, Laguna.

Metillo, E.B., L.C. Sevidal Castro, N.A. Bedoya, L.A. Jimenez, V.T. Quimpang, M.J. Segumpan, M.S. Mahinay, and D.G.G. Bacaltos. 2005. **Participatory Rural Appraisal in the Coastal Ecosystem of Mt. Malindang, Misamis Occidental, Philippines.** BRP Monograph Series No. 3. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Arances, J.B., V.B. Amoroso, W.Sm. Gruezo, C. Ridsdale, L. Visser, B.C. Tan, L.V. Rufila, J.B. Galvezo, G.S. Opiso, R. Comilap, C. Lumaray, c. Comilap, N. Pacut, B. Montimar, and S. Sacal. 2004. **Development of a Participatory Methodology for Inventory and Assessment of Floral Resources and their Characterization in the Montane Forests of Mt. Malindang.** BRP Monograph Series No. 4. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs. SEARCA, College, Laguna.

Sabado, E.M., S.G. Reyes and E.T. Padogdog, Jr. 2004. **Assessing the Diversity of Selected Arthropods in Cabbage-growing Areas in Mt. Malindang, Misamis Occidental.** BRP Monograph Series No. 5. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs. SEARCA, College, Laguna.

Hansel, C.G., T.O. Poblete, V.T. Quimpang, R.A.C. Lumactud, D. Ganob, E. Lumimas, M. Lumimas, L. Pacut, and R. Panchito. 2004. **Participatory Biodiversity Inventory and Assessment of Lake Duminagat, Mt. Malindang Natural Park, Misamis Occidental.** BRP Monograph Series No. 6. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Gomez-Roxas, P., R.D. Boniao, E.M. Burton, A.G. Villarino, and S.S. Nacua. 2005. **Community-Based Inventory and Assessment of Riverine and Riparian Ecosystems in the Northeastern Part of Mt. Malindang, Misamis Occidental.** BRP Monograph Series No. 7. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Amoroso, V.B., J.B. Arances, N.D. Gorne, R.P. Ruba, L.V. Rufila, G.S. Opiso, M.T. Demetillo, K.G. Noval, A. van den Berg, A. Stortelder, P.J.A. Kessler, W.Sm. Gruezo, D.A. Lagunzad, B.C. Tan, L.L. Co, E.C. Aranico, B.A. Roscom, and C.G. Alava. 2006. **Plant Diversity and Status in the Northern Landscape of Mt. Malindang Range and Environs, Misamis Occidental, Philippines.** BRP Monograph Series No. 8. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs. SEARCA, College, Laguna.

Nuñeza, O.M., F.B. Ates, A.A. Alicante, M.R. Calizo-Enguito, A.G. Toledo-Bruno, Y.I. Labajo, and S.M. Dejarme. 2006. **Vertebrate Faunal Diversity and Relevant Interrelationships of Critical Resources in Mt. Malindang, Misamis Occidental.** BRP Monograph Series No. 9. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Ballentes, M.G., A.B. Mohagan, M.C.P. Espallardo, M.O. Zarcilla, and V.P. Gapud. 2006. **Arthropod Faunal Diversity and Relevant Interrelationships of Critical Resources in Mt. Malindang, Misamis Occidental.** BRP Monograph Series No. 10. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Boniao, R.D., R.V.B. Estoista, R. de Goede, C.G. Hansel, O.M. Nuñeza, R.A.C. Lumactud, N.M. Aspe, M.Y.O. Poblete, B.A. Roscom, and S.W. James. 2006. **Soil Ecological Diversity and Relevant Interrelationships of Critical Resources in Mt. Malindang, Misamis Occidental.** BRP Monograph Series No. 11. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Uy, W.H., D.G.G. Bacaltos, F.F.M. Freire, P.M. Avenido, E.C. Roa, R.A. Seronay, D.G. Lacuna, R.N. Rollon, E. de Ruyter van Steveninck, and R.M. Coronado. 2006. **A Comprehensive Analysis of the Ecological Factors for the Development of Strategies to Sustain Coastal Biodiversity and to Improve Fish Stock Management in Northeastern Mt. Malindang.** BRP Monograph Series No. 12. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Gorospe-Villarino, A., D.G.G. Bacaltos, E.C. Roa, C.G. Hansel, S.S. Nacua, R.A. Seronay, F.F.M. Freire, B.A. Roscom, S.F.R. Edubos, J.R. Santamina, and M.J.L. Castro. 2006. **Comparative Assessment of the Langaran and Layawan Rivers.** BRP Monograph Series No. 13. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Hansel, C.G., A.G. Villarino, A.B. Mohagan, S.S. Nacua, T.O. Poblete, E.C. Roa, R.A. Seronay, F.F.M. Freire, B.A. Roscom, M.M. Gorospe, K.P. Culminas, W.H.C. Gay, and D.G.G. Bacaltos. 2006. **Assessing the Headwaters of Layawan River: Linkage Between the Terrestrial and Aquatic Ecosystems in Mt. Malindang, Misamis Occidental.** BRP Monograph Series No. 14. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Roxas, A.T., T.O. Poblete, N.A. Bedoya, E.Y. Adan, R.D.M. Valientes, L.E. Visser, M.P. Lammerink, A.V. Apalit, S.C. Macas, and A.M.G. Galindo. 2006. **Resource Utilization Patterns Across Terrestrial and Aquatic Ecosystems of Mt. Malindang and Its Environs.** BRP Monograph Series No. 15. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Sevidal Castro, L.C., L.S. Viloria, J.E. Hanasan, and R.T. Bago. 2006. **Indigenous Knowledge Systems and Modern Technology-Based Approaches: Opportunities of Biodiversity Management and Conservation in Mt. Malindang and Its Immediate Environs.** BRP Monograph Series No. 16. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Gomez, A.L.V., A.T. Roxas, J.T. Axalan, Z.A.A. Orcullo, I.M. Pabuayon, and L.E. Viser. **Policy Analysis for Biodiversity Management and Conservation in Mt. Malindang and its Environs.** BRP Monograph Series No. 17. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEARCA, College, Laguna.

Sabado. E.M., L.B. Ledres, B.C. Gutos, R.C. Almorado, M.P. Dahug, V.L. Cagas, R.C. Tautuan, and V.P. Gapud. 2006. **Conserving the Diversity of Selected Arthropods in Cabbage-Growing Areas in Mt. Malindang, Misamis Occidental through Participatory Integrated Pest Management.** BRP Monograph Series No. 18. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs. SEAMEO SEARCA, College, Laguna.

Appendix 4

Summary of BRP Research Projects and Studies

DEVELOPMENT OF A PARTICIPATORY METHODOLOGY FOR INVENTORY AND ASSESSMENT OF FLORAL RESOURCES AND THEIR CHARACTERIZATION IN THE MONTANE FORESTS OF MT. MALINDANG

Research Team

J.B. Arances, V.B. Amoroso, W.Sm. Gruezo, C. Ridsdale, L. Visser, B.C. Tan, L.V. Rufila, J.B. Galvezo, G.S. Opiso, R. Comilap, C. Lumaray, C. Comilap, N. Pacut, B. Montimar, S. Sacal

Introduction

The participatory research and assessment of the flora resources in Mt. Malindang forest has identified knowledge gaps: 1) imited extent of participation of local partners with researchers that enhance/enrich scientific results; 2) lack of empirical information that local stakeholders' participation has enriched/enhanced scientific results; and 3) lack of sufficient scientific and indigenous knowledge on species richness, diversity, and conservation status of flora resources.

Objectives

To develop a participatory methodology with the local residents in conducting inventory and assessment of flora resources in order to provide guidance for researchers, communities, and institutions to design protection and conservation strategies of floral resources.

Results

With the participation of Subanuns as local researchers, an assessment of plant diversity in two 1-ha semi-permanent plots located in Mt. Ginanlajan, Brgy. Lake Duminagat and Palo 6 Brgy. Mansawan, Mt. Malindang Range was conducted. The assessment revealed 301 species, 181 genera, and 113 families. The scientific identification of plants was enriched by local indigenous knowledge.
A complete inventory of trees showed high species richness (63-67 species/ha) and high density (961-1000 individuals/ha). The assessment also revealed 2 endangered species, 71 endemic species, 11 rare and 171 economically important species, and 10 species that are socio-culturally important and 79 species as surveyed from the

communities. Endemism was high with 48 (57%) of the 85 tree species endemic. Local Subanun researchers had identified the establishment of a nursery of fast growing trees and a community economic garden as potential livelihood projects for biodiversity conservation. Using stepwise regression, the identification of tree species identified by both trained and untrained local researchers from sub-quadrants (5 x 5 m) revealed no significant relation or contribution to the identification using scientific and common names. Moreover, both trained and untrained local researchers contributed significantly to identifying medicinal uses of plants. The active participation of trained local researchers enriched the scientific results.

Recommendations

1) The forests in which the semi-permanent plots were established should be protected and managed by their respective communities. Furthermore, the flora resources should be monitored and documented by the local communities.

2) Trained local researchers (para-taxonomists) should be tapped by the other barangays in flora inventories and land use planning.

Contact

Dr. Victor B. Amoroso
E-mail: amorosovic@yahoo.com

Location of the one-hectare semi-permanent plot in a primary forest of Mt. Ginanlajan, Barangay Lake Duminagat, Don Victoriano, Misamis Occidental.

BIODIVERSITY ASSESSMENT OF SELECTED ARTHROPODS IN CABBAGE-GROWING AREA IN MT. MALINDANG, MISAMIS OCCIDENTAL

Research Team

E.M. Sabado, S.G. Reyes, E.T. Padogdog, Jr.

Introduction

Insects and their allies are the most diverse group of organisms in most ecosystems. They are bioindicators of habitat disturbances, pollution and climate change. Their assessment therefore would be of great value in providing detailed information on the present status of ecosystems of Mt. Malindang, complementing information that will be obtained with other organisms.

Objective

The overall objective of the study was to assess the diversity of insects and other economically important arthropods in upland vegetable growing area in Mt. Malindang.

Results

Insects, spiders, sowbugs, and amphipods were the arthropods associated with cabbage. Insects dominated among them comprising 10 orders belonging to 60 families. Detrivores include various flies, gnats and their relatives, collembola, termites, sowbugs, and millipedes. The diamondback moth or DBM, (*Plutella xylostella)* was the major pest of cabbage.

Higher larval populations of DBM were recorded on sprayed plots than on unsprayed plots. Results further showed that sprayed cabbage plots located far from the primary forests suffered heavy infestation of DBM compared with the unsprayed plots.

Other insect pests included the cabbage looper (*Trichoplusia ni*), cabbage worm (*Crocidolomia pavonana*), cutworm (*Spodoptera litura*), and the green peach aphid (*Myzus persicae*).

Measurement of the species richness using the Margaleff index did not show any significant difference among treatments for the three sampling sites of Mt. Malindang. Correspondence analysis also showed general uniformity of species richness among sites and treatments. DBM was the dominant phytophagous species; DBM populations from the three sites did not differ significantly. Spiders dominated the predatory guild with spider numbers significantly more abundant in Gandawan and Lake Duminagat. Among the treatments, the farm near the forest harbored significantly more spiders than sprayed and unsprayed cabbage farms far from the forest.

Hymenopterous parasites and predators were minimal in numbers. Parasites included the tachinid flies, black ants, sphecid and braconid wasps.

Recommendation

There is an urgent need to implement integrated pest management (IPM) to minimize the pest problems in cabbage particularly the DBM. Through IPM, farmers will be empowered to make decisions that will manage pests effectively without full reliance on pesticides.

Contact

Dr. Emma M. Sabado
E-mail: emcsab@yahoo.com

a. Typical window-type damage of Plutella xylostella.

b. undamaged cabbage.

Larvae of Plutella xylostella.

PARTICIPATORY BIODIVERSITY INVENTORY AND ASSESSMENT OF LAKE DUMINAGAT, MT. MALINDANG NATURAL PARK, MISAMIS OCCIDENTAL

Research Team

C.G. Hansel, T.O. Poblete, V.T. Quimpang, R.A.C. Lumactud, D. Ganob, E. Luminas, M. Luminas, L. Pacut, R. Panchito

Introduction

Lake Duminagat is a crater lake located in Mt. Malindang Natural Park, Don Victoriano, Misamis Occidental, Philippines. The lake represents a rare wetland ecosystem at high altitude with its own biodiversity and holds a central position in the spiritual life of the Subanun people. The Subanun is an indigenous tribe who has lived in parts of the Zamboanga Peninsula since pre-Hispanic times. Due to more recent encounters with other local Philippine tribes (e.g., Bisayan) and western culture, their traditional customs and practices are gradually changing.

Objectives

The overall objective of the study was to determine the biodiversity status and potentials of Lake Duminagat through participatory research methods. The specific objectives were: 1) to characterize the socio-cultural and economic environment of the lake communities and, 2) to profile the physiographic, morphological, physicochemical, bacteriological, plankton, faunal, and flora characteristics of the lake and its perimeter.

Results

Lake Duminagat is a small lake, with an area of 8.04 ha, maximum depth of 20.95 m, water volume of 933,000 m^3, mean depth of 11.6 m, shoreline length of 1,060 m, and shoreline development of 1.054. It is a thermally stratified lake; though whether it undergoes periodic mixing was not determined. The water was low in alkalinity and is very soft. The water at the middle of the lake was potable enough to be drinking water at various times of measurement. Its various morphometric and physicochemical characteristics such as a low surface area to volume ratio, low lake area to watershed area ratio, low alkalinity, and low amount of dissolved solids all contributed to its low productivity. The macrophytes and zooplankton populations were limited in number of species and in quantity. Consequently, the fish population, which is at the top of the aquatic food chain, was also low in kind, number, and biomass. Nonetheless, the lake supports a high diversity of indigenous shoreline fauna and flora.

Recommendations

1) The results of this research can be used as an input to the experimental and sustaining phases of participatory action development for sustainable livelihood and biodiversity conservation.

2) Treasure the Subanun cultural belief on the lake being the dwelling place of spirits and having healing water were major contributors to the conservation of the lake and its biodiversity and that of its immediate surroundings.

3) Develop the area's very great potential for tourists/visitors.

4) The population size of the area should be limited. Migration of people should be controlled and the community educated on reproductive health and family planning.

5) To identify immediately alternative income possibilities to stop exploitation of resources and lessen the extent of damage created in the uplands of Mt. Malindang.

Contact

Dr. Carmelita G. Hansel
E-mail: carmelita_hansel@yahoo.com

PLANT DIVERSITY AND STATUS IN THE NORTHERN LANDSCAPE OF MT. MALINDANG RANGE NATURAL PARK, MISAMIS OCCIDENTAL, PHILIPPINES

Research Team

V.B. Amoroso, J.B. Arances, N.D. Gorne, R.P. Ruba, F.F.M. Freire, C.G. Alava, L.V. Rufila, G.S. Opiso, M.T. Demetillo, K.G. Noval, A. van den Berg, A. Stortelder, P.J.A. Kessler, W.Sm. Gruezo, D.A. Lagunzad, B.C. Tan, L.L. Co, E.C. Aranico, B.A. Roscom, C.G. Alava

Introduction

Clearing the lower slopes of the forest for farming purposes, kaingin, and human settlement are some of the threats to biodiversity in Malindang Range. It is therefore important to currently describe and assess the quality of the remaining habitats and flora species. Results of this research will serve as inputs for the formulation of strategies and policies for the protection and conservation of the remaining biodiversity in Mt. Malindang.

Objectives

This study was conducted to determine the diversity and assess the plant resources in the northern part of Malindang Range Natural Park. Specifically, it aimed to: a) identify the vegetation types and plant communities; b) determine the species richness and conservation status; c) identify the plant species being threatened by utilization and habitat loss; and d) recommend strategies to conserve and protect the flora resources in Malindang Park.

Results

Participatory inventory and assessment of the forest ecosystems delineated eight types viz., mossy forest, montane forest, dipterocarp forest, almaciga forest, 2 types of mixed dipterocarp forest, lowland dipterocarp forest, and plantation forest. The forest ecosystems showed a total of 1,284 species: 873 angiosperms, 20 gymnosperms, 280 pteridophytes, 85 mosses (bryophytes), and 26 lichen species. It also revealed 56 endangered and locally threatened species.

Among the forest types, the Almaciga forest appeared with the most number of endemic species, followed by the montane forest and the mossy forest. The lowest species richness and endemism were found in the plantation forest. In general, the forest types (except the plantations) scored high on the species diversity index. It is expected that this species diversity index may increase when the forest will be protected and properly managed. This can be combined with sustainable use of these resources by the local people inhabiting the park.

Recommendations

1) Since the research focused only in the northern landscape of Malindang Range, it is necessary to botanically explore the other parts of Malindang to fully assess the quality of biodiversity;

2) Identified threatened species and habitats should be given high priority for protection and conservation.

Contact

Dr. Victor B. Amoroso
E-mail: amorosovic@yahoo.com

Dominant species in montane forest: Clethra lancifolia (Sakam) and Lithocarpus philippinensis (Gulayan-Puti).

VERTEBRATE FAUNAL DIVERSITY AND RELEVANT INTERRELATIONSHIPS OF CRITICAL RESOURCES IN MT. MALINDANG

Research Team

O.M. Nuñeza, A.A. Alicante, M.R.Calizo-Enguito, F.B. Ates,
A.G. Toledo – Bruno, Y.I. Labajo, S.M. Dejarme, M. van Weerd,
J.W. Arntzen, A. van den Berg
Local Researchers: C. Comilap, N. Sencio, R. Villamino, and R. Recolito

Introduction

Fieldwork was conducted in Mt. Malindang, Mindanao from October 2003 until December 2004 in nine different vegetation types at elevations of 120 to over 1,700 masl. A participatory approach was used involving local researchers.

Objective

The objective of the study was to obtain a better understanding of critical faunal resources for subsequent improved implementation of management for conservation.

Results

A summary of the vertebrate faunal species found in Mt. Malindang is given in the table.

The level of endemism was high (42% for amphibians, 48% for reptiles, 41% for birds, 47% for volant mammals and 71% for non-volant mammals). Twenty-five threatened species were recorded, comprising nine amphibians, nine birds, three volant and four non-volant mammals. Results indicate very rich fauna and endemism on Mt. Malindang. Several endemic and threatened species were found despite the habitat loss in some areas.

	Number of Species	Endemic Species	Threatened Species
Amphibians	26	11	9
Reptiles	33	16	0
Birds	162	66	9
Volant Mammals	19	9	3
Non-volant Mammals	17	12	4
Total Number of Species	**257**	**114**	**25**

Recommendations

Actions for the conservation of the remaining faunal resources, in particular for the forest sites that harbor the majority of the endemic and threatened species. It is recommended that the local government, the community and legislators at various levels make use of the research data for formulation of policies which aim for the conservation and protection of Mt. Malindang and at the same time improve and sustain the livelihood of the communities in the area.

Contact

Dr. Olga M. Nuñeza
E-mail: olgamnuneza@yahoo.com

Philautus surrufus, Malindang Tree Frog, a Mindanao endemic and an endangered species.

Tarsius syrichta, Philippine tarsier, a Philippine endemic species.

ARTHROPOD FAUNAL DIVERSITY AND RELEVANT INTERRELATIONSHIPS OF CRITICAL RESOURCES IN MT. MALINDANG

Research Team

M.G. Ballentes, A.B. Mohagan, M.C.P. Espallardo, M.O. Zarcilla, V.P. Gapud

Introduction

Aside from their socioeconomic significance, arthropods play essential roles in ecosystems. A study of the various aspects of arthropods especially the entomo-fauna may show the unique position of Mt. Malindang, different relationships between vegetation zones and elevations and conservation strategies.

Objectives

The general objective of the study was to assess the arthropod diversity resource and to analyze significant interrelationships of arthropod fauna with other resources.

Specific objective were: (1) to identify the arthropods in the forest and agro-ecosystems; (2) to determine the arthropod faunal species richness and endemism; (3) to identify the biodiversity parameters for designing appropriate conservation and management schemes; (4) to assess the impact of socio-economic-cultural activities on the arthropod resource use; and (5) to promote awareness on arthropod resource diversity and conservation through a participatory approach.

Results

The study of Mt. Malindang's arthropods resulted in 741 species in 340 genera, 135 families, 21 orders, and 5 classes. The Coleoptera, Hemiptera, Hymenoptera, Diptera, and Araneida accounted for 78.37 percent of all the species. Species diversity was generally higher in forest ecosystems than in agroecosystems. When treated per vegetation type and per site, diversity was highest in the secondary mixed dipterocarp forest with 82 restricted species (60% beetles) out of 316 species. Out of 67 (mostly curculionid beetles) endemic species, at least 21 species were associated with 18 endemic host plants. Proportional representation of the trophic guilds of the selected taxa indicate biggest proportion of the phytophagous, followed by the predaceous, pollinators, parasitic, scavengers, xyloborous, and ant species. Three major clusters of species composition similarity among vegetation types were discernible: a) agroecosystem sites in different sample sites, b) montane-mossy forest, cereals and grass dominated agro-systems, and Almaciga forest, and c) mixed lowland dipterocarp-plantation forests, agro-cereal, agro-forest systems and, mixed dipterocarp forest. Three vegetation types showed little species similarities among each other or with any of the 3 clusters, i.e., lowland dipterocarp forest, submontane dipterocarp forest, and cereals and grass-dominated system.

Some species were utilized in various ways. The honeybee, *Apis cerana*, provides honey. Crabs, termites, and the larvae and adults of coconut beetle are eaten. Termites and naiads of Odonata serve as fish baits and ants as biocontrol agents (with an attractant) for cabbage worms. Indigenous knowledge on arthropods is very scanty and limited.

Recommendations

The study recommends:

1) Conservation of endemic host plants to conserve endemic arthropods;

2) Maintain or increase species diversity in the agroecosystem;

3) Information dissemination regarding arthropod resource use; and

4) Increase awareness through development and distribution of IEC methods and materials.

Contact

Dr. Myrna G. Ballentes
E-mail: mimi_ballentes@yahoo.com

MMRNP endemic curculinoid, Pachyrrynchus basilisae sp.

MMRNP endemic pierid, Delias diaphana.

SOIL ECOLOGICAL DIVERSITY AND RELEVANT INTERRELATIONSHIPS OF CRITICAL RESOURCES IN MT. MALINDANG

Research Team

R.D. Boniao, R.B. Estoista, R. de Goede, C.G. Hansel, O.M. Nuñeza, R.A.C. Lumactud, M.Y.O. Poblete, N.M. Aspe, B.A. Roscom, S.W. James

Introduction

Absence or scarcity of information on the drastic effects of forest cover loss and any form of disturbance keeps the denudation of forest and soil degradation in Mt. Malindang unabated. Investigating, therefore, the soil properties and their relationship to soil biodiversity must help to develop truly sustainable land use and, thus, ultimately protect Mt. Malindang and its natural ecosystems.

Objectives

The objectives of this study were: 1) to assess the soil physicochemical and biological properties of the range, and 2) to study the changes of such properties with increasing ecosystem disturbance.

Results

The soil properties are at their optimum in ecosystems where occurrence human activities were almost absent. In undisturbed or disturbed forests, unlike the agro and grassland ecosystems, organic matter values were high, pH levels were acceptable, and relatively good amounts of N and P were retained. They have low bulk density, well aggregated loamy soil texture, high soil respiration rate and diverse earthworm population. In contrast, forestlands converted into agricultural lands and later abandoned into grasslands have properties close to critical values.

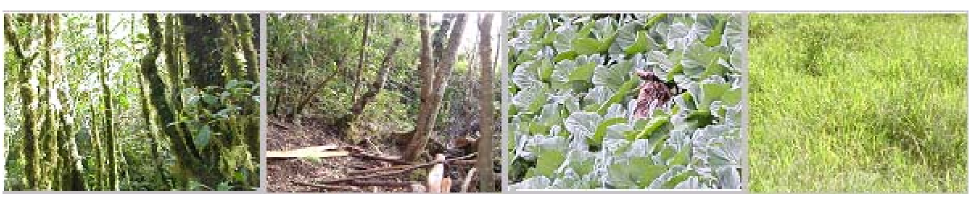
Aside from much lower Cation Exchange Capacity and organic matter content, only one species of earthworm dominated - *Pontoscolex corethrurus*, and most of the nematodes present were semi-endoparasitic. Thus, the disturbance ultimately compromises soil quality and that, earthworms and nematodes, and a number of bio-physicochemical soil properties served well as indicators of this disturbance.

Recommendations

Keep farmers from converting forestlands into agriculture by keeping their existing farms productive. Two general approaches are recommended: 1) prevent or minimize soil erosion, and (2) keep the level of organic matter high. Specifically, in cooperation with the Department of Environment and Natural Resources (DENR), classify the areas currently in use into two: (a) areas on which cultivation should be absolutely discontinued, and (b) areas on which, by necessity and social consideration, a certain degree of agriculture is allowable. Next, implement massive rainforestation on the first group of areas, and on the second, work a range-wide contour farming program with the Local Government Units offering incentives to farmers.

Contact

Dr. Renato D. Boniao
E-mail: rdboniao@msu-naawan.net



From left to right: Undisturbed forest; disturbed forest; agroecosystem, grassland ecosystem

Pontoscolex corethrurus
Dominant agrograssland earthworm

A COMPREHENSIVE ANALYSIS OF THE ECOLOGICAL FACTORS FOR THE DEVELOPMENT OF STRATEGIES TO SUSTAIN COASTAL BIODIVERSITY AND TO IMPROVE FISH STOCK MANAGEMENT

Research Team

W.H. Uy, D.G.G. Bacaltos, F.F.M. Freire, P.M. Avenido, E.C. Roa, R.A. Seronay, D.G. Lacuna, R.N. Rollon, E. de Ruyter van Steveninck, R.M. Coronado

Introduction

A major concern in Misamis Occidental is the poor state of fish stock in the coastal waters. This poor coastal biodiversity may be a result of biophysical and human developments in the Mt. Malindang landscape. The focus of this research is on the two major watershed areas of the Layawan River in Oroquieta and the Langaran River in Plaridel. This study covers only the coastal component around the mouth of the two rivers.

Objectives

This study aimed to: 1) assess the prevailing biological, physical and chemical parameters that potentially cause the poor state of fish stock and relates these existing water quality standards, and 2) recommend regulatory measures and provide information for the development of protocols for basic monitoring systems.

Methods

Field activities were conducted in a participatory manner with local stakeholders, during the northeast and southwest monsoon season. Survey methods employed standard techniques: manta tow for wide area survey; line intercept transect and daytime fish visual census for coral benthos, fish and invertebrate associates; stratified random point quadrat sampling and core sampling for seagrass and seaweeds; and predetermined sites for water quality monitoring and plankton towing.

Results

Most of the reefs within the two-km radius from the river mouth were generally in poor to fair conditions (<50% live coral cover). Reef fish biomass was also generally low and composed of small individuals dominated by the damsel fishes. Seagrass vegetation occurred about a kilometer from the river mouth in Oroquieta but less than a hundred meters in Plaridel. A total of 8 seagrass, 62 macroalgae, 245 reef fish, 87 phytoplankton, and 58 zooplankton species had been recorded in both sites. Water quality measurements indicate that values were within the normal seawater range for pH, nutrients (NO_3-N, PO_4-P) and dissolved oxygen, while TSS and river discharge was higher in Oroquieta than in Plaridel. The impact of the river was apparent between the two sites, with the differences in extent of seagrass and coral reef structure and distribution from the river mouth.

Recommendations

Management recommendations are provided in this report towards biodiversity conservation and sustainable development of Mt. Malindang and its natural resources.

Contact

Dr. Wilfredo H. Uy
E-mail: wili@msu-naawan.net

COMPARATIVE ASSESSMENT OF LANGARAN AND LAYAWAN RIVERS

Research Team

A.Gorospe-Villarino, D.G.G. Bacaltos, E.C. Roa, C.G. Hansel, S.S. Nacua, R.A. Seronay, F.F.M. Freire, B.A. Roscom, S.F. Edubos, J. Santamina, M.J. Castro, J. van Tol, E. de Ruyter van Steveninck, A. van der Berg, V. Kalkman

Introduction

The Langaran and the Layawan Rivers in the Mt. Malindang area are presently utilized for quarrying and agriculture for which purpose several irrigation dams have been constructed. These functions have a significant economic value, but information from the first generation research indicated some threats to the integrity of the rivers.

Objectives

The main objective of the study was to determine the health of the Langaran and Layawan Rivers through assessing the riparian biodiversity and the water quality and quantity. This is in order to establish benchmarks and to generate information useful for the development of protocols for basic monitoring system and environmental management.

Results

Comparing the two rivers in terms of some physico-chemical parameters, results revealed that levels of total dissolved solids (TDS) and conductivity in Layawan River was significantly higher than in Langaran River during dry season. This may imply that Langaran River has better water quality than Layawan River. However, in general all parameters were at levels that fall within the standards set by DENR for the two rivers. The information derived in the study may suggest a unified management strategy for the two rivers. Moreover, there was no significant difference in the number of taxon groups of macroinvertebrates present in the Langaran and Layawan Rivers. Both rivers were dominated with macroinvertebrates that are classified as excellent and good water quality indicators. But as to the presence of coliform, all sampling stations during the two seasons were positive, thus, contamination of the river water with fecal materials was detected. The riparian fauna were recorded at 60 species for birds, 12 species for mammals, 17 for reptiles, and 13 for fishes in Layawan River. While in Langaran River the list was 52 for birds, 11 for mammals, 11 for reptiles, and 25 for fishes. For flora, the sampled riparian area of Layawan River has a record of 105 morphospecies of trees and about 111 of shrubs, herbs, and weeds. The first generation data gathered in Langaran River revealed a total of 251 species of vascular plants.

Recommendations

The relatively healthy conditions in Langaran and Layawan Rivers have to be sustained by designing a monitoring protocol that will be readily adopted by the community using the macroinvertebrates as bio-indicators in the aquatic zones while in the riparian areas, a community-based bird monitoring is recommended. The local community (barangay captains, council members, residents) themselves have suggested some management actions such as tree planting and prohibition of quarrying activities within the rivers.

Contact

Ms. Annabella Gorospe-Villarino
E-mail: bellegorospe@yahoo.com

ASSESSMENT OF THE HEADWATERS OF LAYAWAN RIVER: LINKAGE BETWEEN THE TERRESTRIAL AND AQUATIC ECOSYSTEMS IN THE OROQUIETA WATERSHED OF MT. MALINDANG

Research Team

C.G. Hansel, A. Gorospe-Villarino, A.B. Mohagan, S.S. Nacua, T.O. Poblete, E.C. Roa, R.A. Seronay, F.F.M. Freire, B.A. Roscom, M.M. Gorospe, K.P. Culminas, W.H.C. Gay, D.G.G. Bacaltos

Introduction

The headwaters of Layawan River are located at the village/barangay of Sebucal, Oroquieta City, consisting of three major headwater streams - Layawan, Manimatay, and Panobigon. Assessment of the headwaters was made inasmuch as its state will impact on the lowland sections of the river. The headwaters themselves and their riparian zones represent the linkage between the terrestrial and aquatic ecosystems of this part of the Mt. Malindang landscape. Connection with the human community in the area will give insights for a management plan that will incorporate the goals of biodiversity conservation and sustainable development.

Objectives

This study characterized the headwaters of Layawan River in terms of the physiography and land cover of its catchment area, the physico-chemical and biological components of its major headwater streams, the biota of the riparian zones, and the socioeconomic-cultural characteristics of the human community and their utilization of the headwaters resources.

Results

The headwaters catchment area (ca. 1900 ha.) is a rolling valley varying in elevation from ca. 750 to 1100 m, surrounded by mountains on almost all sides, the land cover varying from farms on the less steep downslopes to primary forest on the steep slopes. Very near the settlement is a 35.5^{o}C hot spring (“bukal”), beside the Panobigon stream, from which the barangay based its name. The headwater streams had low concentration of ions, with pH ranging at 6.8-7.8. Aquatic macroinvertebrates were mostly indicators of good water quality. The aquatic and riparian invertebrate and vertebrate fauna included native and endemic species. The accessible flat riparian areas were frequently cultivated, leaving only a line of native trees at the immediate edge of the river/stream bank. Although the population only consists of 49-52 households (ca. 250 individuals), their land use, hunting and fishing activities, extraction of forest products, if unregulated, all present threats to the conservation of biodiversity and their sustainable use.

Recommendations

1) Environmental education and a "Bantay Lasang" (Forest Watchdog) scheme should be instituted in the community.

2) Prohibit expansion of cultivated lands. Alternative income sources should be tapped, such as butterfly farming, bee culture, and ornamental/bonsai plants propagation. In view of the area's mild cool climate, a hot spring, and challenging foot trails from Brgy. Mialen to Brgy. Sebucal and from there to Lake Duminagat, there is a high potential for ecotourism.

3) A riverbank buffer zone of, at the minimum, 3-5 m be established where indigenous/endemic trees and other plants should be planted.

4) Population increase and in-migration should be controlled.

Contact

Dr. Carmelita G. Hansel
E-mail: carmelita_hansel@yahoo.com

Sebucal hot spring.

RESOURCE UTILIZATION PATTERNS IN THE TERRESTRIAL AND AQUATIC ECOSYSTEMS OF MT. MALINDANG AND ITS ENVIRONS

Research Team

A.T. Roxas, T.O. Poblete, N.A. Bedoya, E.Y. Adan, R.D.M. Valientes, L. Visser, M.P. Lmmerink, A.V. Apalit, S.C. Macas, A.M. Galindo, B.A. Roscom

Introduction

The use of the land and water as the major natural resources for the survival of people inside and around Mt. Malindang is oftentimes in conflict with the requirements of biodiversity's sustainability. The use, access to and control of the existing environmental resources depended also on the availability of other assets such as the physical, financial, and social capital that can be utilized directly or indirectly. There exist lots of pressures such as population growth, economic trends, macro policies, and relative prices mounting over time that threaten the sustainability of the remaining natural resources in the study sites as people struggle for their survival. In addition, social differentiation by gender, class, and ethnicity among households added to the problem because of the differing perceptions as to strategies for livelihood priorities and biodiversity conservation to be adopted.

Objectives

Generally, this study was intended to assess the resource utilization patterns over time in the terrestrial and aquatic ecosystems of Mt. Malindang and its environs viewed in terms of livelihood security and environmental sustainability. Specifically, this study tried to: 1) compare the prevalent land and water resource use patterns of selected barangays along Layawan and Langaran Rivers; 2) describe the major resource use patterns over time in selected terrestrial areas and assess its impact on biodiversity; 3) describe the ethnic, class and gender differentiation in assets used, accessed or controlled in pursuit of livelihood and other activities, with respect to the following: a) the management of the Layawan and Langaran river basins; b) the four identified coastal municipalities with poor fish stock; and c) the conservation and management of critical terrestrial resources.

Results

Across the various ecosystems of Mt. Malindang, massive land use conversion took place. At its terrestrial and riverine ecosystems, people depended on the land and river resources such as sand and gravel quarrying for their living. With the buffer zones of forests turned to agricultural and residential uses, decreasing forested area was noted through time despite policies prohibiting cutting of trees. People's livelihood at the uplands depended on farm sources with a number of them with accumulated capital were able to engage in non-farm livelihood sources. Thus, massive dependence on the natural resources among the majority of the people resulted to its depletion and eventually more poverty among people since other assets such as financial, social, physical, and human were found inadequate or in some instances, absent. Increasing percentage of the Subanuns, the indigenous people of the area were found in more interior parts of Malindang while those occupying the lowlands and coastal areas were mostly Visayan settlers. Major crops at the uplands are vegetables and root crops produced on commercial quantities to neighboring places while at the lowlands are coconuts, vegetables, rice, and fruits. Though people to a limited degree practiced conservation measures across terrain, they often set aside such for their current needs.

Along the Layawan River, massive tree planting happened in the 1990s and only one irrigation was constructed therein. While three irrigation systems were put up at the Langaran River, no such tree planting took place. Both rivers had experienced the occurrence of floods during heavy rains. At certain points of these two rivers, quarrying of sand and gravel took place as income sources of residents with no lands to till and no capital for business engagements. Forests are accessed to by the Subanuns while seas are found used and accessed to by the non-Subanuns though it was reported that prior to colonization, the Subanuns also occupied the coastal areas.

Recommendations

1) Support to the appropriate diversified sources of livelihood should be immediately undertaken to lessen dependence on the natural resources for survival; 2) Enhance other forms of assets such as physical, human, financial, and social especially in the uplands; 3) Start massive dissemination of environmental policies and ensure its compliance; 4) Propagation of sustainable resource use practices among people and development of community-based resource management in all communities.

Contact

Dr. Alita T. Roxas
E-mail: alita_brp@yahoo.com

Dr. Teresita O. Poblete
E-mail: teresita_poblete@yahoo.com

INDIGENOUS KNOWLEDGE SYSTEMS (IKS) AND MODERN TECHNOLOGY-BASED APPROACHES: OPPORTUNITIES FOR BIODIVERSITY MANAGEMENT AND CONSERVATION IN MT. MALINDANG AND ITS IMMEDIATE ENVIRONS

Research Team

L.C. Sevidal Castro, L.S. Viloria, J.E. Hanasan, R.T. Bago

Objectives

The study aimed, in general, to describe the potential of IKS for synergy with modern technology-based approaches to biodiversity resource management and conservation in Mt. Malindang and its environs.

The specific objectives were: (1) to identify the IKS and gender differentiation in the management and conservation of critical resources in the research sites; (2) to distinguish the modern technology-based approaches to biodiversity resource management and conservation that are existing in the research sites; (3) to describe the community's assessment of the IKS and the modern technology-based approaches existing in the research sites in terms of the community's perception of their acceptability, efficiency, effectiveness, gender sensitivity, equitability, and sustainability; (4) to draw up strategies for the integration of IKS in the design of appropriate programs for biodiversity resource management and conservation grounded on a synergism with modern technology-based approaches; and (5) to generate options for the creation of indigenous knowledge resource centers and other community-based mechanisms for awareness, support, dissemination, and preservation of IKS.

Results

This is a study of the indigenous knowledge systems of the Subanun in six barangays in Misamis Occidental. It benefits from a triangulation of data sources and qualitative data-gathering methods. Data were analyzed through thematic and cross-case approaches.

The Subanun, one of the cultural groups referred to as indigenous peoples, were the first occupants of the Zamboanga Peninsula. They may be described in terms of their ethnic identity, territory and property rights regimes and cultural system. Their settlement history reveals how vulnerable they had been to control of various groups much stronger than they were. The study sites, settled by migrants from neighboring municipalities, are situated atop ridges or within valleys, with residences clustered at the center of the community, not along riverbanks, as the name suba-non (“river dwellers”) connotes.

In their strategies for adapting to the ecosystem, the informants had seen that their crop yield depends on soil quality, climatic conditions, presence or absence of pests, and conduct of traditional practices. The actual experience of the people in the efficacy of the belief system was a compelling factor for them to resort to indigenous practices when no technique, singly, accounts for good or poor harvest. These practices are a function of the need for survival (dependent on crop yield), not only for themselves but also for others, now and in the future. Certain of these farming practices are conservationist, as are some hunting and fishing practices, even rituals. These aspects of IKS bear potentials for synergy with modern technology-based approaches to biodiversity resource management and conservation.

Contact

Dr. Luz C. Sevidal Castro
E-mail: cass-lsc@sulat.msuiit.edu.ph

POLICY ANALYSIS FOR BIODIVERSITY MANAGEMENT AND CONSERVATION IN MT. MALINDANG AND ITS ENVIRONS

Research Team

A.T. Roxas, A.L.V. Gomez, G.V. Villanueva, J.T. Axalan, Z.A.A. Orcullo, I.M. Pabuayon, L.E. Visser

Introduction

The Philippines is one country considered to have a relatively stronger co-management model of protected areas. Indeed, the country has a long history of environment-related legislations and is very rich in laws intended to protect, conserve and manage natural resources.

The intent of environmental-related policies, both at the national and local levels, is logically the proper management and conservation of natural resources, without jeopardizing the livelihood of those who are dependent on those resources. Thus, effective implementation of environment-related policies should lead to the conservation of natural resources, while maintaining sustainable livelihood for the people.

Objectives

The study generally aimed to evaluate the effectiveness of the National Integrated Protected Areas System (NIPAS) Act, the Indigenous Peoples Rights Act (IPRA), and the Fisheries Code on biodiversity management and conservation in Mt. Malindang and its environs.

Results

There was a generally low level of awareness among the terrestrial and riverine communities about the NIPAS Act; awareness was almost limited to the perception of the NIPAS Act as the law that prohibits the cutting of trees. In those communities which are heavily populated by Subanuns, the rights and responsibilities of IPs as stipulated in the IPRA were largely unknown.

In the coastal communities, some municipal fishers claimed to be aware about acts prohibited by the Fisheries Code, together with the reasons why they were prohibited. However, results also indicate that awareness and acknowledgment about the positive impact of policies on the environment does not necessarily translate to acceptance of and compliance with those policies, especially if compliance is perceived to have negative effect on livelihood.

Recommendations

It is recommended that intensive and sustained information, education and communication (IEC) campaign be conducted. Such campaign should be conducted at different levels and address various stakeholders. Moreover, any IEC campaign should also highlight the long-term positive effect of biodiversity conservation and management on livelihood. It is recommended that there should be effective coordination among the various agencies involved in policy implementation.

Contact

Ms. Aurelia Luzviminda V. Gomez
E-mail: twin9512@yahoo.com

CONSERVING THE DIVERSITY OF SELECTED ARTHROPODS IN CABBAGE-GROWING AREAS IN MT. MALINDANG, MISAMIS OCCIDENTAL THROUGH PARTICIPATORY INTEGRATED PEST MANAGEMENT

Research Team

E.M. Sabado, L.B. Ledres, B.C. Gutos, R.C. Almorado, V. Cagas, R. Tautuan, V.P. Gapud, M.P. Dahug

Introduction

Arthropods, the most diverse group of organisms in most ecosystems comprise 70 percent of the animal kingdom. Being diverse, they are therefore good biological indicators of ecosystem changes. In agroecosystems, they include the pests, parasites, predators, and pollinators.

Objective

The project was conducted primarily to conserve the diversity of beneficial arthropods in cabbage-growing communites in Mt. Malindang through the implementation of integrated pest management.

Hypothesis

The main hypothesis was that cabbage polyculture would have high populations of beneficial arthropods but low DBM population while cabbage monoculture would have high DBM populations but low populations of beneficial arthropods. Moreover, beneficial arthropods will be conserved in IPM plots but will be decimated in farmers' plots because of frequent spraying of pesticides.

Results

Cabbage is not an indigenous crop in Mt. Malindang hence upland farmers did not have any indigenous control practices for its pests. The diamondback moth or DBM, *Plutella xylostella*, was the major cabbage pest, with minor pests such as common cutworm (*Spodoptera litura*), black cutworm (*Agrotis ypsilon*), green peach aphid (*Myzus persicae*), leaf feeding beetle (*Aulacophora similis*), and an otiorrhynchine weevil.

Generally, cabbage monoculture had higher DBM larval population than polyculture. Less diverse beneficial arthropods were found in IPM plots in Gandawan than in Lake Duminagat due to frequent spraying of pesticides during the dry season. Parasitism by *Aphidius* sp. on aphids and *Diadegma* sp. on the DBM was high in wet season because of less pesticide application. Agroforestry plots harbored more spiders than IPM plots due to the presence of introduced citrus and weeds.

Cabbage yield in IPM and farmers' plots were comparable during the dry season but IPM plots yielded high than farmers' plots during the wet season. Economic analysis showed that IPM plots had the highest net income due to lower cost of pest control. Farmers' plots incurred the highest production cost attributed mainly to the cost of chemicals. Finally results showed that beneficial arthropods were conserved in IPM plots than in farmers' plots due to minimal use of pesticides.

Recommendations

IPM Farmer Field School (FFS) training for vegetable farmers and adoption of IPM technology; biological studies, mass rearing, and field release of *Aphidius* sp. and *Diadegma* sp. in Mt. Malindang.

Contact

Dr. Emma M. Sabado
E-mail: emcsab@yahoo.com

Some predators conserved in IPM plots: (a) vespid wasp, Ropalidia sp. and (b) assassin bug, Eugoras sp.

CONSERVATION AND UTILIZATION OF ENDEMIC, RARE AND ECONOMICALLY IMPORTANT PLANTS IN THREE BARANGAYS OF DON VICTORIANO, MISAMIS OCCIDENTAL

Research Team

C.B. Amoroso, E.P. Leaño, R.A. Marin, R.Y. dela Cruz, T.W. Kuyper, C.R.M. Lituañas, J.H. Jumawan
Local Researchers: M.L. Anggang, V.L. Tumagna, L.M. Impil, A.U. Sacal

Introduction

This research project was an off-shoot of the first generation research of a local community validation meeting of Subanuns and local officials. They suggested to use these plant resources in a sustainable way by establishing a community economic garden and nursery where these plants could be propagated as a possible livelihood project.

Objectives

Guided by the local community's suggestion and with their participation, the objectives of this project were: 1) to select, identify, evaluate, and mass propagate the endemic, rare, and economically important plants found in three barangays (Mansawan, Gandawan, and Lake Duminagat) of Don Victoriano, Misamis Occidental by establishing a nursery and greenhouse as an *ex situ* conservation strategy; 2) to conduct *in situ* conservation by out-planting them; and 3) to produce flyers, handouts, and a handbook on the propagation and planting of these plants.

Results

Sixteen tree and 40 ornamental plant species were selected and propagated in the new established nursery and greenhouse. Wildlings potted in various media showed no significant difference in survival rates. This indicates that the wildlings could grow well in Mansawan soil, even if this soil has low organic matter and phosphorus contents and high exchangeable potassium content. Hardened wildlings planted along the roads and trails showed high survival rates. Two species, *Agathis philippinensis* and *Podocarpus rumphii* showed nodule formation, an indication of mycorrhizal association which could be one of the reasons of their high survival in the nursery and in the field. Cuttings of *Agathis philippinensis* and *Cinnamomum mercadoi* in distilled water (control) and various hormone solutions did not show significant difference. Cuttings of two ornamental plants, *Medinilla sp*.

and *Lycopodium clavatum* showed high percentage of survival when potted in Mansawan garden soil. For *in vitro* cultures, node explants of *Agathis philippinensis*, formed apical buds. Likewise, there was high percentage survival of the germinated spores of *Diplazium esculentum* which eventually formed sporophytes when inoculated in spore culture medium. Flyers, handouts, and a handbook were produced. Based on the research results, a resolution in Barangay Mansawan has been drafted which appoints a denuded area hill in the barangay as a site for rainforestation. The propagation, planting, and maintenance will be conducted by the local community. The resolution provides further for prohibition of pasturing.

Recommendations

The management team of the nursery and greenhouse (after the turn-over) should make use of the research results. Further, the barangay should require visitors and reforestation projects to buy seedlings from the nursery for planting along roads, trails, and reforestation sites.

Contact

Dr. Cecilia B. Amoroso
E-mail: cbamoroso@yahoo.com

THE DEVELOPMENT OF THE MT. MALINDANG BIODIVERSITY INFORMATION SYSTEM

Research Team

F.F.M. Freire, J. Badinas, T.C. Mercado, X. Fuentes, J.M. Buladaco

Introduction

The main objective of this study was to develop a database system that would serve as a clearinghouse for all the biodiversity-related information about the Mt. Malindang protected landscape and its environs. Mt. Malindang, its biodiversity and factors affecting it is the subject of a detailed study encompassing the terrestrial (highlands) to the aquatic (coastal) ecosystems. These studies produced invaluable information that would serve as the basis for the management of this very important landscape. This project was tasked with incorporating this information into an electronic database system computer software development tools.

Objectives

The project had the following objectives: 1) to review and collate the various data/information collected by the BRP project researchers and design a system that will enable this data/information be stored in electronic format; 2) to design and implement database management program that would hasten data retrieval, access, and allow data integration for a more in depth analysis; and 3) to strengthen the capacity of stakeholders of Mt. Malindang in data management, retrieval and analysis.

Results

This project represents one of the first studies of its kind in the country where the biodiversity conservation merges with computing technology. During its development, the researchers needed to interact with researchers from the different various fields of study in order to come up with a system that would make it easy to store, access and query the information coming from the different studies.

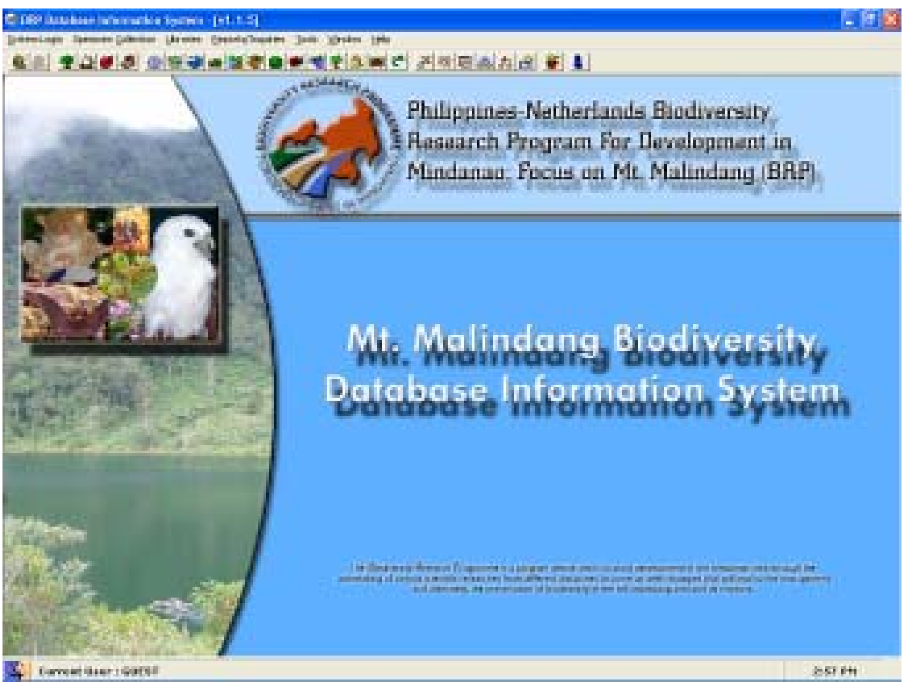
Among the highlights of the developed system was the capability of the other researchers to produce reports from the data and thus undertake other analysis. This system also makes it easier to integrate the different studies thus making it an effective tool in the management process.

Recommendations

It is the feeling of the researchers that even though the project has already achieved its objectives there are still more work to be undertaken. Thus, the researchers feel that the work is too important for it to end but rather it is a beginning. New technologies are being developed that could greatly enhance the usability of this system. It is envisioned by the researchers that the work started would eventually be expanded to cater to the biodiversity needs not only for Mt. Malindang but for the whole Mindanao Island as well. We hope that with this study, we could more easily improve our understanding of the biodiversity and thus help us better manage this critical resource

Contact

Mr. Francis Fletcher M. Freire
E-mail: Freire@usep.edu.ph



Homepage of Mt. Malindang's Biodiversity Information System.

The Biodiversity Research Programme (BRP) for Development aimed at undertaking participatory and interdisciplinary research to promote the sustainable use of biological resources, effective decision-making on biodiversity conservation, and improvement of livelihood and cultural opportunities in Mindanao.

It intended to make biodiversity research more responsive to real-life problems and development needs of local communities. It also introduced participatory knowledge generation as a strategy for biodiversity management and conservation. BRP initiatives were likewise geared towards strengthening the capacities of local research partners and stakeholders to empower them in undertaking biodiversity research and participatory decision-making.

BRP is a collaborative research initiative that was jointly undertaken by Filipino and Dutch researchers from 2001 to 2005 in Mt. Malindang and its environs in Misamis Occidental, Philippines.