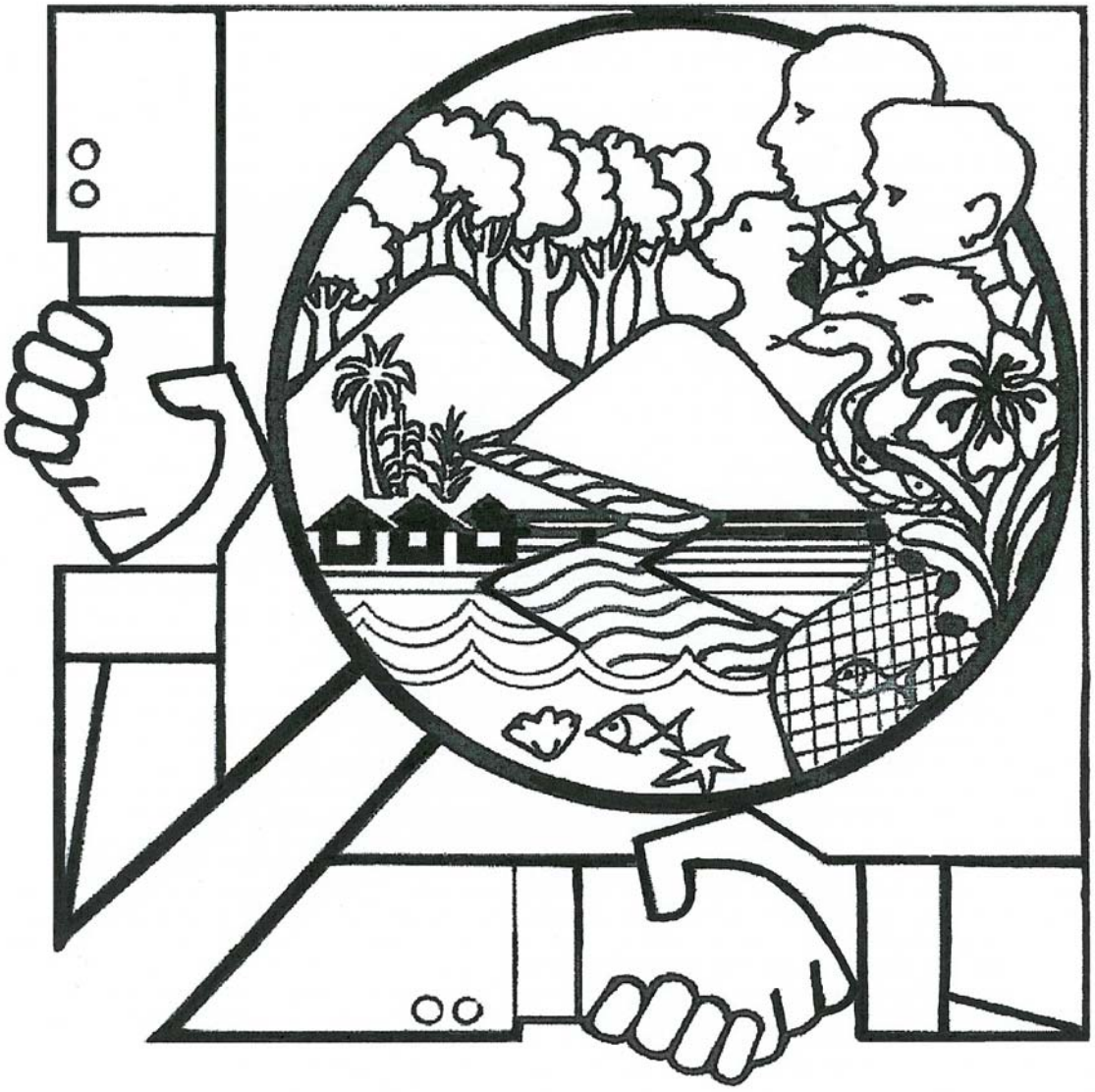
Participatory Biodiversity Inventory and Assessment of Lake Duminagat, Mt. Malindang Natural Park, Misamis Occidental



Carmelita G. Hansel
Rhea Amor C. Lumactud
Margilyn Lumimas
Teresita O. Poblete
Diosdado Ganob
Luzminda Pacut
Victoria T. Quimpang
Emelyn Lumimas
Roseller Panchito

SEAMEO SEARCA

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

Carmelita G. Hansel, Teresita O. Poblete, Victoria T. Quimpang
Rhea Amor C. Lumactud, Diosdado Ganob, Emelyn Lumimas,
Margilyn Lumimas, Luzminda Pacut, and Roseller Panchito

under the

Biodiversity Research Programme (BRP) for Development in Mindanao:
Focus on Mt. Malindang and Environs

The Biodiversity Research Programme (BRP) for Development in Mindanao is a collaborative research programme on biodiversity management and conservation jointly undertaken by Filipino and Dutch researchers in Mt. Malindang and its environs, Misamis Occidental, Philippines. It is committed to undertake and promote participatory and interdisciplinary research that will promote sustainable use of biological resources, and effective decision-making on biodiversity conservation to improve livelihood and cultural opportunities.

BRP aims to make biodiversity research more responsive to real-life problems and development needs of the local communities, by introducing a new mode of knowledge generation for biodiversity management and conservation, and to strengthen capacity for biodiversity research and decision-making by empowering the local research partners and other local stakeholders.

ISBN 971-560-113-8

Funding for BRP is provided by the Netherlands Ministry for Development Cooperation (DGIS) through the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA).

Contents

Tables

Figures

Appendix Tables **85**

Acknowledgment

This research project was supported by the Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, which is funded by a grant to the Southeast Asian Regional Center for Graduate Study and Research in Agriculture (SEARCA) by the Netherlands Ministry for Development Cooperation (DGIS), Project No. 2902, Contract No. DCO 0013915.

Abstract

This project employed the Participatory Biodiversity Assessment methodology to characterize the Lake Duminagat area. The local communities surrounding Lake Duminagat were described in terms of their cultural and socioeconomic profile, perceptions, beliefs and practices about the lake, and utilization of the lake and its resources. The lake's biodiversity and that of its perimeter were inventoried and assessed. Some of the lake's morphophysicochemical characteristics were measured. It is hoped that involvement in this research gave the local researchers and the community an awareness of the natural and social factors that determine/ affect the Lake Duminagat ecosystem. It is also hoped that through the results of this research, the local communities will come up with a strategy to conserve the lake's biodiversity and sustainably utilize its resources so as to improve livelihood and cultural opportunities.

Abbreviations and Acronyms

AIC	Appreciation-Influence-Control
BGBL	brilliant green bile lactose
BOD	biochemical oxygen demand
BRP	Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs
DA	Department of Agriculture
DENR	Department of Environment and Natural Resources
DO	dissolved oxygen
DOST-R.O. 10	Department of Science and Technology – Regional Office 10
EMB	eosin methylene blue (agar)
ICBP	International Council for Bird Preservation
IDB	Inter-American Development Bank
ICWSO	Iligan City Waterworks System Office
IIRR	International Institute of Rural Reconstruction
LGU	Local Government Unit
masl	meters above sea level
NAMRIA	National Mapping and Resource Information Authority
NGO	Nongovernment Organization
NIPAP	National Integrated Protected Areas Programme
NIPAS law	National Integrated Protected Areas System Act of 1992
PA	Protected Area
PAGASA	Philippine Atmospheric, Geophysical and Astronomical Services Administration
PAMB	Protected Area Management Board
PAR	Participatory Action Research
PAWB	Protected Areas and Wildlife Bureau
PBA	Participatory Biodiversity Assessment
PCARRD	Philippine Council for Agriculture, Forestry and Natural Resources Research and Development
PERT	Program Evaluation and Review Technique
ppm	parts per million
PRA	Participatory Rural Appraisal
SEAMEO	Southeast Asian Ministers of Education Organization
SEARCA	Southeast Asian Regional Center for Graduate Study and Research in Agriculture
TDS	total dissolved solids
TOP	Technology of Participation
TSS	total suspended solids
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
USAID	United States Agency for International Development
WB	World Bank
WWF	World Wildlife Fund for Nature
ZOPP	Ziel Orienterte Projekt Planung (Objectives Oriented Project Planning)

Introduction

The Biodiversity Research Programme for Development in Mindanao (BRP) is focused on an area that contains part of Mt. Malindang, the whole range of which has been declared the Mt. Malindang Natural Park. See Fig. 1. Mt. Malindang was declared a National Park and Watershed Reservation in 1971, covering 53,262 hectares of the Malindang range, per Republic Act (R.A.) 6266. Following the law on the National Integrated Protected Areas System (NIPAS), R.A. 7586 of 1992, it was declared a Natural Park in 2000. Its boundary was resurveyed and the park proper is now 34,464 hectares; the remaining area out of the original being proposed as a buffer zone. The National Integrated Protected Areas Programme (NIPAP), a project of the Department of Environment and Natural Resources (DENR), supported with a grant from the European Commission, came up with the Management Strategy and General Management Plan for Mt. Malindang (DENR-NIPAP, 2000a; DENR-NIPAP, 2000b).

The Park is threatened by over-exploitation for its timber, by traditional practices, encroachment and tourism development (DENR-NIPAP, 2000a). The conservation of its biodiversity is an urgent need as it is the water source for irrigation, industrial and domestic water supply and food for the province of Misamis Occidental and some municipalities of Zamboanga del Sur and Zamboanga del Norte (San Juan, 1999; DENR-NIPAP, 2000b).

This research is a component of BRP that has for its vision, "economically and culturally prosperous communities living harmoniously in a sustainable environment where biodiversity conservation is founded on an integrative and participatory research model". Furthermore, for the BRP's mission, it is "committed to undertake and promote collaborative, participatory, and interdisciplinary research that will promote sustainable use of biological resources, and effective decision making on biodiversity conservation to improve livelihood and cultural opportunities" (BRP, 2000).

During the pre-implementation phase of BRP, Lake Duminagat was regarded with great interest among the freshwater ecosystems in Mt. Malindang. It is biologically significant as a water source for flora and fauna, as an area of high species diversity, and, in cultural terms, as a sacred place for the Subanon people (BRP, 2000). The region is one of the last areas representing the flora and fauna of the Zamboanga biogeographic zone (DENR and UNEP, 1997).

The high-altitude lacustrine ecosystem of Lake Duminagat is one of those comprising the diversity of ecosystems in Mt. Malindang. The lake itself would have its own biological diversity, aside from creating conditions that could support a possibly unique flora and fauna at its perimeter. Researchable areas identified for this aquatic ecosystem are a profile of the lake's hydrobiological and physicochemical conditions, unrecorded floral species, and an inventory and ethnobiological survey of unique or threatened flora and fauna (BRP, 2000). What could be seen either as a threat or as an opportunity is the observation that the lake is a destination site of local tourists, especially during the summer months.

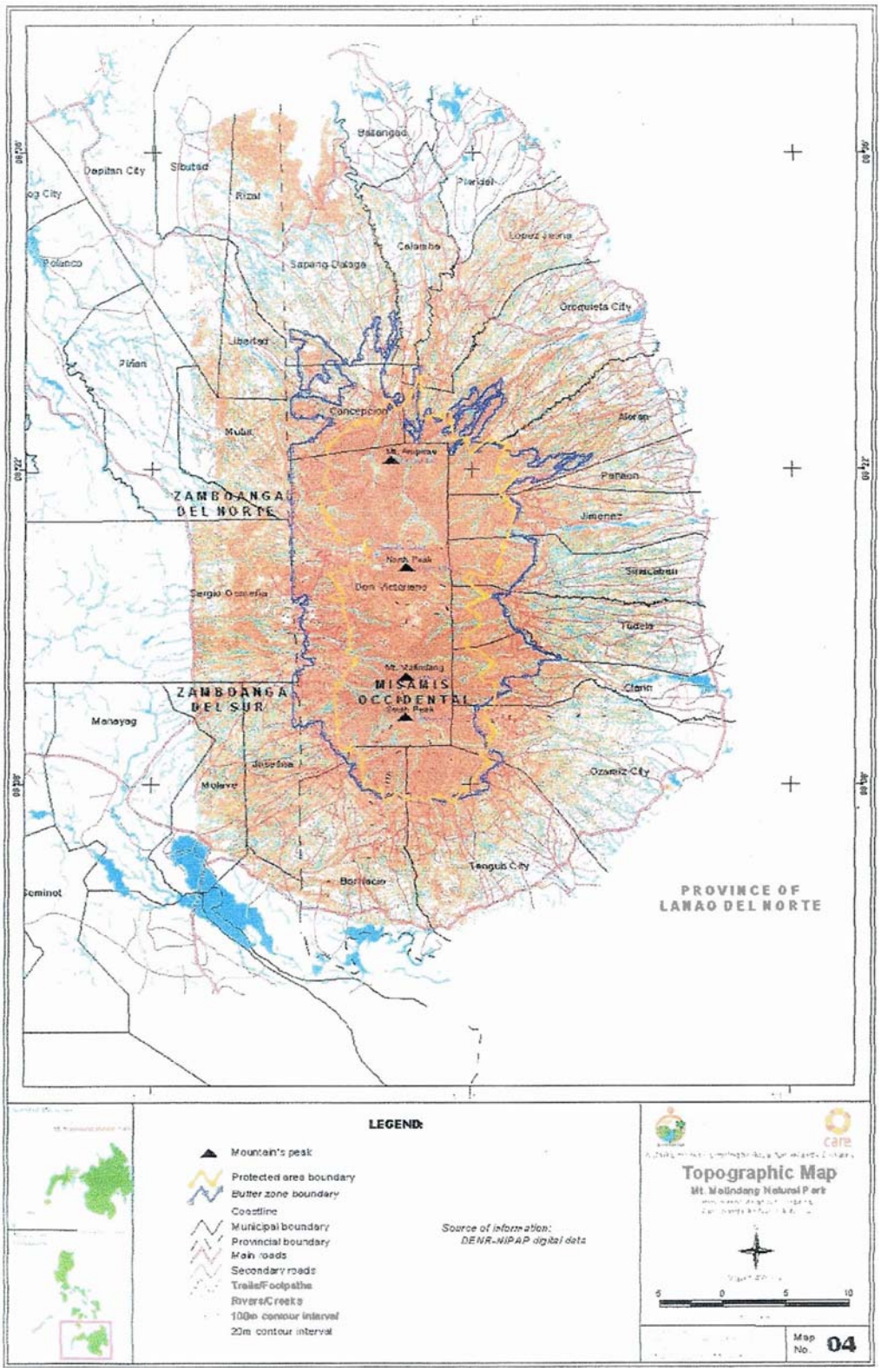


Figure 1. Location map of Mt. Malindang range and environs (CARE AWESOME)

Adjacent to the lake are two villages (barangays): Barangay Lake Duminagat, of which the lake is a part, and Barangay Gandawan, both of the municipality of Don Victoriano, Misamis Occidental. The residents of both villages think that the lake is important to them. It is important to them as a water source for domestic use and also as a source of "healing water". Many people go to the lake to take water in bottles and use this for healing. Many others go to the lake during Holy Week and take a bath there as treatment for their illnesses. The community agrees that it would be beneficial and informative to have studies done on the lake and its shoreline flora so as to explain its perceived mysteries.

They believe that as Subanon natives (having resided in the area since 1960), they are heirs to the lake of their ancestors who discovered the lake. Thus, they should take care of the lake and conserve it for posterity. They are willing to impart any information they might have on the lake and its surroundings. Likewise, it is their desire that information obtained from the research be disseminated to them (interviews with residents, 2001).

A new paradigm for resource management is integrated multi-disciplinary science, management, and education outreach efforts (Crosby et al., 2000). This involves the participation of the academic community to do research to provide new understanding of the structure, ecological processes and impacts on natural resources; results of which the manager should base new policies and which the agencies can use to educate the public. Likewise, the local community participates in the research process from problem analysis up to designing solutions to achieve sustainable resource use and development. These participatory approaches have been developed for coastal resource management (e.g., IIRR, 1998; Crosby et al., 2000) and for various development projects, though the results may vary depending on the extent/degree of participation by the community.

Bearing in mind the vision and mission of BRP, the overall objective of this project is to determine the biodiversity status and potentials of Lake Duminagat through participatory research methods.

Review of Related Literature

Biodiversity is defined by the Convention on Biological Diversity as "the variability among living organisms from all sources, including terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems" (Watson et al., 1995).

Biodiversity provides goods and services essential to support human livelihoods and aspirations, and enables societies to adapt to changing needs and circumstances. The values of biodiversity includes the economic value of natural products, the various roles of biodiversity in maintaining ecosystem functions such as water production from catchments, primary production and carbon cycling, regulation of climate, biogeochemical cycles, and the production of soil and raw material for evolution, maintains systems through transfer of matter, nutrients and energy, and provides the biophysical foundation for human life at the ecosystem and landscape levels (Wilson, 1988).

Global Biodiversity

The total number of species worldwide is estimated to be between 13 and 14 million of which only about 1.75 million have been scientifically described (Watson et al., 1995). Biological diversity is declining. According to the United Nations Environmental Program (UNEP) "thousands of species worldwide are under threat from overuse, loss of habitat and environmental pollution. Because species in ecosystems are interdependent, the loss of one species can lead to the disappearance of many other." Ecosystems such as forests, wetlands and grasslands are being altered and destroyed, upsetting the delicate balance of nature.

The general trend of the rate at which humans are altering the environment, its extent and the consequences of these changes for biological diversity are increasing in a global scale. And these are now beginning to pose substantial threats to the economic and cultural lives of many societies.

Philippine Biodiversity

In the Philippines, the rate at which biological resources are destroyed is indeed threatening. The preliminary report of the International Council for Bird Preservation (ICBP), which studied the status of biodiversity in the country in 1990 summed up the situation as follows: (1) the present protected areas represent only a small fraction of the remaining forest; (2) many areas previously considered as habitat for birds are now deforested; and (3) there is inadequate information available of the fauna of Philippine forest (PCARRD, 1999).

The Philippines is considered as one of the megadiversity countries and also as one of the biodiversity hotspots of the world. That is, it has a very high number of species to land area ratio, coupled with a high percentage of endemism. Unfortunately, due to habitat destruction and other factors, these species are becoming extinct at an alarming rate (DENR and UNEP, 1997). The biodiversity of Mt. Malindang represents one of the last remaining remnants of the Zamboanga biogeographic zone.

Lake Duminagat and Its Culture

Lake Duminagat is located in Barangay Lake Duminagat, the main spot of which is called Centro. Its adjacent barangays are Barangay Gandawan and Barangay Mansawan, all three belonging to the municipality of Don Victoriano of the province of Misamis Occidental.

The municipality of Don Victoriano is wholly located within Mt. Malindang Natural Park. The municipality was created on February 6,

1982 under the Marcos regime by virtue of Batas Pambansa Blg. (Republic Act No.) 171 and was named as Don Mariano Marcos. On January 20, 1990, by virtue of R.A. 6845, the name of Don Mariano Marcos was changed into Don Victoriano, in honor of Don Victoriano Chiongbian, the richest and most influential person in the place. The town is composed of 11 barangays, which were formerly part of different municipalities in the lowland areas in the east, i.e., towards the coast (Figure 1): Barangay Petianan which used to be under the municipality of Bonifacio; barangays Bag-ong Clarin, Lampasan, Lalud, Tuno and Mara-mara were formerly under the jurisdiction of the municipality of Tudela; Barangay Lake Duminagat was under the jurisdiction of the municipality of Jimenez; and barangays Mansawan, Gandawan, Napangan and Liboron were formerly under the municipality of Sinacaban. The seat of the municipal government of Don Victoriano is located in Barangay Tuno (Cali et al., 1999).

More interestingly, Lake Duminagat is bound to the culture of Subanon (native people), their myths and legends, the lake being a sacred place and the source of healing water (BRP 2000; personal interview, 2001). Two Subanon residents at the lakeside ascribe the discovery of the lake to their late father, Pedro “Mali” Villamino, around 1930 (E. Cati, P. Villamino, personal communication, 2001).

The work of Manuta (2001) and Suminguit (1989), who both cited earlier authors, described the Subanon (variously spelled as Subanun, Subanen) as the indigenous people who, according to earliest Spanish records, first settled in the southwestern and northwestern Mindanao region - the Zamboanga peninsula. The peninsula is composed of the provinces of Misamis Occidental, Zamboanga del Norte, and Zamboanga del Sur. The name Subanen means "river dweller" which comes from the word "suba" meaning river, in Bisayan language. The term Subanon has been used to distinguish the indigenous peoples of the region from the Visayan settlers and Muslims. During the American rule, the Subanon ancestors used to occupy the coastal areas and the lowland plains. They moved into the hinterlands to avoid raids of and exploitation by Moros and Visayans, who collected tributes from them and made them slaves. Subsequently, the greatest threat to the Subanon was the increasing number of settlers who sought land within their ancestral domain. These new settlements threatened the foundation of Subanon culture and survival. The influx of Muslim and Christian settlers also made the Subanon flee and move further into the more remote interior of the Peninsula. The national government had continuously and purposely penetrated into the Subanon hinterland for administrative control, tax assessment and collection, and law enforcement. After World War II, the presence of government was further felt with the proliferation of logging concessions throughout the whole Peninsula.

Suminguit (1989) describes the richness of the Subanon cultural heritage. In the olden days, among the Subanon, there was relative harmony between man, nature, and the supernatural world, which can be seen in the way the Subanon related to their environment, to their fellow Subanon and to the spirit world, and their abhorrence of violence. Also, the existence of different Subanon social institutions maintained the harmonious relationship and restored any disharmony. The disruption of this harmony was concomitant with the alteration of their social, spiritual, and physical environment by constant encroachment of outsiders upon their lands. This was accompanied by the assimilation of the Subanon into the lowland population that resulted to the displacement and urbanization of their indigenous culture and consequent loss of identity. Other influences were the western and hispanic cultures which were introduced through teachings in schools and radio programs; the penetration of market economy which made the Subanon petty commodity producers; the incorporation of the Subanon into the Philippine nation-state which resulted into the disappearance of the Subanon indigenous legal system and

reduction of their once autonomous villages into increasingly dependent political entities. Suminguit (1989) added that the remnants of the Subanon traditional culture could be preserved by raising their social and political consciousness using their indigenous culture. They must be made to appreciate first the beauty and the richness of their cultural heritage to encourage them to protect their human dignity and assert self-identity. This new consciousness would lead them to take charge and direct change according to their needs; their awareness would enable them to resist the external forces invading their indigenous culture.

Making inferences from the information given in Suminguit (1989) and Barbosa (1996), both of whom cited earlier authors, coupled with the list of titles in Noorduyn et al. (2002), the Subanons may be divided into five geographic groups that exhibit slight differences in their language and customs. These are: (1) Sindangan Subanon (Sindangan); (2) Western Subanon (Siocon-Sibuco-Gutalac); (3) Eastern Subanon (Sibuguey/Sibugay Bay); (4) Southern Subanon (Lapuyan); and (5) Salugnon Subanon (Malindang area, migrated from Salug Valley). The Subanon people residing in Mt. Malindang therefore belong to the Salugnon Subanon group. Their language is Salugnon Sinubano (Pacut, N., personal communication).

Lake Hydroecology

Lake Duminagat is considered a crater lake, located at one of the mountains adjacent to North Peak, one of the notable peaks at Mt. Malindang Natural Park. As of the 1956 topographic map reprinted by NAMRIA in 1989, the name of the lake was not yet written on the map. It is not surprising then that it was not included among the lakes of the Philippines reported by Pratt (1916) and by Woltereck (1941). As of May 1992, it was not even included in the listing of Philippine lakes compiled by the NAMRIA Fort Bonifacio office.

The hydrobiological studies of lakes, which include the physical and chemical properties as well as the biological components, determine the type, class, quality and nature of the ecosystem (Goldman and Horne, 1983). The deep upland crater lake in New Zealand shows distinct thermal stratification, with extremely low salinity, inflows rich in nutrients, higher water transparency, and less abundant plankton species than the main lake (Jolly and Flint, 1975). In African lakes, algal seasonality is pronounced and is controlled by the hydrological features (water input-output) (Talling, 1986). A survey of the biological limnology of Lake Titicaca (3800 masl) shows the abundance of varied flora and fauna which serve as important resources for nearly 1000 peasants in the area; the production pattern is typical of mesotrophic waters with high algal biomass (Widmer et al., 1975). In other upland lakes in northern Wales, the lakes exhibit thermal stratification; oxygen level was related to phytoplankton populations that are the major indicators of distinction between the lakes (Happy-Wood, 1975).

Biodiversity Conservation Approaches

In the first decade of the 21st century, the issue of sustainability has come to the forefront of science. This has called for worldwide collaborative efforts among scientists and resource managers to develop research and management approaches to address the issues of sustainable development and sustenance of the Earth's life support systems. Among these approaches are educating the people through the establishment of traditional informal institution (Chulun et al., 2000), conducting long term ecological research to examine impacts of management practices (Darrow et al., 2000), economic resource valuation (Saastamoinen, 1992), community-based conservation or participatory approaches (Galvin, 2000: Lammerink, 1999). The latter concept is becoming popular because it adheres to the notion that if local communities can derive some value, nominal income, through conserving biodiversity, they will do so.

However, results from this approach have more failures than successes (Galvin, 2000). Many community-based conservation efforts involve local communities in name only, but local involvement at all levels of the project is insufficient. For example, the community-based fisheries management of Lake Kariba, Zimbabwe failed because resource managers imposed management regulations on a community without prior consultations and with little or no explanation on why they are necessary (Nyikahadzoi, 1994). Likewise, the imposition of state management and control of the fishery resulted in locals losing their traditional legal rights to control local resource use.

In the participatory approach, the process follows a logical sequence of stages - the diagnosing phase, the experimenting phase, and the sustaining phase. This can only be done in close contact with the rural communities with patience, wisdom and good sense for community life (Lammerink, 1999; Lammerink et al., 1999a, 1999b). The facilitators and community members develop relationships that are often intense, satisfying and challenging for all. Also, local people should be considered a component of the ecosystem being conserved and brought into the project process from the beginning (Galvin, 2000).

Participatory Approach, Methodologies, Methods and Techniques

The concept of participation is now a widely recognized basic operational principle in development. This is the guiding approach in the development programmes and projects of various organizations and agencies, e.g., World Bank, United Nations Development Programme (UNDP), Inter-American Development Bank (IDB), United States Agency for International Development (USAID). Most of the ideas presented in this section come from the websites on participation of these agencies.

As the concept of participation in development matured, two viewpoints- neither clear-cut nor mutually exclusive, also developed. One viewpoint considers participation as a MEANS, a process whereby local people cooperate or collaborate with externally introduced development programmes or projects. The other viewpoint shows participation as an END, a goal in itself; the goal being the empowering of people in terms of acquiring the skills, knowledge and experience to take greater responsibility for their development. As the process of participation occurs, it develops along a continuum, from passive participation (where beneficiaries/local stakeholders welcome the project proposals and support them but are generally cautious, even suspicious, in relation to project management) to increasing involvement (where beneficiaries begin to develop more trust in the project and more contact with its activities and staff; they may also begin to take on some responsibilities). This leads to active participation (where beneficiaries play the role of active partners in the project's implementation and development and assume increasing responsibilities) culminating in ownership/empowerment (where beneficiaries are both willing and able to sustain and develop the initiatives started by the project). These various stages of participation may also be expressed as starting from nominal to instrumental, then representative and finally transformative, resulting into people's empowerment. This continuum may also be thought of as different forms, or levels, or degrees of participation (UNDP website).

Ideally, participation in development is defined in broad terms as the PROCESS through which people with a legitimate interest (stakeholders) influence and share control over development initiatives, and the decisions and resources that affect them (IDB website). The participatory approach to development may then be considered as having this definition/goal as its guiding spirit or philosophy. The various strategies or mechanisms in order to effect

participation are its methods/ methodologies, and specific steps/ procedures in the methods are referred to as techniques. Methodology is defined as a comprehensive, organized, systematic and disciplined approach to a problem while technique is viewed only as an integral component of a methodology, as the means or procedures used to carry out the methodology itself (IDB website). Techniques may also be thought of as tools. Various authors, though, variably interchange these terms – approaches, methodologies, methods, techniques, and tools.

In Brian Atwood's Statement of Principles on Participatory Development, he lists a set of characteristics of approaches to development assistance that one might call "participatory" or "customer-focused". The list has been used as a discussion aid, as a way to escape from the tendency to rely on "official" definitions. Participatory work takes as many different forms as there are contexts and innovative development practitioners (USAID website).

Participatory methods are the means by which the principles of participation are translated into the actual practice of development. They ensure that all stakeholders become involved in a number of different activities that are integral to the development process. A wide range of distinctive methods have been developed. None of these methods need be used exclusively; rather they can be used in combination. Each has its own strengths and weaknesses and different methods can be used for different purposes (UNDP website). The basic ingredients of all good participatory methodologies may be categorized under the broad headings of social invention, social learning, social commitment, and iterative planning (IDB website).

There are many factors involved in choosing the participatory method that is most appropriate for a project. The best methodology for an individual practitioner, planner or manager to be used on a specific project is one that ultimately responds and matches with one's goals, values and capabilities.

IDB lists the following commonly used methodologies: Appreciation-Influence-Control (A-I-C): A Self-Organizing Process; Consultation Process: A Regional Approach Stressing Partnership; Future Search: A Consensus-Building Approach to Project Design; The Logical Framework Approach (LFA): A Structured Approach to Project Planning; Open Space: A Better Place to Meet (An Empowering Approach); Participatory Action Research (PAR); Participatory Rural Appraisal (PRA): An Approach to Community-Level Participation; Stakeholder Analysis Method: A Structured Group Approach; and Technology of Participation (TOP): Winning Through Participation.

In the case of techniques, IDB lists the following commonly most used: meetings, categorized to large scale and/or public meetings (conferences and seminars) and working meetings (focus groups, workshops, roundtables); standing bodies (advisory committees and task forces); information giving (news media [newspapers, radio, television], open houses, site visits and demonstrations); and participatory data gathering (social profile, community mapping, interview). For each of the above-stated methodologies, there are also various listed techniques, though not exclusive to them. For example, the AIC self-organizing process can use brainstorming, search conferences, Delphi techniques, storytelling, art, etc. in the appreciative phase. In the influence phase, it can use techniques such as dialogue, open-space, negotiation and conflict resolution. In the control phase, it can employ such methods as management by objectives, the Logical Framework, the *Ziel Orienterte Projekt Planung* or Objectives Oriented Project Planning (ZOPP), and Program Evaluation and Review Technique (PERT). Another example is PRA - the techniques used within the PRA methodology present a rich and varied array. These include: semi-structured

interviewing; casual, random encounter, focus and/or specialist groups; local people serving as investigators and researchers; case studies and stories; participatory mapping and modeling; local analysis of secondary sources (e.g., aerial photographs); transect walks; time lines, trends and change analysis; seasonal calendars and daily time use analysis; institutional diagramming; well-being or wealth ranking; matrix scoring and ranking; local indicators (e.g., what are poor people's criteria of well-being?); team contracts and interactions with agreed norms and modes of behavior; and shared presentations and analysis.

Considering the wide array of participatory methods and techniques, one author makes this wise caveat: It would be misleading to claim that any tools or methods are inherently participatory or that they spontaneously encourage ownership and innovation among stakeholders. The participants in development planning and action – the users of these methods and tools – must be the ones to encourage and enable participation. The methods and tools themselves facilitate learning, preparation, and creative application of knowledge. Nevertheless, these same methods can be implemented in a "top-down" manner, thereby merely paying lip service to participation. The ultimate responsibility for using these methods well, therefore, rests with the users and facilitators (World Bank website).

The Participatory Approach and Biodiversity

One application of participation is in environment and natural resources management. Many countries are gradually embracing the concepts of "collaborative management" and "participatory management". One illustration is in the Lao PDR. Since 1996, the World Wildlife Fund-Thailand Project Office has worked with the staff and local people of four protected areas (PAs) in southern Lao PDR, with the goal of eventually establishing collaborative management of the PAs. This process started with what they have termed a Participatory Biodiversity Assessment (PBA). Since one of the first tasks in the management of a PA is surveying and understanding its components and mechanisms, this meant developing a knowledge base about two major elements – local people (including social, cultural, and resource use values) and biodiversity (including all natural and ecosystem service values) – and where and how these elements interact. The PBA involved the local people in these initial surveys, using a range of PRA tools, some adapted to focus more specifically on ecological knowledge. The surveys were followed by "returning the results" to local communities. These allowed local interpretations of data, leading to a mutual understanding of the issues that face the PA, from which participatory actions can follow. In this context, the surveys were not simply a means to extract information, but the first step in developing a partnership, to help inform subsequent biological surveys, future research and monitoring efforts. The PBA revealed local resource use practices and cultural aspects which, when crosschecked with biological data, helped determine "points of intersection", thus presenting co-management starting points. Collaborative management begins with and builds upon the partnership that the PBA started (Steinmetz, 2003).

Framework of the Study

The factors that affect biodiversity include those in the natural system and the social system as depicted in the following diagram (adapted from Sajise, 1992 by Ticsay-Ruscoe, 1995):

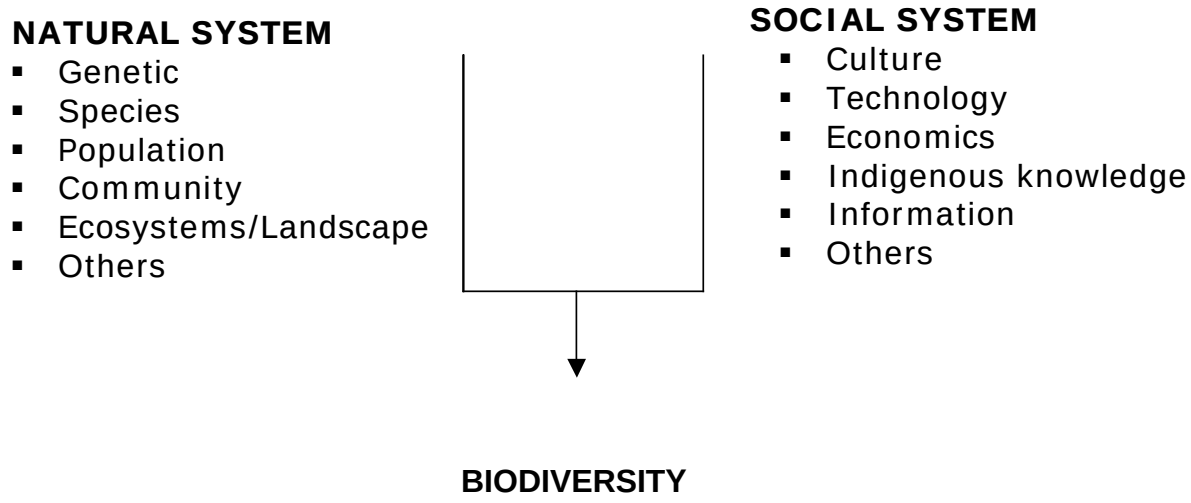


Figure 2. Natural and social variables that affect biodiversity

Biodiversity research would include, first of all, finding out the current state of these biodiversity resources (inventory and assessment), and then looking into the factors that determine and affect this biological diversity (e.g., socioeconomic forces such as roads, transportation and income; cultural factors such as belief systems and practices). Research into these variables would result into a better understanding and increased knowledge of biodiversity, which would lead to sustainable use of these biodiversity resources, thereby benefiting both the human communities and biodiversity together.

The interactions between the human (social) system and the natural system may also be viewed according to Rambo's Systems Model of Human Ecology (Castro, 2002), adapted in the diagram below (Figure 3).

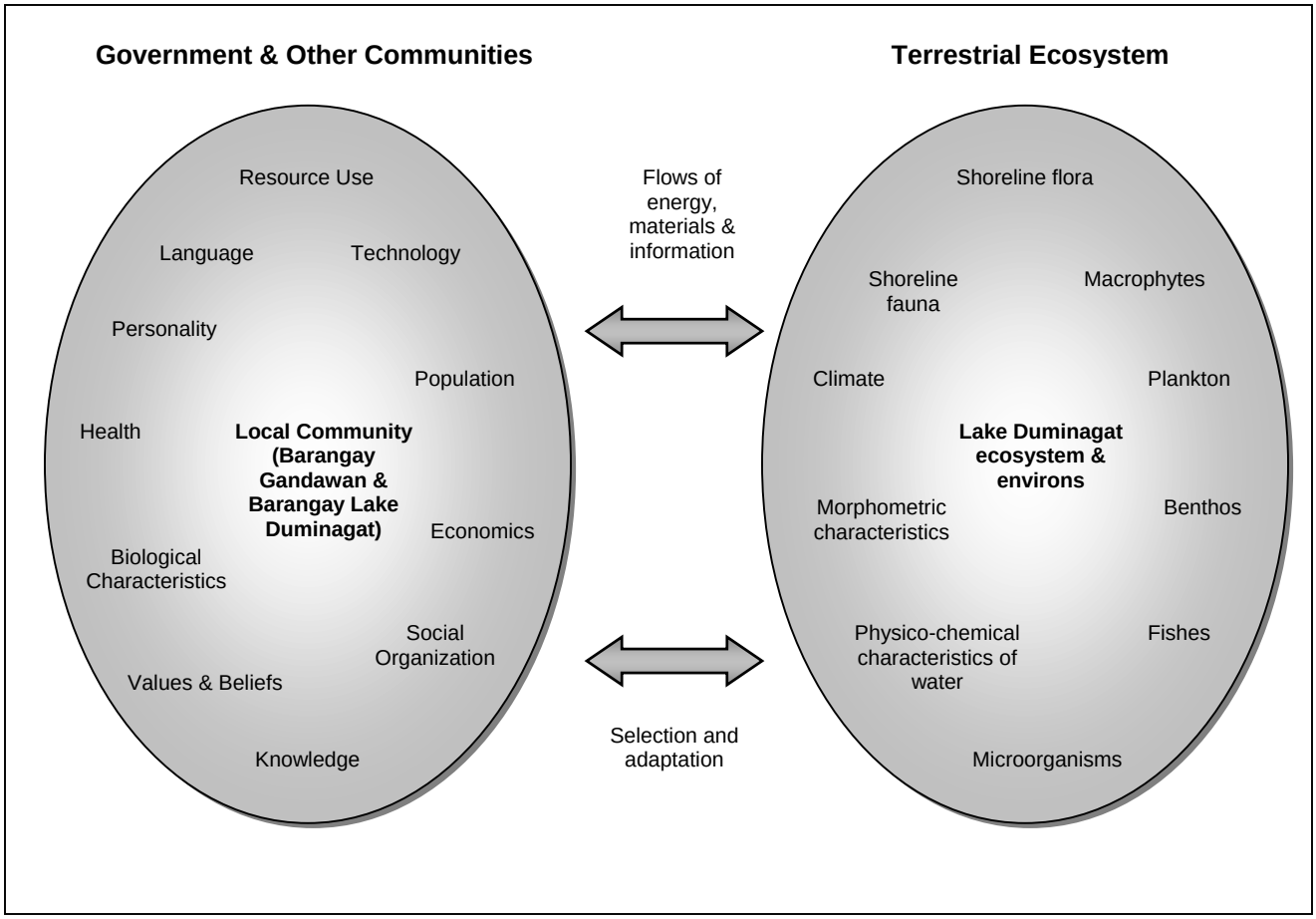


Figure 3. Interaction between social and natural systems

Two arrows that represent the interaction between the two systems connect the two circles in the diagram. This interaction includes the use and management of the lake and its resources by members of the community.

This research is process-oriented participatory research. It employed the participatory approach and participatory techniques, particularly the methodology termed as Participatory Biodiversity Assessment (Steinmetz, 2003). Here, the support agency (BRP) and the external researchers were just facilitators. The external researchers used the tools of participation to help strengthen and enhance the capability of the local communities to manage, protect and develop their local resources. The primary resource users are, rightfully, the managers of their resources. The communities are no longer passive receivers but active participants. The external and local researchers engaged in a common undertaking to describe the conditions related to biodiversity conservation in Lake Duminagat (e.g., finding out what organisms are there) and associated problems. This approach generated information from local and indigenous knowledge (e.g., traditional ecological knowledge), at the same time obtained information using standard scientific methodologies. Both the external and local researchers drew learning, insights and develop different levels of skills as they jointly carried out the research. This is shown in the following diagram (Figure 4) (adapted from IIRR Vol.

3, 1998). Following the philosophy of participatory action development, this initial diagnosing phase (the joint community, lake and biodiversity characterization) should lead to the experimental and sustaining phases (Lammerink, 1999; Lammerink et al., 1999a; 1999b).

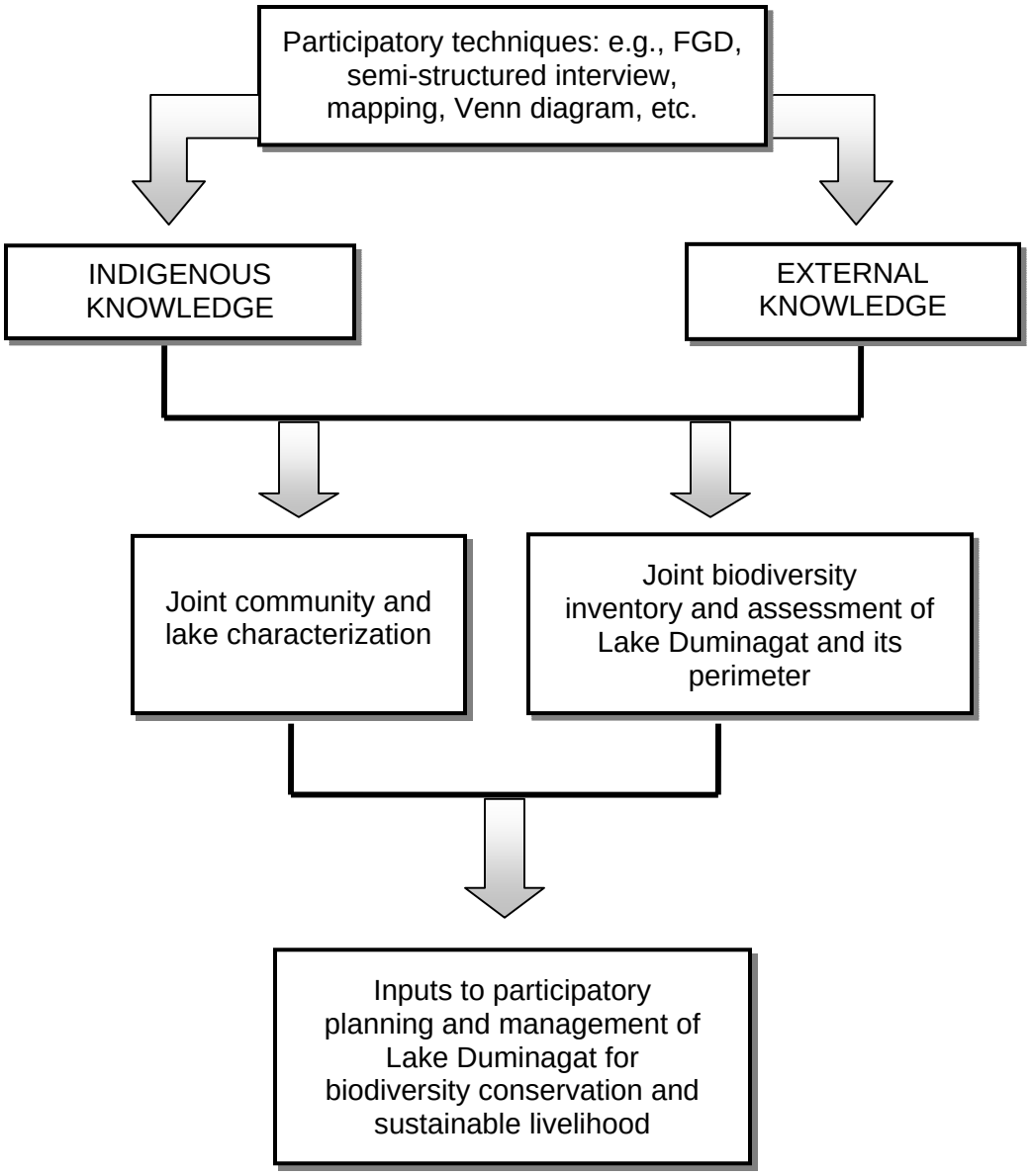


Figure 4. Roles of external and local researchers in participatory action development

Rationale

The biodiversity inventory and assessment of Lake Duminagat and its environs includes collection of vital and accurate information to characterize the communities of people living around it. Their demographic and socioeconomic characteristics, as well as the perceptions, beliefs on and uses of the lake and its resources are necessary for the inventory because of their constant interaction with the lake and its surroundings. Such interaction affects the biodiversity status of both the lacustrine and terrestrial ecosystems. Therefore, they should be partners of government agencies and non-government organizations (NGOs) in the conservation and protection of this aquatic and terrestrial biodiversity that the lake supports, even if they already understand how these biological resources are necessary for their continued existence/ survival. The people who will be directly affected should always be involved in the planning of any program and project that comes their way to pave for their development.

Furthermore, the data on the demographic and socioeconomic conditions of the communities around Lake Duminagat are important inputs in the development of biodiversity conservation and protection plans for Mt. Malindang. No plans can succeed if it is not based on accurate and timely information as basis for action.

Objectives

Overall Objective

The overall objective of the Project is to determine the biodiversity status and potentials of Lake Duminagat through participatory research methods.

Specific Objectives

1. To characterize the sociocultural and economic environment of the lake communities; and

2. To profile the physiographic, morphological, physico-chemical, bacteriological, plankton, faunal, and floral characteristics of the lake and its perimeter.

Methodology

Participatory Methodology

The first step in the involvement of the community was for the researchers to follow the entry protocol. Entry to the community was carried out by making courtesy calls on the mayor of the municipality of Don Victoriano, the barangay captains of Barangay Gandawan and Barangay Lake Duminagat, and the "timuay" (Subanon religious leader) of Barangay Lake Duminagat. This was actually a re-entry because the BRP as a whole was already introduced to the community by the upland ecosystem team during its Participatory Rural Appraisal (PRA) as part of the pre-implementation phase of BRP in April to May 1999. Prior to the official start of this project, the researchers themselves went on a community revalidation visit in January 2001 where both the BRP and the Lake Duminagat project were presented during the community meeting. Another community meeting was conducted at the start of the research to re-orient the residents about BRP and the project. This continued the development of rapport and mutual acceptance between the external researchers and the community.

The appropriate permits were obtained from the Office of the Mayor and from the DENR-Protected Areas and Wildlife Bureau (PAWB). Consent was also obtained from the two barangays/villages.

This research employed community participation from the start up to the end of the study. The techniques used mostly came from those already tested for community-based coastal resource management (IIRR Vols. 1-3, 1998). This reference provides useful details and specific alternative steps for various participatory tools/methods. The participatory methodology used may be referred to as Participatory Biodiversity Assessment (Steinmetz, 2003).

During the field visits to the research area, for two to five days at a time, the external researchers stayed by the lake, at Centro or at Barangay Gandawan. This provided opportunities for direct/participant observation and greater interaction with the residents.

At the start, a community meeting was called for consultation and re-orientation about the project, followed by the identification and selection of local researchers and key informants. Training and orientation of local researchers on the methods such as household survey/house-to-house interview, group interviews, and focus group discussions were done. The information sought by these methods are discussed in the section on community characterization.

Semi-structured interviews were used with the key informants; some of whom have stayed in the place the longest. Note taking and photo documentation were done with permission.

To get more information, informal interviews were done with the respondents during long walks, horseback rides, clothes washing, meal preparation, and group meals. During the conversations (informal interviews) and focus group discussions (FGDs), the researchers motivated the community members to tell stories and to speak freely of historical events, important issues and concerns such as plants or animals they used for medicines and for other purposes, their indigenous practices and beliefs, experiences, and observations on their environment.

As participant observers, it was necessary for the external/academic researchers to respect and follow the customs and practices of the local community. These included doing the "pamuhat", i.e., making a "halad" (offering) to the "diwata" (spirits) of the lake before conducting the lake fieldwork.

Local partners were used as researchers/investigators. They were trained on field research and limnological

research work and were involved in studying the lake and its biodiversity. They handled all the instruments that were not delicate and did not require technical expertise.

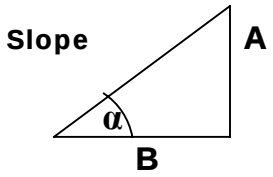
During community meetings, data gathered were referred back to the community for validation and awareness. At the end of the research, the results were presented and discussed. The species that were scientifically identified were displayed for the community. Ideally, the research results should have enabled the local community to realize their situation and the status of biodiversity in Lake Duminagat so they can start conserving and sustaining the resources.

Physiographic Characterization of the Landscape

Topography

The DENR NAMRIA topographic map of Mount Malindang, Sheet 3744 IV, was examined to determine the elevation/ altitude in meters above sea level (masl), latitude, and longitude of Lake Duminagat and its two nearest villages/barangay – Barangay Lake Duminagat and Barangay Gandawan. Although these places were not yet labeled on the map, they could be easily recognized because of the lake, a water body and the two barangays which are crater valleys. Furthermore, their proximity to North Peak also makes it easy for them to be located.

The section of the map was computer-scanned and enlarged to facilitate measurements (Figure 5). The area of the somehow level part in each of the two barangays (i.e., differing in elevation by not more than 20 m), as well as that of the catchment basin of Lake Duminagat, was measured by means of a planimeter. The slope of the area surrounding the lake and that of the mountains enclosing the two barangays were calculated with the use of the formula, *slope = vertical distance / horizontal distance*. Vertical distance was determined by counting the intervening contour lines that were at 20-m intervals and multiplying by 20 m, while horizontal distance was determined with a millimeter ruler and converted to meter based on the scale. The resulting number is really the tangent of the angle of the slope, wherein tan 45^{o} = 1.00. Slope is either expressed in degrees by finding the equivalent angle of the obtained tangent, or expressed as per cent by multiplying the quotient with 100[1]. This can be illustrated by the figure below:



A/B = tan α; arctan (A/B) = α = slope
or slope = A/B x 100

[1] Some references (e.g., PASA Report 1993, as cited by Cali et al., 1999) confuse the expression of slope value in degrees and percent. Where a slope value should have been expressed in degrees, it had been expressed in percent. The two are not interchangeable. If slope =α =15°, slope in percent is 26.79%. If slope =15%, slope in degrees or α is 8.53°.

The dimensions of the lake in the east-west and north-south directions were measured with a millimeter ruler and converted to the actual value based on the scale. However, more accurate values of these dimensions were obtained by actual engineering survey during determination of the lake's morphology.

Climatic Factors

Due to lack of appropriate instruments, only air temperature and relative humidity were measured scientifically. Ideally, the system of this area needs an empirical determination of its own because of its high elevation and unique physiographic features. The nearest weather station of PAGASA is in Dipolog, Zamboanga del Norte, which is in the northwestern coast and is at about sea level.

To get an idea of the prevailing temperature, an ordinary laboratory thermometer was used to measure the air temperature. Ideally, this should have been over a 24-hour period but measurements were taken only from early morning to early evening in May and at random hours at other times. A more rigorous method for measuring temperature is described by Linsley et al. (1958).

Relative humidity was measured with a sling psychrometer. The wet bulb and dry bulb temperatures were recorded and the difference between the two calculated. The relative humidity was then determined by consulting Table 2B.1 in Brower and Zar (1984), the values of which are for a barometric pressure of 743 mm Hg. For other barometric pressures or for altitudes over 600 m, a correction factor was used (Table 2B.2, ibid.). If the dry bulb temperature is T (in ^{o}C), the difference between dry and wet bulb temperature is ΔT (in ^{o}C), the relative humidity in Table 2B.1 is RH, and the barometric pressure is P (in mm Hg), then the corrected RH is:

$$RH_c = RH + c\,\Delta T\,(743\text{ mm} - P)$$

If barometric pressure is not measured directly, it may be assumed to decrease about 9 mm Hg per 100 m altitude up to about 800 m, about 8 mm Hg per 100 m from 900 to 1700 m, and about 7 mm Hg per 100 m thereafter up to about 2,500 m. Therefore, the decrease in pressure at Lake Duminagat (elevation approximately 1560 masl) is 128 mm, having a barometric pressure (P) of 615 mm Hg.

Lake Characterization

Morphology

A lake's morphology can best be described by a detailed bathymetric map, which is needed for the determination of all other morphometric parameters. A detailed bathymetric map will show the shape of the lake and its bottom contours at various depths. This involved an engineering survey so as to be able to determine the location of various points in the shoreline and the location of various points in the lake at which the depth was measured.

The basic tools/equipment used in the depth measurement and survey were: engineering transit (Model: World GT-5W, Serial #20289; this instrument is built with a magnetic compass, graduated to 1^{o}); 30-m engineering tape measure attached to a rock to determine depth; 400-m polyethylene rope, with 10-m increment permanent markings on it; one hand paddle-powered outrigger dugout canoe manned by three people: the rower, the data recorder, the surveyor; and synchronized watches with the surveyor on the canoe and the surveyor at the transit.

The transit was installed at the shoreline on the most eastern edge of the lake. This was chosen as it is near the settlement of five households, and is less steep than any other side of the lake. Three long stakes had to be driven into the soil, the legs of the transit securely tied to the stakes, to assure the stability of the transit. One end of the 400-m polyethylene rope was tied to a small tree near the transit; one person on the canoe held the rest of the rope.

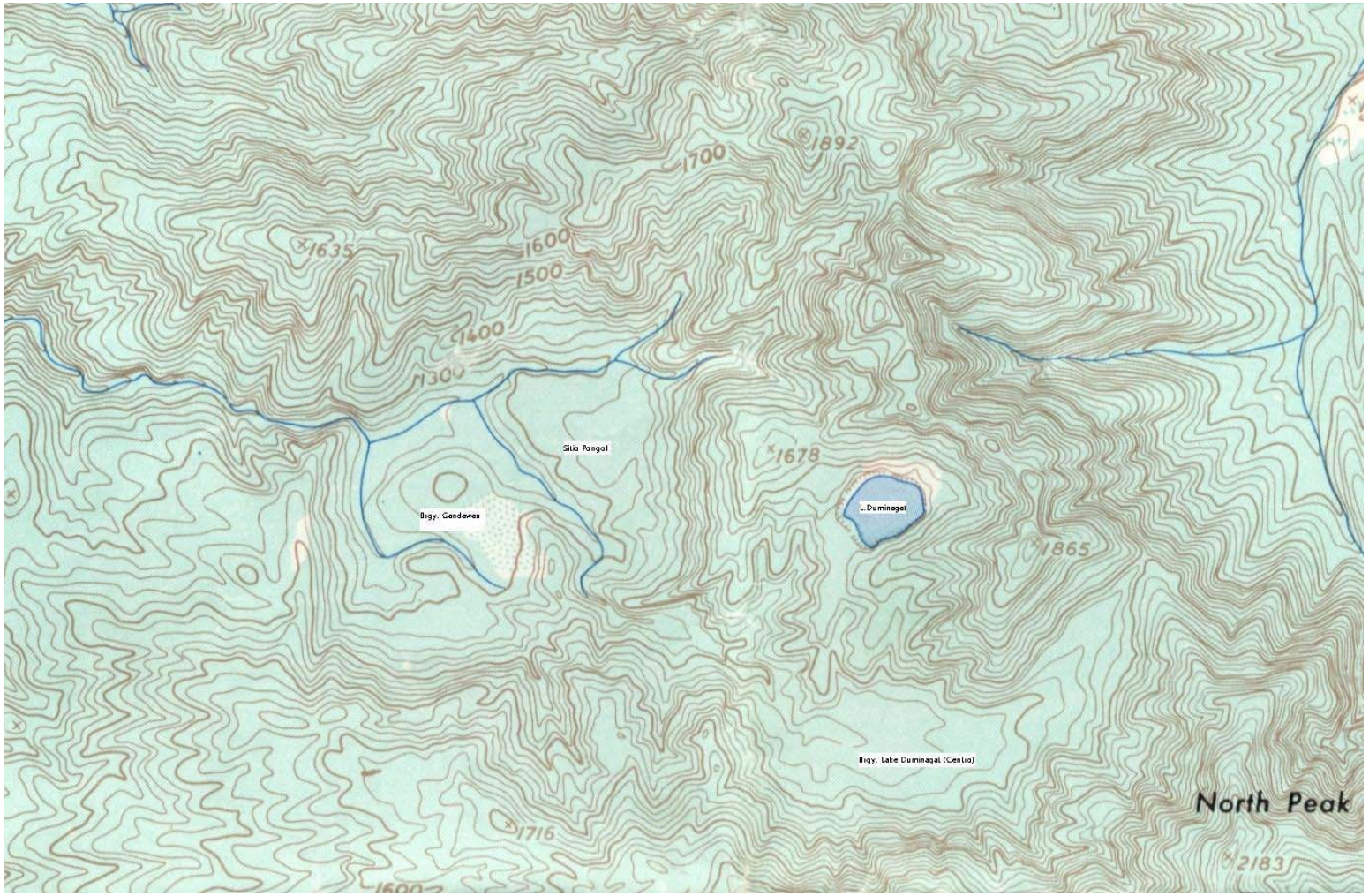


Figure 5. Enlarged portion of topographic map showing Lake Duminagat area

The canoe made circular chord sweeps at 20-m increments. That means the canoe started on the shore to the left of the transit, at a 20-m distance from the transit, and went on to the right while maintaining the same distance to the transit with the aid of the rope. The canoe surveyor would blow a whistle or wave a flag when the canoe was at the desired location, and at that time the surveyor at the transit would record the time and the magnetic bearing. (A surveyor's magnifying glass was used to assure accurate angular reading). The recorder in the canoe would also record on the same occasion the time and the water depth ("0" at the shore line).

The canoe rower would paddle at the direction of the canoe surveyor, who would make sure the canoe stays on the desired radial chord line, and then stop the canoe to take a water depth reading, and signal the surveyor at the transit to take the bearing reading. This continued at increments decided by the canoe surveyor, who took regular trial depth readings, until she decided to stop for the scheduled reading. This continued until the shoreline at the right (i.e., opposite end) was reached.

The polyethylene rope was extended to 40 m and a new radial chord line was started from the beginning with the right shoreline, until the left shoreline was reached. This procedure was continued in extending the radial chord lines until the far westerly shoreline was reached at 315 m. During this process, the polyethylene rope was being weighted down by the water if it was left on the surface, as the distance to the transit (i.e., the radius) increased. This proved to be a difficulty because it needed quite a bit of effort to lift up the rope in order to allow the canoe to be rowed.

The bathymetric map was drawn to scale with the data gathered by the survey. Radial chords were drawn at 20-m incremental radii, and then the magnetic gradients were drawn on the corresponding chords, and the water depth was then recorded on the intersectional points. Lines connecting the same depth were drawn beginning with the shoreline (0 m depth) and at increasing depths at 5-m intervals, producing the 5-m, 10-m, 15-m, and 20-m depth contour lines. The radial chord lines, locations at the shoreline, and the points at which the water depths were measured are shown in Figure 6.

Based on the bathymetric map, the following major morphometric parameters of the lake were measured and/or calculated: area, volume, shoreline length, shoreline development, maximum length, maximum width, maximum depth, mean depth, and relative depth. The formulas come from Lind (1985), Wetzel (1983), and Wetzel and Likens (1979).

The area of the surface and each contour at depth *z* was determined using a planimeter. The volume of the lake is the integral of the areas of each stratum at successive depths from the surface to the point of maximum depth. This was approximated by calculating and summing the volumes of conical segments (frusta), with upper and lower surfaces delimited by the areas of sequential depth contours. The calculation is then:

$$\text{Lake volume} = \Sigma \text{ Frustum volumes}$$

where

$$\text{Frustum volume} = h/3\ (A_1 + A_2 + \sqrt{A_1 A_2})$$

h = depth of frustum
A_1 = area of frustum surface
A_2 = area of frustum bottom

The volume of the last stratum was calculated as a cone (cone volume = $1.047\ r^2h$).

In the absence of a cartometer, the shoreline length (S) was measured simply with a string, having predetermined the scale of the bathymetric map.

Shoreline development (SD) is an index of the regularity of the shoreline. It is the ratio of the length of the shoreline to the circumference of a circle with area equal to that of the lake

$$SD = S / 2\sqrt{\pi A}.$$

Very circular lakes would approach the minimum shoreline development value of 1.

Maximum length (l) is the longest straight line that may be drawn without intersecting any mainland. This length is the maximum effective length or fetch for wind to interact on the lake without land interruption.

Maximum width or breadth (b) is the maximum distance on the lake surface at a right angle to the line of maximum length.

The mean width is equal to the area divided by the maximum length.

Maximum depth (z_m) is the greatest depth of the lake.

Mean depth ($\bar{\Sigma}$) is calculated from the volume divided by its surface area. Relative depth (z_r) is the ratio of the maximum depth as a percentage of the mean diameter of the lake at the surface, expressed as a percentage.

$$z_r = 50\ z_m\ \sqrt{\pi}\ /\ \sqrt{A}$$

Physicochemical Characteristics

The physical factors measured in the lake included the following: temperature, visibility (transparency), and turbidity. A vertical temperature profile was obtained by measuring water temperature at various depths at 1-m intervals. When presented as a depth-temperature plot, this will show whether the lake exhibits temperature stratification. Temperature was measured with an ordinary laboratory thermometer (0-100^{o}C; 1^o graduation). The water at various depths was simply brought up to the surface by means of a Kemmerer water sampler and its temperature quickly measured. Because of the high specific heat of water, its temperature reading was expected to be stable. However, a more accurate measurement of the temperature was done with the use of a dissolved oxygen (DO) meter (Model Oxi 330/SET, WTW, Made in Germany) which also had a sensor for temperature.

Visibility or transparency is a measure of the depth to which one may see into the water. This is commonly measured as Secchi disk visibility/transparency, with the numerical value termed as Secchi depth. The Secchi disk used was improvised, made of wood 20 cm in diameter, with the surface painted gloss white and gloss black in opposing quarters. The clearness of the day, position of the sun, time and the observer were also recorded as these affect the Secchi disk readings.

Water turbidity is affected by the presence of suspended solids, which reduce the transmission of light either through scattering or absorption. Water samples were brought to the Iligan City Waterworks System Office (ICWSO) for turbidity determination, which was expressed in NTU (nephelometer turbidity units).

The chemical characteristics of lake water included the quantification of the following: dissolved oxygen, salinity (if present), pH, total alkalinity, total hardness, nitrate-nitrogen, total phosphorus, total suspended solids (TSS), and total dissolved solids (TDS). Dissolved oxygen and salinity were determined on site. The pH, total alkalinity, total hardness and TDS were analyzed by the Iligan City Waterworks System Office and the nitrate-nitrogen, total phosphorus, TSS by DOST-R.O. 10 in Cagayan de Oro City. Prior to leaving the research area, water samples for chemical analyses were collected in bottles previously containing distilled drinking water (e.g., Wilkins) which were rinsed first with the water sample before filling. These were placed in a styrofoam container with ice (approximately 4^{o}C) during transport. Upon arrival in Iligan City, they were submitted to the Iligan City Waterworks System Office for analyses. Other samples were brought to Cagayan de Oro City and submitted to the DOST-R.O. 10 laboratory for analyses.

Dissolved oxygen content of the water obtained at various depths was measured in order to get a vertical dissolved oxygen profile. The water sample was obtained at

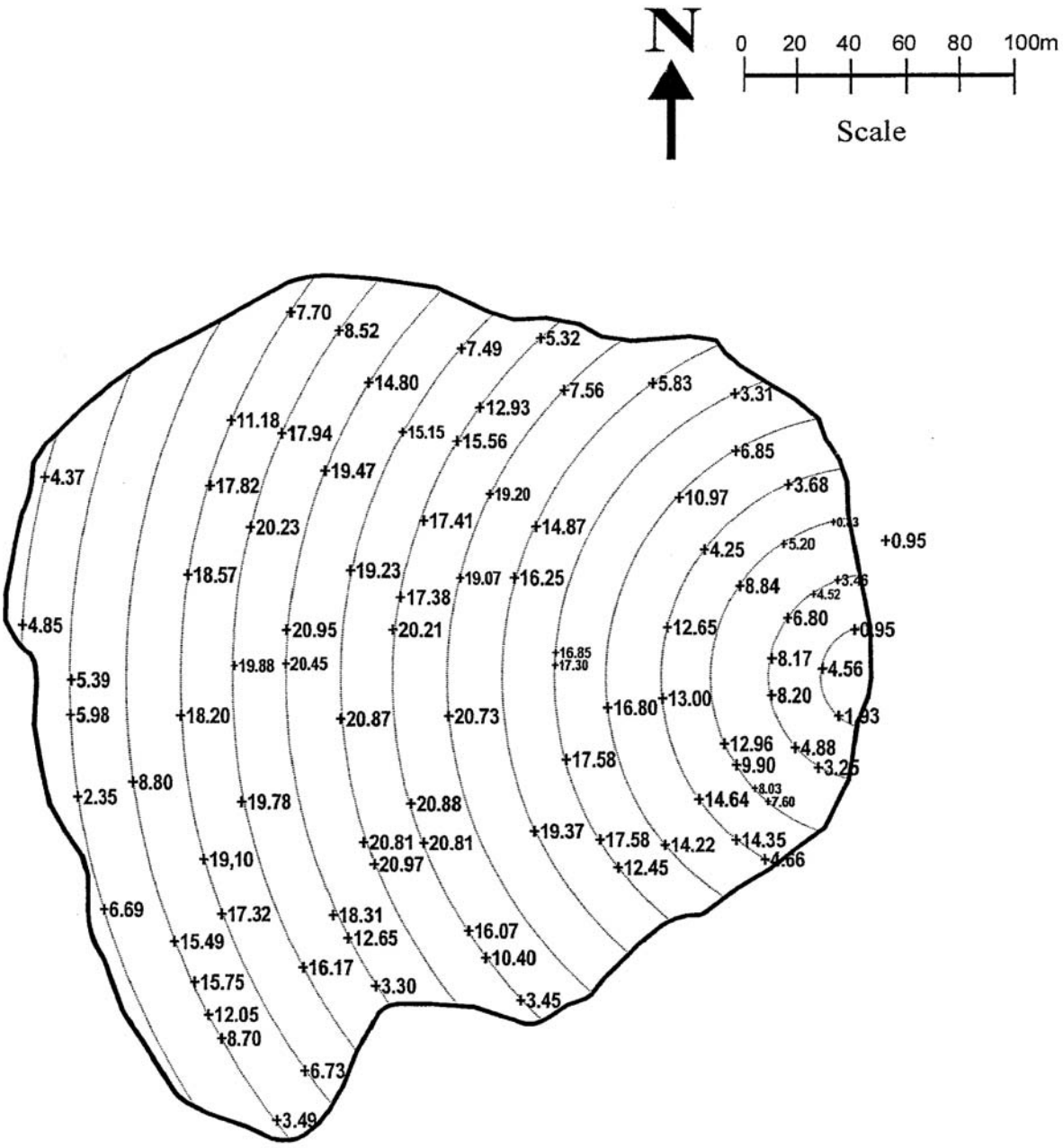


Figure 6. Method in preparing bathymetric map showing the radial chord lines

1-m intervals with a Kemmerer water sampler, made to flow into a BOD bottle, then its dissolved oxygen measured by a DO meter.

The salinity of inland waters is generally very low compared with that of the sea. Salinity was measured using a refractometer (Model: Atago S/Mill-E, Salinity 0~100 ^{o}/oo, Made in Japan). The pH of the lakewater should ideally be measured on site. In the absence of a portable pH meter, this was determined on the water samples brought to the Iligan City Waterworks System Office.

Total alkalinity of the water samples brought to the Iligan City Waterworks System was determined. The method used was titrimetric, using methyl orange as indicator. It was expressed in terms of milligram per liter $CaCO_3$. Total hardness of the water samples brought to the Iligan City Waterworks System Office was determined.

Inorganic nitrogen in the form of nitrate was measured on the water samples brought to DOST-R.O. 10, using Method 53, Spectroquant 118, Merck. Total phosphorus was analyzed on the water samples brought to DOST-R.O. 10, using 4500-P D. Stannous chloride method, Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF, 1995 (H_2SO_4-HNO_3 digestion).

The TSS of the water samples brought to DOST-R.O. 10 was determined, using 2540 D. Gravimetric method, Standard Methods for the Examination of Water and Wastewater, APHA, AWWA, WEF, 1995. The method involves filtering a known volume of water (usually 100 ml) through a pre-dried and pre-weighed filter paper (hard-finish filter paper for fine precipitates or 0.45 um membrane filters). The filter paper is dried overnight in an oven at 103^{o}C and weighed. The difference in weight of the filter is taken and expressed as milligram per liter. The TDS of the water samples brought to the Iligan City Waterworks System Office was determined and was expressed in ppm.

Bacteriological Analyses

The bacteriological analyses of water is mainly done to determine its potability rather than as an inventory of the bacterial population of the water. Bacteriological analyses were done on the surface water samples taken from approximately the middle of the lake where the lakeshore residents get their drinking water. The Iligan City Waterworks System Office water laboratory did the analyses. Heterotrophic plate counts were determined and the coliform test performed. The coliform test consisted of three tests: the presumptive test (which made use of the multiple-tube fermentation technique), the confirmed test, and the completed test.

Plankton

An integrated vertical sample of plankton was obtained by lowering a plankton net with 25-ml bucket (119 μm mesh size; 24.5 cm mouth diameter) almost to the bottom (about 19 m) and hauling it vertically. Mostly zooplankton was obtained. The concentrated plankton sample in the bucket was poured into a bottle (amber) and preserved with Lugol's iodine to make a 1% final concentration (about the color of weak tea). (Zooplankton should preferentially be preserved with 10% neutral formalin to make a final 4% to 5% concentration [Lind, 1985]).

In the laboratory, 1-ml aliquot samples were examined under the microscope using a Sedgwick-Rafter counting cell for the identification and enumeration of the zooplankton species. Total count was made for each species in the 1 ml of water. These data need to be converted back to the number in the unconcentrated lake water by using the formula as follows:

$$\text{Organisms per liter of lake water} = \frac{\text{Organisms per ml of concentrate} \times 100}{\text{Concentration factor}}$$

where

$$\text{Concentration factor} = \frac{\text{Volume of lake water filtered (ml)}}{\text{Volume of concentrate (ml)}}$$

Volume of lake water filtered is obtained by multiplying the mouth area of the plankton net (πr^2) with the actual depth through which the net was towed.

Aquatic Fauna

Lake fishes were collected using the residents' traditional fishing methods, namely, fish traps or "bubu", and hook and line. A mosquito net was dragged around to catch whatever pelagic organisms were there. For benthos, an Ekman dredge was used to collect sediments from various points of the lake, specifically two replicate samples from the middle of the lake (20.4 m depth) and near the shore. Sampling near the shore proved to be difficult because of the large number of dead trees that have fallen and accumulated at the bottom. Thus, a near-shore sample was not taken. The sediment obtained was subsequently sieved successively through sieves of mesh sizes 4, 8, and 12 (0.203 in, 0.097 in and 0.060 in, respectively, as marked in the sieves; six-hundredth inch is approximately 1.5 mm). The concern of this study was the macrobenthic invertebrates visible to the naked eye. Collected animal specimens were documented by photographs.

Aquatic Flora

By extending the stations to the lake's littoral area, the aquatic flora (the submerged macrophytes in particular) and shoreline flora were able to share common sampling stations. Stations 1 and 2 were near the residential houses in the east, then researchers proceeded to the other stations in a counter clockwise direction.

At each station, a 1 x 1 m quadrat was laid out in the lake's littoral and species density counts were determined. Local names and local uses, if any, were recorded for each plant. For plants whose local names were not known to the local researchers, the specimens were referred to key informants. Representative plants were collected, photographed and prepared into herbarium voucher specimens.

Shoreline Fauna

The shoreline fauna was less rigorously determined. These fauna were terrestrial and went to the lake only to drink or to eat the surrounding vegetation. Through ocular observation and interviews of the local residents, available shoreline fauna were determined. A lakeside resident also installed traps, which was a common practice.

Birds seen were recorded according to local names and description given by the local researchers. For insects, representative specimens were collected for photo documentation and laboratory identification. For mammals, traps were laid out by the local residents, the species photo documented and released into the wild. For amphibians, local residents did the collecting of specimens. These were photographed by the team. Some were kept for identification, while others were released.

Shoreline Flora

With four local researchers bringing bolos, knives, plastic and sack containers, a transect walk was done along the lake's perimeter up to 10 m outward of the waterline. Ten sampling stations were established around the lake's perimeter. When facing the lake's settled eastern side, Stations 1 and 2 were near the residential houses. Researchers then proceeded to the other stations in a counterclockwise direction equidistantly. Since the shoreline has a length of 1,060 m, the stations were approximately 100 m apart.

At each station, a quadrant of 5x10 m size was laid out starting from the waterline perpendicular to the lake. Density counts of each species of vascular plant were made. All plants encountered were identified by the local researchers by their local names. Whole small plants and sample parts (stems, leaves, flowers and fruits, if present) of trees and shrubs and big herbs were collected, tagged and labeled with the local name. Unidentified plants were referred to the key informants. Local uses of each plant, if any, were recorded. Plants were tagged, pressed and brought to the CMU laboratory for herbarium making.

Community Characterization

A brief historical background of each of the two barangays was obtained from secondary data (DENR Mt. Malindang topographic map; Noorduyn et al., 2002) and from key informants. The key informants selected were those among the oldest residents and the "Timuay" (Subanon religious leader). The Venn diagram generated during the focus group discussion validated the information from the key informants and provided additional information. The Venn diagram was a tool used to establish partly the chronological entry of important services/agencies to the community. The participants were briefed on the purpose of the exercise and the circles of various sizes (the bigger the size, the more important was the agency/service to the community). The year of entry was also indicated.

Demographic and economic data were generated from the house-to-house interview conducted by the local researchers, using an interview schedule translated to Visayan. Information obtained from each respondent/household head included: age, gender, marital status, religion, ethnic group, educational attainment, household size, age and sex distribution of household members, schooling of children, length of stay in barangay, main and other income sources, monthly income, size of cultivated land, kinds of planted crops, kinds of fish caught from lake/river/fishpond, fishing methods, and health and sanitation practices. There were 79 out of 85-90 households surveyed in Barangay Gandawan; and 42 out of 55 households were surveyed in Barangay Lake Duminagat. The sampling method used was opportunity sampling, and depended on whom the local researchers chanced upon to interview within the two-week schedule given to them. Additional data were obtained by means of focus group discussion or FGD (in the case of wealth ranking) and from direct/participant observation (e.g., other kinds of cultivated plants, sites of tilled land).

Data on community problems were generated from the house-to-house interviews and by means of FGD. The FGD is a participatory research method involving 15 or less members of the community who discussed about certain topics facilitated by an external researcher. FGDs were conducted on these other topics as well: current and proposed uses of the lake, causes of lake/environment destruction and their solutions, gender roles in lake/natural resources conservation and in community (as the opportunity arose), and beliefs on the lake.

Data on utilization of the lake by the local community was obtained from the house-to-house interviews and from FGD. Utilization of the lake by people from outside the local community was monitored.

The exact number of people who visited the lake during Holy Week 2002 was recorded by assigning the local researchers as monitors. Aside from secondary data from records, the Barangay Secretary (Romeo Doria) and a lakeside resident (Rosalyn Alaya-ay) also gave information on the number of visitors in the past. Direct observation by the research team during the field visits gave them an approximation of the number of visitors going to the lake. Proposed uses of the lake by the community were drawn out from FGD.

Information on cultural beliefs concerning the lake were obtained from semi-structured interviews of key informants: the oldest people in the community and the "timuay". Information on cultural beliefs were also gathered from FGD and from participant observation. Participant observation is a technique used to study social situations or organizations where researchers become part of the social environment they are studying (Castro, 2002). In this case, the researchers stayed in the area seven times from two to five days at a time. They followed the ritual of "pamuhat", making an offering to the lake spirits so as to be allowed to do research on the lake.

Although the Subanon residents talked Sinubano in their households (especially if they did not want outsiders to understand), they generally communicated in Cebuano (Bisaya). Some information were drawn out from informal talks with some residents while interacting or walking with them.

Data Collation and Analysis

Species Diversity

Ratios between the number of species and "importance values" (numbers, biomass, productivity, etc.) of individuals are called species diversity indices. One index is the Shannon function or H index, which combines the species' richness/variety and evenness/equitability components of diversity as one overall index of diversity. The Shannon index of general diversity is calculated using the formula,

$$H = - \Sigma \, n_i/N \log n_i/N$$

where

n_i = importance value for each species (e.g., number of individuals)

N = total of importance values.

The Shannon index of diversity was calculated for the zooplankton and the shoreline flora.

Species Identification

Fresh and preserved specimens were used for species identification. Manuals, pictorials and books were referred to (e.g., Fassett, 1957; Hotchkiss, 1972; Madulid, 2000; Mamaril, 1986; Merrill, 1912). Keying out was difficult for some plant specimens because of the absence of reproductive structures. Resource persons from Central Mindanao University working on the Biodiversity Research of Dr. Victor B. Amoroso and Dr. Jose B. Arances; as well as several of their publications (e.g., Arances, Amoroso et al., 2002) were consulted. For birds and mammals, scientific identification was simply based on the local names, using Rabor's Philippine Birds and Mammals (1977) as the reference. The collection of the ITBACS Museum of Central Mindanao University was also tapped for reference.

Collation and Analysis of Socio-economic Data

The raw data from the household survey were tabulated and subsequently categorized into qualitative or quantitative. They were interpreted using descriptive analysis. All the data gathered were validated by presenting them back to the community.

Results and Discussion

Physiographic Characteristics of the Landscape

Topography

Lake Duminagat is located approximately at latitude 8°18'N and longitude 123°37'E, with an altitude (elevation) of approximately 1560 masl. Its nearest barangays are Barangay Lake Duminagat, of which it is a part of, the barangay proper (or Centro) situated to its south at latitude 8°17.8'N longitude 123°37'E (elevation from 1440-1460 masl); and Barangay Gandawan, situated to its west at latitude 8°18.3'N longitude 123°36'E (elevation from 1240-1280 masl). One of the mountains at the periphery of Barangay Lake Duminagat is North Peak, which has an elevation of 2183 masl.

The geologic history of the Mt. Malindang range (Dickerson, 1928) and the lake basin's topography would justify the description of Lake Duminagat as a crater lake. There was possibly a violent ejection of magma forming the depression that accumulated water, which gave rise to the lake. Lake Duminagat is surrounded by mountains at all sides, except the opening in the westerly direction. The surrounding slope of the shoreline is least steep on the westerly side of the lake, with the other slopes averaging to 45.6°. The total area of its catchment basin is about 53.2 hectares. The map scales show the lake dimensions to be 350 m in the E-W direction and 300 m in the N-S direction. The lake has no inlet streams, with only one small outflow stream located at the southwestern part of the lakeshore. Due to its small size, this small outflow stream is not reflected on the DENR topographic map. It is said to drain towards Kalilangan River, ultimately joining Dapitan River (Arances and Amoroso, 2004). During the May 2002 visit to the area, there was virtually no water flowing out of the lake.

Both Barangay Lake Duminagat (Centro) and Barangay Gandawan are crater valleys. The plain area of Centro is 0.478 km^2 or 47.8 hectares, surrounded by mountains having peaks of 1,678 m, 1,865 m, and 2,183 m (North Peak). Majority of the slopes are 35°. Barangay Gandawan has a larger plain area, divided into the two plains of the barangay proper and of Sitio Pongol, totaling to 1.019 km^2 or 101.9 hectares. The surrounding mountains have peaks of 1,635 m, 1,716 m, and 1,678 m, with majority of the slopes averaging to 33°.

Accessibility

Lake Duminagat was accessible on foot only through a narrow trail about an hour's walk from Centro, the main settlement of Barangay Lake Duminagat. Alternatively, it can be reached directly (without passing through Centro) by horse or foot on a wider trail for about an hour and a half from Barangay Gandawan. Centro itself was accessible by horse or by foot on a narrow trail from Barangay Gandawan for about an hour's walk (a distance of approximately 3 km). In the case of Barangay Gandawan, a wide road led to it from Barangay Mansawan through which a four-wheeled vehicle was able to pass (in August 2000). However, the road had been badly eroded (due to lack of proper drainage) so the barangay could be reached only by traveling on horse or by foot for about an hour's walk (or approximately 3 km). The end of the road for motor vehicles, both private and public, was Barangay Mansawan.

A mini-bus left each morning to Barangay Mansawan at the Integrated Bus Terminal in Dipolog City. It passed through Polanco, Piñan, and Mutia, all municipalities of Zamboanga del Norte. At odd hours, one may take the more regular mini-buses going to Mutia, and then take a motorcycle ("habal-habal") to Barangay Mansawan. The mini-bus usually went back to Dipolog in the late afternoon. A converted cargo

truck may also go to Barangay Mansawan and in the evening be loaded with vegetables (chayote, green onions, cabbage) and people going to Dipolog.

The area of Mansawan-Gandawan-Lake Duminagat which was located in Barangay Tuno was isolated from the seat of the municipal government of Don Victoriano. To go to the municipal office by car would involve a roundabout route that will take one to Ozamiz, then to Bonifacio, Josefina, and several barangays of Don Victoriano. Thus, to go to the municipal office directly, the barangay captains just walked from Mansawan to Barangay Tuno, which took approximately four to five hours (about 15 km), for their official transactions. The Postal Office, offices of government agencies (DA, DENR, Lingap Para sa Mahirap, Telecommunications) and offices of NGOs (PALS, CARE-Philippines) were also located in Barangay Tuno.

From Centro of Barangay Lake Duminagat, the foot trail continued northeastward to Barangay Liboron, which was on the other side of North Peak. The trail followed the riverbank, very steep at some places, of the headwater stream of Layawan/Oroquieta River, and continued on to Barangay Sibucal (part of Oroquieta City) until it reached Barangay Toliyok (end of access for motor vehicles to Oroquieta) where the foot trail transformed into a motor vehicle-passable road that connected Barangay Toliyok to the more developed parts of Oroquieta City.

Climatic Factors

Only air temperature and relative humidity were measured scientifically, but not rigorously. The nearest weather station of PAGASA was in Dipolog, Zamboanga del Norte, which was at the northwestern coast at almost sea level. Thus, its climatic data, especially air temperature, cannot be used to describe the Lake Duminagat environment.

Air temperature measurements are shown in Table 1. Temperature was recorded at random times just to get an idea of the prevailing temperature. Daily temperature observations should ideally consist of the current, maximum, and minimum temperatures with the aid of a maximum thermometer and minimum thermometer or some other instrument (Linsley, 1958). The mean daily temperature is the average of the daily maximum and minimum temperatures. Once-a-day temperature observations should be made around 7 a.m. or 5 p.m. The *normal daily temperature* is the average daily mean temperature for a given date computed for a specific 30-yr period.

Air temperature was measured at Barangay Gandawan in the morning of March 21 and 22, 2002, at Centro in the afternoon of March 22, 23 and 24, 2002 and Oct. 27, 2002; and by the lake on May 16 and 17, 2002 and June 8 and 9, 2002 (Table 1).

Table 1. Air temperatures (in °C) of Barangay Gandawan, Centro and area by the lake taken at different dates and time

Time\Date	Mar. 21	Mar. 22	Mar. 23	Mar. 24	May 16	May 17	June 8	June 9	Oct. 27
5:00 a.m.								16.5	
6:00 a.m.					16.0	15.0	18.0		19.0
7:00 a.m.						15.0			
8:00 a.m.			20.0			16.0			
9:00 a.m.						19.0			
10:00 a.m.		21.0				19.5			21.25
11:00 a.m.				20.5	22.0	21.0		23.5	
12:00 pm					22.0	-			
1:00 p.m.		22.0	21.0		20.0	23.0	21.5		
2:00 p.m.					18.5	-			
3:00 p.m.					20.0	-			
4:00 p.m.					20.0	20.5	19.5		
5:00 p.m.					20.5	19.5			
6:00 p.m.	20.0				18.5	18.5			
7:00 p.m.									
8:00 p.m.					19.0*				
9:00 p.m.					18.5				

* - temperature taken inside the house

Though no generalization was made from the limited data, it was possible that the temperatures in this area were comparable to Baguio City (in Northern Luzon and labeled as the summer capital of the Philippines), based on elevation. Baguio City has an average annual temperature of 17.9°C and is located on a high upland plateau with an elevation ranging from 1,200 to 1,500 meters (Dickerson, 1928). The elevation of Lake Duminagat and its nearby two barangays also ranged from 1,200 to 1,500 meters. During the field visits of the researchers to the area on December 2001 and January 2002, the temperature was very cold, coupled with strong winds and continuous rain. In January 2002, for example, one of the carabaos in Barangay Gandawan had to be slaughtered because it could no longer get itself up and was shivering uncontrollably.

The relative humidity data and calculated values are shown in Table 2. Similar to the general characteristic of the Philippines, the area is characterized by high humidity, ranging from about 83.0 to 91.5% in relative humidity during daytime, on two consecutive days of measurement.

The climate map of the Philippines (Dickerson, 1928), which was adapted from the Philippine Weather Map published in the Philippine Census in 1920, classified the Mt. Malindang area as Intermediate B type – No very pronounced maximum rain period and no dry season. Indicated annual rainfall at the northwestern tip of the peninsula (Dipolog) was 2099 mm. Barangay Gandawan residents identified the months of December and January to be the most rainy and windy months, February as less rainy, and March and April as the least rainy months.

Table 2. Relative humidity measured at Lake Duminagat on May 16 and 17, 2002

Date, Time	Dry-bulb T (°C)	Wet-bulb T (°C)	ΔT	RH (%)	C	RH_c
May 16, 2002						
10:23 a.m.	20.25	19.25	1.0	91.0	.00378	91.5
11:23 a.m.	19.0	17.5	1.5	86.5	.00408	87.3
12:23 p.m.	19.5	18.0	1.5	86.5	.00396	87.3
1:23 p.m.	17.0	15.0	2.0	81.5	.00474	82.7
2:23 p.m.	18.0	17.0	1.0	91.0	.00433	91.6
3:23 p.m.	18.5	18.0	0.5	91.0	.00420	91.3
4:23 p.m.	18.5	18.0	0.5	91.0	.00420	91.3
5:23 p.m.	18.0	17.0	1.0	91.0	.00433	91.6
6:23 p.m.	18.0	17.0	1.0	91.0	.00433	91.6
8:15 p.m.	18.5	16.5	2.0	82.0	.00420	83.1
May 17, 2002						
7:25 a.m.	17.0	16.5	0.5	90.5	.00474	90.8
8:25 a.m.	17.5	17.0	0.5	90.5	.00448	90.8
9:25 a.m.	18.5	17.5	1.0	91.0	.00420	91.5
10:25 a.m.	19.0	18.0	1.0	91.0	.00408	91.5
11:25 a.m.	20.5	19.0	1.5	86.5	.00372	87.2
1:25 p.m.	20.5	18.5	2.0	83.0	.00372	84.0
2:25 p.m.	21.0	19.0	2.0	83.0	.00361	83.9
3:25 p.m.	20.5	19.0	1.5	86.5	.00372	87.2
4:25 p.m.	17.5	17.0	0.5	90.5	.00448	90.8
5:25 p.m.	17.5	17.0	0.5	90.5	.00448	90.8

Lake Characteristics

Morphology

A lake's morphology, which is best described by a detailed bathymetric map, has important effects on nearly all of the physical, chemical and biological parameters of lakes. The bathymetric map of Lake Duminagat is shown in Figure 7. The measured and calculated morphometric characteristics are shown in Tables 3a and 3b.

Lake Duminagat is a small lake with a surface area of only 80,400 m^2 or 8.04 hectares (=0.0804 km^2). Its maximum depth of 20.95 m is about at the middle of the almost circular lake. Its shoreline development (SD) is 1.054. Shoreline development is an index of the regularity of the shoreline. Thus, circular lakes would approach the minimum shoreline development value of 1. The SD of Lake Duminagat is very close to unity, showing its almost circular shape and implying the limited extent of its littoral zone. At some places, there is an abrupt increase in depth so that the 5-m depth contour line is quite close to the shore. This is true at the northern side of the lake where the forested perimeter occurs. The limited littoral zone substrate bed is soft and muddy and can reach up to a person's midshin. The significance of shoreline development is that it reflects the potential for greater development of littoral communities in proportion to the volume of the lake (Wetzel, 1983). Because of the small value for shoreline development of Lake Duminagat, the amount of aquatic macrophyte community, as observed, is low.

Table 3a. Calculated morphometric characteristics of Lake Duminagat

8°18'N, 123°37'E	
Area	80,400.00 m^2
Maximum depth	20.95 m
Mean depth	11.60 m
Relative depth	6.50%
Length of shoreline	1,060.00 m
Shoreline development	1.054
Maximum effective length	345.00 m
Maximum effective width	285.00 m
Mean width	233.00 m

Table 3b. Measured morphometric characteristics of Lake Duminagat

Depth	Area		Stratum	Volume	
(m)	(m^2 x 10^3)	Percent	(m)	(m^3 x 10^3)	%
0	80.4	100.0	0 – 5	367.733	39.414
5	66.9	83.2	5 - 10	291.752	31.270
10	50.2	62.4	10-15	203.257	21.785
15	31.8	39.6	15 - 20	69.625	7.462
20	2.0	2.5	20 - 20.95	0.633	0.068
20.95	0				
			Total	933.000	100.000

The lake has a small surface area relative to its volume, thus it has a relatively large value for mean depth (11.6 m). Mean depth is generally considered as a reliable morphometric indicator of trophic conditions with it being inversely related to production (Wetzel, 1983). Thus, the large mean depth of Lake Duminagat is another indicator of its low productivity (oligotrophy). When the mean depth is divided by maximum depth, the value for Lake Duminagat is 0.55. Apparently, this value is a reflection of the shape of the lake basin. Likens (1985) cites the value for Mirror Lake (North Hampshire) of 0.52, which is higher than for many kettle lakes and is characteristic of ellipsoid basins.

The larger the surface area relative to its volume, the greater will be the amount of gas exchange and mixing due to winds.

The relatively small surface area of Lake Duminagat relative to its volume thus reduces the amount of gas exchange and mixing due to winds. Furthermore, the short maximum length (345 m) results into insufficient interaction of the wind on the lake. The lake is also protected from wind action by the surrounding topography. The resulting non-mixing of the deeper layers of lake water promotes the maintenance of the lake's stratification.

Lakes with high relative depths are characterized by a small surface area relative to their maximum depth. The relative depth of Lake Duminagat is 6.5%. Most lakes have a relative depth of less than 2.0%, whereas deep lakes with a small surface area usually have a z_r greater than 4.0% (Wetzel, 1983).

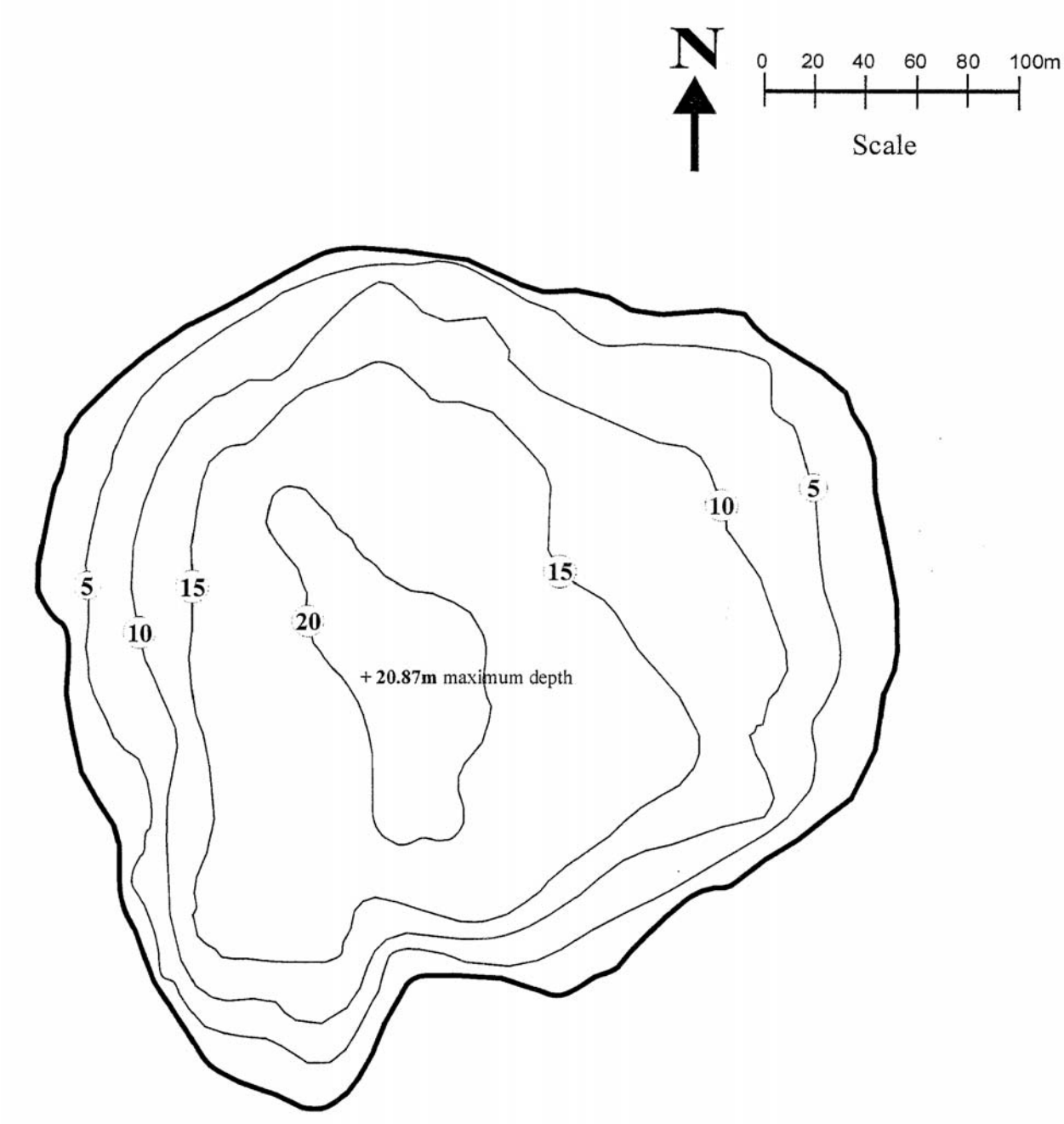


Figure 7. Bathymetric map of Lake Duminagat

The current volume of the lake is 933 x 10^3 m^3 with 70% of the total volume contained in the top 5 m. In contrast, the bottom 6 m contains only 7.5% of the total volume. This has significance in that the bottom stratum of the lake would be receiving organic matter settling from the much larger volumes of water above. Because of this volume effect (sediment focusing), this makes the bottom water of most similar-shaped lakes anaerobic (Likens, 1985). However, as shown in a later section, this is not true for Lake Duminagat, probably because the amount of settling organic matter is not great enough to deplete the dissolved oxygen of the bottom layer.

The lake area (8.04 ha) to watershed area (53.2 ha) ratio is 1:6.6. The small catchment basin implies that there is lesser amount of inorganic material that can be dissolved by the surface water flowing into the lake. This contributes further to the low production of the lake.

Hydrologic Aspects

The amount of lake water is equal to the balance between water input and water output. Because there are no inflow streams in Lake Duminagat, water input is only due to precipitation, surface water runoff and possibly seepage. A single outlet of the lake is in the form of a small stream located at the southwestern side. There seems to be no great changes in the lake water volume though because the lake's morphology is such that the outflow passes through only a shallow depression in the lake's rim. Excess water will flow out when there is much precipitation. When there is insufficient rain, the lake water is kept in. During the May 2002 visit to the area (when there was an occurrence of El Niño), there was virtually no outflow. Due to presence of rainfall throughout the year, water evaporates but is replaced immediately. This allows the lake water volume and elevation to remain stable. One elderly lakeshore resident remarked that she had not observed the lake undergo any visibly marked change over the years even in its elevation (E. Villamino Cati, personal communication, 2001).

Physicochemistry

Physical parameters measured in the lake water included temperature, Secchi disk visibility and turbidity. Temperature was measured at various depths to create a depth-temperature plot. See Figure 8 for the profile and Table 4 for the numerical values. (Numerical values have been included to show that some values are outliers and may indicate some imprecision in the instrument.) The figure shows temperature stratification in the lake; the upper layer is the epilimnion (0-8 m), the next layer where the change in temperature is great per unit depth is the thermocline (or metalimnion; ~8-11 m), and the bottom layer is the hypolimnion (from 11 m down). Although the difference in temperature of the water in the various depth layers is not so great, this causes a marked difference in the density of the water, which causes the various layers not to mix. The lake is said to be stratified. Thus, nutrients that concentrate on the bottom from the falling of dead bodies of aquatic organisms and from allochthonous input are not recycled as long as the lake is stratified.

However, thermally stratified bodies of water exhibit mixing when their temperature becomes uniform. This happens in temperate lakes during the spring and fall, the so-called spring and fall overturns. Such lakes are thus called dimictic lakes (Wetzel, 1983). Those lakes in which mixing occurs only once in a year are monomictic. Whether Lake Duminagat is dimictic, monomictic, or oligomictic (very rarely mixing) can be found out if depth temperature measurements were to be made at various times of the year. Mixing would occur only if the temperature in the area becomes cold enough so that the upper layer of water (epilimnion) together with the metalimnion attains the low temperature of the hypolimnion. In this case, this will happen if the temperature becomes uniformly 18.7°C. Overturn will recycle both inorganic and organic nutrients that settled in the sediments.

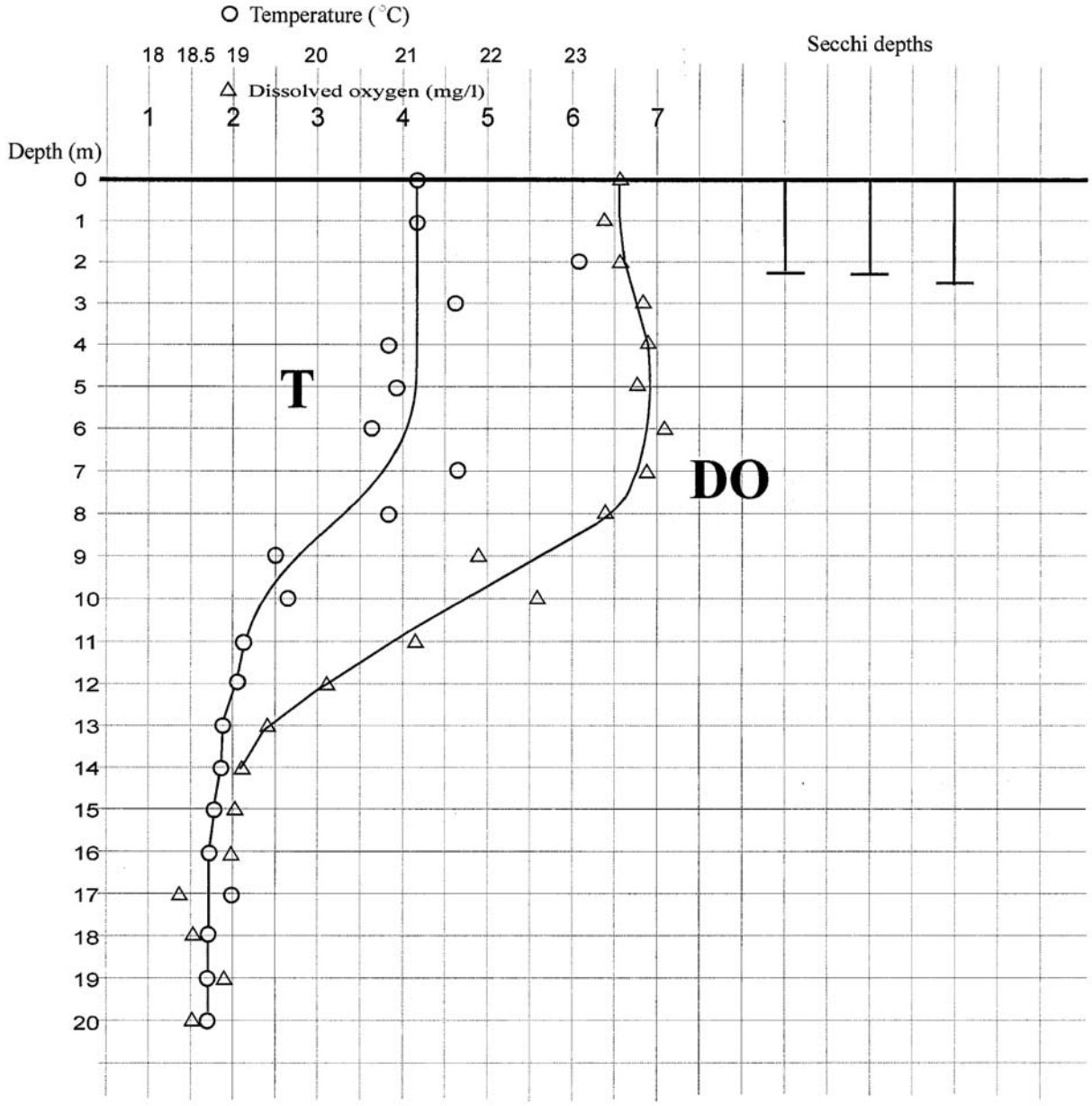


Figure 8. Vertical profile of temperature and dissolved oxygen. Secchi depths are also shown.

Table 4. In situ measurements of temperature and dissolved oxygen on April 28, 2002

Depth (m)	Temperature (°C)	Dissolved oxygen (mg/L)
0	21.2	6.6
1	21.2	6.4
2	23.1	6.6
3	21.7	6.8
4	20.8	6.9
5	20.9	6.8
6	20.6	7.1
7	21.6	6.9
8	20.8	6.4
9	19.5	4.9
10	19.6	5.6
11	19.2	4.2
12	19.1	3.1
13	18.9	2.4
14	18.9	2.0
15	18.8	1.9
16	18.7	1.8
17	18.9	1.4
18	18.7	1.6
19	18.7	1.8
20	18.7	1.6

The Secchi disk depths are also shown in Figure 8. Actual data are in Table 5. Secchi disk visibility/transparency is an indirect measurement of turbidity. It measures the degree of light penetration. The Secchi depth can be used to estimate the photic depth, or the depth of 1% surface illumination, which is the limit of the photosynthetic zone. By actual measurement of the photic depth (with a submarine photometer) and relating it to the Secchi depth readings of a particular observer, one can obtain a factor to multiply the Secchi depth with for subsequent estimations. For most natural waters, this factor falls between 2 and 5 (Lind, 1985). Thus, the bottom limit for photosynthesis in Lake Duminagat probably falls between 4.38 and 10.95 m.

Table 5. Secchi depth measurements at various dates in 2002

Date	Secchi depth (m)	Conditions
March 25, 2002	2	
April 25, 2002	2.25; 2.35	12:15 p.m.; with full sun
May 16, 2002	2.15	3:00 p.m.; cloudy

It is surprising that Lake Duminagat has a shallow Secchi depth of ~2.19 m. As shown by the geology of the area, topography, lake morphology and the chemical composition of the lake water (discussed in the next section), the lake is oligotrophic. Oligotrophic lakes are characterized by transparent water, deep light penetration (often to below thermocline), and Secchi depth ranging from 8-40 m (Goldman and Horne, 1983). But there are known oligotrophic lakes that do not have the described Secchi depth. For example, oligotrophic Mirror Lake has its Secchi depth ranging from 5-7 m in the summer (Likens, 1985). Hence, there has to be an explanation for the shallow Secchi depth of Lake Duminagat. One explanation could be the presence of dissolved chemicals, especially the tannins that are present in the bodies of the trees that have fallen into and remain submerged in the lake. But because of the low zooplankton population (see later section) and the low amount of total suspended solids (4.4 ppm), we cannot ascribe the shallow Secchi depth of the lake to these factors.

Turbidity values as measured by the Iligan City Waterworks System Office on the water samples brought to them are shown in Tables 6 and 7. Turbidity refers to the presence of suspended solids, which causes light to be scattered or absorbed in the water, resulting in a decrease in water transparency. It affects the depth of light penetration and thus, the distribution and intensity of photosynthesis in the body of water. Turbidity was expressed in NTU (nephelometer turbidity units); a nephelometer being an instrument that measures light scattering, higher turbidity causing greater scattering. Turbidity was greater in March (mean of 2.59 NTU) than on the months of April, June and October.

The chemical analyses of the lake water included measurement of its salinity, dissolved oxygen, pH, total alkalinity, total hardness, total dissolved solids, nitrate-nitrogen, total phosphorus, and total suspended solids.

Three replicate measurements of salinity gave readings of 4 ppt, 3 ppt, and 3 ppt, with a mean of 3.3 ppt. This shows that the lake is made of fresh water and discounts one of the theories that the lake supports some marine organisms. The salinity of inland waters is generally very low in comparison to that of the sea (32-38 ppt).

The most fundamental parameter of lake waters is dissolved oxygen (DO), which is essential to the metabolism of all aerobic organisms. The DO content of waters results from: (1) the photosynthetic and respiratory activities of the biota in the water; and (2) the diffusion of oxygen into the water which is dependent on the diffusion gradient at the air-water interface and distribution by wind-driven mixing (Lind, 1985). The vertical distribution of DO is shown in Figure 8. The saturation concentration of dissolved oxygen in pure water at 21^{o}C at an atmospheric pressure of 760 mm Hg is 8.68 mg/L. When corrected for salinity and atmospheric pressure (lake salinity of 3.3 ppt (parts per thousand) and atmospheric pressure of 615 mm Hg at the lake's elevation), using the values in Table 2E.1 of Brower and Zar, 1984, the dissolved oxygen saturation concentration becomes 7.017 mg/L. The measured value of DO in the surface water of the lake on April 28 was 6.6 mg/L, which means that the water was only 94% oxygen-saturated. This DO concentration was more or less uniform in the upper water layer, the epilimnion, where there is mixing of water due to the action of wind. The DO concentration rapidly decreased below the thermocline (~8-11 m) to less than 2 mg/L (from 14 m depth to the bottom). However, it did not become completely anaerobic. Oxygen reduction in the hypolimnion was expected because there was no replacement of the oxygen used up in biological oxidation of organic matter. There was no replacement because: (1) it is below the photic depth so there was no photosynthesis by the phytoplankton that will evolve oxygen, and (2) there was no mixing of the denser hypolimnion with the less dense epilimnion and metalimnion.

Bacterial decomposition of organic matter dominates, both in the water and especially at the sediment-water interface. In fact, such situation causes the oxygen concentration in eutrophic lakes to quickly turn to zero in the hypolimnion (clinograde oxygen curve) because of the great amount of dead organisms falling to the bottom. This did not happen in oligotrophic Lake Duminagat because it did not support a high plankton population and other aquatic biota that will contribute to the dead biomass in the hypolimnion.

The pH, total alkalinity, total hardness, and total dissolved solids were measured by the Iligan City Waterworks System Office on the water samples brought to them for analysis on March 24, 2002. The data are shown in Tables 6 and 7. The pH of most natural waters falls more often in the 6.0 to 8.0 range while expected total alkalinities in nature usually range from 20 to 200 mg/L.

Results showed that water was low in alkalinity and was very soft. The low amount of ions in the lake water was due to the fact that water in the lake only comes from precipitation and from surface water runoff in its small catchment basin. Rainwater has virtually no ions/solutes present in it except in areas where industrial activity emits particulate/soluble matter into the atmosphere. The small catchment area of the Lake Duminagat basin (53.2 ha) and the basaltic nature of this volcanic region of Mt. Malindang further contributed to the low alkalinity and softness of the water. The lack of carbonates and bicarbonates in the igneous rocks of the area was the reason why the pH is at the acidic side of neutrality. All these factors contributed to the oligotrophic character of the lake.

The nitrate-nitrogen, total phosphorus content and total suspended solids (TSS) were determined by the DOST-R.O. 10 laboratory on the water samples collected at various depths on various dates in 2002. Data are shown on Table 8. The method used by DOST-R.O. 10 was not sensitive enough to detect nitrate-N less than 1.0 mg/L and total phosphorus less than 0.01 mg/L.

Table 6. Physicochemical parameters of water samples from various depths of Lake Duminagat

Depth (m)	Turbidity (NTU)	pH	Total alkalinity (mg/L $CaCO_3$)	Total hardness (mg/L $CaCO_3$)	Total dissolved solids (ppm)
0	2.58	6.5	15.19	6.0	6
2	2.48	6.8	13.02	4.0	6
3	2.89	6.8	15.19	4.0	5
4	2.93	6.7	13.02	6.0	5
15	2.08	6.7	13.02	5.0	5

Table 7. Physicochemical parameters of surface water samples collected from Lake Duminagat on various dates

Date (2002)	Turbidity (NTU)	pH	Total alkalinity (mg/L $CaCO_3$)	Total hardness (mg/L $CaCO_3$)	Total dissolved solids (ppm)
March 24	2.58	6.5	15.19	6.0	6
April 28	1.62	6.6	14.49	6.0	5
June 9	1.89	-	13.32	-	5
October 28	1.38	6.5	13.62	6.0	6

Table 8. Chemical analyses done by DOST-R.O. 10 laboratory

Depth (m)	NO_3 (mg/L)			Total P (mg/L)			TSS (mg/L)
	March 24	April 28	June 9	March 24	April 28	June 9	April 28
0	-	1.2	<1.0	-	0.02	n.d.	-
1	1.3	-	-	0.029	-	-	4.44
5	1.0	1.8	-	0.032	0.05	-	-
10	<1.0	1.2	<1.0	0.025	0.04	n.d.	-
20	1.0	2.6	<1.0	0.125	0.02	n.d.	-

Legend: n.d. – not detected

Natural concentrations of nitrate-N rarely exceed 10 mg N per liter and are frequently less than 1 mg N per liter. Oligotrophic lakes have a nitrate concentration of up to 0.3 mg/L while eutrophic lakes range from 0.5 to 1.5 mg/L (Wetzel, 1983). In the case of total phosphorus, its concentration in nonpolluted waters is usually less than 0.1 mg P per liter (100 μg P l^{-1}) and inorganic (orthophosphate) soluble phosphorus is often less than 0.01 mg P per liter (Lind, 1985). Oligotrophic Mirror Lake has less than 5 μg PO_4-P per liter while eutrophic Lake Erie has 30-50 μg per liter (Likens, 1985).

Bacteriological Analyses

All water samples analyzed bacteriologically were surface water samples taken from the middle of the lake where the lakeside residents get their drinking water. Results of the analyses performed by the Iligan City Waterworks System Office are shown in Table 9. The confirmed test using BGBL (brilliant green bile lactose) broth showed the presence of coliforms in all samples, numbering to 5.1, 9.2, >16 MPN per 100 ml in March, April and June respectively. However, growth obtained from these positive tubes plated onto EMB agar showed the presence of atypical colonies. That is, the coliforms were not *Escherichia coli* and it can be concluded that there was no contamination with human fecal matter on that part of the lake. Thus, the remarks placed in the analysis said that the water is reasonably safe and probably safe for drinking purposes in March and April. The water was assessed to be bacteriologically unsafe in June because of the high background heterotrophic bacterial population in the sample. This could be due to the rains which brought large bacterial loads in the surface water runoff that drained into the lake.

Both the Philippine National Standards for Drinking Water (1993) and Guidelines for Canadian Drinking Water Quality (1993) set the maximum acceptable concentration for total coliforms in drinking water to be 0 organisms per 100 ml. However, in the Canadian guidelines, it was further stipulated that no sample should contain more than 10 total coliform organisms per 100 ml, and none of these should be fecal coliforms. The March and April water samples meet this condition. The guideline also says that if the sample contains more than 500 HPC (heterotrophic plate counts) colonies per ml, the water should be resampled. The March and April water samples contained 143 and 290 colonies per ml and thus met the guideline.

Zooplankton

It was mostly zooplankton that was collected in the methodology used for plankton collection. The mesh size of the plankton net used, 119 μm, allowed many phytoplanktons to pass through, although they were exceedingly diverse in size and form. Many of the common phytoplankton species are small (a few μm in diameter). Phytoplankton are said to be best collected with a sampling bottle which collects all phytoplankton regardless of size since more than 90% of the phytoplankton will pass

even through the finest mesh nets (Goldman and Horne, 1983). Nonetheless, some phytoplankton was observed, which included several kinds of diatoms and one-celled green algae. Most zooplankton collected were about 0.5 to 1 mm in length. The zooplankton observed and their abundance is shown in Table 10.

Table 9. Results of surface water bacteriological analyses at various dates

Date (2002)	Presumptive test		Confirmed test			Completed test		Colony count (col/ml)		Remarks
	Lactose Broth		BGBL broth		EMB	EC medium		24 h	48 h	
	24 h	48 h	24 h	MPN		24 h	MPN			
Mar 24	0/5	3/5	2/3	5.1	*1	2/3	5.1	86	143	**1
Apr 28	5/5	-	3/5	9.2	*1	0/5	<2.2	-	290	**2
Jun 9	5/5	-	5/5	>16	*1	0/5	<2.2	-	TNTC	**3

Legend:
MPN – most probable number
EC med. – *E. coli* medium
*1 – Atypical colonies
EMB – eosin methylene blue agar
BGBL broth – brilliant green bile lactose broth

Remarks:
**1 – Water is reasonably safe for drinking purposes.
**2 – Water is probably safe for drinking purposes. Disinfection is necessary.
**3 – Water is bacteriologically unsafe for drinking purposes.

Table 10. Kind and abundance of zooplankton collected in May 2002

Zooplankton	#/ml R1	R2	R3	Total	Ave.	#/liter	#/m^3
Cop sp 1	9	6	28	43	14.3	0.53	530
Cop sp 2 *Diaptomus*	8	4	13	25	8.3	0.30	300
Cop sp 3	0	0	1	1	0.3	0.01	10
Cop sp 4	1	0	3	4	1.3	0.05	50
Cop sp 5	0	0	8	8	2.7	0.10	100
Cop sp 6 *Cyclops*	6	0	1	7	2.3	0.08	80
Cop sp 7 *Epischura*	0	4	0	4	1.3	0.05	50
Cop sp 8 *Tropocyclops*	3	0	0	3	1.0	0.04	40
Nauplius	0	1	1	2	0.7	0.02	20
Prot sp 1	4	0	1	5	1.7	0.06	60
Unid sp 1	2	0	0	2	0.7	0.02	20
Unid sp 2	1	0	1	2	0.7	0.02	20
Unid sp 3	1	1	0	2	0.7	0.02	20
					Total	1.3	1300

Legend: Cop – copepod; Prot – protozoa; Unid – Unidentified group
Vol. of lakewater filtered = Mouth area of net x depth
Mouth area = 471.436 cm^2
depth = 17 m or 1700 cm
Volume of plankton concentrate was 29.5 cm^3
1 m^3 = 1000 liters

The Shannon index of overall diversity was calculated and gave a value of 0.7872. The nauplius was not included in the calculation since it is a developmental stage of a copepod and it is not known to which copepod species it belongs to.

Groups comprising the zooplankton were the protozoans, rotifers, cladocerans and copepods. Both cladocerans and copepods are microcrustaceans. In Lake Duminagat, there was a glaring absence of rotifers and cladocerans. It is said that there is a dominance of cladocerans over copepods in productive (eutrophic) lakes while copepods usually outnumber cladocerans in unproductive lakes (Goldman and Horne, 1983). Up to 500 individuals per liter may be found in eutrophic lakes while only less than one per liter characterizes most oligotrophic waters. As shown, Lake Duminagat had a total zooplankton abundance of only 1.3 per liter.

There were only 12 species in this particular freshwater ecosystem, unlike in larger lakes where there were as many as 25 crustacean species; and tropical oceans where more than 50 species of copepods and species of other planktonic groups thrive (Goldman and Horne, 1983). This low number of species in Lake Duminagat is consistent with its small size. Despite the lake's oligotrophy, the species diversity may be considered quite high (0.7872) because there is no correlation between diversity and productivity (Odum, 1971).

Aquatic Fauna

There were five (5) kinds of fishes reported to be in the lake (Table 11). Three were collected and photographed: carp, paitan, pargo. Only one, the paitan was actually weighed and measured. Data on fish caught by using bamboo fish traps or "bubo" is shown in Table 12. Local residents used hook and line and fish traps only in catching fishes, yielding very low catch per unit effort. The fish trap, locally called "bulantak" or "bubo" is more preferred because it can be left in the lake and examined hours after, while the hook and line, called "bingwit" is a lot more time-consuming since it required watching for hours on end.

Table 11. Fish catch composition in Lake Duminagat (April-May 2002)

Local name	Scientific name	Size (L; cm)	Wt. (g)	Remarks
Tilapia	*Oreochromis* sp.			reported
Carp	*Cyprinus* sp.			collected
Paitan	*Barbodes binotatus*	3-6	10-28	collected
Kasili	*Anguilla* sp.			reported
Pargo				collected

Table 12. Fisheries data on April 25 to 27, 2002 and May 16 to 18, 2002

Fishing gear types	Total no. of units	No. of fishermen	CPUE pcs/gear/day	Species
Hook & Line	6	3	-	tilapia, carp
Bamboo Trap (Bulantak/Bubo)	7	3	38	paitan

During the validation and presentation of biodiversity assessment results to the Barangay Lake Duminagat residents in October 2002, additional information on fish catch was obtained. "Kasili" (eel) was reported to have been caught the previous day using "taga" or bait. The "kasili" (Bisayan name; also called "blug") native to the area and is relatively shorter than the regular eel. "Bingwit" (hook and line) and "taga" (bait) are the ways by which to catch "kasili". A small hook and line, "sarang baba pait" which means just enough to enter the mouth of "paitan", is also used to catch "paitan".

Due to the residents' belief that the lake is a dwelling place of spirits, fishing was generally not encouraged. In April and May 2002, it was observed that only the lakeside residents and the "surhano" (spirit medium) of Barangay Lake Duminagat were the only ones fishing in the lake. However, during the October presentation, it was reported that 20 people from Centro went to the lake to catch fish by hook and line; thus adding 20 to the total number of people who used hook and line. In the case of bamboo traps, seven were owned by the lakeside residents and eight by people from Centro.

From data in preceding sections – lake morphology such as low volume to surface area ratio, low amount of inorganic nutrients, low secondary productivity as indicated by the low zooplankton population - Lake Duminagat is an oligotrophic lake. It is therefore expected that fish, being at the top of the aquatic food chain, will be quite low in number and biomass.

"Paitan" was identified as *Barbodes binotatus*. However, Cali et al. in their PRA (1999) reports it as *Harengula tawilis*, which was recorded to be endemic to Taal Lake by Conlu in 1986. Furthermore, it was stated that "pait-pait" or "paitan" is a freshwater herring that was very common to the streams and riverine systems before the devastation or denudation of the forest environment of Don Victoriano and Concepcion.

The benthos was sampled using an Ekman grab in the middle of the lake (20.4 m depth). A benthic sample could not be obtained near-shore because of the large number of dead trees that have fallen and accumulated at the bottom. The sediment obtained from the middle of the lake was very fine silt and brown in color, classified as dy type (Wetzel, 1983). No macrobenthic invertebrates visible to the naked eye were observed after sieving the sediment through successive sieves of mesh sizes 4, 8, and 12 (0.203 in, 0.097 in and 0.060 in, respectively; 0.060 in = ~1.5 mm). There are three possible reasons for this absence: (a) The oxygen tension at the bottom (~1.6 mg/L) is not sufficient to support the aerobic benthos; (b) The benthic animals are very sparse and very limited in their distribution, another indication of the lake's oligotrophy; and (c) The smallest sieve used was not small enough to keep the smaller macro- invertebrates, even if it had been previously claimed that they had been retained by a U.S. No. 30 sieve (=0.589 mm spaces).

Aquatic Flora

The true submerged aquatic macrophytes, samples of which were collected on April 25 to 27, 2002 and May 16 to 18, 2002, were composed of three species (Table 13), which were prominent in the shallow shoreline: the "lusay" (or "lusay-lusay"), which looked like a big violet rose. The "dagum sa tubig" which were green and needle-like and the "busikad sa tubig" (also known as "bila-bila sa tubig") which were also green but shorter than the latter, with white globose inflorescence.

All the three macrophytes exhibit the rosette growth-form (or isoetid growth-form), that is, all the leaves arise in a whorl from a greatly shortened stem. The predominance of the isoetid growth-form in the submersed vegetation of softwater lakes and the elodeid form (leaves arising from the stem at nodes separated by distinct internodes, e.g., *Elodea/Hydrilla*, *Potamogeton*, *Ceratophyllum*) in hardwater lakes is a striking ecologic difference.

Moreover, the well-developed root systems of these plants may be a key adaptation mechanism to nutrient-poor waters (Likens, 1985). These well-developed root systems were observed in the specimens. Elodeids, on the other hand, require relatively high concentrations of inorganic carbon which exist in hardwater lakes (Likens, 1985). The suboptimal amounts of inorganic carbon, and possibly other nutrients, are responsible in keeping most elodeids from becoming established in softwater lakes such as Lake Duminagat.

The macrophyte, "lusay", was difficult to identify because of the absence of reproductive structures. It appears to be an underwater form of *Sagittaria cristata*. However, it was puzzling why the emergent form was not present. There was a possibility that it was a new undiscovered species.

Shoreline Fauna

The inventory of shoreline fauna was based just on reports and non-rigorous sightings or collections since these were just terrestrial animals. These included arthropods (an example of which is the "gangis" which sounded exactly like a chainsaw), birds, mammals, reptiles and amphibians. See Table 14 for the arthropods and Appendix Tables 1 to 3 for the other animals. Monkeys reportedly went to the lake, in a group of more than 20 individuals, to eat the chayote (*Sechium edule*) planted by the lakeside residents. The Mindanao tree shrew ("mugsaw") was trapped and photographed. The scientific names given for the birds and mammals were based on their local names as reported by Rabor (1977).

Shoreline Vascular Flora

The shoreline vascular flora is summarized in Table 15. There were eight (8) plant groups, according to habit and common taxa, in 75 families, 99 genera, and 221 species. The number of family, genera, and species taxa in these plant groups is illustrated in Figure 9.

A closer examination of the terrestrial vegetation within 10 m of the lake margin of Lake Duminagat showed an ecotonal mixture of terrestrial and aquatic communities. These are classified into several ecologic groups as follows (Likens, 1985): (1) The forest trees and shrubs. These root near the shore and frequently overhang the margin of the littoral zone; (2) The herbs of the forest floor; (3) Shrubs and herbs that are specialized for wet, even water-logged soils; (4) Weeds of old fields and roadsides (these take advantage of light and, where human impact is greatest, the disturbed soils of the lakeshore and may include some introduced species); and (5) Some emergent grasses and sedges. Because of the forest vegetation in the undisturbed northern part of the lake margin, many of these plants were similar to those in the Barangay Lake Duminagat forest studied by Arances, Amoroso et al. (2002). Although, there seemed to be some that were unique to the lake.

Table 13. The macrophyte species in the shallow littoral area of Lake Duminagat

Local name	Scientific name	Family	Abundance
Lusay	*Sagittaria cristata*	Alismaceae	12-58
Dagum sa tubig	*Eleocharis acicularis*	Cyperaceae	15-43
Busikad sa tubig	*Eriocaulon* sp.	Eriocaulaceae	4-36

Table 14. Arthropods observed in the lake vicinity

Local/Common name	No. of species observed	Order; Family
Butterfly	1 sp. – *Papilio alphenor*	Order Lepidoptera Family Papilionidae
Moth larvae	4 sp.	Order Lepidoptera Family Saturniidae
Scarab beetles	2 sp. adults 2 sp. larvae	Order Coleoptera Family Scarabaeidae
Stag beetle	1 sp.	Order Coleoptera Family Lucanidae
Mole cricket	1 sp.	Order Orthoptera Family Gryllotalpidae
"Gangis"/Cricket	1 sp.	Order Orthoptera Family Gryllidae
Unidentified	1 sp.	Order Blattodea Family Cryptoceridae
Spiders	2 sp.	(Class Arachnida) Order Araneidae

Table 15. Shoreline flora of Lake Duminagat (April & May 2002)

Plant Groups	No. of families	No. of genera	No. of species
Trees	19	18	61
Shrubs	9	10	36
Herbs	21	23	39
Vines & Lianas	6	7	14
Palms	1	2	2
Orchids	1	6	14
Grasses & Sedges	2	7	17
Pteridophytes	16	26	38
Total	75	99	221

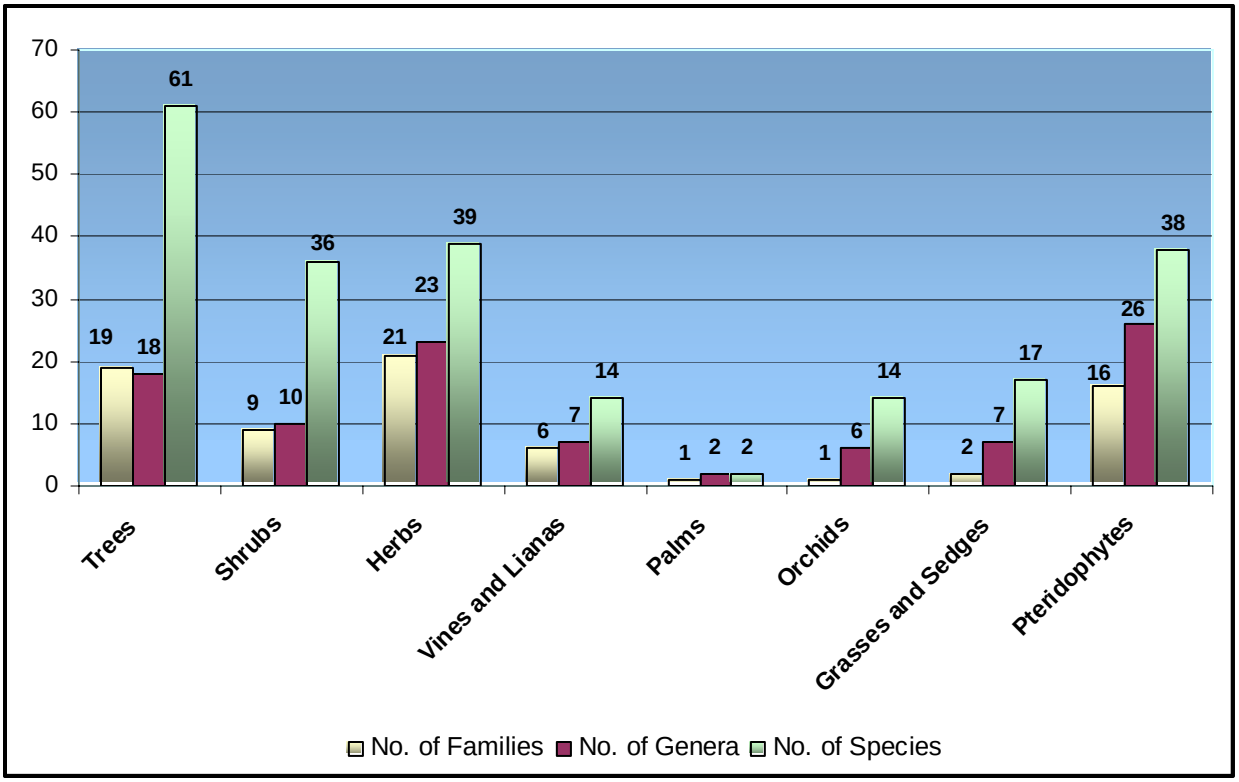


Figure 9. Shoreline flora of Lake Duminagat

The abundance of these plants, separated into the growth habits (trees, shrubs, herbs, vines and lianas) are shown in Appendix Table 4, together with their computed Shannon index. For the trees and herbs, their Shannon index is greater than 1.0. It is expected that stable communities such as the forest flora around the shore of Lake Duminagat would exhibit a high diversity.

The scientific identification of the plants, where we were able to make one, is given in tables according to plant groups in Appendix Tables 5a to 5h. There was difficulty in identifying some plants due to the absence of flowers and fruits. The vascular flora in this area was no longer that of a dipterocarp forest, whose upper limit was 800 m, but that of a mid-mountain forest, which thrives at an elevation of around 1000 to 1500 m (Rabor, 1977). These plants along the lakeshore, except for some introduced weeds, were different from the lowland flora with which we are familiar. The introduced weeds include elepante (*Stachytarpheta jamaicensis*), sirok-sirok (*Drymaria cordata*), neskape (*Cassia* sp.), dila kanding *(Elephantopus* sp.), and tilapia.

Apart from the identified local uses of the plants made by the local researchers and key informants, some plants seem to have interesting possibilities. Plants that seem to be potential ornamentals include: buyo-buyo (*Piper retrofractum*), gibuyon (*Hydrangea chinensis*), gibuyon puti (*Mussaenda* sp.), karopay (*Pinanga* spp.), katipo (*Medinilla* sp.), mamangpang (*Begonia* spp.), the various kinds of ferns and fern allies (e.g., plastek, *Selaginella*, *Lycopodium)*, and the various orchids. Some plants had interesting fruits: kalonawan, with its blue-colored fruit; and balagon tagok, which had its fruits in a spike-like structure but pierced by the rachis and looked like rosary beads. Some plants such as "kalingag" (source of cinnamon powder; *Cinnamomum* spp.), and "almasiga" (source of resin; *Agathis philippinensis*) have potential economic

uses; while various medicinal plants may turn out to be effective sources of medicines/drugs. These plants may just need to be propagated in the area since they may not thrive very well in the lowlands.

Indigenous Knowledge on Plant Names and Local Uses

Two hundred fifty-nine local names of plants (shoreline vascular flora and aquatic macrophytes of Lake Duminagat) were given to the external researchers by the local researchers, key informants, and community residents. A few of these are probably repetitions due to illegible writing, mishearing, or due to slight variations.

Local names are quite changeable and variable, which was precisely the reason for Linnaeus' proposal and acceptance by the scientific community of scientific names. In order to avoid confusion and to have order, there are strict rules in the naming of plants as stipulated in the International Code of Botanical Nomenclature (Jones and Luchsinger, 1986).

To illustrate this changeability, the recently published Dictionary of Plant Names by Madulid (2001) lists 1,106 Subanon names. Yet, of the 259 names in our list, only twenty names are found in Madulid. Ten of these names do not even refer to the same plant. This indicates a possible loss of many of these names, i.e., that they are no longer being used. This is understandable, especially if with the concomitant destruction of forests, not too many people become conversant with these plants and their names. Also, in the absence of written records, and hampered literacy of the community, it may very well be difficult for the plant names to survive. Furthermore, people also vary in their inclinations/interests and in their plant visual acuity, which would affect their recognition of plants.

It was not known where Madulid got the Subanon names for the plants; but there were already plants identified with local names but with different names in the Arances and Amoroso list. Examples of these were: *Hydrangea chinensis* – gibuyon (ours) & salisip (Arances and Amoroso); *Rubus* sp. – kurerol (ours) & sampinit (Arances and Amoroso); *Psychotria diffusa* – kuyanap (ours) & bagun (Arances and Amoroso); *Phyllocladus hypophyllus* – magaringan (ours) & tungog (Arances and Amoroso). In other cases, the names are the same but they refer to different plants. Examples are salapid, lago tulang, magamatong, and magulimon, which are identified as *Dendrobium* sp., *Toona calantas*, *Neolitsea vidalii* and *Dioscorea* sp., respectively by Arances et al. (2002). In another study made by Suminguit (1997) in the SW part of Mt. Malindang (Josefina, Zamboanga del Sur and adjacent barangay of Don Victoriano), of the 285 names given (129 names of cultigens removed from his total 413), forty plant names were the same as ours. Suminguit did not give scientific identifications for most of these plants.

The local uses of plants are given in Appendix Table 6. This knowledge was usually handed down more correctly from generation to generation because of their relevance and practicality, especially with regard to medicinal plants. In some cases, the possible medicinal or economic use of the plant was suspected and was then tried out empirically based on the odor and taste of the plant (Cati, F., personal communication). One example is "halang", which tastes just like its name, i.e., spicy hot.

Community Characteristics

Socioeconomic-cultural Profile of Barangay Gandawan

Brief Historical Background

The DENR Mt. Malindang topographic map, Sheet 3744 IV, had a note that it was compiled in 1956 from 1947-1953 photographs. The map already showed many houses and numerous foot paths on both the left and right fringes of the Mt. Malindang range, at some places up to 900 meters above sea level. However, the rest of Mt. Malindang seemed wooded. No houses were shown in the area of what is now Barangay Gandawan (easily recognized because of its topography), except for a scrub portion, possibly clearings made by early settlers. Other landmarks/places already have names labeled on them such as North Peak, Mt. Malindang, South Peak, and on the right fringe, the villages of Mapa and Gala, Sungan Creek and Clarin River.

Rand and Rabor (1960; as cited by Noorduyn et al., 2002) described Gandawan in 1956 as covered with virgin forest, except for some 10 hectares of cultivated patches within an area of 200 hectares and several new clearings where the trees had been chopped down but not yet burned. They stated that only one family lived there, with several families from elsewhere who came to plant and harvest crops now and again. One resident in Barangay Mansawan recalled that she lived in Gandawan during the early '60s but transferred to Barangay Mansawan in 1963 to go to the elementary school there (L. Lumaray, personal communication). It seems that logging commenced around the early 1960s and opened the area to more settlers. In 1993, Fraser (1995; as cited by Noorduyn et al., 2002) reported that Gandawan was mostly under cultivation or grassland, with only secondary forest present, and 45 families living there.

According to a key informant, Diego Ubas, the "Timuay" of Barangay Gandawan and 72 year-old son of Juan Ubas (also known as "Gumitao") who was one of the first settlers of the area, the place was first called "Gandawan Valley". Gandawan was said to be a forested area when Juan Ubas and his contemporaries first settled there. Distinctly visible all over the vicinity were the white flowers of the plant known to them as "silangka". This plant is still commonly seen today especially along the banks of the Dapitan River and the surrounding forest on the way to Lake Duminagat. The community got its name from a flower, whose whiteness seemed to brighten the darkness of the night. The word "Gandaw" to the Subanon means a bright light that shines just like the sun by day and that of the moon and the stars at night.

Apart from Juan Ubas or "Gumitao", the three other original settlers of this area were Puwak Tindeng, Guniasan and Tumangge. The last two settled in the area now known as Sitio Pongol.

Before 1970s, this Barangay was previously a Sitio of Barangay Lake Duminagat. It was only in 1972 that it was recognized as a separate barangay under the municipality of Jimenez, Misamis Occidental. Its first Barangay Captain was Librado "Loloy" Banay-banay who was brutally killed by the New People's Army in 1984 along with two other residents (known to the community merely as Nono and Belen). At its initial stage as a separate barangay, a purely self-help undertaking was done by the earlier community people. They constructed a schoolhouse from their own contribution and labor. After its completion, they requested a teacher from the Municipality of Jimenez to be assigned to their community to teach children basic literacy. Ms. Elsa Tuminalao was the first teacher assigned to the area. Also during this period, a religious sect called Rock Christ of Jesus entered this community and settled in Sitio Pongol.

In 1982, the new municipality of Don Victoriano was created in the province of Misamis Occidental. The jurisdiction of this barangay was transferred from the

Municipality of Jimenez to that of Don Victoriano. This barangay then formed its own Barangay Council to legislate its own ordinances. It was during this period when communists' rebellion was strong in the countryside and the area was not spared. NPAs sowed terror to residents by brutal killings of persons who transgressed their laws. After the death of the first Barangay Captain Librado Banay-banay in 1984, the first councilman, Mr. Narciso Ruiz, was appointed by the Mayor of Don Victoriano as the new Barangay Chairman. He served the community until May 2002. During his term, he was able to: (1) get a grant from former President Estrada's Lingap Para sa Mahihirap where 20 selected families were each given P10,000 worth of home construction materials; and (2) facilitate the construction of the Day Care Center worth P130,000, a joint effort of the Department of Social Welfare and Development (DSWD) and the Barangay Council of Gandawan.

The Philippine Army put up a military camp in 1986 to safeguard peace and order and stop NPA infiltration. Then, another religious group called Body of Christ came to find followers and settled in the barangay. It was also during this decade that the Municipal Agricultural Officer of Don Victoriano, Mr. Ludivico Pasoc, reached the community.

In the 1990s, the Sangguniang Kabataan of Gandawan was established and the Civilian Armed Forces Geographical Unit (CAFGU) was created and trained to assist in the maintenance of peace and order. In 1996, Gandawan was subdivided into three sitios namely: Sitio Centro, Sitio Pongol and Sitio Maliapa. Around that time, treasure hunters came to the area, as well as representatives of the Department of Environment and Natural Resources (DENR). A nongovernment organization based in Ozamiz City came and organized the Subanon into "Banwa nak Subanen" in an attempt to bring back its old customary traditions and build a separate Subanon community. This was an attempt to empower the Subanon to run their own affairs. It even led to their joining the electoral race by nominating their own candidates. But such move did not succeed and displeased many existing local leaders. Around 1999, a cooperative was organized in Gandawan that lasted for only a year due to lack of unity among its members.

By the year 2000, another nongovernment organization came to assist the community. This NGO was CARE Philippines. Its interventions were mostly on livelihood alternatives. During the October 2002 visit of the external researchers to the area, the presence of coffee seedlings provided by CARE was observed. SEARCA, through the Biodiversity Research Programme: Focus on Mt. Malindang, also started to work with the community from 2001 to date. In mid-2002 when the barangay elections were held nationwide, a new Barangay Chairman was elected in the person of Mr. Nerio "Bobong" Paler. He was formerly the Pastor of a Born Again Christian Group in this barangay (Figure 10).

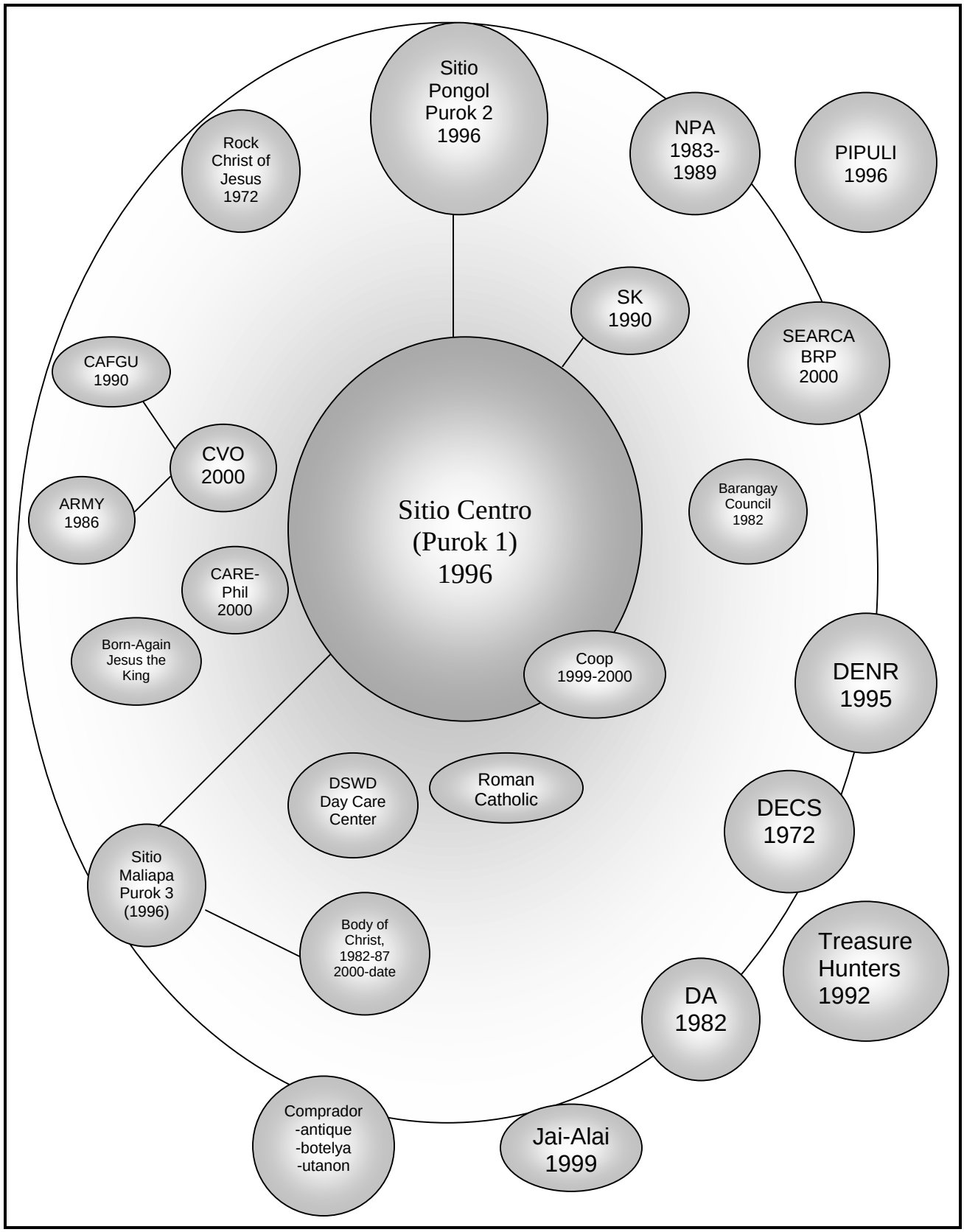


Figure 10. Venn diagram of Barangay Gandawan

Demographic Profile

1. Gender, Age and Civil Status of Household Heads. Of the total 79 households that were surveyed, 65 or 82.27% of the respondents were male and 14 or 17.73% were female. The majority of the respondents therefore were male since in most Filipino families, household leadership is given to men whether husband or eldest son. It is only when they are not around that women perform their roles. Table 16a reflects these data.

The youngest age of household heads reported was 22 and the oldest was 84. The mean age was computed and found to be almost 40 (39.92). The majority of the respondents' ages were in the 40s or younger (63.33%). Nineteen (28.33%) were between 41-60 years old and less than 10 (8.34%) were above 60 years. This means that most household heads were still in their reproductive years and still influence population growth in the area. Please refer to Table 16b for details.

Seventy-two (91.14%) of the household heads were married; five (6.33%) of them were widowed and two were single eldest sons who earned a living for their household (Table 16c).

2. Household Composition by Size, Sex and Type. Forty (50.63%) of the households had four to six members. Only 25 (31.64%) of the households had one to three members. Fifteen households had seven or more members. The smallest household size is one and the biggest is 11. The average household size is five. Of the 79 households that were surveyed, there was a total of 342 members. Of this number, 178 (51.89%) were female and 164 (48.11%) were male. There were 3.78% more female than male members. Only parents and children composed the households which were mostly of the nuclear type.

Table 16a. Gender of household heads

Gender	Frequency	Per Cent
Female	14	17.73
Male	65	82.27
TOTAL	79	100.00

Table 16b. Age of household heads

Age Category	Frequency	Per Cent
30 years & younger	19	23.33
31 – 40	33	40.00
41 – 50	9	13.33
51 – 60	10	15.00
Over 60 years	7	8.34
TOTAL	78*	100.00

*One respondent did not give his age.

Table 16c. Civil status of household heads

Status	Frequency	Per Cent
Married	72	91.14
Widower	5	6.33
Single	2	2.53
TOTAL	79	100.00

Table 17a. Household composition by size

Household Size	Frequency	Per Cent
1 – 3	25	31.64
4 – 6	40	50.63
7 – 9	13	16.45
10 & above	1	1.28
TOTAL	79	100.00

Table 17b. Household composition by gender

Gender	Frequency	Per Cent
Female	164	48.11
Male	178	51.89
TOTAL	342	100.00

3. Length of Stay in Barangay Gandawan and Areas of Migrants' Origin. Almost half of those who responded (38 out of 77 or 49.35%) had resided in the barangay since birth and had an age range of 16-68 years. Four were 16-26 years old; 20 were 27-37 years old and 14 were above 37 years old. The rest have stayed in the barangay for varying periods of time and only eight (10.39%) said that they had lived in the community for less than five years. Ten (12.99%) had resided in the barangay for 5-15 years, while 11 (14.28%) for 16-26 years. Ten household heads said that they had been staying in the barangay for 27 years and more. This means that almost half of the residents were natives, having lived there since birth, while those who migrated to the area, had been residents for a very long time. Table 18 shows the respondents' length of stay in the barangay.

Only 28 out of 39 migrants gave their answer as to their place of origin before settling in this area. Out of this number, almost 70% came from Mindanao. Only nine (32.14%) came from the Visayas (Dumaguete and Negros). Twelve (42.86%) of these migrant residents came from different areas of Zamboanga del Norte. Only three came from Zamboanga del Sur. The rest (with one respondent each) came from Lanao Norte, nearby cities of Oroquieta, Ozamiz and Davao. Table 19 shows the distribution of the respondents' places of origin.

Table 18. Length of stay in the barangay

Length of Stay (in years)	Frequency	Per Cent
Since birth	38	49.35
Less than 5	8	10.39
5-15	10	12.99
16-26	11	14.28
27-37	9	11.69
over 37	1	1.30
TOTAL	77*	100.00

*Two respondents failed to give their response.

Table 19. Place of origin of migrant residents

Place of Origin	Frequency	Per Cent
Zamboanga del Norte	12	42.86
Dumaguete and Negros	9	32.14
Zamboanga del Sur	3	10.72
Oroquieta City	1	3.57
Ozamiz City	1	3.57
Lanao Norte	1	3.57
Davao City	1	3.57
TOTAL (n=39)	28*	100.00

*Eleven respondents had no response.

Table 20. Ethnic origin of respondents

Ethnic Origin	Frequency	Per Cent
Visayan/Cebuano	43	54.43
Subanon	33	41.77
Boholano	2	3.33
Mestiza Cebuano & Subanon	1	1.67
TOTAL	79	100.00

4. Ethnic Origin of the Respondents. Forty-three (54.43%) of the household head respondents claimed to be of the Visaya or Cebuano group. However, during the community validation meeting, residents said that these Visayans were married to the Subanons. There were only 33 (41.77%) who were Subanons and two (3.33%) who claimed to belong to the Bol-anon tribe who were also married to the Subanons. One of them said that she was a mixture of Cebuano and Subanon tribe. Thus, most of those who were not originally Subanon residents became so after marriage with a Subanon. Table 20 shows these data in detail.

5. Religious Affiliation of the Respondents. The residents were members of various religious groups. Almost half (38 or 48.1%) claimed to be Roman Catholics. There were 22 (27.85%) who belonged to a religious group called Rock Christ of Jesus. Members of this group inhabited Sitio Pongol of the barangay. There were also seven (8.86%) who belonged to the Evangelical Born Again Christian and four (5.06%) who claimed to be members of the Independent Catholic Church of the Philippines. Only three of the respondents, all Subanons, still believed in the spirits and worshiped these spirits based on the positioning of the moon. Others (one respondent each) claimed to be members of Seventh Day Adventist, Alpha Omega, and Christianity. Freedom of religion was observed in the community, as shown by the various religious affiliations to which the people belonged (Table 21).

6. Highest Educational Attainment of Household Heads. Generally, the respondents had low educational attainment as indicated by the data. Eight (10.13%) did not have any formal education. About 25 of them reached the primary level but 23 (29.11%) did not finish. Thirty-eight of them were able to reach elementary level but only 11 (13.92%) were able to graduate. Only seven reached high school but only two graduated. Only one reached college but was not able to get a degree. A greater number of the respondents had reached either primary or elementary levels only. This may be the reason why they remained in the area (Table 22).

Table 21. Religious affiliation of respondents

Religious Group	Frequency	Per Cent
Roman Catholic	38	48.10
Rock Christ of Jesus	22	27.85
Evangelical Born Again	7	8.86
Philippine Independent Catholic Church	4	5.06
Spiritists/Agong-agong	3	3.79
Body of Christ	2	2.53
Seventh Day Adventists	1	1.27
Alpha Omega	1	1.27
Christianity	1	1.27
TOTAL	79	100.00

Table 22. Educational attainment of respondents

Educational Level	Frequency	Per Cent
No formal education	8	10.13
Primary level	23	29.11
Primary graduate	2	2.53
Elementary level	27	34.18
Elementary graduate	11	13.92
High School level	5	6.33
High School graduate	2	2.53
College level	1	1.27
TOTAL	79	100.00

7. Number of Children In School. Twenty-two households have 1-2 children in school, 13 have 3-4, while only two have 5-6 children in school. On the other hand, there were nine households with one child each not in school, and eight with two children each not in school. The other households did not have children of school age. The most cited reasons why children were not enrolled were: children have no interest (8), no financial capacity to send them to school (6), children wanted to work (2), and not able to enroll (1). The school in Barangay Gandawan was only for Grades 1 and 2. For Grades 3-6 and high school, the nearest ones were in Barangay Mansawan.

8. Health and Sanitation Practices

8.1. Common Diseases Afflicting Respondents' Families. Based on responses given, the most common illnesses suffered by their families were cough, fever and colds. There were 59 (74.68%) who mentioned cough as the common disease afflicting their families. This was followed by fever or what was locally known as "*hilanat*" in which 57 (72.15%) had been afflicted. Common colds ranked third with 55 (69.62%) afflicted family members. Other diseases identified were stomachache (9 or 11.39%); body pains/aches (8 or 10.13%) and headache (7 or 8.86%). There were only three (3.8%) who reported that his children had measles while two (2.53%) each identified the following diseases as able to afflict their families: skin diseases, rheumatism and diarrhea. There was one (1.27%) each who mentioned toothache, epilepsy and colic as the diseases that afflicted members of their families. No serious disease was identified by the respondents; perhaps because they seldom consulted doctors or health specialists due to distance from clinics or hospitals. However, in the initial meetings with the people, they mentioned an unidentified disease that afflicted older people which led

to their deaths. This was described as bloating or swelling of the body parts from feet upwards.

8.2. Medical Experts Consulted by Community Members. Fifty-five (69.62%) of the 79 total household heads said that they usually brought their sick to the indigenous healers in the community. Fifteen (18.99%) brought their sick to the health center at Barangay Mansawan that is managed most of the time by a midwife and only 9 (11.39%) were able to consult doctors at Dipolog or Dapitan City. It might be that only seriously ill members were forced to see doctors (Table 24).

8.3. Local Remedies Used By Families to Treat Their Sick. Forty-nine (62.02%) used medicinal herbs to treat diseases/ illnesses, four (5.16%) used the roots of plants as remedies, four made use of over-the-counter tablets, while others said they massage their sick with kerosene and herbs; used water from the lake, or just prayed (Table 25). The herbs or plants used to treat diseases were identified by the respondents in their local dialect. These plants were only named by the respondents, but were not seen or collected by the external researchers. It will be informative to find out the scientific names of these plants and to identify those that were endemic to the area and unknown elsewhere.

Table 23. Common illnesses afflicting families of respondents

Diseases	Frequency	Per Cent
Cough	59	74.68
Fever	57	72.15
Colds	55	69.62
Stomachache	9	11.39
Body pains/aches	8	10.13
Headache	7	8.86
Measles	3	3.80
Mumps	2	2.53
Skin diseases	2	2.53
Rheumatism	2	2.53
Diarrhea	2	2.53
Toothache	1	1.27
Epilepsy	1	1.27
Colic	1	1.27

Table 24. Medical experts consulted by community members

Medical Experts Consulted	Frequency	Per Cent
Indigenous healers	55	69.62
Midwife	15	18.99
None (Self-medication only)	12	15.19
Medical doctor	9	11.39

Table 25. Local remedies used

Remedies Used	Frequency	Per Cent
Medicinal herbs	49	62.02
Roots of plants	4	5.16
Tablets	4	5.16
Massage of kerosene and herbs	1	1.27
Bark of trees	1	1.27
Water from Lake Duminagat	1	1.27
Prayers	1	1.27

Table 26. Manner of waste disposal

Manner of Waste Disposal	Frequency	Per Cent
Compost pit	30	37.97
Burning	28	35.44
Throwing anywhere	27	34.18

The following were the medicinal plants identified by the people and commonly used to remedy diseases:

1. gabon (for colds)
2. escuba malawis
3. busikad (for cough and fever)
4. mayana (cough)
5. guava leaves (for loose bowel movement)
6. limotan leaves
7. lalambo
8. buyo (for cough)
9. betel nuts
10. calabo (for cough)
11. singgam-singgam
12. tanlad or lemon grass
13. ganda lupot
14. bila bila
15. handalosa
16. anonang
17. hot pepper leaves
18. dila-dila
19. pisaw-pisaw (for colds)
20. lemonsito (for cough)
21. bugayana
22. roots of certain trees
23. hilbas
24. kalingag
25. lagundi
26. cocobanug
27. itoson

8.4. Households' Manner of Waste Disposal. Thirty (37.97%) households used compost pits for their wastes and twenty-eight (35.44%) burned their wastes. However, there were a considerable number of households - 27 (34.18%) - that threw their wastes anywhere. Although garbage disposal was not a problem in the area, burning and throwing wastes anywhere were not environmentally sound practices (Table 26).

8.5. Types of Toilet Used by Residents. The majority (57 or 72.15%) made use of water sealed toilets and only 12 (15.19%) had the antipolo type of toilet (i.e., toilet that does not use water because fecal material drops directly into the hole). However, there were still 10 households with no sanitary toilets (Table 27).

Table 27. Types of toilet used by the households

Type/Kind of Toilet	Frequency	Per Cent
Water sealed	57	72.15
Antipolo	12	15.19
No toilet	10	12.66
TOTAL	79	100.00

Economic Profile of Barangay Gandawan

1. Income Sources of Residents. Seventy-seven (97.47%) households earned their living mainly from gardening. Only two (2.53%) said their major source of living was the Civilian Armed Forces Geographical Unit (CAFGU) (Table 28a).

When household heads were asked whether or not they had other sources of income apart from gardening, 48 (60.76%) said they had no other income sources other than gardening; while only 31 (39.24%) indicated they had other income sources. Of those who said they had other income sources, nine (29.03%) said they received honoraria as barangay officials of their community; six (19.36%) were engaged in animal raising; five (16.13%) were members of CAFGU and five were engaged in the buy-and-sell business of vegetables in the area. Two were found to be faith healers and another two operated sari-sari stores. The two residents who claimed that CAFGU was their major source of income had gardening as their second source. Thus, all households were engaged in gardening activities.

2. Respondents' Monthly Income. Forty (50.63%) of the respondents had a monthly income of P1,000 or less; 26 (32.91%) earned P1,000-P3,000, 10 (12.66%) with monthly income of P3,000-P5,000; while only the Barangay Chairman Narciso Ruiz had earned more than P5,000 a month. Two of the respondents failed to give their responses. The highest earned income was P10,000 and the lowest, P50. The average monthly income of the people was only P1,873.42.

Table 28a. Major income sources of residents

Main Source of Income	Frequency	Per Cent
Gardening	77	97.47
CAFGU	2	2.53
TOTAL	79	100.00

Table 28b. Other income sources of residents

Other Sources of Income	Frequency	Per Cent
Honoraria as Barangay Officials	9	29.03
Animal Raising	6	19.36
Buy & Sell of Vegetables	5	16.13
CAFGU	5	16.13
Gardening	2	6.45
Sari-sari store	2	6.45
Faith Healer/local hilots	2	6.45
TOTAL	31	100.00

3. Size of Cultivated Land. Thirty-nine (49.37%) of the respondents tilled 1-2 hectares of land; 35 (44.3%) indicated that they worked on less than a hectare of land; two had worked on three hectares and above and three did not respond. The data obtained showed that respondents tilled only small sizes of land for their living. It was observed that cultivated areas were both on the plain and on the lower, sometimes upper, slopes of the surrounding mountains.

4. Kinds of Crops Planted. Seventy-three (92.41%) planted spring onions; 60 (75.95%) raised sweet potatoes, one of the people's staple foods; 52 (65.82%) planted taro, locally known as "gabi" or "lutya" which, just like sweet potato, was a major source of carbohydrates. Forty-eight (60.76%) planted "chayote", a watery fruit vegetable that grew well in the area and marketed mostly to the cities of Dipolog, Dapitan, Oroquieta and Ozamiz. Only eight planted cabbage; seven planted bananas and another seven planted bell pepper. Other crops planted were squash, carrots, pechay, corn and sugarcane. Therefore, the major crops planted by the respondents are spring onions, root crops and chayote (Table 31). The cash crops were green onions, chayote, cabbage, bell pepper, squash, carrots, and pechay. The other crops, especially the root crops (gabi/lutya/ kanaka), were subsistence crops and only excesses were sold. No data was obtained on production per unit area.

Table 29. Monthly income of respondents

Income Category	Frequency	Per Cent
P 1,000 and less	40	50.63
1,001-3,000	26	32.91
3,001-5,000	10	12.66
More than 5,000	1	1.27
No Response	2	2.53
TOTAL	79	100.00

Highest income = P 10,000 a month
Lowest income = P 50.00/mo.
Average monthly income = P 1,873.42

Table 30. Size of land cultivated by respondents

Size of land	Frequency	Per Cent
Less than one hectare	35	44.30
One-two hectares	39	49.37
More than two hectares	2	2.53
No response	3	3.80
TOTAL	79	100.00

Table 31. Crops planted by respondents*

Crops	Frequency	Per Cent
Spring/green onions	73	92.41
Sweet potatoes	60	75.95
Gabi/Lutya/Kanaka	52	65.82
Chayote	48	60.76
Cabbage	8	10.13
Banana	7	8.86
Bell pepper	7	8.86
Squash	3	3.79
Carrots	2	2.73
Pechay	1	1.26
Sugar cane	1	1.26
Corn	1	1.26

*multiple responses

5. Seasonal Calendar of Crops

Jan-March	April-June	July-Sept	Oct-Dec
Corn	Corn	Corn	Sweet potato
Sweet potato	Sweet potato	Sweet potato	Root crop/kanaka, gabi
Cabbage	Cabbage	Root crop/kanaka, gabi	Bell pepper
Root crop/kanaka, gabi	Root crop/kanaka, gabi	Bell pepper	Green onions, chayote
Carrots	Carrots	Green onions, chayote	
Baguio beans	Bell pepper		
Green onions, chayote	Baguio beans		
	Green onions, chayote		

Community Problems

1. Identified Common Problems in the Barangay. Although household survey results showed that most of the respondents identified the difficult/bad road as their number one problem, the community validation altered the result since participants recognized and explained that almost everyone had difficulty in livelihood. All were engaged in gardening and their income out of this activity was not even enough for their basic needs. They said that their income was low and they lacked basic farm inputs such as fertilizers and seeds. They also complained of the lack of electricity in the barangay and bad weather. Results also showed the lack of basic necessities in life such as food and clothing. Seven (8.86%) mentioned insufficient food; three (3.8%), lack of clothing; and four (5.06%) said there was no health center. Residents of Sitio Pongol mentioned the need for a bridge that would allow them to cross a tributary of Dapitan River to reach their area from Gandawan Poblacion. The identified problems are shown in Table 32.

Table 32. Identified problems in the barangay

Problems Cited	Frequency	Per Cent
Difficult livelihood & low income	22	27.84
Bad road	64	81.01
Lack of electricity	47	59.49
Bad weather condition	11	13.92
Lack or insufficient food	7	8.86
No Health Center	4	5.06
Lack of clothes	3	3.80
Lack of bridge	3	3.80
Floods	2	2.53
No supply of medicine	1	1.27
Others (leeches, no fertilizer & seedlings)	3	3.80

2. Identified Community Needs. Only 14 responded to this query. However, out of that number, seven (8.86%) indicated their need for additional livelihood; three (3.8%) expressed the need for a Health Center and also three expressed the need to improve/repair the old school building. One indicated the need for a hanging bridge so people can cross the river even during heavy rains. People seemed to be apprehensive to tell their community needs; perhaps because they had doubts whether these can be met.

Current and Proposed Uses of the Lake

1. Frequency of Respondents' Visits to the Lake. Forty-three (54.43%) of the respondents indicated that they go to Lake Duminagat only once a year. One respondent said that in his 10 years of stay in Barangay Gandawan, he was able to visit the lake only thrice. Nine (11.39%) went there twice a year; and three visited the lake many times in a year for various reasons (Table 34).

2. Respondents' Reasons for Going to the Lake. Thirty-three (41.77%) went to the lake only to take a bath; fourteen (17.72%) visited the lake for sightseeing and to enjoy nature; three (3.8%) went to the lake to get water for healing; and only two (2.53%) went there for fishing purposes. This indicated that residents of Barangay Gandawan mostly used the lake for bathing and recreation; and valued it most for such purposes (Table 35).

Table 33. Identified community needs

Community Needs	Frequency	Per Cent
Livelihood	7	8.86
Health Center	3	3.80
Improvement of School Building	3	3.80
Hanging Bridge	1	1.27

Table 34. Frequency of respondents' visits to the lake

Incidence of visits	Frequency	Per Cent
3x in 10 years	1	1.27
Once a year	43	54.43
Twice a year	9	11.39
Many times in a year	3	3.80

Table 35. Reasons for going to the lake

Reasons	Frequency	Per Cent
Bathing	33	41.77
Sightseeing	14	17.72
Getting water for medicine	3	3.80
Fishing	2	2.53

3. Residents' Reactions to the Plan to Develop Lake Duminagat for Ecotourism. Provided that the majority of the people will benefit, the residents were all open to the idea to develop Lake Duminagat for ecotourism. They were even willing to share the earnings with the municipal government of Don Victoriano if it requested for its share.

Causes of Lake / Natural Resources Destruction and Their Solutions

The following were the major concerns brought up by the barangay residents; which they thought could hinder the continued protection and conservation of the lake:

- Pasturing of horses near the lake whose feces might reach the water.
- Building of houses near the lake because household dirt/wastes might contaminate the water.
- Practicing *kaingin* (swidden farming) in the forest surrounding the lake.
- Occurrence of landslides/soil erosion in the areas surrounding the lake.

1. Proposed Actions for the Continued Conservation of Lake Duminagat. The people gave the following suggestions that could help in the continued conservation of Lake Duminagat:

- Protection of the lake from dirt/wastes.
- Construction of dressing rooms for bathers and swimmers.
- Construction of comfort rooms that are of considerable distance to the water.
- Formulation and implementation of a policy prohibiting the disposal of non-biodegradable wastes into the lake; and requiring visitors to take with them their wastes when they leave the lake.
- Prohibition of the use of soap in the lake unless near the outlet.

2. Problems Encountered by Residents Regarding the Protection and Conservation of the Natural Resources.

- The regulation prohibiting the hunting of wild boars and monkey was not practical for the residents since these animals eat their crops.
- There were a lot of wild rats in their fields that eat all kinds of crops and plants, like 'laksoy', a kind of mammal, which eat the corn and sweet potatoes planted by the residents.
- Due to the widespread practice of 'kaingin', there were diminished sources of firewood; residents needed to gather firewood from distant areas.
- Bad roads.
- Lack of seedlings to plant, both trees and cash crops.
- Resident's lack of interest to plant trees in preference of cash crops.

3. Actions that Should be Undertaken to Solve the Problems

- Assistance should be sought from various agencies of the government.
- Seedlings should be requested from NGOs.
- A public toilet should be built for lake visitors.
- Measures should be undertaken to prevent the wild boars from eating the crops; like the use of traps or hunting and selling them. Another effective way is to place human feces along the way to scare them out.
- Monkeys should be simply driven out of the field.

Community Gender Roles in Lake/Environment Conservation

1. Women's Role in the Protection and Conservation of the Environment. The residents believe there were a lot of ways women can participate in the protection and conservation of the environment; and these were by:

- Cleaning and planting flowers that are aesthetically appealing to visitors.
- Taking care of the endangered plant and animal species.
- Doing the same things that men do.
- Safeguarding the plants and animals from outsiders.

2. Roles performed by women and men in households and community. The women's roles in the home included household and farm work, washing of clothes, feeding the children, and gathering firewood (if the husband was out). In the community, the women attend meetings of women's organizations and work in day care center.

The men on the other hand were in charge of farm work and gathering firewood. They were the ones who attend farmers' organization meetings and the ones who travel on foot to Don Victoriano when needed.

3. Roles of Men and Women in Farms. Both men and women did the plowing, planting and weeding. Women sometimes did the spraying of pesticides, but most of the time, it was the men who apply fertilizers and spray the chemicals on plants. Men also did the harvesting.

4. Participation in Community Affairs. At the time of the research, there were five male councilors and two female councilors.

5. Men and Women's Roles in the Conservation and Protection of Biodiversity Resources. Men and women both perform specific roles that go hand in hand in the conservation and protection of biodiversity resources. They help each other take care of plants and animals in the community.

Stories/Beliefs Related to Lake Duminagat.

The following were some of the most popular beliefs and folk tales told by the residents concerning the lake:

- The "Timuay" had seen the lake filled with buildings similar to a city.
- A visitor took a picture of the lake and when that photograph was developed, there was a person standing in the middle of the lake with a house and three children waving at the window.
- The lake is a sacred body of water with healing powers and can heal cysts, boils, and fever.
- There was once a soldier who shot a fish in the lake and the water bubbled. The soldier died without reaching the municipality of Mutia.

- The lake's water can wash away sins.
- There is a giant fish in the lake and ducks that come out only during the full moon.
- The lake has the ability to renew one's powers during the Holy Week.

Socioeconomic-cultural Profile of Barangay Lake Duminagat

Brief Historical Background

The DENR Mt. Malindang topographic map, Sheet 3744 IV, which was compiled in 1956 from 1947-1953 photographs, showed the absence of houses and footpaths in the areas of Mt. Malindang beyond 900 masl. These areas were denoted as still being forested. No houses were shown in the part that is now Barangay Lake Duminagat (Centro), easily recognized because of its topography. A small clear area is shown on the northeastern shoreline of the lake, possibly a clearing made by early settlers. The lake was not labeled yet even if other landmarks/places such as North Peak, Mt. Malindang, South Peak, and on the right fringe, the villages of Mapa and Gala, Sungan Creek and Clarin River were already labeled.

Rand and Rabor (1960, as cited by Noorduyn et al., 2002) described that in 1956, Lake Duminagat had only one abandoned house near the lake, formerly a house of worship. There were no clearings, only a few fish traps in the water, which belonged to a Gandawan resident.

From interviews, it was gathered that the lake was discovered around 1930 by Pedro "Mali" Villamino, a Subanon who was said to be a "surhano" (spirit medium). A number of residents of the barangay today are his descendants. It seems though that the majority settled in the area in the 1960s.

Pedro Villamino or "Mali" was called the lake 'danao' or 'tubig sa tiwala sa kagulangan'. He originated from Kanibungan, a place in Alvenda (now Buenas Suerte, Upper Mutia, Zamboanga del Norte). The mountain ranges of Malindang are said to be named after him ('Mali') and his wife 'Baindang'. The couple had 10 children of whom only four were still living. The original house of the couple beside the lake was constructed in the same location as the present cottage/rest house established by the Barangay Council at the western side of the lake. Except for five households at the eastern side of the lake, most of the inhabitants of the barangay now reside in Centro, located in a crater valley about an hour's walk from the lake. There used to be houses located in a ridge at the southern side of the lake but people moved when the houses were burned in 1987.

The barangay was established as a political unit under the municipality of Jimenez in 1968. It experienced turbulent times from the latter part of the 1970s to 1984 when the New People's Army entered the area and were followed by the military. According to the people, houses of Subanons (located on a ridge at the southern side of the lake) suspected to have supported the rebels were burned in 1987 and the people were forced to evacuate to safer and neutral grounds.

It was also in 1980 that a new municipality in Misamis Occidental was created and named as Don Victoriano. With its creation, the jurisdiction of Barangay Lake Duminagat was transferred from the Municipality of Jimenez to Don Victoriano, one of two municipalities of Misamis Occidental with no coastal area. The other municipality was Concepcion. Both Don Victoriano and Concepcion have most of their land area within Mt. Malindang Natural Park.

A school was built in the area upon its recognition as a barangay to cater to the residents of the barangay and what is now Barangay Gandawan. It operated from 1968 to 1980 but its operation was suspended for two years when people were evacuated at the height of the NPA-military encounters.

The Department of Agriculture in 1984, through its Municipal Agricultural Officer, Mr. Ludivico Pasuc, provided fingerlings of tilapia and carp to the lake. Prior to the provision of these fingerlings, informants said that only eels were present. He also tried to measure the area covered by the lake and its depth.

The barangay was named after the upland lake in the area. Duminagat is a Visayan term meaning lake. The lake was held sacred by the Subanon people who inhabited the area. Several organizations and groups had been created and entered the community at various times to provide the people much needed basic services. Some were successful. Please see the Venn diagram generated during the focus group discussions for details (Figure 11). The diagram shows the chronological entry of important services/agencies to the community. The bigger the size of the circle, the greater is the perceived influence of the organization or agency to the community. The circles inside the biggest circle means that these groups were successful in penetrating community while the circles outside were those that were not too successful in penetrating the area.

Demographic Profile

1. Age, Gender and Civil Status of Household Heads. More than half of the respondents were between the ages of 31-50 years old. Half were 40 years old and younger while the other half were above 40 but not over 79 years old. The youngest of the older half was 45.5 years old. About one-fourth of them were above 50 years old. Majority of them were still in their productive years and therefore capable of contributing to the increase of population in the area.

Majority (78.57%) of the household respondents were male. Only a little over one-fifth were female. Females only responded to the surveys when their husbands were unavailable at the conduct of the interview or were already dead. Almost all of them were married except for one who was widowed. Please see Tables 36a, 36b, and 36c for details.

2. Household Composition. For the 42 households surveyed out of the more than 50 families residing in the community, a total of 263 individuals were accounted for. Of this number, 129 were female and 134 were male. Almost 50% were children aged 12 years and younger. The average household size was five members per household. The highest consisted of 10 members and the lowest was two. Twenty-six (61.9%) households had 4-6 members; less than a quarter of them had seven or more; and less than 15% had three or less members.

Table 36a. Age of household heads

Age (in years)	Frequency	Per Cent
30 and below	8	19.05
31-40	13	30.95
41-50	10	23.81
51-60	1	2.38
Above 60	10	23.81
TOTAL	42	100.00

Average age = 45.5 years
Youngest = 24 years
Oldest = 79 years

Table 36b. Gender of household heads

Gender	Frequency	Per Cent
Male	33	78.57
Female	9	21.43
TOTAL	42	100.00

Table 36c. Civil status of household heads

Marital Status	Frequency	Per Cent
Married	41	97.62
Widow	1	2.38
TOTAL	42	100.00

Table 37. Household composition by size

Household Size	Frequency	Per Cent
1-3	6	14.29
4-6	26	61.90
7-9	8	19.05
More than 9	2	4.76
TOTAL	42	100.00

Table 38. Household composition by age and gender

Age (in years)	Male		Female		Total	
	Frequency	Per Cent	Frequency	Per Cent	Frequency	Per Cent
6 and <6	30	29.70	25	20.84	55	24.88
7 – 12	20	19.80	22	18.33	42	19.00
13 – 18	11	10.90	15	12.50	26	11.76
19 – 24	9	8.91	8	6.67	17	7.69
25 – 30	3	2.97	12	10.00	15	6.79
31 – 36	7	6.95	9	7.50	16	7.25
37 – 42	9	8.91	7	5.83	16	7.25
Above 42	12	11.86	22	18.33	34	15.38
TOTAL	101	100.00	120	100.00	221	100.00

3. Respondents' Length of Stay in Barangay Lake Duminagat. Almost 50% of the total household heads surveyed had lived in the barangay since birth. Those who said that they were residents of the barangay since birth were between the ages of 24-75 years. Of that age range, two had been residents for 16-26 years, 10 for 27-37 years and eight for more than 37 years. Almost ¼ of the settlers not born in the

barangay have lived there for more than 27 years. Only six families had been there for 5-15 years, while the four others had resided there for 16-26 years. There were two respondents who could not estimate their length of stay in the barangay. Most of the residents had either lived in the barangay since birth or had lived there for a very long time that they were considered natives of the place; some even returned and settled there after their parents moved to other places (Table 39).

Table 39. Length of respondents' stay in the barangay

Length of Stay (in years)	Frequency	Per Cent
Since birth	20	47.63
5-15	6	14.28
16-26	4	9.52
27-37	8	19.05
More than 37	2	4.76
No response	2	4.76
TOTAL	42	100.00

4. Respondents' Ethnic Origin. Majority of the respondents comprising 40 out of 42 (95.24%) were Subanons. There was only one Ilongo and another who was Siquidnon who resided in the community. Both were married to women who belonged to the Subanon tribe (Table 40).

5. Religion of the Respondents. All of 42 respondents belonged to the Roman Catholic Church but still maintained their beliefs in the spirits ("diwata"). Because of this, they still performed their customary religious rituals regardless of their conversion to Catholicism. This explained why they call themselves "Katolikano", subscribing to a mixture of Catholic beliefs and their native rituals ("kano"- referring to "buhat-buhat"). The Subanons hold their worship of the spirits during full moon and new moon periods. The mixture of folk beliefs and Roman Catholicism may be an interesting phenomenon for an anthropologist to investigate.

6. Educational Attainment of Respondents. The respondents had very low educational attainment as shown by Table 41. Seven (16.67%) of the respondents were not able to attend any formal education, eight (19.05%) were able to avail of primary level education but only six (14.38%) of them were able to graduate. There were 18 who reached elementary education. Only three had reached high school but only one graduated. None of the household heads reached college. This may be the reason why they stayed and engaged farming for a living. It was only in 1968 that school operation started with full elementary classes from Grades 1-6. Children from Barangay Gandawan also attended school until 1972 when their own school was constructed. At the height of NPA activities in the area in 1980 up to May 1982, the school ceased operation. It resumed operation in June 1982 with only Grades 1 and 2.

7. Schooling of Residents' Children. Nineteen (45.2%) of the total households had children out of school. There were 15 (35.7%) households with either one or two children going to school. Seven of the households had three to four children in school and only one had five to six. The majority of the families in the community had either no child in school or had only one to two children.

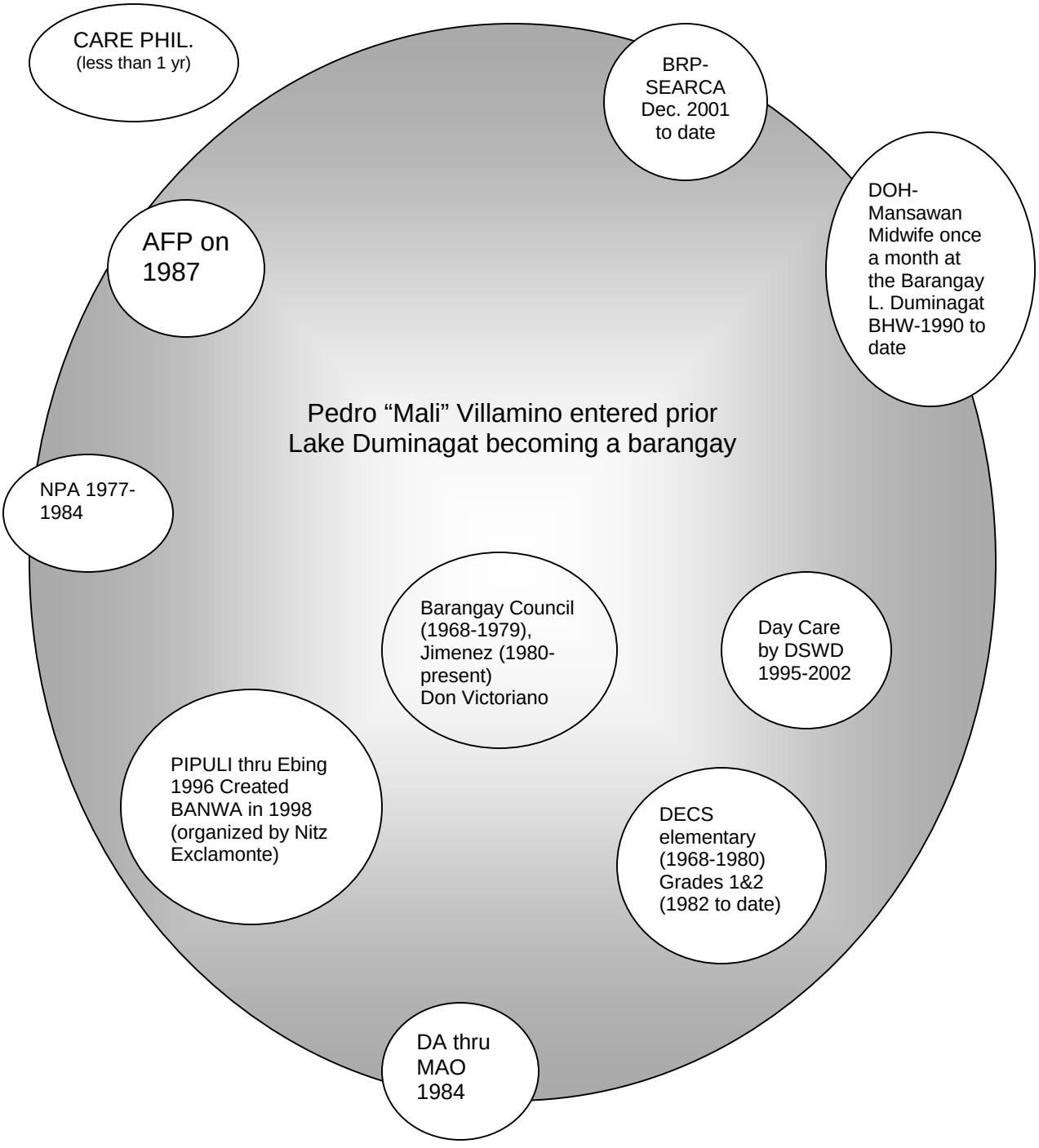


Figure 11. Venn diagram of Barangay Lake Duminagat

Table 40. Ethnic origin of respondents

Ethnic Group	Frequency	Per Cent
Subanon	40	95.24
Ilongo	1	2.38
Siquidnon	1	2.38
TOTAL	42	100.00

Table 41. Educational attainment of respondents

Educational Attainment	Frequency	Per Cent
No formal education	7	16.67
Primary level (Grades 1-4)	8	19.05
Primary Graduate	6	14.38
Intermediate grade level	9	21.43
Elementary Graduate	9	21.43
High School level	2	4.76
High School Graduate	1	2.38
TOTAL	42	100.00

When crossed-checked, it was found out that five families who had children in school also had non-schooling children. Of these, two households claimed they each had one child out of school and another two families each had two children out of school. One family stated that five of their children had not gone to school. Their reasons for not sending their children to school were: (1) they lacked the finances to sustain their schooling after the second grade, by which time, the children had to avail of the next levels of education outside their community, usually in Barangay Mansawan which is about 4-5 kilometers away, which can be reached either by foot or by horse; (2) the children had no interest to go to school; and (3) one respondent explained that his child decided to work in order to earn (Tables 42a, 42b and 42c).

8. Health and Sanitation Practices

8.1 Common Diseases Afflicting Respondents' Families. There were four diseases commonly afflicting households. These were: fever and colds (35); cough (27); stomachache (23); headache (13) and toothache (11). Others mentioned body pains due to the hard work they put into gardening activities; three reportedly experienced gastritis because they did not eat meals on time and three had arthritis. One respondent had skin disease and another one said that a member of his family had colic. Because respondents' sick members were not really examined by medical doctors, there may have been diseases which they failed to identify (Table 43).

Table 42a. Number of children in school

Number of children in school	Frequency	Per Cent
NONE	19	45.20
1-2	15	35.70
3-4	7	16.60
5-6	1	2.50
TOTAL	42	100.00

Table 42b. Number of children out of school

Number of children out of school	Frequency	Per Cent
One	2	40.00
Two	2	40.00
More than two	1	20.00
TOTAL	5	100.00

Table 42c. Reasons for not enrolling children in school

Reasons	Frequency	Per Cent
Lack of money to sustain their schooling	3	60
Child had no interest in schooling	1	20
Child decided to work instead	1	20
TOTAL	5	100

Table 43. Diseases afflicting respondents' families

Diseases	Frequency	Per Cent
Fever	35	83.33
Colds	35	83.33
Cough	27	64.28
Stomachache	23	54.76
Toothache	11	7.14
Headache	13	30.95
Gastritis/Gas pains	3	7.14
Arthritis/Rheumatism	3	7.14
Body Pains	2	4.76
Skin Disease	1	2.38
Colic	1	2.38

8.2. Medical Experts Consulted by Community Members. None of the household respondents brought their sick to medical doctors; 38 brought their sick to faith healers or 'surhanos'; three treated their sick with over-the-counter tablets; while two claimed to have used herbal remedies for sick family members. Only one consulted with the Barangay Health Worker when there were sick family members. Inhabitants of the community relied mostly on traditional remedies for treating their sick. This may have been due to their distance to health clinics and hospitals and the costs involved (Table 44).

8.3. Households' Manner of Waste Disposal. Most of the household heads said that they have compost pits for their wastes or garbage. Seven claimed to have burned their garbage. This means that they were not aware of the consequences brought about by burning to the environment. One respondent said he threw his garbage anywhere convenient for him, which was not only unsanitary but environmentally harmful. Majority had learned to allot a permanent spot for waste disposal (Table 45).

8.4. Toilet Facilities of Households. Thirty households had toilets; only 12 had none. Twenty-two of those with toilets used the antipolo type, i.e., a toilet bowl that does not need water as waste drops directly into the hole. Only eight used water-sealed toilets, which had no seat (Table 46).

Table 44. Medical experts consulted by community members

Medical Experts Consulted	Frequency (N=42)	Per Cent
Indigenous Healers (surhanos)	38	90.47
Self-Medication (tablets)	3	7.14
Herbal Medicines	2	4.76
Barangay Health Worker	1	2.38

Table 45. Manner of waste disposal

Manner of Waste Disposal	Frequency	Per Cent
Compost Pit	35	83.33
Burning	7	16.67
Throw Anywhere	1	2.38

* multiple responses per respondent.

Table 46a. Number of households with toilets

Response	Frequency	Per Cent
Have Toilets	30	71.44
Do Not Have Toilets	12	28.56
TOTAL	42	100.00

Table 46b. Types of toilet in households

Type of Toilet	Frequency	Per Cent
Antipolo	22	73.33
Water Sealed	8	26.67

Economic Profile

1. Income Sources of the Respondents. All respondent household heads said their main source of income was gardening; but majority (83.33%) indicated that they had other sources of income. Twenty-eight to 30 households said they were also engaged in river and fishpond fishing. However, they admitted that they seldom sold their catch since the fishes they caught were just enough for their families' meals. Four respondents received honoraria from being officials or leaders of the barangay; three (8.57%) received fees for being local counterpart researchers of the Biodiversity Research Project of SEARCA; while another three earned extra income from animal raising. One respondent said that her extra source of income came from operating a sari-sari store, and buying and selling vegetables. There were multiple ways for household heads to earn their living but very few opportunities were available in the area (Tables 47a and 47b).

Table 47a. Households with other sources of income

Response	Frequency	Per Cent
With other income source	35	83.33
Without other income source	7	16.67
TOTAL	42	100.00

Table 47b. Other income sources of households

Other Income Sources	Frequency (N=35)	Per Cent
River and fishpond fishing	30	85.71
Honoraria for being a barangay official	4	11.43
SEARCA	3	8.57
Animal raising	3	8.57
Sari-sari store and buy & sell	1	2.86

2. Monthly Income of Respondents. Though it was noticed that the reported monthly income of the respondents were very low, it was clarified during the community validation that most reported only their net monthly income. The lowest monthly income reported was P10.00 and the highest was P1,800.00, which was equivalent to the monthly honorarium of barangay officials. The average monthly income of the respondents was computed to be only P521.65. More than 70% of the households had only P500.00 net income per month. There were five households that had more than P500.00 but not over P1000.00 a month and only six (14.32%) households with monthly net income of over P1000.00 but not greater than P1,800.00 (Table 48). When participants were made to take part in a community wealth ranking exercise, gathering their opinions with regard to people with material wealth in the community, all said that all of them in the community were poor and only a selected few were better off.

3. Size of Cultivated Land. Since all respondents revealed that their main source of income was gardening, it was significant to know the size of their gardens. Thirty-two (76.2%) claimed they were tilling 1-2 hectares; five (11.9%) cultivated less than this size; and an equal number cultivated more than 2 hectares of land. Gardens were located mostly on the slopes of the surrounding mountains; although one lakeside resident cultivated a small area for cabbage near the outlet stream. The small sizes of lands they cultivated explained why their incomes were very low (Table 49).

4. Wealth Ranking. In the respondents' viewpoint, in terms of material wealth, those who are considered better off were the members of the CAFGU, the barangay captain and his councilors, the day care teacher, the SK chairman and some businesswomen. All other residents were perceived as poor.

If the basis of wealth was character, those who were perceived as well-off were all of the residents. Only very few were considered poor.

Table 48. Monthly household income of respondents

Monthly Income (in PhP)	Frequency	Per Cent
500 and below	31	73.78
501-P1,000	5	11.90
1, 001- 1,500	4	9.52
Above 1,500	2	4.80
TOTAL	42	100.00

Table 49. Size of cultivated land

Land Size (in hectares)	Frequency	Per Cent
Less than one	5	11.90
1-2	32	76.20
More than 2	5	11.90
TOTAL	42	100.00

In terms of farming activities, people or residents of Lake Duminagat believed in cooperativism. They organized "hunglos" or cooperative farming where families help each other in cleaning, cultivating and harvesting activities including marketing of their produce. A group of 8-10 families exchanged services to facilitate farming activities and make these activities enjoyable.

4. Kinds of Crops Planted by the Respondents. The major crops produced in the community were root crops; such as sweet potatoes, gabi and kanaka that were also their staple food. Almost all of them also planted chayote. Their second major crop was abaca and the third was spring onion. There were 13 of them who planted cabbage with other vegetables and only two who had planted bananas. They were not able to produce either corn or rice for both were not suitable to the weather conditions of the area. Rice did not develop grain; while corn took about seven months for its ears to form and mature. No fruits were grown to supplement the food intake of residents. The community did not appear to be self-sufficient in food production.

The crops planted for cash were chayote, onions, abaca and cabbage. The root crops were usually subsistence crops. It was observed, but not reported in the household survey, that some households grew the ornamental plant milflores (*Hydrangea macrophylla)* which were sold in lowland cities such as Dipolog. It was suggested to the local researchers that they could replant and propagate the native lakeside plants that have ornamental potential and sell them for additional income. However, they said that the DENR prohibited any gathering and cultivation of these plants.

5. Fishing Information

5.a. Kinds of Fish Caught (river/fishponds). Although lakeside residents and some others from Centro sometimes fished in the lake, it was generally discouraged because of the residents' belief on the lake as a dwelling place of spirits. Thus, residents fished only from their own fishponds and river and streams in the barangay.

Although many indicated during house to house survey that their extra source of income was either from river or fishpond fishing, it was found out during the community data validation that fishing was done by respondents not for other income source but for their household consumption only. Respondents were asked as to the kinds of fish that they usually caught. Results showed that the most common fishes they caught were "paitan", tilapia and carpa; very few got eel and crustaceans similar to small crabs. One resident, in a time of scarcity, had to catch tadpoles for food (Table 51) for details.

5.b. Fishing Methods Used by the Respondents. In river fishing, respondents said that all of them used hook and line or what was locally called "pamasol". There were 13 of them who used a method they called 'balantak' and only six stated that they used fish basket or "bobo". Most of them with fishponds indicated that other methods were used to catch fish. These methods consisted of "sikop", "sarap" and "pahubas" or draining of fishpond.

Community Problems

Residents revealed just a few problems regardless of the difficult situation they were in. Twenty-nine complained of the bad weather at the time of the interview; 12 stated lack of money as their problem; three complained about the difficult livelihood; two identified lack of food as their problem; one complained of health related problems and another of the damaged house that he and his family were staying in. None of them complained of the muddy roads when it was raining or the lack of electricity. Because their lives were simple, most seemed content with their situation as they themselves decided to settle in the community.

Table 50. Crops planted by the respondents

Crops	Frequency	Per Cent
Chayote	36	85.71
Root crops (camote, kanaka and gabi)	36	85.71
Abaca	30	71.42
Spring onions	17	40.48
Cabbage & other vegetables	13	30.95
Banana	2	4.76

Table 51. Kinds of fish caught by respondents from the river/fishponds

Kind of Fish	Frequency	Per Cent
Paitan	30	100.00
Tilapia	30	100.00
Karpa	27	90.00
Crustacean	4	13.33
Eel	3	10.00
Tadpoles locally known as boliok	1	3.33

Table 52. Fishing methods used by respondents

Fishing Methods	Frequency	Per Cent
A. River Fishing		
Hook & Line (*pamasol*)	30	100.00
Balantak	13	43.33
Bobo or basket	6	20.00
B. Fishpond only		
Sikop	1	3.33
Sarap (w/ the use of net)	1	3.33
Pahubas (draining)	1	3.33

Table 53. Problems identified by the respondents in the community

Problems	Frequency	Per Cent
Bad weather condition	29	69.04
No money	12	28.57
Difficult livelihood	3	7.14
Lack of food	2	4.76
Diseases	1	2.38
Destroyed house	1	2.38

Current and Proposed Uses of the Lake

1. Frequency of Respondents' Visits to the Lake

- Everyday, for some who needed to pass by it on their way to their gardens or other daily destinations
- Occasionally, only when there were reasons to go, such as to assist in the delivery of a baby or to take a bath
- During the Holy Week (for many people)

2. Uses of the Lake

- Domestic and drinking water since the water system in the barangay came from the spring which was an offshoot of the lake
- Washing and bathing
- Water used by the local healers (*surhano*) for healing

It was learned that the Municipal Development Plan of Don Victoriano included the use of Lake Duminagat for fish farming (where fish cages will have to be constructed in the lake); and as a resource of a hydroelectric power plant. Based on the obtained data on productivity and hydrology of Lake Duminagat, these plans were not feasible. The people had blocked a past attempt to put fish cages in the lake because they were aware that this would pollute the lake (Luminding, personal communication).

The Barangay Captain, Danny Pata, having observed visitors bottle the lake water for healing purposes, thought that it would be a good idea to take advantage of this opportunity to earn money for the community. Given sufficient funding, he thought people from the community can bottle the lake water and sell it to outsiders; although he himself did not believe in the Subanon cultural belief that the lake water can heal.

The exact number of visitors from outside the community was monitored during Holy Week 2002 when there were the most number of visitors (Table 54). The increased number of visitors, especially on Maundy Thursday and Good Friday, was probably due to people's belief that bathing in the lake can wash away their sins. The number of lake visitors in the past are shown in Table 55, although this reflects only those recorded in their visitors' logbook.

Table 54. Number of visitors during Holy Week 2002 (March 25-31, Mon-Sun)

	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
No. of people	7	4	75	253	225	15	Not recorded

Table 55. Number of visitors in the past (only those recorded in community logbook)

Year	Male	Female	Total
1998 (Apr-May)	27	16	43
1999	16	0	16
2000 (Jan-Nov)	154	210	364
2001 (Jan-Jun)	100	13	113

During all the field visits of the external researchers, there were always some outsiders observed at the lake or going to the lake: a busload in December 2001, about 30 people in January, an extended family in May, a religious group accompanied by DENR personnel in June, about 30 people (a group of Adventists) in October. In April, about eight motorcross riders rode their motorcycles to the lake through the road that goes directly to the lake from Barangay Gandawan. This was the road bulldozed in 1999, to make it passable by motor vehicles. However, construction of this road was objected to by the residents of Barangay Lake Duminagat. In October, the Adventist group camped at Centro rather than at the lake because the Barangay no longer allowed people to camp at the lake. Furthermore, the Barangay had started collecting a fee of P10 per head after such a regulation was passed by the Provincial Board.

Based on the number of people going to the lake for various reasons – religious, sightseeing, nature trekking, and others, there really is a high potential for the lake to be developed for ecotourism (said to be part of the Municipal Development Plan). It was not just the lake attracting outsiders to the area, but also North Peak, which was popular to mountaineers. However, the barangay would need to know what ecotourism really is and how it can be developed without adverse effects on the environment (Libosada, 1998).

Causes of Lake/Environment Destruction and Their Solutions

The residents were asked what problems may face the effort to conserve Lake Duminagat. The following were their answers:

- Residents near the lake raised animals that eliminate fecal wastes near the water. There were also toilets constructed in the vicinity so near the water that human wastes could contaminate it.
- Lack of public toilets. Most tourists therefore eliminated wastes near the lake.
- Tourists' practice of getting various plants, flowers, bark and roots of plants including lake water.

There was already an ordinance formulated for certain prohibitions concerning the lake, but it had to be approved by the Municipal and Provincial governments.

1. Proposed Actions for the Continued Conservation and Protection of Lake Duminagat

The residents were asked what the community needed in order to pursue conservation and protection of Lake Duminagat. The following were their answers:

- The community should find a way to hire a caretaker for the lake but there was no budget for it. The Mayor's plan was to take the salary from the Municipality.
- Prohibit cutting of trees.
- Prohibit cultivation of land surrounding the lake.
- Prohibit uprooting or picking of plants that grow.

2. Problems that can be Encountered in the Protection and Conservation of Fauna and Flora in the Community. The following were the foreseen problems that the residents felt they could encounter:

- Plants in the fields can be consumed by the monkeys, wild pigs, and rats.
- Plants with ornamental and medicinal values may be sold by many. If restrictions were not imposed immediately, this could result to their disappearance.
- After restrictions were implemented, very few animals and plants will be

available for the community to catch or gather for food.

3. Effect of the Mentioned Problems to the Lives of the Residents. Community residents were asked how the problems they mentioned affected their lives and they said that if the government will prohibit them from using available resources around them, they will lose their income sources and it will be difficult for them to live.

4. Actions that should be Undertaken to Solve the Problems. Residents were asked what actions or steps they thought need to be undertaken in order to solve the problems, especially those related to the protection and conservation of biodiversity resources and the following were their proposals:

- Seek the government's assistance to support the community in their livelihood.
- Ensure the provision of the people's daily needs.
- Ask development assistance or grant from foreign countries.
- Improve the road going to the area even if it's only a trail.
- Improve the scenic spots for tourists.
- Put up a swimming pool at the outlet of Lake Duminagat supported by PALS.
- Establish a cooperative canteen to be operated by the women organization near a hostel to be put up by the government so that people can be employed. The residents of the community will help in conserving biodiversity.
- CARE Philippines, an NGO operating in Mt. Malindang established the Biodiversity Monitoring System and Team in the area.
- Assistance was already sought from PALS for the Income Generating Projects amounting to one million pesos for the following:
    a. infrastructures - improvement of road trail
    b. animal dispersal (carabaos and goats)
    c. swimming pool
- Build linkage with other funding institutions with the assistance of SEARCA.

Stories/Beliefs Related to Lake Duminagat

The residents were asked what their beliefs were regarding Lake Duminagat. The following were some of the folk tales and common beliefs related to the lake:

- It was sacred because it is a city of the spirits.
- As handed down to them by their leader, Mr. Pedro Villamino, the whole of America is not enough to pay if Lake Duminagat is destroyed.
- It is a remnant of the great flood that engulfed all the earth during Noah's time.
- It is the navel of the entire world and so it is prohibited to make noise and make fun or foolishness there.
- It has healing powers.
- It can cleanse away sins if the person's character is changed.

Although the Subanons believe in God as a supreme and powerful being, they also believed that there were lesser gods or spirits ("diwata") who were also powerful. Thus, they usually made an offering to these spirits during "daktol" or full moon. They also worshiped and offered to these spirits gifts twice a month, on full moons and new moons.

The work for the Subanon community was subdivided among themselves. The "Timuay" took care of the community's visitors and can administer marriage among them. The "surhano", on the other hand, healed the sick and talked to the spirits. Even if all of the Subanons adhered to the Roman Catholic belief, they also continued their practice of offering gifts to the spirits.

Since Lake Duminagat was sacred to the people, for it was believed to be the city of the spirits, they were then very careful not to offend these spirits. For this reason, the BRP researchers inquired what is the ritual ceremony and offerings required so that they and the local researchers can carry out research work in the lake. Heavy requirements were asked as offerings for they could not afford to make the spirits in the lake angry and retaliate to them or to anyone in the form of sickness. The required offering consisted of one pig, four chickens (two roosters and two hens), four eggs, 28 cigarettes, four bottles of local liquor and one ganta of rice. A ritual ("pamuhat") was made after the pig and the chicken were butchered and cooked in water and salt. A table was set for four people with four plates and glasses, surrounded by four chairs. The "pamuhat" ritual was performed by the Timuay's wife and the "surhano" (local medium for the spirits). The following paragraphs describe the ritual in greater detail.

One small pig and four chickens (two hens and two roosters) were slaughtered. After draining the blood, burning the hair of the pig and removing the feathers of the chickens, the internal organs were removed. Then the animals were cooked simply by boiling with salt.

A table was set up with four chairs surrounding it. The table was covered with white sack and on top of it were the boiled chickens and pig (four chickens which were whole and one small pig which was cut up), four bottles of mallorca (a local gin-like liquor), four plates of cooked rice with one boiled egg each, 28 cigarettes and a glass of water.

The wife of the Timuay chanted something or talked (in "Sinubano" language) to the spirits while beating a porcelain bowl with a stick. The beating was done 4 times by 7, totaling 28 beats. Simultaneously, there was a "palina" (burning of incense, with the smoke being wafted on the food offering). Afterwards, the "surhano" (Vicente Tamon) concentrated and talked to the spirits, to ask permission for the research work. After some time, the "surhano" relayed that the spirits agreed inasmuch as the mayor has given the permit and because the end goal of the research is good, for the environment and for the people. The spirits further qualified that only a little amount of water should be taken from the lake for the laboratory analysis. We asked if 11 bottles would be agreeable. Initially, the spirits refused but the "surhano" pleaded on our behalf, after which the spirits consented. After the ritual, the people ate the food offering.

The spirits called upon during the ritual included Apo Gumolang (the counterpart of Jesus Christ, caretaker of the lake and the diverse organisms in Mt. Malindang), "sampit ni Hesukristo, magbalantay sa lake og tanan mga kinaiyahan sa Mt. Malindang". Another spirit, "Pinyalan", was sent by Apo Gumolang to take charge of the lake and its environs.

Summary and Conclusions

Lake Duminagat is a crater lake located in Mt. Malindang Natural Park, which is one of the Protected Areas in the Philippines. Two communities are adjacent to it – Barangay Lake Duminagat, of which it is a part, and Barangay Gandawan, which are both included in the municipality of Don Victoriano, province of Misamis Occidental. The municipality of Don Victoriano is wholly circumscribed by the Park. The Park represents the flora and fauna of the Zamboanga biogeographic zone.

Lake Duminagat was a worthy area to study, not only for its biodiversity but because it supports the biodiversity of its surroundings. The lake also holds a central place in the spirit life of the Subanon people, who look on the lake as sacred and a source of healing water. The Subanon is an indigenous people group who had lived in parts of the Zamboanga Peninsula, starting from pre-Hispanic times, one group of which have lived in the Mt. Malindang area. Although the Subanons had their own traditional customs and practices, they had become enculturated by the influence of Visayan and western cultures, brought about by Visayan settlers/businessmen and mass media.

As part of the Philippines-Netherlands Biodiversity Research Programme for Development: Focus on Mt. Malindang and Environs (shortened as BRP), the project utilized the participatory approach, one aspect of which was participatory inquiry, formally termed as Partcipatory Biodiversity Assessment. The research involved people in the local community as local researchers or local partners. It aimed to study the morphophysicochemical and biodiversity characteristics of the lake and its perimeter. The socioeconomic-cultural profile of the community was included in the research as a situationer, so the community will know their situation, how they were related to the lake and its biodiversity, how they might affect these resources, and how they can conserve these resources and maximize their use to improve livelihood opportunities. Following the principle of participatory action development, it is hoped that this research (the diagnosing phase) will lead to the experimenting and sustaining phases, possibly collaborative management of this protected area with the Subanon community.

The area of study consisted of valleys and mountains, Barangay Gandawan, Barangay Lake Duminagat, and the lake basin being considered as crater valleys, surrounded by varyingly tall mountains. Being at high elevation (~1,240 to 1,560 masl), the climate in the Lake Duminagat area was cooler compared to the lowlands. The area belonged to the region classified as Intermediate B type – No pronounced maximum rain period and no dry season, with an annual rainfall of 2099 mm. Lake Duminagat was 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 was a thermally stratified lake; though whether it undergoes periodic mixing was not determined. The water was low in alkalinity and 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 physico-chemical 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. Its macrophytes (representing one component of primary productivity) and zooplankton (representing secondary productivity) population were thus low in numbers, aside from being limited in number of species. Consequently, the fish population, which was at the top of the aquatic food chain, was also low in kind, numbers and biomass. Nonetheless, the lake supported a high diversity of indigenous shoreline fauna and flora.

In the two barangays adjacent to the lake, majority of the settlers probably started residing there in the early '60s when the area was opened up due to logging. Prior to this period, it is claimed that the lake was discovered by a Subano, Pedro "Mali" Villamino, a number of whose descendants still reside by the lakeside itself and in the main settlement of Barangay Lake Duminagat (Centro; about an hour's walk away).

The population of the two barangays consisted of about 60 households each. The population had a high potential for increase because a greater sector of the population was at their reproductive age. There is also the potential for migration to the area, since other parts of the Philippines/Mindanao have a growing population. However, there could also be out-migration for people who want to seek "greener pastures". Although the area had an attractive cool climate because of its high elevation (from 1240 to 1560 masl), it was beset by heavy rains, bad roads, leeches, lack of food, difficult livelihood, lack of electricity, and lack of the finer amenities of life. This may just as well be because making the place more attractive by providing more basic services could lead to increased in-migration that can overshoot the area's carrying capacity. How to strike a balance between a better quality of life and sustainable management of the environment is the question that the local residents/researchers should explore.

The major source of income in the community was gardening, a livelihood that cannot sufficiently meet the people's basic needs. As one resident complained, their products were being sold at a low price, yet the basic necessities they needed to buy (e.g., rice) commanded a higher price. Consequently, most of the residents regarded themselves as poor. Gardening cannot really lift up the economic condition of the residents and further opening of the area to agricultural pursuits would destroy the Park. Livelihood alternatives should be developed.

The residents considered the lake as the dwelling place of spirits and did not encourage fishing in the lake. This was just as well since the lake did not support a substantial fish population. The residents themselves knew that they can preserve the cleanliness of the lake by not allowing the construction of toilets and defecation at the lake's perimeter. They allowed swimming, bathing, washing of clothes only near the outlet. The lakeside residents, consisting of five households, got their drinking water from the middle of the lake.

It was not only the Subanons but outsiders who considered the lake as source of healing water and to have the capacity to wash away sins. The occurrence of many visitors to the lake, especially during the Holy Week, attested to that belief. It was not only for this purpose that people troop to the lake but for recreation. Thus, the lake and the adjacent North Peak have very good potential for ecotourism, provided that certain precautions can be done to preserve and conserve them.

Considering the need for sustainable livelihood alternatives in conjunction with biodiversity conservation of the lake and its surrounding, what might be some possible options? It was mentioned that the lake supports a surrounding lush vegetation. This plant resource can offer a potential mine of ornamentals, medicinals, source of bioactive compounds, raw material for mat making, source of fiber, etc. if it is conserved and encouraged to flourish. The lake's surroundings also supported a diverse fauna/wildlife that can be encouraged to multiply. With these biological resources, coupled with the area's cool climate and general scenery, will it be possible to develop the area into a nature park with indigenous ornamental plants for sale, promoting activities such as birdwatching and mountain climbing; all of which are to be taken charge of by the residents who would become the hosts and businessmen-entrepreneurs?

Recommendations

Participation

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. The results are also useful inputs for the participatory planning and management of the Lake Duminagat area.

2. For the external researchers, participatory tools and methods should be refined and applied such that they will result to the empowerment of the local community. Participatory planning should be facilitated to tie this up with the first recommendation. Ideally, this should result into co-management of the protected area.

3. The participatory tool of institutional analysis should be carried out in order to resolve possible issues and conflicts with Lake Duminagat/Mount Malindang being a part of the municipality of Don Victoriano and at the same time a Natural Park under the DENR-PAWB.

4. For the external researchers, direct/ participant observation should be more systematically recorded, presented to and validated by the community.

5. The community should be assisted in the recording and documentation of their fast vanishing traditional customs and practices and other indigenous knowledge so that they can be proud of their cultural heritage.

Lake/Biodiversity Conservation and Management

6. The Subanon 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. It is therefore necessary to maintain such beliefs in the community and to pass them on to the next generation; while, at the same time, encouraging acquisition of new knowledge through modern and scientific learning.

7. The community already knows how to protect the lake from contamination and pollution. They are also aware of possible things that might destroy the lake. Their awareness and sense of duty towards it just need to be encouraged.

8. The area has a very great potential for tourists/visitors because of its cool climate, lake for swimming, various mountains and North Peak for mountain climbing. The community can be aided to engage in brainstorming on their concept of ecotourism and to do a SWOT analysis. The possibility to develop the area for ecotourism with the residents becoming managers and entrepreneurs would require partnerships for capability building and funding. The community can be aided to develop these partnerships.

9. The cool, almost temperate climate of the area may probably be exploited for the planting of high-value crops/fruit trees suited to cool temperatures. Care should be taken though in the introduction of exotic species. For this purpose, the climate pattern should be more rigorously monitored.

10. The bad roads should be improved and provided with drainage to prevent erosion. Although, it would probably be more preferable not to make it passable by motor vehicles in order to prevent

massive influx of visitors. Walking on foot or horseback riding would make for greater nature enjoyment. (One has to think of the residents' needs though.)

11. There is a need for a full inventory and scientific identification of the lake flora and fauna for future scientific purposes and sustainability of resources in the area.

Community Socioeconomic Components

12. The population size of the area should be limited to the carrying capacity of the area for biodiversity conservation and sustainable livelihood. Migration of people should be controlled and the community educated on reproductive health and family planning.

13. Though massive ecological campaign needs to be undertaken at the level of people's understanding, it will never be effective unless other alternative income sources can be identified immediately to stop exploitation of resources and lessen the extent of damage created at the uplands of Mt. Malindang.

14. Less agricultural activities should be encouraged at the uplands to really ensure that protection and preservation of biological resources in Mt. Malindang can be ensured.

15. Because of dwindling resource base and poverty in the area, there is an urgent need to educate the people on reproductive health to be able to manage their population size. At the same time, this is a necessary action to prevent further destruction or damage to the environment wherein they are not the only ones who are directly affected. People's survival in this area is at stake due to harsh weather conditions and decreasing soil fertility. Thus, the Department of Health, the Population Commission and the Local Government Unit of Don Victoriano should be involved the soonest time possible.

16. It is also recommended that basic facilities and services be established and provided such as the following:

    a.) Elementary schools and teachers- for local children to learn basic literacy. To prevent teacher absenteeism, Subanon teachers who are residents of the area should be hired. Having a school built in the community will answer one of the primary problems of parents and children who felt that going to a school situated far from their home is just too much trouble. It can somehow ensure that there will be a lot less children out of school and parents will have no more excuse not to send them.

    b.) Health centers/units. In view of the distance of the two communities from Barangay Mansawan Health Center, where the service of a midwife are also made available, it is requested that the Municiplity of Don Victoriano consider putting up such a facility, first in Barangay Gandawan. The services of the health service providers can be shared by residents of Barangay Lake Duminagat. This can provide residents reproductive health education, provide medical services to the ill, and teach people preventive measures against illnesses especially among women and children.

    c.) Improvement of roads – to provide access to markets and other services not available in the area. Good roads can also facilitate monitoring of implemented projects in the area by municipal authorities.

    d.) Animal house - necessary to protect the residents' animals from harsh weather. The community should set aside a common area to establish this facility since this is a basic

concern of all households with horse, cow and carabaos.

17. The DENR should monitor the area to assess the extent of damage done to the mountaintops by farming activities. With linkages to other agencies of the government, they can think of appropriate alternative income sources that people can engage in so as to provide the community's basic needs.

Literature Cited

American Public Health Association. 1971. Standard Methods for the Examination of Water and Wastewater, 13th ed., Washington, D.C., USA.

Arances, J.B., V.B. Amoroso, et al. 2002. Development of participatory methodology for inventory and assessment of floral resources and their characterization in the montane forests of Mt. Malindang. Draft Final Report. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang and Environs, SEAMEO Regional Center for Graduate Study and Research in Agriculture, Los Baños, Laguna, Philippines.

Barbosa, A.C. 1996. The Buklug of Gutalac, Zamboanga del Sur. Mindanao Journal 23 (1-2): 55-70.

Brower, J.E. & J.H. Zar. 1984. Field and laboratory methods for general ecology. 2nd ed. Wm. C. Brown Publishers, Dubuque, Iowa, USA.

Biodiversity Research Programme. 2000. Philippine-Netherlands Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang. Netherlands Development Assistance Research Council & SEAMEO Regional Center for Graduate Study and Research in Agriculture, Los Baños, Laguna.

Cali, C., J.B. Arances, E.G. Tobias, E.M. Sabado, A.A. Alicante, L.B. Ledres, O.M. Nuñeza, & D. Ramirez. 1999. Participatory rural appraisal: A tool for biodiversity research programme identification in the upland ecosystem of Mt. Malindang in Misamis Occidental, Mindanao Islands, Philippines. Biodiversity Research Programme for Development in Mindanao: Focus on Mt. Malindang, SEAMEO Regional Center for Graduate Study and Research in Agriculture, Los Baños, Laguna, Philippines.

Castro, L.F. 2002. Communicating indigenous knowledge systems and practices in managing forest resources: The case of the Barlig tribe in Mountain Province. Undergraduate Thesis, B.S. Dev. Comm. University of the Philippines Los Baños, Laguna, Philippines.

Chin, W.Y. 1997. Ferns of the tropics. Times Editions Pte Ltd, Singapore.

Chuluun, T., A. Enhbat & B. Shurentuya. 2000. Conservation through development of traditional institutions in Mongolia. Abstracts. The Ecological Society of America 86th Annual Meeting. Aug. 6-10, 2000. Snowbird, Utah, USA. p. 9.

Clay, A., P. Oakley, & B. Pratt. 1997. CSOPP Documents: Empowering people: A guidebook to participation. http://www.undp.org.

Crosby, M.P., K.S. Geenen, & R. Bohne. 2000. Alternative access management strategies for marine and coastal protected areas: A reference manual for their development and assessment. U.S. Man and the Biosphere Program, Washington DC, USA. 168 pp.

Darrow, D., J.M. Kabrick, J. Grabner & R. Jensen. 2000. Missouri Ozark Forest Ecosystem Project: Aiming for adaptive management. Abstracts. The Ecological Society of America 86th Annual Meeting. Aug.6-10, 2000. Snowbird, Utah, USA. p. 11.

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.

Department of Environment and Natural Resources - National Mapping and Resource Information Authority. 1989. Mount Malindang topographic map. Sheet 3744 IV. Reprint of 1956 compilation. DENR NAMRIA, Fort Bonifacio, Makati, Metro Manila, Philippines.

Department of Environment and Natural Resources - National Integrated Protected Areas Programme. 2000a. Management Strategy for Mt. Malindang. 22 p.

Department of Environment and Natural Resources - National Integrated Protected Areas Programme. 2000b. Summary: General Management Plan, Mt. Malindang Natural Park (2000-2003). Misamis Occidental, Northwestern Mindanao, Philippines.

Department of Environment and Natural Resources and United Nations Environment Programme. 1997. Philippine biodiversity: An assessment and action plan. Bookmark, Makati City, Philippines.

Department of Health. 1993. Philippine National Standards for Drinking Water. Manila, Philippines.

Dickerson, R.E. 1928. Distribution of life in the Philippines. Bureau of Printing, Manila. (1975 reprint. Bookmark, Inc., Manila), Philippines.

Fassett, N.C. 1957. A manual of aquatic plants. The University of Wisconsin Press, Madison, Wisconsin, USA.

Galvin, K. 2000. Community based conservation: Does it work? Abstracts. The Ecological Society of America 86th Annual Meeting. Aug. 6-10, 2000. Snowbird, Utah, USA. p. 16.

Goldman, C. & A. Horne. 1983. Limnology. McGraw-Hill Book Company, New York, NY, USA. 575 pp.

Happy-Wood, C. 1975. Distinction in algal ecology and production in two linked upland lakes, Gwynedd, N. Wales. Verh. Internat. Verein. Limnol. 19: 1045-1056.

Heaney, L.R. et al. 1998. A synopsis of the mammalian fauna of the Philippine Is. Fieldiana Zoology New Series No. 88. Publ. 1493, Field Museum of Natural History.

IDB Resource Book on Participation. http://www.iadb.org./exr/english/POLICIES/participate/index.htm.

International Institute of Rural Reconstruction. 1998. Participatory methods in community-based coastal resources management. 3 vols. International Institute of Rural Reconstruction, Silang, Cavite, Philippines.

Interviews with key informants: Enopenia Villamino Cati, Filemon Cati, Lusa Lumaray, Timuay Filomeno Luminding, Nang Ely Luminding, Barangay Capt. Danny Pata, Barangay Capt. Narciso Ruiz (until May 2002), Timuay Dodoy Ubas, Pastor Villamino.

Jolly, V. & E. Flint. 1975. Limnological variations between two regions of a New Zealand lake. In: II. Lakes. 7. New Zealand and Oceania. Verh. Internat. Verein. Limnol. 19: 1450-1451.

Jones, S.B., Jr. & Luchsinger, A. 1986. Plant systematics, 2nd ed. McGraw-Hill Book Company, New York, NY, USA.

Kent, M. & P. Coker. 1994. Vegetation description and analysis: A practical approach. John Wiley & Sons, Inc.

Lammerink, P. 1999. A detailed look at the PAD approach. PLA Notes 35.

Lammerink, M.P., P. Bury, & E. Bolt. 1999a. An introduction to participatory action development (PAD). PLA Notes 35. June 1999.

Lammerink, M.P., E. Bolt, D. de Jong, & T. Schouten. 1999b. Strengthening community water management. PLA Notes 35. June 1999.

La Voy, D. Undated. How to recognize a participatory approach (if you bump into it in a dark alley). http://www.usaid.gov/abouy/part_devel/docs/darkally.html.

Libosada, C.M., Jr. 1998. Ecotourism in the Philippines. Bookmark Inc., Makati City, Philippines.

Likens, G.E., ed. 1985. An ecosystem approach to aquatic ecology: Mirror Lake and its environment. Springer-Verlag, New York, NY, USA.

Lind, O.T. 1985. Handbook of common methods in limnology, 2nd ed. Dubuque, Kendall/Hunt Publishing Company, Iowa, USA.

Linsley, R.K., Jr., M.A. Kohler & J.L.H. Paulhus. 1958. Hydrology for engineers. McGraw-Hill Book Company, Inc., New York, NY, USA.

Madulid, D. 2000. A pictorial cyclopedia of Philippine ornamental plants. 2nd ed. Bookmark, Makati City, Philippines.

Madulid, D.A. 2001. A dictionary of Philippine plant names. Vol. I. Local name-scientific name. Vol. II. Scientific name-Local name. Bookmark, Manila, Philippines.

Madulid, D.A. & M.G. Agoo. 1992. A bibiliography on biodiversity research in the Philippines. National Museum, Manila, Philippines.

Mamaril, A. Sr. 1986. Zooplankton. In: Guide to Philippine Flora and Fauna. Vol. VII. Natural Resources Management Center, Ministry of Natural Resources and University of the Philippines.

Manuta, J. 2001. Negotiating the political economy of dispossession and commodification: Reclaiming and regenerating the ancestral domains of the Lumad of Mindanao, Southern Philippines. Ph.D. Dissertation. University of Delaware, Delaware, USA.

Minister of National Health and Welfare. 1992. Guidelines for Canadian recreational water quality. Minister of Supply & Services, Canada.

Minister of National Health and Welfare. 1993. Guidelines for Canadian drinking water Quality. 5th ed. Minister of Supply & Services, Canada.

Moermond, T. 2000. Integrating conservation into rural development: Perspectives from a community-based approach in Latin America. Abstracts. The Ecological Society of America 85th Annual Meeting. Snowbird, Utah, USA.

Mooney, H. 2000. Ecology and sustainability at the beginning of the 21st century: Next step is the international community. Abstracts. The Ecological Society of America 85th Annual Meeting. Snowbird, Utah, USA.

Myers, W.L. & R.L. Shelton. 1980. Survey methods for ecosystem management. John Wiley & Sons, Inc.

Noorduyn, R., G. Persoon, E. de Roos & M. van't Zelfde. 2002. Short bibliographic survey: Mt. Malindang Protected Area, Mindanao, Philippines. Center of Environmental Science, Leiden, The Netherlands.

Nyikahadzoi, K. 1994. Overview on community based fisheries management. In: Practical aspects of stocking small water bodies: An example in Zimbabwe. Committee for Inland Fisheries of Africa Technical Paper No. 28. ALCOM Food and Agriculture Organization, Rome, Italy.

Odum, E.P. 1971. Fundamentals of Ecology. 3rd ed. W.B. Saunders Company, Philadelphia, USA.

Pratt. 1916. Philippine lakes. Phil. J. of Science.

Rabor, D.S. 1977. Philippine birds and mammals: A project of U.P. Science Education Center. University of the Philippines Press, Diliman, Quezon City, Philippines.

Saastamoinen, O. 1992. Economic evaluation of biodiversity: Values of dipterocarp forests in the Philippines. The 2nd meeting of the International Society of Ecological Economics (ISEE), Investing in natural capital - a prerequisite for sustainability, August 3-6, 1992. Stockholm University, Stockholm, Sweden.

San Juan, R.P. 1999. Strong ties, more challenges surface during Malindang groundbreaking. Suhay (NIPAP). October-December. pp. 12-13.

Steinmetz, R. 2003. Methods for participatory biodiversity assessment and monitoring in Lao PDR a starting point for collaborative management of protected areas. http://www.mekonginfo.org/mrc_en/meko-3yjcyp.nsf.

Suminguit, V.J. 1989. The Subanen culture in Mt. Malindang: An ethnography. Thesis, M.S. Anthropology. University of the Philippines. Diliman, Quezon City, Philippines.

Suminguit, V.J. 1997. Indigenous knowledge systems of agroforestry and the restoration of a despoiled environment: A case study in northwestern Mindanao, Philippines. PhD Dissertation. University of Kentucky, Kentucky, USA.

Talling, J.F. 1986. The seasonability of phytoplankton in African lakes. Hydrobiologia 138: 139-160.

Ticsay-Ruscoe, M. 1995. Biodiversity and sustainability: A case study of the traditional swidden-based production system of the Ayangan of Haliap-Panubtuban, Asipolo, Ifugao Province. Dissertation, PhD Forestry. University of the Philippines Los Baños, Laguna, Philippines. 332 pp.

Umaly, R.C. and M.L.A. Cuvin. 1988. Limnology: Laboratory and field guide, physico-chemical factors, biological factors. National Book Store, Manila, Philippines.

Watson, R.T., H.T. Heywood, I. Baste, B. Dias, R. Gamez & W. Reid. 1995. Global biodiversity assessment: Summary for policy-makers. United Nations Environment Programme, Cambridge University Press, New York, NY, USA.

Wetzel, R.G. 1983. Limnology. 2nd ed. Saunders College Publishing, Philadelphia.

Wetzel, R.G. & Likens, G.E. 1978. Limnological analyses. Saunders College Publishing, Philadelphia, USA.

Widmer, C.T., Kittel & P. Richerson. 1975. A survey of the biological limnology of Lake Titicaca. Verh. Internat. Verein. Limnol. 19: 1504-1510.

Wilson, E.O. ed. 1988. Biodiversity. National Academy Press, Washington, D.C., USA.

Woltereck, W. 1941. Die seen und inseln der "Wallacea" zwischenregion und ihre endemische Tierwelt. Zweiter Teil: Inseln und seen der Philippinen. Int. Rev. Gesamten Hydrobiol. 41: 37-176.

World Bank. 1996. The World Bank participation sourcebook. Environmental Management Series. Washington, DC: World Bank. http://www.worldbank.org/html/edi/sourcebook/sbhome.html

Appendix Tables

Appendix Table 1. List of birds reported to be found in Lake Duminagat and vicinity (April, May, October 2002)

Local/Common Name	Scientific Name	Ecological status	Conservation Status	Economic Importance	Description Given
1. Siyaw = sayao	4 sp. w/ same local name: *Collocalia troglodytes, Collocalia esculenta marginata, Hemiprocne comata major, Hirundo tahitica abbotti*				small, yellow green, in flock
2. Tamsi	*Nectarinia jugularis jugularis*				
3. Mangotot					
4. Alimukon	*Phapitreron leucotis nigrorum*				
5. Magwa					
6. Takwaw = tukwao	*Macropygia phasianella tenuirostris*				
7. Bagwa = bakwa	*Pitta sordida sordida*				long beak
8. Duyan					big, chicken-like, green wings
9. Tibalas	*Lanius cristatus lucionensis*				with dirty white breast
10. Lokilok					yellow posterior end
11. Manok-ihalas	*Gallus gallus gallus*				
12. Kulasisi/kalusisi, Phil. hanging parakeet	*Loriculus philippensis apicalis*		Near-threatened	Commercial	bigger white color
13. Pungak					
14. Bulanting					cannot fly, in cogon grasses
15. Kusi					
16. Trek					black yellow beak, also observed
17. Agila, Eagle	*Haliaeetus leucogaster*				visit lake during dry spell from Sibukal
18. Pestra					
19. Banok = banog	*Haliastus indus intermedius*				
20. Sayaw-sayaw, laksayaw					
21. Bungabok, blue chest					blue chest
22. Lapay	*Nycticorax caledonicus manilensis*				
23. Balod	*Ducula poliocephala poliocephala*				like chicken
24. Kotok					brown neck, flock
25. Sal-ing	*Sarcops calvus melanonotus*				bald, black
26. Uwak	*Corvus macrorhynchos philippinus*				black
27. Bankigot					
28. Ananakyod	*Motacilla cinerea robusta*				
29. Pisoton					orange beak, brown body
30. Kulansyang = galanciang	*Aplonis panayensis panayensis*				
31. Gitgit	*Artamus leucorhynchus leucorhynchus*				white-bellied or breasted

Appendix Table 2. List of mammals reported to be found in Lake Duminagat and vicinity (April, May, October 2002)

Local/Common Name	Scientific Name	Ecological Status	Conservation Status	Economic importance	Description
1. Unggoy, black tail monkey	*Macaca philippinensis mindanensis*	Rare	Vulnerable	Meat	Band of ~20 visit lake to drink; eat chayote
2. Unggoy, white tail monkey	*Macaca philippinensis mindanensis*	Rare	Vulnerable	Meat	-do-
3. Kagwang, balaw, flying lemur	*Cynocephalus volans*	Rare	Vulnerable	insect eater	black
4. Kagwang, bulanting, flying lemur	*Cynocephalus volans*	Rare	Vulnerable	insect eater	red/orange
5. Kagwang, bakiki, flying lemur	*Cynocephalus volans*	Rare	Vulnerable	insect eater	varied colors; light brown
6. Kagwang, flying lemur	*Cynocephalus volans*	Rare	Vulnerable	insect eater	7 colors; white spotted to colorless
7. Kawag, flying squirrel	*Hylopetes mindanensis*			delicious meat	
8. Kulabyaw, bat	5 sp. w/ same local name: *Emballonura alecto alecto, Pipistrellus imbricatus,* etc.				big, hang on trees
9. Kuwaknit = kulaknit, bat	*Macroglossus lagochilus lagochilus; Eonycteris spelaea glandifera*				small, hang on banana leaves
10. Kabog, bat	*Pteropus vampyrus lanensis; Acerodon jubatus mindanensis*				biggest and fruit eating
11. Baboy-ihalas, small wild pig	*Sus celebensis negrinus*	Rare	Vulnerable	meat	make hole in trees
12. Baboy-ihalas, big wild pig	*Sus celebensis negrinus*	Rare	Vulnerable	Meat	-do-
13. Salarong/lagsaw, deer	*Cervus* sp.				small, brown reddish
14. Binaw, deer	*Cervus* sp.				big, black
15. Milo (tinggalong), wild cat	*Viverra tangalunga*	Uncommon	Vulnerable	Meat	visit lake to drink
16. Milo (sapobanlas), wild cat					with foul odor
17. Milo (bahog-sikwa), wild cat					visit lake to drink
18. Milo (lubing or lubyang), wild cat	*Paradoxurus philippinensis*	Rare	Vulnerable	Commercial	smallest, visit lake to drink
19. Ilaga, wild rat	*Rattus mindanensis mindanensis*				white; biggest rat (about 10 kg)
20. Ilaga, wild rat					black; smallest like thumb
21. Ilaga, wild rat					brown
22. Mugsaw, Mindanao tree shrew	*Urogale everetti*				trapped
23. Basing, wild rat					white, quick to disappear like lightning, smallest mugsaw
24. Laksoy, Philippine tree squirrel	*Callosciurus philippinensis*				makes sound like chicks; as big as one's arms
25. Talaksing					like laksoy but smaller

Appendix Table 3. List of reptiles and amphibians reported to be found in Lake Duminagat and vicinity (April, May, October 2002)

Local/Common Name	Scientific Name	Ecological Status	Conservation Status	Economic Importance	Description Given
1. Sawa	*Python reticularis*	Common	Near-threatened	Commercial	
2. Baksan	*Python reticularis*	Common	Near-threatened	Commercial	
3. Mamuan					
4. Udto-udto, Green snake					
5. Handolukay					
6. Dupong					spotted yellow
7. Kobra					
8. Ulopong					
9. Hanlulupong					green on tree
FROGS:					
1. Bakbak	*Rana* sp.	Fairly common	Near-threatened	Mosquito eater	big, edible
2. Tikatik	*Rana* sp.	Fairly common	Near-threatened	Mosquito eater	small
3. Luwat-luwat, tree frog					brown color

Appendix Table 4. Abundance of shoreline flora and computation for Shannon index

TREES	Sta1	Sta2	Sta3	Sta4	Sta5	STa6	Sta7	Sta8	Sta9	Sta10	Total	ni/N	ni/N log ni/N
Babasa					2	15					17	0.043	0.0588
Bakhaw-bakhaw					1		21	1	1		24	0.06	0.0733
Balangog								1			1	0.00251	0.00653
Balite						4		1			5	0.013	0.0245
Banisil						1	1		1		3	0.00754	0.0160
Bentanggol			5		3	2					10	0.025	0.0400
Bentuko	2										2	0.005025	0.0116
Gibuyon			2	2	4	4				3	15	0.038	0.0540
Gulayan							16				16	0.04	0.0559
Gulayan pula					1			2			3	0.00754	0.0160
Gulayan puti					1			1	1		3	0.00754	0.0160
Kalingag								2			2	0.005025	0.0116
Kape-kape	2				2	4		2	1	4	15	0.038	0.0540
Karupay						1		1			2	0.005025	0.0116
Karupay pula							10				10	0.025	0.0400
Lagotulang	1						2				3	0.00754	0.0160
Lagundi				1							1	0.00251	0.00653
Ligad							11				11	0.028	0.0435
Lingatong			6	2		1					9	0.023	0.0377
Lumbilan										4	4	0.01	0.0200
Malabago						4					4	0.01	0.0200
Malakube						1					1	0.00251	0.00653
Marang-marang	1					2					3	0.00754	0.016
Megasile							1				1	0.00251	0.00653
Niyop			2		1	1				1	5	0.013	0.0245
Pandan	70	18	6	6							100	0.25	0.1505
Pine tree					1						1	0.00251	0.00653
Pulayo									1		1	0.00251	0.00653
Pulayo pula						1	1				2	0.005025	0.0116
Pulayo puti						2					2	0.005025	0.0116
Sabon-sabon	30				1	12					43	0.011	0.0215
Sakam					2		12	2	2	5	23	0.058	0.0717
Salumay					1	2	13	3	3		22	0.055	0.0693
Subing diwata						1					1	0.00251	0.00653
Tabantes							2				2	0.005025	0.0116
Tagbak								3	10		13	0.033	0.0489
Tambis-tambis		1									1	0.00251	0.00653
Tulang-tulang							1				1	0.00251	0.00653
Tulanmanok			3			5					8	0.02	0.0340
Ulingon								2			2	0.005025	0.0116
Uling-Uling								4	2		6	0.015	0.0274
										Total	398	0.903465	1.18947

Appendix Table 4. Abundance of shoreline flora and computation for Shannon index *(continuation)*

SHRUBS	Sta1	Sta2	Sta3	Sta4	Sta5	Sta6	Sta7	Sta8	Sta9	Sta10	Total	ni/N	ni/N log ni/N
Babakag			74								74	0.32	0.1584
Baknit						1					1	0.00438	0.0103
Korerol										5	5	0.022	0.0365
Lagnob	1		2	2		21				2	28	0.12	0.1105
Magalablab			26			15				3	44	0.19	0.137
Magatalo									2		2	0.00877	0.018
Medinilla					1		2		1		4	0.0175	0.0307
Sabinit			2								2	0.00877	0.018
Tagima	2		37		2	1		6	1		49	0.21	0.1423
Tatanak								2		1	3	0.013	0.0245
Tulanmanok									1		1	0.00438	0.0103
Tulog-tulog							2				2	0.00877	0.018
Tutungaw	6							2		5	13	0.057	0.0709
										Total	228	0.98457	0.7854
HERBS													
Adlay-adlay	6						3				9	0.00527	0.012
Balile	150	24								110	284	0.166	0.1295
Banag								1			1	0.000586	0.00189
Bila-bila	10										10	0.00586	0.0131
Blasnotong								4			4	0.00234	0.00616
Bokinggan ihalas					40	1		2			43	0.025	0.04
Busyong				1	2			1		2	6	0.00352	0.00864
Bugang										6	6	0.00352	0.00864
Buksakan wasay										5	5	0.00293	0.00742
Dapaw-dapaw										4	4	0.00234	0.00616
Dila kanding										1	1	0.000586	0.00189
Gabi	175										175	0.1	0.1014
Gamong		2	24	1	3	1		1			32	0.019	0.0327
Gamong puti							2				2	0.00117	0.00343
Gusahis	150	20									170	0.0996	0.0998
Halibhon ihalas			2					1	2		5	0.00293	0.00742
Handalamay							20				20	0.012	0.0230
Kabilaw	80										80	0.047	0.0624
Kogon									3	70	73	0.043	0.0588
Limbas-limbas					2			4	1	2	9	0.00528	0.0120
Mamampang				2							2	0.00117	0.00343
Pisik-pisik	150										150	0.088	0.0929
Silangka		11								5	16	0.00938	0.019
Surop-surop			150								150	0.088	0.0929
Talaid	220	50	4				10	3		5	292	0.17	0.1308
Talong-talong						2					2	0.00117	0.00343
Tambok-tambok			40	20		50	5				115	0.067	0.0787
Telapya	30										30	0.018	0.0314
Tulay-tulay										10	10	0.00586	0.0131
										Total	1706	0.996512	1.10201

Appendix Table 5a. Identification of tree species in Lake Duminagat, Mt. Malindang Natural Park

Local Name	Scientific Name	Family Name	Remarks
Akube			
Almaciga	*Agathis philippinensis*	ARAUCARIACEAE	Gymnosperm
Bakhaw-bakhaw			
Balangog	*Saurauia* sp. 1	ACTINIDIACEAE	
Balangog puti	*Saurauia arellana*	ACTINIDIACEAE	
Balete	*Ficus* sp.	MORACEAE	
Bintoko	*Euodia confusa/Leea guineensis*	RUTACEAE/LEEACEAE	
Bita-og	*Calophyllum inophyllum*	GUTTIFERAE	
Busyong	*Ficus odorata*	MORACEAE	
Gamong=magamatong			
Gulayan	*Lithocarpus apoensis*	FAGACEAE	
Gulayan puti	*Lithocarpus* sp.	FAGACEAE	
Kalingag	*Cinnamomum mercadoi*	LAURACEAE	
Kalingag puti	*Cinnamomum* sp.	LAURACEAE	
Kalobay nga kahoy			
Kendagaw	*Podocarpus pelgeri*	PODOCARPACEAE	Gymnosperm
Labalod	*Ludeka bernadoi*	RUBIACEAE	
Labanog	*Ficus* sp.	MORACEAE	
Lagnob	*Ficus septica*	MORACEAE	
Lago tulang		SAPINDACEAE	
Legad	*Rhodomyrtus* sp.	MYRTACEAE	Red fruit
Magabiyalong	*Dysoxylon decandrum/ Dracontomelon edule*	MELIACEAE/ANACARDIACEAE	
Magamatong	*Eusideroxylon zwageri*	LAURACEAE	
Maganangka			
Magasile	*Radermachera whitfordi*	BIGNONIACEAE	
Magopong	*Neolitsea* sp.	LAURACEAE	
Malabago	*Pometia pinnata*	SAPINDACEAE	
Malakubi	*Flacourtia rukam*	FLACOURTIACEAE	
Niyop	*Callicarpa erioclona*	VERBENACEAE	
Pulayo	*Syzygium* sp.	MYRTACEAE	
Quintas-quintas	*Alixia* sp.	APOCYNACEAE	
Sakam	*Clethra lancifolia*	CLETHRACEAE	
Salumay	*Ficus variegata/Macaranga dipterocarpifolia*	MORACEAE/ EUPHORBIACEAE	
Suha-suha	*Aralia bipinnata*	ARALIACEAE	
Tagima	*Scefflera odorata*	ARALIACEAE	
Tambis-tambis	*Drypetes karapinensis*	EUPHORBIACEAE	
Tulog-tulog	*Glochidion canescens*	EUPHORBIACEAE	
Tungog/Magaringan	*Phyllocladus hypophyllus*	PODOCARPACEAE	Gymnosperm

Appendix Table 5b. Identification of shrub species in Lake Duminagat, Mt. Malindang Natural Park

Local Name	Scientific Name	Family Name	Remarks
Banesil			
Beti-beti/Puso-puso	*Neolitsea vidalii*	LAURACEAE	
Biyante	*Macaranga bicolor*	EUPHORBIACEAE	
Buksakan nuasay	*Perrottetia alpestris*	CELASTRACEAE	Red petiole & red fruit
Gibuyon = Duyan-duyan	*Hydrangea chinensis*	HYDRANGEACEAE	
Gibuyon puti	*Mussaenda* sp.	RUBIACEAE	
Hantatongaw	*Melastoma* sp. 1	MELASTOMATACEAE	
Kalonawan			
Kape-kape	*Tarenna* sp.	RUBIACEAE	
Katambaw sa bukid			
Katipo	*Medinilla cumingii*	MELASTOMATACEAE	
Lagundi	*Elmerillia platyphylla*	MAGNOLIACEAE	
Libangna	*Glochidion album*	EUPHORBIACEAE	
Lima-lima	*Schefflera* sp.	ARALIACEAE	
Lumbilan	*Leucosyke capitellata*	URTICACEAE	Whitish leaf underneath
Oling-oling	*Decaspermum fruticosum*	MYRTACEAE	
Sabon-sabon	*Ternstroemia urdanatensis*	THEACEAE	
Subing diwata	*Podocarpus neriifolius*	PODOCARPACEAE	
Tatibag	*Ficus* sp.	MORACEAE	
Tulan manok			
Tutongaw	*Melastoma malabathricum*	MELASTOMATACEAE	Violet flower

Appendix Table 5c. Identification of herb species in Lake Duminagat, Mt. Malindang Natural Park

Local Name	Scientific Name	Family Name	Remarks
	Zingiber sp.	ZINGIBERACEAE	
	Rubus sp.	ROSACEAE	
Baknit	*Rubus fraxinifolius*	ROSACEAE	
Balakag itom	*Sarcandra glabra*	CHLORANTHACEAE	Red fruit when ripe
Bubukog or Serok-serok	*Drymaria cordata*	CARYOPHYLLACEAE	
Bukinggan ihalas			
Bulase	*Pilea melastomoides*	URTICACEAE	
Dapaw-dapaw			Hairy leaves
Dela-dela sa kanding	*Elephantopus* sp.	ASTERACEAE	
Elepante	*Stachytarpheta jamaicensis*	VERBENACEAE	Introduced weed
Gabi	*Colocasia esculentum*	ARACEAE	Common edible root crop
Gutay-gutay	*Scindapsus* sp.	ARACEAE	
Halang-halang	*Spilanthes acmella*	ASTERACEAE	Yellow flower, medicinal
Halib-on ihalas	*Blumea bicolor*	ASTERACEAE	
Handalusa	*Justicia* sp.	ACANTHACEAE	
Kurerol	*Rubus* sp.	ROSACEAE	Stem with many spines
Lusay		ALISMACEAE	Aquatic weeds, violet leaves
Luy-a luy-a	*Zingiber* sp.	ZINGIBERACEAE	
Mamangpang	*Begonia* sp. 1	BEGONIACEAE	
Mamangpang	*Begonia* sp. 2	BEGONIACEAE	
Mayana pula	*Coleus* sp.	LABIATAE	
Salapid			
Selangka	*Impatiens montalbanica*	BALSAMINACEAE	
Tagbak	*Alpinia zerumbet*	ZINGIBERACEAE	
Tilapiya			
Veno-veno		LABIATAE	

Appendix Table 5d. Identification of vine and liana species in Lake Duminagat, Mt. Malindang Natural Park

Local Name	Scientific Name	Family Name	Remarks
Balagon	*Hoya* sp.	ASCLEPIADACEAE	
Balagon magulimon			
Balagong plastek			
Banag ihalas			
Banag-banag	*Smilax pygmaea*	SMILACACEAE	Stems with very sharp spines
Gutay saging	*Raphidophora lobbata*	ARACEAE	Creeping vine, red fruit
Kuyanap	*Psychotria diffusa*	RUBIACEAE	
Pandan-pandan	*Freycinetia* sp.	FREYCINETIACEAE	Climbing pandan-like

Appendix Table 5e. Identification of palm species in Lake Duminagat, Mt. Malindang Natural Park

Local Name	Scientific Name	Family Name	Remarks
Karopay	*Pinanga* sp.	PALMAE	Commonly known as black palm
Uway	*Calamus merrillii*	PALMAE	Climbing lianas when mature with many spines

Appendix Table 5f. Identification of grass and sedge species in Lake Duminagat, Mt. Malindang Natural Park

Local Name	Scientific Name	Family Name	Remarks
	Cyperus sp. 2	CYPERACEAE	
Adlay-adlay	*Sorghum* sp.	GRAMINAE	
Balili	*Paspalum conjugatum*	GRAMINEAE	
Blasnotong	*Cyperus* sp. 1	CYPERACEAE	
Bugang	*Panicum* sp. 1	GRAMINEAE	
Dagom sa tubig	*Eleocharis* sp.	CYPERACEAE	Aquatic macrophyte
Gisais	*Setaria palmifolia*	GRAMINEAE	
Humay-humay	*Echinochloa* sp.	GRAMINEAE	
Kogon	*Imperata cylindrica*	GRAMINEAE or POACEAE	
Limbas-amol	*Cyperus* sp. 3	CYPERACEAE	
Limbas-limbas	*Cyperus* sp. 4	CYPERACEAE	
Talaid	*Gahnia* sp.	CYPERACEAE	
Tambo			
Tambo-tambo	*Paspalum* sp.	GRAMINEAE	

Appendix Table 5g. Identification of Pteridophyte species in Lake Duminagat, Mt. Malindang Natural Park

Local Name	Scientific Name	Family Name	Remarks
	Arachnioides sparsa	DRYOPTERIDACEAE	Terrestrial
	Arachnioides dentata	DRYOPTERIDACEAE	Terrestrial
	Histiopteris incisa	DENNSTAEDTIACEAE	Terrestrial
	Davallia denticulata	DAVALLIACEAE	Epiphyte
Balogbog	*Belvisia* sp.	POLYPODIACEAE	Epiphyte
Buki nga pula	*Sphenomeris chinensis* var. *rubens*	LINDSAEACEAE	Terrestrial
Butetay	*Nephrolepis cordifolia*	OLEANDRACEAE	Terrestrial, Medicinal
Butetay	*Asplenium excisum*	ASPLENIACEAE	Terrestrial
Gaksam sa bukid	*Sticherus loheri*	GLEICHENIACEAE	Terrestrial
Gantaw	*Cyathea contaminans*	CYATHEACEAE	Terrestrial, Edible
Gantaw	*Cyathea elmeri*	CYATHEACEAE	Terrestrial
Kahogpong balagon	*Oleandra colubrina*	OLEANDRACEAE	Epiphyte
Kapay-kapay dako	*Goniophlebium percussum*	POLYPODIACEAE	Epiphyte
Kapay-kapay mubo	*Cheiropleura bicuspis*	CHEIROPLEURACEAE	Terrestrial
Kulangkag	*Lycopodium cernuum*	LYCOPODIACEAE	Terrestrial, Ornamental
Lukdo-lukdo	*Pteridium aquilinum*	DENNSTAEDTIACEAE	Terrestrial, Medicinal
Magolaglab	*Marattia sylvatica*	MARATTIACEAE	Terrestrial
Pagaypay balagon	*Thayeria cornucopia*	POLYPODIACEAE	Terrestrial
Pako	*Diplazium esculentum*	ATHYRIACEAE	Terrestrial
Pako-pako	*Diplazium* sp.	ATHYRIACEAE	Terrestrial
Pako-pakong pula	*Blechnum orientale*	BLECHNACEAE	Terrestrial
Palang-palang	*Gleichenia truncata*	GLEICHENIACEAE	Terrestrial
Palang-palang	*Dicranopteris linearis*	GLEICHENIACEAE	
Palang-palang	*Gleichenia dicarpa/ Gleichenia truncata*	GLEICHENIACEAE	
Pay-pay	*Microsorium palmatum*	POLYPODIACEAE	Terrestrial, Ornamental
Paypay latay	*Crypsinus trilobus*	POLYPODIACEAE	Terrestrial
Plastek	*Asplenium decorum*	ASPLENIACEAE	Epiphyte

Appendix Table 5h. Identification of orchid species in Lake Duminagat, Mt. Malindang Natural Park

Local Name	Scientific Name	Family Name	Remarks
	Bulbophyllum sp. 1	ORCHIDACEAE	Epiphyte, red flowers
	Bulbophyllum sp. 2	ORCHIDACEAE	Epiphyte
	Cymbidium sp. 2	ORCHIDACEAE	Epiphyte
Ahos-ahos	*Dendrochilum cobbianum*	ORCHIDACEAE	Epiphyte
Ahos-ahos dako	*Dendrochilum sp.*	ORCHIDACEAE	Terrestrial
Bari-bari	*Cymbidium* sp. 1	ORCHIDACEAE	Epiphyte
Betay-betay	*Ceratostylis wenzelii*	ORCHIDACEAE	Epiphyte
Bulak nga balagon	*Bulbophyllum* sp. 3	ORCHIDACEAE	Epiphyte
Ekog-ekog	Unidentified sp. 1	ORCHIDACEAE	Epiphyte
Kamang-kamang	*Dendrobium* sp.	ORCHIDACEAE	Terrestrial
Waling-waling violet	Unidentified sp. 2	ORCHIDACEAE	Terrestrial

Appendix Table 6. Local uses of plants as given by the settlers of Lake Duminagat, Mt. Malindang Natural Park (April, May 2002)

LOCAL NAME	HABIT	USES
1. Bentangol	tree	firewood and construction material; mortar making
2. Mamangpang	herb	leaves are used for souring fish “paksiw” (seviche)
3. Toyabang	herb	fruit edible
4. Bulongisi	herb	sap is used to relieve toothache
5. Lagundi	tree	flooring
6. Pulayo pula	tree	construction material, lumber
7. Katipo	shrub	relieves “talimughat”, a form of fatigue experienced by some women after childbirth
8. Sakam	tree	firewood; construction material
9. Salumay	tree	firewood
10. Gibuyon puti	tree	ornamental; bark scraping used as “hampol hawak” or poultice for body pain
11. Tutungaw violet	shrub	fruit edible; sap from shoot is drank to cure “ugam/ulas” or canker sore in mouth cavity and to remove a child’s fever
12. Neskape	shrub	leaves are dried and grounded as coffee
13. Halang	tree	leaves or stems are chewed to relieve stomachache, and treat fish poisoning
14. Hinagdong	tree	bark decoction is used to cure diarrhea
15. Lumbilan		root decoction is used to cure diarrhea; and sap from bark scrapings is used as a rub for epilepsy
16. Kalingag	tree	treats all forms of poisoning; bark decoction used to cure stomachache and headache
17. Gilon	tree	decoction of bark scraping is used to cure stomachache and diarrhea; and its fruit juice to treat wounds
18. Tambok-tambok	vine	treats wounds; fruit can be eaten to relieve panting
19. Uway tonokon	climber	bird nesting
20. Karupay puti	fern	used as spiritual offering
21. Talayd	herb	relieves “talimughat”
22. Pandan	palm	material used for mat making
23. Balili	grass	leaf extract treats bee bites

Appendix Table 6. Local uses of plants as given by the settlers of Lake Duminagat, Mt. Malindang Natural Park *(continuation)*

LOCAL NAME	HABIT	USES
24. Gamong	tree	housing material
25. Beti-beti	tree	firewood
26. Balogbog	epiphytic fern	ornamental, big earthworms' habitat
27. Niyop	tree	bark decoction for cough, relieves "talimughat"
28. Sabinet	vine	root decoction cures hard cough
29. Gutay saging	vine	leaves given to monkeys as food
30. Bino-bino	herb	relieves fatigue
31. Plastek	fern	ornamental
32. Hugalpo		treats wounds from dog bite
33. Babakag	tree	firewood
34. Tulan manok	tree	firewood
35. Bosyong	tree	firewood
36. Tagema	shrub	fruits as bird food
37. Marang-marang	tree	construction material
38. Bakhaw-bakhaw	tree	housing material
39. Pako-pako	fern	shoot used as vegetable, root is used to cure "talimughat"
40. Kabilaw	herb	vegetable as likway; "ihampol sa piang"
41. Salaped	herb	ornamental
42. Molakobe	tree	material for house construction
43. Lagnob	shrub	leaves are used to treat itchy skin, sap removes warts
44. Dapaw-dapaw	herb	scrapings used to treat wounds
45. Dalandan		bark and leaves cure diarrhea
46. Balagon	vine	treats boils
47. Magataynok		root concoction cures "talimughat"
48. Lalambo		eaten as vegetable

Project Leader: **Carmelita G. Hansel**
Study Leaders: **Teresita O. Poblete and Victoria T. Quimpang**
Research Assistant: **Rhea Amor C. Lumactud**
Subanon Researchers: **Diosdado Ganob, Emelyn Lumimas, Margilyn Lumimas, Luzminda Pacut, Roseller Panchito**

Editing/Layout: **Claudia Svetlana Z. Cabrera**
Production Assistant: **Carina S. Fule**

Biodiversity Research Programme (BRP)
for Development in Mindanao:
Focus on Mt. Malindang and Environs

National Support Secretariat (NSS)
SEAMEO SEARCA, College, Laguna
4031 Philippines

Site Coordinating Office (SCO)
Don Anselmo Bernad Avenue
cor. Jose Abad Santos St.
Ozamiz City
7200 Philippines

ISBN 971-560-113-8