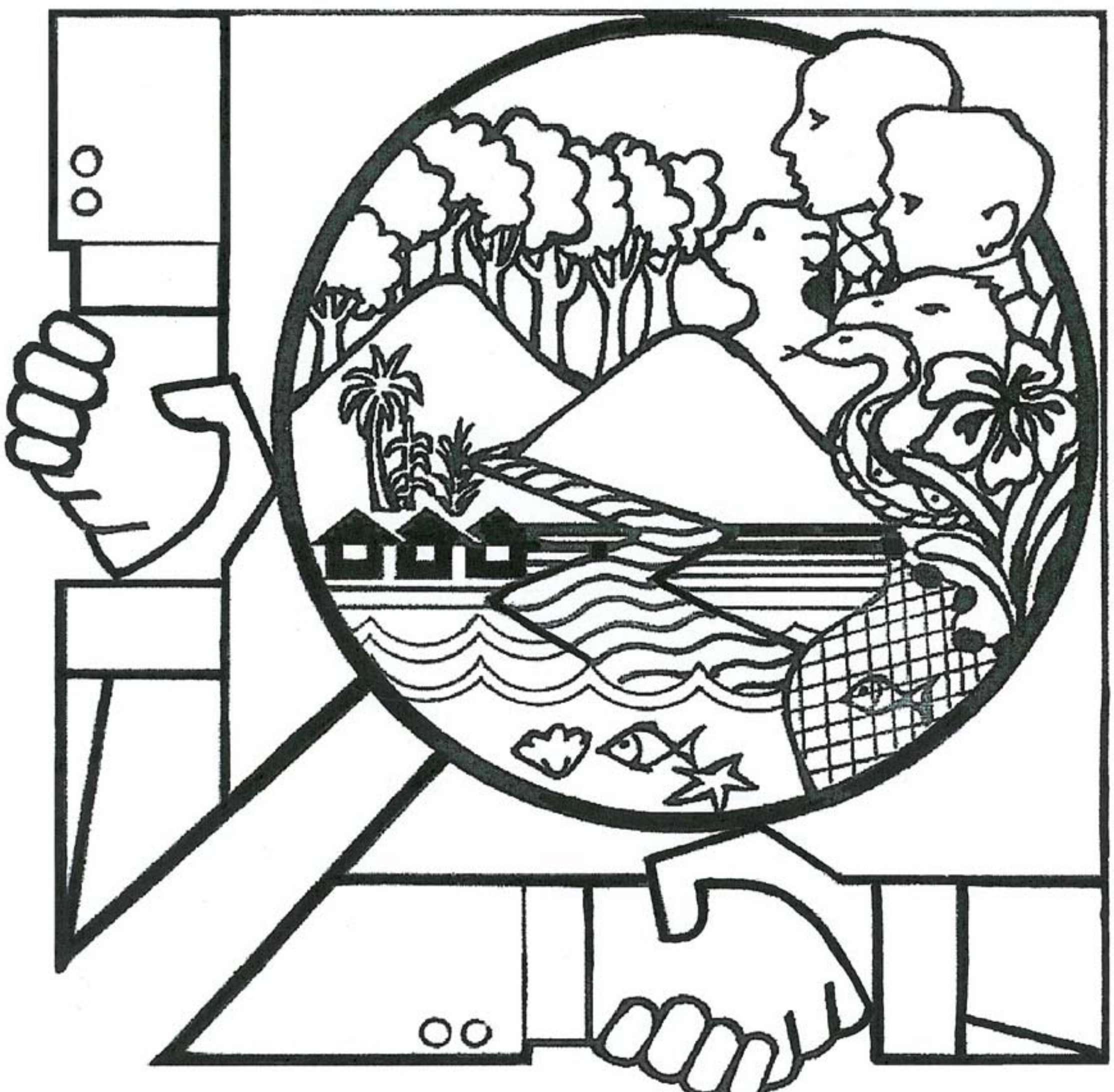
Community-Based Inventory and Assessment of Riverine and Riparian Ecosystems in the Northeastern Part of Mt. Malindang, Misamis Occidental



Proserpina Gomez-Roxas   Renato D. Boniao   Erlinda M. Burton
Annabella Gorospe-Villarino   Sherwin S. Nacua

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

Proserpina Gomez-Roxas, Renato D. Boniao, Erlinda M. Burton,
Annabella Gorospe-Villarino, Sherwin S. Nacua

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 971-560-116-2

Wildlife Gratuitous Permit No. 105 for the collection of wild floral and faunal specimens including planktons and benthos for taxonomic purposes, issued by DENR-PAWB, Diliman, Quezon City on 22 April 2002.

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).

Table of Contents

Tables

Figures

Appendices

Appendix Tables

Acknowledgments

This research project is part of the Biodiversity Research Programme (BRP) for Development in Mindanao: Focus on Mt. Malindang and Its Environs. The Netherlands Ministry for Development Cooperation (DGIS) through SEAMEO SEARCA provided the funding.

The authors are grateful to the Mindanao State University at Naawan, the Mindanao State University at Marawi, and the Research Institute for Mindanao Culture (RIMCU) at Xavier University for the support given.

The authors also appreciate the help provided by the following individuals, agencies, and organizations who were involved in the project:

Mayors Edilma Bulawin and Inocencio Pagalaran, Jr. for facilitating entry to the study areas and for other support extended, especially with regard to the use of the Farmers' Training Center in Panalsalan, Plaridel;

the residents of barangays Singalat, Mamalad, Bonifacio, Tipolo, and Catarman for their enthusiastic participation during the conduct of the project;

NCIP Provincial Coordinator Datu Felipe Ending and the Banwak Subanon for the permission to implement the project and for encouraging the participation of Subanons;

Leonard Co of the UP Diliman Herbarium and Conservation International for the assistance in identifying plant samples;

Elizabeth Talam, the Municipal Agricultural Officer of Plaridel, and her technicians for the unwavering assistance;

and others whose help made the project a success.

Executive Summary

Mt. Malindang is a mountain range that became a National Park in 1971 by virtue of Republic Act No. 6266. It is an important biodiversity refuge with still many unknown faunal and floral species. CARE (Philippines) and the Department of Environment and Natural Resources (DENR) made several inventories of Mt. Malindang's rich flora and fauna focused mainly on its remaining forests. These surveys, however, did not include the survey of plants and animals inhabiting the river and riparian habitats of the buffer zone, outside the core protected forest zone of Mt. Malindang National Park. The importance of these riparian habitats needs to be emphasized, considering its value in maintaining linkages between forest and coastal ecosystems.

The Biodiversity Research Programme (BRP) in Mindanao: Focus on Mt. Malindang

The BRP believes that biodiversity research should be harnessed for development of the local populace. The program is committed to undertake and promote collaborative and interdisciplinary research that will enable the communities to sustain use of biological resources and make effective decisions concerning biodiversity conservation in order to improve their livelihood and cultural opportunities. As an initial step in accomplishing this goal, it is imperative that biodiversity inventories of the diverse ecosystems be conducted, their current state assessed and interaction of elements and the flows of materials, energy, and people be thoroughly studied.

After a participatory rapid appraisal (PRA) of coastal, lowland and upland ecosystems in Mount Malindang was conducted by multidisciplinary teams composed of BRP representatives and members of the Mindanao research community, riverine ecosystems was identified as one of the areas that needed urgent attention.

The project was carried out to assess the aquatic and riparian communities in the Langaran River located in the northeastern part of Mt. Malindang and to study the status of the habitat in terms of biophysical parameters in order to have enough basis for policy setting and recommendations for management as well as to bring about environmental awareness among the community.

Langaran River was chosen as the place of study because of its unique combination of political, cultural, economic, and biological environment. The stretch of the river is under the jurisdiction of four political entities or municipalities, namely; Concepcion, Calamba, Lopez Jaena, and Plaridel. The barangays upstream (Singalat, Mamalad, and Bonifacio), were inhabited predominantly by indigenous people called the Subanons while those in the downstream (Catarman and Tipolo) were inhabited by a mix of migrants from all over the Philippines and nonmigrants.

The river plays a vital role in the economy of the surrounding municipalities. Aside from being the domestic abode of many communities, vast farmers are dependent on the irrigation waters from the three dams built along it.

Biodiversity

The inventory and assessment of the biological communities revealed that the upstream barangays were still relatively rich in biodiversity compared with the downstream barangays. For the floral component, the riparians in the upstream barangay of Singalat harbored a total of 125 plant species, 12 of which were endemic to the Philippines and many unique to this part of the river. The upstream species were trees and tree-like while those in the downstream part were short-growing and mostly exotic.

The survey of animals also indicated a healthier river upstream than downstream. There were more endemic and resident bird species in the three upstream barangays. Some species were unique to a barangay. Overall, the bird diversity indices in the upper three barangays were higher than those in the downstream barangays.

Only few samples of amphibian and reptile species were collected. Six common species of frogs were recorded in the five barangays along the river. *Rana magna* is endemic and common and inhabits forest streams throughout the

Philippines. This species was not found in Catarman because the river water turns brackish during high tide. The rock frog *Staurois natator,* also reported to inhabit only clean and clear mountain streams at sea level up to elevations of 1,300 m, was recorded in the upper three barangays.

Only 11 reptilian species, most of which were common, were recorded in the five barangays along the river. Seven of these were lizards and three were snakes. Only one turtle species was found in two of the five barangays. The *Hydrosaurus pustulatus,* commonly called ibid in many parts of the Philippines, categorized as vulnerable and reported to favor only unpolluted mountain streams including freshwater swamps, makes it a valuable indicator of the state of the environment. This species was found in the three upper barangays (Singalat, Mamalad and Bonifacio) suggesting that the riparian habitat in these parts of the river was still unpolluted. *Tropidophorus misaminus,* recorded as endemic and rare, was also found in the three upper barangays.

A total of 11 mammalian species were recorded; nine of which were endemic and common, except for one species from Singalat that is listed by Heaney, et al. (1998) as uncommon. All the 11 species were found in Singalat, while eight species were recorded in both Mamalad and Bonifacio. Only three were recorded in Tipolo and Catarman.

On the contrary, the survey of fish showed that Catarman had the highest number of species, 16; followed by Tipolo with 13 species. Upstream, where water was fresh, fewer species were collected. Bonifacio, Mamalad, and Singalat had seven, 11 and eight species of freshwater fish, respectively.

In all the five barangays, local researchers claimed that fish catch, compared to that of a few years ago, declined. There were two main factors which could have caused this: the presence of dams that impeded the migration of species and the occurrence of *lahar* flow in the 1990s. In Barangay Tipolo, local researchers believed that quarrying activities caused the decline in fish catch.

Abundance and diversity of macroinvertebrates varied from upstream to downstream. Macroinvertebrates that are good water quality indicators were found in Singalat, Mamalad and Bonifacio. Barangay Tipolo had very few macroinvertebrates and all were poor water quality indicators. The coliform load analysis also showed that water in Barangay Tipolo was heavily contaminated.

A total of 18 species of cryptozoans were collected in the five barangays along the river. Of these, only two species were common to the five barangays: one species of earthworm and red and black ants. Species composition varied from upstream to downstream but there was no trend in the number of species along the river landscape.

The soils in the riparian zones were moderately to very slightly acidic; but most plants grow best in soils that are slightly acidic. Organic matter of 11% was about the average content of all the soils. This did not differ significantly among the five barangays. Riparian soils are inherently heterogeneous in mineral or organic character by virtue of the influence of water or flooding in these zones. The bulk densities (BD) of the sample soils showed that Catarman soils had the highest BD values which is common for areas close to the coast. The soil upstream was more porous, a physical condition more desirable for plant growth and for other soil–thriving organisms.

The Communities Along Langaran River

The upstream communities were predominantly Subanons while downstream communities were a mixture of long-time residents and migrants from all over the country. Farming was the main occupation. The river was the center of the family's domestic activities. Fishing, using different methods, was a major activity from upstream to downstream but was not considered a source of income. Nevertheless, illegal fishing methods such as the "tubli" (*Derris* root extract), "kuryente" (mild current) and pesticides in the guise of tank and hand washing were rampant.

Environmental State of the Langaran River

According to residents of the communities, there was a time when the river was narrow and deep and fishery resources were very abundant; there were even claims of crocodile sightings from Catarman. At the time this study was conducted, the river was already shallow and wide, the water was turbid and the trees were very few. The riverbanks were also eroded and denuded of major vegetation. The kinds of fish and the number of fish individuals have also declined, hence the difficulty in catching fish. The participants mentioned a number of factors that affected the status of the river and its riparians. These were: (1) illegal fishing activities (e.g., tubli and use of the pesticide decis, "kuryete"), (2) absence of trees in the bank, (3) (illegal) logging activities in the uplands, (4) quarrying, (5) irrigation, (6) throwing of domestic and municipal wastes into the river, (7) extraction of water by the National Waterworks and Sewerage Authority (NAWASA), and (8) natural phenomena like landslides and floods. In general, the people were aware of the activities that are beneficial and destructive to the river and its riparian areas; but despite this knowledge, many still engaged in destructive and illegal activities.

The women in the five communities were primarily involved in the farming and fishing activities of their families. Among these were marketing of products and watching over the farm, protecting it against animal attacks (usually by monkeys). The communities believed that women can play a role in the preservation and conservation of the river and its riparian areas but need to attend seminars, trainings and the like to be equipped with appropriate knowledge and skills.

The riparian areas near the headwaters are still relatively rich in biodiversity and are a refuge for many endemic plant and animal species. The water is still clean as revealed by the survey of macroinvertebrates and the analysis of coliform load. However, the pressure on the river and its riparians is increasing. Cutting of trees continue and there is no visible effort to sustain the remaining biodiversity and to rehabilitate the degraded parts. In contrast, the riparians downstream are already degraded and the waters are already poor. The high pressure from agricultural activities continues to threaten the state of biodiversity and the environment. Government agencies and nongovernment organizations need to work together in organizing the communities along the river (i.e., Bantay Suba), in preserving the environment and conserving the natural resources that are still present as well as in restoring the degraded riparians downstream. Upstream, the upland farmers should be taught of a sustainable farming technology to parallel intense efforts of planting "bungahoy" (fruit trees) along the riparians. Downstream, anti-erosive infrastructure is necessary in areas where efforts to plant trees proved futile. All these activities should go hand in hand with economic livelihood programs that would reduce pressure on the river and its riparians.

Introduction

Background

The Philippines is a relatively small country, but is one of the few countries that are classified both as a "biodiversity hotspot" and "megadiversity" country (www.earthscape.org/r2/scb/scb14_5/scs01/scs01.html). Its vertebrate fauna includes a total of 572 species of birds (Kennedy, et al. 2000), 172 species of terrestrial mammals (Heaney, et al. 1998), 240 species of reptiles (IUCN 1996), and more than 80 species of amphibians (Alcala and Brown 1998). Some 13,500 plant species are found in the country, representing 5% of the world's flora. This account includes some 8,000-12,000 species of flowering plants in 200 families and 1,500 genera. The fern and fern allies are estimated to total to about 1,035 species (Zamora, et al. 1986) and 640 species of mosses (members.tripod.com/philmuseum/botany.htm). Forty percent of the flowering plants in the country are endemic (www.haribon.org.ph/saving_sites/default.asp. 20 Dec 2002).

Mt. Malindang is a mountain range that became a National Park on 19 June 1971 by virtue of Republic Act No. 6266. It is an important biodiversity refuge with still many unknown faunal and floral species. It has a total area of 53,262 hectares, and a forest area of about 24,500 hectares. About 80% of this forest is classified as lower and upper montane forest, while only about 2.5% is considered lowland forest. This forest provides habitat for the many vertebrates whose continued existence is dependent on these forests. CARE (Philippines) and the Department of Environment and Natural Resources (DENR) made several inventories of Mt. Malindang's rich flora and fauna focused mainly on its remaining forests. These surveys, however, did not include the survey of plants and animals inhabiting the river and riparian habitats of the buffer zone, outside the core protected forest zone of Mt. Malindang National Park. The importance of these riparian habitats needs to be emphasized, considering its value in maintaining linkages between forest and coastal ecosystems.

The Biodiversity Research Programme (BRP) in Mindanao: Focus on Mt. Malindang

The BRP believes that biodiversity research should be harnessed for development of the local populace. The programme is committed to undertake and promote collaborative and interdisciplinary research that will enable the communities to sustain use of biological resources and make effective decisions concerning biodiversity conservation in order to improve their livelihood and cultural opportunities. As an initial step in accomplishing this goal, it is imperative that biodiversity inventories of the diverse ecosystems be conducted, their current state assessed and interaction of elements and the flows of materials, energy, and people be thoroughly studied.

After a participatory rapid appraisal (PRA) of coastal, lowland and upland ecosystems in Mt. Malindang was conducted by multidisciplinary teams composed of BRP representatives and members of the Mindanao research community, riverine ecosystems was identified as one of the areas that needed urgent attention.

Riparian Ecosystems

Riparian areas play an important role in the landscape by providing plant and wildlife habitat, increasing landscape connectivity, and protecting water quality. The riparian vegetation influences river ecosystems by maintaining low water temperatures that allow many native plants and animals to survive. The shade decreases the amount of available light and so prevents excessive growth of nuisance plants or algae. It creates dim or patchy lighting that provides habitats for predators and prey.

However, by the nature of their constitution, riparian zones are inherently fragile ecosystems. Any activity adjacent to or intruding into the riparian area has the potential to negatively impact riparian elements, functions and values. Once natural riparian vegetation is cleared for agriculture or urban development, water temperature and light intensity increase. This greatly disturbs the natural ecosystem; and if combined with nutrient pollution from agriculture or urban run-off, can lead to excessive growth of algae or massive growth of water plants. Natural disturbances such as storms, floods, slope failures, and forest fires also have an overwhelming effect on the dynamics of the river ecosystem. Where such disturbances overwhelm the system, diversity is reduced and a host of other problems particularly related to water quality and habitat quality is inevitable.

An aerial view of the Mt. Malindang protected area shows an intricate network of rivers and tributaries that provides a unique but diverse habitat for both flora and fauna. There are some indications that most of the original endemic/ restricted range species may have already disappeared on Mt. Malindang, because the riparian habitats were already severely denuded and that most part of the river system have been destroyed by erosion. The varied interests of stakeholders (e.g., logging, tourism development, and farming) threaten the biodiversity of this park.

The Langaran River is one of the big rivers of the northeastern part of Mt. Malindang that drains the Mt. Ampiro and Mt. Balabag Range and empties itself into the coastal waters of Plaridel and Calamba in Misamis Occidental, which are dominated by sea grasses, seaweeds, corals and mangroves. There are several barangays along the river that are under the jurisdiction of the municipalities of Lopez Jaena, Calamba and Plaridel. The socioeconomic survey in these barangays showed that residents were heavily dependent on the river for their domestic and livelihood activities (e.g., quarrying). The river basin was used mainly for agricultural purposes. Three irrigation dams are built along the stretch of the river, supplying irrigation waters to some farms in the municipalities of Calamba and Lopez Jaena and all the ricefields in the municipality of Plaridel.

Rationale

Because of Langaran River's importance to the community and the connection it serves for the terrestrial and marine ecosystems, inventory of biodiversity and assessment of the river and its riparian areas were conducted. The baseline information obtained serves as basis for future studies that will lead us to understand the functional dynamics of river and riparian ecosystems. It will also serve as inputs in attempts to develop a management program for the Langaran River in particular, and riverine and riparian habitats, in general. Furthermore, to date, there is no comprehensive management plan for the river. It is therefore important to assess the status of this body of water because of the people who highly depend on it.

Objectives

The research project was undertaken to assess the aquatic and riparian communities in the Langaran River located in the northeastern part of Mt. Malindang, to evaluate the utilization of the resources present and to study the status of the habitat in terms of some biophysical parameters. The following specific objectives were set:

1. To assess the vegetation in the riparian zones of Langaran River.
2. To assess the bird communities in the riparian zones of Langaran River.
3. To assess some of the faunal communities in the river and riparian zones of Langaran River.
4. To assess the macroinvertebrates present in Langaran River.
5. To determine the coliform load of the water in the river and relate this to the ongoing activities in the area.
6. To characterize the riverine and the riparian systems in terms of some bio-physico-chemical parameters.
7. To determine the socioeconomic characteristics of the communities in five barangays along Langaran River.

8. To know the uses of riverine and riparian resources, determine land-use activities and human habitat alterations along the river system and riparian areas, including agricultural practices of the surrounding farmlands.
9. To gather primary and secondary data on the factors (present and historical) affecting the status and uses of the riverine and riparian resources.
10. To determine the programs related to utilization of the river and riparian ecosystems.

Limitations of the Study

Data on the socioeconomic characteristics of the selected communities along the Langaran River was obtained by local researchers who may not be as experienced and keen as the professional researchers, despite the training that were given to them. The respondents may have withheld some information for apprehensions that the interviewers, who were their companions in the community, may divulge information beyond the project.

The difficulty of the topography and the inaccessibility of some locations, especially in the upper barangays, made faunal survey very difficult. It was possible that certain animal species that were present in some areas were not represented in the collection.

Water current was very strong; hence it became very difficult to set up standard traps for aquatic animals. Furthermore, there was risk of being caught in flash floods and this also limited the collection of aquatic animals.

The study is generally descriptive, obtaining baseline information on the socioeconomic and biological diversity of the area. There is therefore minimum attempt to do extensive statistical analysis of the data.

Review of Related Literature

The term *riparian* comes from the Latin word *riparius*, meaning 'bank of stream' (Dunne and McGinnis 2002). Riparian areas are simply defined as the green areas found along the edges of rivers, streams, lakes, ponds and wetlands.

The USDA/NRCS (1998) definition of riparian zones was more specific and conveyed a more definitive boundary. It defined riparian area as an area of trees and/or shrubs located to and up-gradient from water bodies with three specific zones. Zone 1 is identified as that area beginning at the normal water line, or at the top of the bank, and extending up-gradient a minimum distance of 15 feet. These areas are made up of trees and shrubs. Zone 2 is that additional strip of land, which begins at the edge and up-gradient of Zone 1. The minimum measurement of Zone 2 is twenty feet of up-gradient width. Fifty percent of the area should be trees and the remainder in shrubs and grassy plant materials. Zone 3, a grass buffer zone, is set at a width of 20 feet starting at the outer most edge of Zone 2.

Through the complex interaction of their soils, hydrology, and animals and plant life, riparian zones provide many important environmental functions. Riparian zones provide wildlife habitat, reduce the impact of flooding, and generally protect the aquatic system from upland disturbances. Riparian areas are also valued for their productive soils and forage, as well as the water present in the adjacent aquatic system.

The Riverine and Riparian Ecosystems

Riparian zones are areas of transition between aquatic and upland ecosystems, and they offer numerous, yet often overlooked, benefits to wildlife and people. The riparian zone forms a critical link between land and water environments. It shares characteristics with, and contributes to, both systems as well as holding unique characteristics of its own. There is an increasing recognition of the role of the zone in the maintenance of productive and stable catchments. It acts as the final filter for any slope run-off that may enter streams directly. Riparian vegetation, for example, aids in stabilizing stream banks, filtering run-off and is vital for healthy streams and coastal waterways. Abundant floral species provide shade and decrease light availability thus preventing excessive growth of nuisance plants and algae in the riverine area. On the other hand, removal of riparian vegetation reduces concentration of dissolved oxygen (Welch, et al. 1998).

Diverse plant species of healthy riparian vegetation create numerous niches for local resident wildlife and provide valuable habitat for migratory ones. The forest canopy, and overhanging and near stream vegetation lower water temperatures by blocking solar energy; thus, creating a healthy environment for fish populations and other aquatic species. However, for a riparian ecosystem to adequately function as such, it must remain healthy.

Bounded by the riparian zones is the riverine ecosystem otherwise known as the lotic ecosystem. The riverine ecosystem includes spring, stream, or river viewed as an ecological unit of the biotic community and the physiochemical environment, within which mass and energy are exchanged (www.britannica.com/eb/article, 03 June 2003). The riverine system can be a wetland or deepwater habitats contained within a channel. The system is bounded on the landward side by upland, by the channel bank, or by wetland dominated by trees, shrubs, persistent emergents, emergent mosses, or lichens. The riverine system terminates at the downstream end where the concentration of ocean-derived salts in the water exceeds 0.5 during the period of annual average flow. At the upstream end, it terminates where tributary streams originate (www.epa.nsw.gov.au, 04 June 2003). Rivers in general, support and sustain various plant and animal life and help stabilize the ecology of the said habitat, aside from providing livelihood and sustenance to communities nearby.

Factors Affecting River Systems

Numerous studies show that the behavior of river systems is affected by various factors. The use and condition of nearby land in particular have a profound influence on water quality or the biophysical constituents affecting the character of the aquatic environment. The percentage of forested land and other uses were the best predictors of overall water quality in river basins in Texas and Illinois (Hunsaker and Levine 1995). The vegetation in the high water mark towards the uplands of the riparian corridors may be influenced by elevated water tables or flooding, and by the ability of soils to hold water.

Biotic communities are sensitive to natural variations in abiotic factors including current, light and nutrients. Separate studies on freshwater ecosystems indicated some important information. Changes in water temperature regimes impact all aspects of physiology, behavior, and life history strategies of aquatic organisms (Naiman and Anderson 1997). Algal communities respond positively to nutrient enrichment causing aesthetic, water quality and habitat degradation. The study of Knapp, et al. (1998) showed that stream channel morphology affects the spawning habitat and recruitment of the Californian golden trout. Welsh and Ollivier (1998) recorded evidences of the effect of stream ecosystem stress by sedimentation on three species of amphibians.

River environments were found to be sensitive to nutrient enrichment, temperature alteration, introduction of suspended solids, and acid precipitation. Removal of riparian vegetation, as well as alteration of organic inputs and hydrologic regimes by forest and agricultural activities and expanding urbanization, generally results in increased erosion, increased algal production, changes to temperature regimes, and reduced concentrations of dissolved oxygen (Welch, et al. 1998). All these studies indicate that biodiversity in freshwater ecosystems, particularly streams and rivers, is determined by numerous factors which, when altered could have significant impact on the species' composition, abundance and richness.

Role of Water in an Aquatic Ecosystem

Water is the most prominent physical component of an aquatic ecosystem, interacting with the biota, geography and climate of an area to produce a specific kind of environment. Geography and climate affect the behavior of the water, whether it will stand still or flow, freeze or evaporate, stagnate or circulate. The water's interaction with its environment determines its physical and chemical properties that in turn affect the productivity, biodiversity and complexity of the aquatic community formed therein.

Riparian areas in good condition slowly release water to stream channels, thus increasing seasonal quantity and quality of water. Woody and herbaceous plants slow down flood flows, and provide a protective blanket against the erosive force of water. Their foliage shields the soil from wind and sunlight, which keeps soil temperatures low and reduces evaporation. They produce a variety of root systems that bind the soil and hold it in place. Riparian vegetation filters out sediment that builds stream banks and forms productive wet meadows and floodplain and reduces downstream sedimentation.

Rainfall across a catchment moves through drainage lines, intermittent creeks and small streams to the major river of the catchment. During its journey, the water picks up eroding soil, nutrients, salt or other contaminants and moves them into the river system. It also transports food- nutrients, leaf litter, fine particles of organic matter and other dissolved substances- for aquatic plants and animals.

Land and Water Interrelationship

Because of the close relationship between land and water, river management and land management must be considered together. The relationship between the river system and its catchment is strongest in riparian zones. Here, vegetation exerts a powerful influence on where the river is located in the landscape, on in-stream energy production and on the type and quantity of food matter and nutrients in the stream.

Riverbanks are characterized by high species richness, which is mainly based on habitat diversity in cross-section and periodic disturbances, such as floods. Riparian vegetation influences river ecosystems. Where slopes are steep, tributary streams may be partially shaded by the adjoining stream bank and hills. However, most river shade comes from riparian vegetation. The shade created by intact, healthy riparian vegetation in small tributary streams maintains low water temperatures (reducing the daily maximum by as much as 10ºC in small streams), allowing many native plants and animals to survive. Excessive growth of nuisance plants and algae is prevented by a decrease in the amount of available light while the dim or patchy lighting provide habitats for some predators and prey.

Soils and the Riparian Areas

The periodically inundated flat lands surrounding riverbanks are known as floodplains. Covered with vegetation, these areas act as sink, absorbing the flooding river's energy and much of its water. Water flow is moderated through the connected processes of physical resistance from vegetation, absorption of water into the soil and groundwater discharge. This primary riparian phenomenon, along with the constant presence of water during all or part of the year, distinguishes riparian soils. Sediment deposition is a natural process that takes place during periodic flooding in the riparian zone. Accelerated upland erosion can increase sediment deposition. Depending upon the activity in uplands nearby, these soils are inherently productive.

The type and amount of stream-deposited sediments impact the chemical composition of riparian soil. In addition, high inputs of organic material, whether as large woody debris or litterfall, along with high decomposition rates are what made these soils particularly fertile.

Organic matter

Soil organic matter is defined as the totality of organic fraction of soil, which includes the organisms present (the soil biomass), the plant and animal residues at various stages of decomposition and, the stable humus synthesized from residues (Syers and Craswell 1995; Nelson and Sommers 1996; Jenkinson 1988).

Soil organic matter plays important roles in the improvement of various soil properties. The role it plays in the improvement of physical properties is widely understood. Organic matter binds soil into aggregates, giving rise to soil structure and associated soil porosity, which are important in regard to permeability and aeration of clay soils, moisture holding capacity and aggregation of sandy soil, and nutrient holding capacity of soils, in general.

Organic matter often accounts for at least half the cation exchange and buffering capacity of the soil. Van Dijk (1971) reported that 25 to 90% of the total cation exchange capacity (CEC) of the surface horizon of mineral soils is due to organic matter. This is not really surprising since the CEC of organic matter ranges from 100 to 500 $cmol_c\ kg^{-1}$, with a mean value of 300 $cmol_c\ kg^{-1}$ which is equivalent to about 30 times that of kaolinite (Green 1971). For an Oxisol in Sierra Leone, Brams (1971) has reported a 30% reduction in CEC when organic matter levels decreased by 50% due to continuous cultivation.

Baert (1995) has shown how significantly CEC is related to organic matter. In his work, the topsoil of highly weathered soils, having a similar mineralogical composition as the subsoil within the same profile, and having a higher content in organic matter gave higher CEC values than the underlying subsoils having poor organic matter contents.

Organic matter influences the soil fertility status in many ways and its beneficial effect on growing plants is tremendous. Its decomposition releases essential elements, both macro and micronutrients.

Soil organic matter increases the population of beneficial soil microorganisms. It stimulates the activity of fauna and microorganisms in soil which contribute to nutrient release during decomposition of plant and animal residues, and to the synthesis of humified compounds, which are important in relation to soil physical and chemical properties.

Soil pH in H_2O and KCl

Soil pH is considered the single most important variable that can be measured and that tells more about the soil than merely indicating whether it is acid or basic. Brady and Weil (1999) considered it as a master variable. They are convinced that pH does not only affect the chemical and biological properties of soils, but also the physical properties including air and water movement in soils. Another author, Tan (1998) considered pH as a master determinant instead of a master variable in controlling plant growth and crop production. He stated that the effect of the acid-base reactions or pH in the soils is manifested directly or indirectly on the growth of plants. Directly because H^+ ions have a toxic effect on plants when present in high concentration or indirectly because the soil reaction may influence plant growth through its effect on solubility and availability of plant nutrients. A case in particular is the concentration of micronutrients like iron (Fe) and manganese (Mn) reaching toxic or adequate levels with changing soil pH.

Soil pH is also measured using salt solutions such as 1 M potassium chloride (KCl). The pH obtained is sometimes referred to as the buffered pH (Tan 1998). It is believed that the pH (KCl) reflects closely the cation exchange capacity (CEC), and the cationic composition of the exchange complex. Moore and Loeppert (1987) stated that the pH obtained by this method provides more information concerning the chemical properties of the system. The delta pH (ΔpH), which is equal to pH (KCl) minus pH (H_2O), is used to estimate the proportion of positive and negative charges on variable charge colloids (Van Wambeke 1992). Positive values imply that the soils have a net positive charge (Mekaru and Uehara 1972). According to Uehara and Gillman (1981), delta pH values above -0.5 are indicative of soils that are dominated by variable charge minerals.

Bulk Density

Defined as the mass of a unit volume of dry soil, bulk density is important in determining whether the soil has the physical characteristics necessary for plant growth. It also determines soil's vulnerability to degradation, particularly surface runoff. Root growth is inhibited by excessively dense soils for a number of reasons, including soil's resistance to penetration, poor aeration, slow movement of water and nutrients, build up of toxic gases and root exudates (Brady and Weil 1999). Another important consequence of increased bulk density is a diminished capacity of the soil to take in water, hence increased losses by surface runoff.

The bulk density takes into account the total soil volume and this volume includes both solids and pores. Soils with a high proportion of pore space to solids have lower bulk density than those soils that are more compact and have less pore space. Thus, any factor that influences pore space will affect bulk density. In particular, these factors include soil texture and presence of organic matter. Fine textured soils such as silt loams, clays, and clay loams generally have lower bulk densities than do sandy soils (Brady and Weil 1999). This is so because the solid particles of the fine-textured soils tend to be organized in porous granules, especially if adequate organic matter is present. In sandy soils, however, organic matter contents are generally low and the solid particles less likely to be aggregated together.

Typical cultivated clay and silt loams soils have bulk densities ranging from 1.1 to 1.5 g/cm^3 (Mg/m^3). Forests and grasslands (uncultivated) have bulk densities between 0.8 and 1.2 g/cm^3 (Mg/m^3) (Brady and Weil 1999). An undisturbed soil typically has 40% to 55% pore spaces. Once disturbed or compacted, soil bulk density typically increases to between 1.5 and 2.0 g/cm^3 and reduces the percent pore space significantly. Furthermore, disruption of soil pore spaces disrupts or kills most of the beneficial biota as it removes the air spaces in the soil that the aerobic biota need in order to live and thrive.

Riparian Flora and Biodiversity

Streamside Vegetation

Natural streamside vegetation is a natural source of leaf litter, insects and other organic debris that is food for aquatic plants and animals. These riparian inputs are a major component of the diet of many species of native fishes and aquatic vertebrates, such as turtles. Riparian fruits can also be important, especially in tropical and subtropical regions, and some native fish feed exclusively on the insects and other land animals which, from these fruit trees, fall, and are washed or are blown into the water. What goes into upper tributary streams may be an important food source in the lower reaches of the river.

Healthy riparian vegetation helps stabilize and protect stream banks from erosion. Stable undercut banks provide shaded habitat for fish and other aquatic animals. The vegetation also plays a role in trapping sediment and nutrients from eroded soils. This trapping or buffer capacity is particularly important where a catchment is used for intensive agriculture or urban development, because it can improve water quality and prevent excessive growth of aquatic plants. Sediments entering the stream can settle out, blanketing the streambed and logs and reducing habitats, spawning sites and food sources for fish.

Riparian Forests

The riparian forests also play an important role in the landscape by providing plant and wildlife habitat, increasing landscape connectivity, and protecting water quality (Gilliam 1994).

From time to time, branches, large limbs and even whole trees fall into stream or river; remaining where they fall or are being washed downstream. Whatever their fate, they are an important natural component of our river systems. Tree branches and trunks provide niches and habitats for small invertebrates. These shred and consume leaves and fine litter and, in turn, become food for larger animals and fish. In sandy rivers, logs provide the only stable base for microscopic plants and animals. The larger branches and trunks, usually known as debris or snags, also provide habitat and refuge for important fish species. The Mary River cod, for example, requires submerged hollow logs in which to lay and nurse its eggs.

Many river management agencies in the past undertook programs to remove all snags and large debris from river systems, believing that they impeded flood flows or caused increased rates of erosion by directing flows against riverbanks. However, woody debris has an important role in the ecological health of our river systems. The removal of woody debris from long sections of some rivers appears to have been a major cause of reduction in native fish stocks.

Riparian Vascular Flora

Aquatic plants play an important role within a river's ecosystem. During the Rideau River Biodiversity Project, 51 species of aquatic plants were found in the river. The river has moderate aquatic plant diversity wherein the common species encountered were common waterweed and coontail. Diversity of riverine flora was lowest at downstream sites between Mooneys Bay and Manotick. Aquatic plants were found out to grow best in places where the river bottom sloped very gradually and diversity was higher where the water rate of flow is slower (www.nature.ca/rideau/b/b8-e.html).

The riparian flora of the Oker River system in Germany was examined and investigated following a standardized method. Bank of the said river is characterized by high species richness, due to habitat diversity and periodic disturbances, such as floods. A total of 546 vascular plants were found along the Oker River. Most of the frequent alien species (e.g., *Bidens frondosa* and *Impatiens glandulifera*) are escaped ornamental plants coming from adjacent gardens (www.biblio.tu-bs.de/geobot/lit/okerpage.html-3k-8Dec 2002).

In Malaysia, Kinabatangan's riparian forests recorded hundreds of endemic plant species which include beautiful mosses, about forty oaks and many coniferous trees. Orchids and insectivorous pitcher plants were also observed in the diverse cloud forests. Diversity of plants in the lowland and hill forests is even higher than in the mountains (www.hotcity.com/~vladimir/malay.htm - 70k - 8 Dec 2002). In Fitzgerald River National Park, South Coast of Western Australia, more than 1,800 beautiful and bizarre species of flowering plants, as well as a myriad of lichens, mosses and fungi, have been recorded. Of these, 62 plant species were endemic and 48 species were noted to be more or less confined to the park. Royal hakea (*Hakea victoria*) is one of the most famous and certainly the most striking known species from the park (www.naturebase.net/national_parks/previous_parks_month/fitzgerald.html).

Land use activities in the surrounding area affect the vegetation in the riparian zones. In Germany, intensive economic utilization of land along with industrialization and intensive agriculture resulted to the collapse of ecological balance in clean rivers. Around 560 out of 2,030 plant species were reported to have disappeared by 1983 in Bayern, Germany (www.mlit.go.jp/river/english/bio-d1.html). In contrast, the pristine state of Malaysia's river system was attributed to the absence of large-scale human settlements and development programs. The upper reaches of the rivers are dominated by plants from families *Lauraceae, Ericaceae* (*Rhododendron*), *Myrtaceae* (*Eugenia*) and *Gesneriaceae* (*Gesneria*), together with orchids, pitcher plants, mosses and lichens. Progressing downstream, the riverine vegetation gives way to the dipterocarp trees. Saraca trees predominate, together with *Tristania*, *Dillenia, Pometia*, *Ficus*, *Licuala* and *Pandanus*. As the rivers reach the estuary, various species are found including *Oncosperma*, *Calamus*, *Pandanus*, *Intsia, Barringtonia* and *Gluta* (agrolink.moa.my/did/river/books_flora.html-11k). Similarly, the flora of Kern River Valley, California and its environs are among the most diverse in the region. Over 2000 species of plants have been documented (www.natureali.com/plants.htm).

The numerous floral species of the Philippines can be encountered in different ecosystems, which in turn are highly dictated by habitat diversity and periodic disturbances. Of the many ecosystems where plant species abound, the freshwater environment is one critical habitat because of its riparian corridors, which provide a lot of services to the ecosystem.

An assessment of floral resources and livelihood development in Malindang range, Misamis Occidental was made by Amoroso and Arances (2002). Plant diversity in a two 1-hectare plot revealed 287 species in 173 genera of 108 families. Ethnobotanical survey indicated the economic importance of the plant species. Thirty-nine species were found out to be medicinal, 14 species were used as food, 18 species were classified as ornamental and 90 species were used as lumber, firewood or as raw materials for handicraft making.

Diatoms

Diatoms are excellent biological indicators for many types of pollution in aquatic systems (Patrick and Palavage 1994; Kelly, et al. 1995). Fish communities are also very useful indicators of aquatic degradation (Karr 1991). It is also well established that longitudinal variation (e.g., from upstream to downstream) in physico-chemical characteristics of a river significantly influences benthic communities.

River and Riparian Fauna

Vertebrates

There are more than 500 species of birds recorded in the Philippines. It belongs to 19 orders and 73 families with nine endemic genera. About 15% of this figure is threatened with extinction (Collar, et al. 1999). Of the many compounding factors to this threat, habitat loss is considered the most prominent. Majority of this number of Philippine birds is forest dependent. Of the 65 threatened endemic bird species for example, only three (Philippine Duck, Brown-banded Rail and Luzon Buttonquail) are believed to be not forest birds. It is fortunate that local and international community took notice of the critical biodiversity situation in the Philippines and initiated some conservation measures. The importance of bird conservation is emphasized by the recognition in the Philippines of at least 117 Important Bird Areas (IBAs). Mt. Malindang National Park, located in the western part of the island of Mindanao is one of the IBAs (Code PH107, the site of the present study is on its NE slope) lists a total of 28 threatened and restricted range species of birds (Mallari, et al. 2001). Collar, et al. (1999) on the other hand, listed 11 species of threatened endemic species of birds found in Mindanao and Eastern Visayas, which is the highest among the five major faunal regions.

The Philippine avifauna has been extensively documented. As early as 1760 Brisson described 31 species of birds from the Philippines (Dickerson, et al. 1991 as cited by WCSP 1997). Many more documents were published since then, to mention but a few, Mc Gregor (1909-1910), Dickerson (1928), Delacour and Mayr (1946). duPont published a comprehensive list of Philippine birds in 1971. More recent listing of Philippine birds is by Kennedy, et al. (2000). The recent status of some Philippine birds on the other hand are provided by WCSP (1997), Collar, et al. (1999). The voluminous listing of studies on Philippine birds may gleaned from the listings on the references of WCSP (1997) and Kennedy, et al. (2000).

Several studies have shown that birds are important bio-indicators of the condition of riparian vegetation. Wetlands and riparian areas comprise only <1% of the land area in the western U.S., yet they support a tremendous amount of species diversity and abundance of wildlife. In Arizona and New Mexico, at least 80% of all animals use riparian areas at some stage of their life history. In the Interior Columbia River Basin, about 64% of neotropical migratory land birds depend on riparian vegetation during the breeding season. This habitat may harbor from 2-10 times as many individual birds as the adjacent, nonriparian vegetation.

Additional monitoring to assess the occurrence of "riparian-obligate species" on riparian habitats will provide a complete picture of ecosystem's health. On the San Pedro River in Arizona, the Common Yellowthroat and Song Sparrow, among other birds, are excellent indicators of ecosystem recovery following the cessation of livestock grazing. Populations of five riparian obligate species increased dramatically on the San Pedro River in Arizona following the complete removal of livestock. Thus, monitoring riparian systems can be readily done by determining the presence of these birds using calls and thereby assess the health of the riparian vegetation.

The riparian ecosystem provides a unique habitat for certain animals and in turn, indicates the health of the river and the riparian environment. There are indications that most of the nine species may have disappeared in these riparian habitats, since much of watersheds were already denuded and some of the rivers were destroyed.

Many mammalian species endemic to Mindanao has been reported to occur here (Mallari, et al. 2001). One threatened endemic mammalian species, the Greater Mindanao Shrew, *Crocidura grandis*, was recorded only from this area (Heaney, et al. 1998). Of the 172 species of mammal recorded in the Philippines, about 64% (111) are considered endemic with 52 being threatened with extinction due to habitat loss (WCSP 1997). Heaney, et al. (1998) however, commented recently that the lack of information on the distribution of these mammals lead to the mislabeling of some species in the threatened category, citing the case of Philippine tarsier and the flying lemur both of which are restricted to the Mindanao Faunal Region, and maintain healthy populations in the lowlands. A comprehensive list of Philippine mammals and their conservation status by Heaney, et al. (1998) was recently published. A list of other threatened vertebrates is listed in the Philippine Red Data Book by WCSP (1997).

Cryptozoans

In the past, soil has been perceived as inert and inanimate and soil properties are distinctive but relatively unchanging. Faunal constituents have been ignored in management activities and studies are focused on high profile organisms such as soil-borne pathogens and certain mycorrhizal fungi and nitrogen-fixing bacteria. Recently however, interest is on faunal composition of the soil, most of which are invertebrates that include the cryptozoans.

Cryptozoans are invertebrates that prefer cool, dark and moist microhabitats. They include some species of mollusks (Frest and Johannes 1995), worms (James 1995) and arthropods such as millipedes and other insects (Schowalter 1995). Soil microorganisms and cryptozoans as invertebrates play critical roles in maintaining soil health and fertility (Coleman, et al. 1992). Their roles include: (1) decomposing plant material, (2) immobilizing nutrients in soil, (3) improving soil aggregate structure, which increases water-holding capacity, clay surface interaction with nutrients and plant-root architecture, (4) altering soil pH, (5) mineralizing nutrients, and (6) controlling disease-causing organisms (Ingham 1994).

Like any other animal group, the abundance and distribution of cryptozoans are affected by environmental factors like temperature, moisture and light. Fluctuations in these factors therefore ultimately determine the soil health and fertility by affecting the cryptozoans in the area. In a sense, this group of organisms determines the health of the ecosystem. However, despite their importance, this group of organisms is often excluded in most surveys. Some members may be covered in studies on soil organisms, like earthworms; otherwise, they are left out in many biological studies.

Cryptozoans are found in most ecosystems worldwide. They drive ecosystem processes. They are vital to energy and nutrient processing and cycling. Because of their abundance in diverse habitats, they play the major role in nutrient flow through ecosystems. They are considered important both as consumers (herbivores, detritivores and predators) and as secondary producers (prey). Being important consumers in the ecosystem, cryptozoans help the decomposers consume and shred large quantities of dead leaves and wood debris in the forest litter and inoculate microbes into larger detrital surface area that makes the nutrients more readily available to microbes that continue the cycling process. The cryptozoans help by crushing up plant fragments and thereby hastening decomposition by bacteria and fungi. Nutrient cycling and decomposition process is more efficient if dead leaves and other forest debris are shredded first (Schowalter 1995).

Cryptozoans have unique value for scientific study, assessment and monitoring because they include many species of large populations and diverse habitats, with short generation times and rapid population growth, and they provide a fine grain representation of the system. They have diverse life history patterns, generation times, reproductive strategies, trophic levels and behavior. Their short generation times and high reproductive potential makes them an excellent indicator and "early warning" organisms that could be used as soil condition indicator. A sudden reduction in their population could be indicative of environmental changes such as chemical contamination, drought or over predation (Plafkin, et al. 1989).

Like most vertebrates, cryptozoans are well suited for monitoring the recovery of ecosystem after large-scale perturbations such as fires (Christiansen, et al. 1992; Pilmore 1996). They have high dispersal rates, being the first animals to colonize an area after a serious disturbance where a habitat has been altered (e.g., burned, bulldozed, or flooded). They change microhabitats, spread seeds, modify soils and initiate processes that reestablish viable habitats for other taxa. Each stage in the development and succession of an ecosystem has its own group of invertebrates altering the habitat and paving the way for latest successional stages (Brown 1982; Southwood, et al. 1979).

Macroinvertebrates as Water Quality Indicators

Aquatic ecosystems are inhabited by animals that respond to specific changes in water conditions. As such, these animals can potentially serve as indicators of the quality of water. The most widely distributed species in freshwater environments are the invertebrates. Invertebrates are animals without backbones. Macroinvertebrates are organisms which can be readily observed with the naked eye. Macroinvertebrates not only form an integral part of the aquatic ecosystem but also serve as important link in the aquatic food chain. Some of these organisms are herbivores and feed on algae, green plants or leaves that would fall on water. Others are predatory, catching and devouring any moving creatures smaller than them while a lot others are scavengers of decaying matter. Macroinvertebrates, in turn, are principal food for fishes, amphibians and water birds.

The presence of fish in a body of water could hardly provide information about a pollution problem because fish can move away to avoid polluted water and then return when conditions improve. Thus, macroinvertebrate monitoring has been recognized as a front line indicator of stream health (http://www.ecn.ac.uk/freshwater/state_taxa.htm). Generally, in a clean stream, a wider variety of macroinvertebrates is observed while only a few types of tolerant ones (e.g., worms, leeches and sludge worms) are present in an unhealthy stream.

Nearly all pollution causes harm to the environment in some way. Waste pollution affects almost immediately the amount of dissolved oxygen (DO). Fertilizers, detergents, sewage and other organic wastes, as well as warm water from factories, all bring the level of oxygen to a critical minimum. Oftentimes, this problem is detected only when economically useful organisms such as fish start to decline and eventually disappear due to suffocation.

In areas where there are threats of organic pollution, water quality should be monitored so that appropriate action can be taken before the situation in the aquatic environment deteriorates. Water quality is determined by testing several parameters like DO, biological oxygen demand (BOD), total dissolved solids (TDS), pH, temperature, fecal coliform, heavy metals, nutrients, conductivity and suspended solids. However, the tests for these parameters are costly, unless there is an equipment that can measure most, if not all of the parameters mentioned. All chemical testing would only pick up the toxicant if it was present at that time. Therefore, there is a need to develop a basic water quality monitoring system that is economical, sustainable and can be independently implemented by the community.

Recently, studies have been done using the macroinvertebrates as water quality indicators. Controlled experiments and field observations have shown that macroinvertebrates differ in their sensitivity to water pollution, specifically to availability of dissolved oxygen (which is a function of organic pollution). Because these kinds of animals need different amounts of oxygen, their presence or absence can indicate the levels of pollution. Their presence or absence was found to indicate whether a stream's condition is excellent, good, fair or poor (Sangpradub, et al. 1997). Although not a measure of chemical pollutants, the macroinvertebrates speak of the long-term conditions of the water environment. Most of the species are abundant, can be easily identified, have long life cycles and have sedentary larval stages. Macroinvertebrate data are also easy to collect and do not require expensive equipment.

Benthic invertebrates are small animals that live on the bottom of a pond, lake, stream, or river for at least part of their lives. They inhabit tiny spaces between submerged stones, within organic debris, on logs and aquatic plants, or within fine sediments (silt, clay). Technically, invertebrates are animals that do not have backbones like the larger animals (vertebrates) such as fishes, amphibians, reptiles, birds, and mammals.

Benthic macroinvertebrates are bottom-dwelling invertebrates large enough to be seen with the naked eye. Usually greater than 1 mm, most species of stream macroinvertebrates are aquatic insects although crustaceans (crayfish, sideswimmers, aquatic pillbugs), mollusks (snails, mussels, clams), oligochaetes (earthworms, leeches), and arachnids (aquatic mites) also occur commonly. The tolerance of most of these invertebrates to pollution has been documented. A number of authors have categorized most of the stream animals in order of pollution tolerance, from those that can live in the cleanest water to those that can put up with dirty water (Miller, 1983). Good water quality indicators are sensitive to changes in water quality, especially to changes in oxygen level. They survive only in water environments that are never polluted; thus their presence indicates that the quality of water is still good. The extreme group of macroinvertebrates includes those that can tolerate a wide range of environmental conditions, from the cleanest to the dirtiest water. Where good water quality indicators are absent, macroinvertebrates could still be very abundant. Flatworms are among the species that can tolerate pollution.

Studies in many parts of the world attempted to relate macroinvertebrates to the quality of water. In San Lorenzo River in California, macroinvertebrates were assessed. Results showed that 91% of the benthic macroinvertebrates (BMIs) collected were indicators of good water quality. These include caddisflies (72%), stoneflies (5%), mayflies (1%), damselflies (1%) and deerflies (2%). This amount of good water indicators suggested good river health (www.usc.edu/CSSF/History/2002/Projects/SO601.pdf).

An open-ended field exercise in sampling the BMI populations in a given stream was made by Bartsch (www.accessexcellence.org/AE/AEC/AEF/1994/bartsch_benthic.html). They obtained a diversity index of 0.5 for benthic macroinvertebrates. The higher number they obtained indicated more diverse communities and good water quality. Best water quality indicators like stonefly nymphs, mayfly nymphs and caddisfly larvae were the dominant species among the invertebrates collected.

Using macroinvertebrates, determination of the health of water in Sasco Brook, Mill River and Rooster River in Fairfield County Connecticut from June 1999 to October 2001 was made (www.fairfieldct.org/waterquality.pdf). It was concluded that these bodies of water were able to meet aquatic life goals set in Connecticut's water quality standards. Most of the water parameters, including benthic macro-invertebrates, were also used in monitoring the lakewaters in the city of Tallahassee. The study showed that the lake is inhabited by juvenile freshwater insects, annelids, flatworms, roundworms and crustaceans that indicate a not so clean water (http://talgov.com/citytlh/stormwater_man/lakes/lakewqp.htm).

Effect of headwater catchment degradation on water quality and benthic macroinvertebrate community in Northeast Thailand was investigated by Sangpradub, et al. (1997) (www.wetlab.hypermart.net/headwater/discuss.html). Macroinvertebrate species composition is more diverse in the control site compared to the impact sites. Degradation of the Cheon headwater was evident by water physicochemical parameters and benthic macroinvertebrates. The water quality in the forest land sites was less degraded than at bared sites. Clearing for agriculture caused the apparent degradation of water quality in this catchment. The streams in the forested areas were less affected by surface runoff, resulting in high DO and low BOD level. The DO, BOD and SS levels resulting from land clearing have influential effects on macroinvertebrates. The macroinvertebrate analysis more accurately reflected these impacts in the streams than the water physicochemistry. As was found out, the species richness and abundance in the disturbed sites were less diverse than the pristine sites. The degree of fauna composition in disturbed areas also varied according to the extent of land clearing. Among the benthic macroinvertebrate fauna, Trichoptera was the most distinctive and abundant taxon in very pristine sites. The net-spinning caddis larvae and riffle beetle *Cleptelmis* sp. clearly showed the significance of a good forest cover condition and high DO level. The sensitive Heptagenid and Ephemerid mayflied nymphs were found only strictly in microhabitats with high DO level but were not strongly related to forest cover or land clearing. Oligochaetes, dipterans and mollusks that are considered pollution indicator taxa were abundant (wetlab.hypermart.net/headwater/abstract.html).

Coliform Load

Bodies of water such as lakes and rivers are a source of water for drinking, cleaning, bathing, washing clothes, preparing and cooking food, gardening and even for irrigating farmlands. They are also a source of livelihood like fishing and in some areas, quarrying. They are also places for recreation such as boating, swimming, water skiing, scuba diving, for camping sites or simply as part of a beautiful landscape enjoyed for its existence (Murdoch 1971). But these bodies of water can become unfit for use if contaminated by microorganisms. The water in fact, has also become a mode of transmission of deadly diseases such as cholera, typhoid fever and amoebic dysentery (McKinney 1962). Shigellosis (dysentery caused by some members of bacterial genus *Shigella*), infectious hepatitis, and a variety of low-grade *Salmonella* infections are also waterborne diseases that are commonly transmitted through water and food (Buffaloe and Ferguson 1976). In some cases, contamination or pollution of water has resulted to fishkills (Hynes 1970). To sustain their utility, bodies of water should be kept clean and protected against harmful and pathogenic microorganisms. Unfortunately, presence of these microorganisms is difficult to detect because they are invisible to the naked eye.

Some organisms such as fecal coliform bacteria, "blooms" of blue-green algae, sludge worms (Tubificidae), and the so-called rat-tailed maggots of some syrphid flies serve as indicators of organically or nutrient-enriched waters. In 1885, it was discovered that a particular type of bacteria called coliform bacteria are numerous and can be detected in animal feces and sewage. It is also known that an average of 1.4 billion coliform bacteria is present in one ounce of human feces. Although these bacteria are not known to cause illnesses, their presence indicates or predicts the presence of other disease-causing agents. Based on this finding, coliform bacteria was made as the first "microbial indicator" of fecal and sewage contamination (Funk 2000). Henceforth, the health of water has been assessed by the presence or absence of coliforms because they are easier to detect than any other group of pathogenic and infectious microorganisms. Water management options are now generally based on the presence or absence of these microorganisms.

In practice however, test for coliforms is commonly done for the marine and lake waters.

The test is rarely used to assess the microbial health of the streams and rivers because of the belief that everything that is discharged into flowing bodies of water will end up in the seas and lakes. The same belief is also behind the abuse and misuse of our river systems. There is therefore a need to assess the coliform load of rivers on a landscape (i.e., from upstream to downstream) and to determine if coliform bacteria can be used as indicators of the aquatic environment's health.

The Langaran River, which stretches from the municipality of Concepcion down to the municipalities of Lopez Jaena, Calamba and Plaridel, is considered very important to the communities because among other domestic uses, it is the source of water for the three dams that supply irrigation waters to the ricefields of Calamba and Plaridel and some parts of Lopez Jaena.

Microorganisms in Water

Water as a unique substance and physical environment favors the existence of many types of organisms, whether flora or fauna (Prescott, et al. 1993). Most of the organisms ranging from smallest to the largest can be found here, including microorganisms. In fact, the microorganisms are a natural component of lakes, rivers and streams. Over 60 genera of bacteria are present in aquatic systems and numbers can range from 40,000 to over 12 million bacterial cells in an amount of water that will barely cover the bottom of an average-sized coffee cup (Gregory and Frick 2000).

Water is also a 'cruel master' because it serves as a mode of transmission of diseases. Since the beginning of recorded history, it has been recognized as a potential carrier of diseases (Prescott, et al. 1993). But the presence of microorganisms *per se* is not a good basis for condemning water as unfit for human consumption. Some of these microorganisms like yeasts and other fungi are beneficial to man. It is the kind of microorganisms, whether pathogenic or not, and its relative abundance that is important (Bryan, et al. 1962).

The cycle of water is one of the factors that could transport the microorganisms (Keeton and McFadden 1983). As the water falls in the form of rain or snow, it acts as a vacuum cleaner picking up all the dust and dirt in the air. Needless to say, the first water that falls picks up the greatest concentration of contaminants. This water running across the surface of the ground, designated as surface water, will pick up many substances, microorganisms, organic matter, and minerals as it flows back to the rivers then to the oceans. Surface water collects in low areas forming lakes and ponds, and being rich in nutrients, it becomes a perfect medium for the growth of all types of microorganisms (McKinney 1962).

Waterborne diseases can be acquired through consumption of contaminated or polluted water. Bodies of water such as rivers and lakes can either be physically, chemically or biologically polluted (Murdoch 1971). Biological pollution develops from microorganisms that enter water from human wastes, food processing and meatpacking plants, medical facilities, and similar source. A major type of this pollutant is a bacterium, specifically coliform bacterium *Escherichia coli* (Alcamo 1991). The presence of coliform bacteria in water is an evidence of fecal contamination and therefore the possible presence of intestinal pathogens causing typhoid fever, paratyphoid fever, dysentery and cholera. It is estimated that 10-40 percent of the total cases of typhoid fever is a result of water contamination (Bryan, et al. 1962).

Aside from bacterial diseases, there are also viral diseases transmitted by water and that include hepatitis A and gastroenteritis due to Norwalk virus. These diseases are generally related to fecal contamination of water. Other viruses that may be found in water include the Coxsackie virus, the echovirus and adenovirus. In 1977, adenoviruses caused 44 cases of conjunctivitis in patrons of Georgia swimming pool. Moreover, many protozoa form cysts that survive for long periods in water. In July 1982, gastrointestinal illnesses occurred among numerous scuba divers from New York City's police and fire departments. Stool examination revealed 12 infections by intestinal protozoa: five by *Entamoeba histolytica* and seven by *Giardia lamblia* (Alcamo 1991).

Many waterborne illnesses are due to the toxin-producing strains of *Escherichia coli* (Alcamo 1991). This bacterium is also associated with urinary tract infections. Diarrhea, which is one of the deadly waterborne diseases, caused by bacteria such as *Escherichia coli* and other bacteria, is considered second to respiratory diseases as a cause of death worldwide. For example, each year, around one million children (more than 13,600 a day) die from diarrhea in Asia, Africa and South America. In the United States, estimates exceed 10,000 deaths per year from diarrhea and an average of 500 childhood deaths have been reported (Prescott, et al. 1993).

The coliform bacteria or colon-typhoid-dysentery group bacteria in polluted water are Gram-negative non-spore forming bacilli, usually motile rods that ferment lactose to lactic acid and gas. These organisms may be normally present in the gastrointestinal tract or invade upon infection. Included in this group are *Escherichia coli* and the species of *Enterobacter* (Davis, et al. 1980). *Escherichia coli*, which provides the best-studied example of virulence plasmids, is referred to as the colon bacillus because it is the predominant facultative species in the large bowel. It is known that the pathogens that gain entrance into bodies of water arrive there via intestinal discharges. *Escherichia coli* and related organisms designated as coliforms, fecal streptococci (e.g., *Streptococcus fecalis*), and *Clostridium perfringens*, are normal inhabitants of the large intestine of man and other animals and are consequently present in feces. Fecal coliforms by themselves are not pathogenic (do not cause disease). They are ordinarily found in the intestines of humans and aid in the digestion of food. However in infected individuals, pathogenic organisms are found along with fecal coliform bacteria.

The bacteriological examination of water usually involves the estimation of the number of bacteria as determined by Total Plate Count or the Multiple Tube Fermentation Technique as the standard methods. It also involves the detection of the presence or absence of members of the coliform group specifically *E. coli* (Bryan, et al. 1962).

The analysis of water for the possible presence of pathogens involves an indirect approach that is aimed at learning whether or not water contains any microorganisms that are of human fecal origin. The presence of such microorganisms is considered presumptive evidence that human pathogens might be present. They may or may not be present, but the policy underlying water analysis test is to give the consumer, not the pathogens, the benefit of the doubt (McKinney 1962).

The method for bacteriologic examination of water is designed to provide an index of fecal contamination. Pathogenic microorganisms do not necessarily multiply in water, and therefore they may be present in small numbers that are difficult to demonstrate in culture. However, *E. coli* and other coliform bacteria are not only abundant in feces but excreted into water, coliforms eventually die but not at a faster rate than pathogenic bacteria, so that they are present in large, readily detectable numbers if fecal contamination has occurred. Thus, culture demonstration of *E. coli* in water indicates a fecal source of the organisms. By bacteriologic standards, water for drinking should be free of coliforms and contain no more than 10 organisms per milliliter of water (Wilson, et al. 1979).

Escherichia coli is one of the microbial water quality indicators. This bacterium is the preferred indicator for freshwater recreational areas and its presence provides direct evidence of fecal contamination from warm-blooded animals. Although usually harmless, *E. coli* can cause illness such as meningitis, septicima, urinary tract, and intestinal infections. A recently discovered strain of this bacteria (*E.coli* 0157:H7) can cause severe disease and may be fatal in small children and the elderly. Along with *E. coli* is the *Enterobacter* species (Davis, et al. 1980).

Riparian Management and Development

Excessive growth of aquatic weeds, which can result from clearing of riparian zones for development, slows the stream flow, causing sediments to accumulate and resulting in shallower, broader stream channels and increase erosion of banks. It can also block stream channels and increase the likelihood of flooding and erosion of valuable agricultural land. Excessive growth can destroy natural habitats and reduce water quality as plants decompose.

Some blue-green algae are highly toxic to both stock and humans, and few aquatic animals can consume introduced water plants or blue-green algae.

Riparian management plans to protect river systems should therefore be an integral part of any land-use plan like agriculture and urban development. An example is the riparian habitat along the Sacramento River that is a diverse mosaic of habitat ranging from broad gravel bars to shady sloughs, from gallery forests to emergent cottonwoods at the water's edge.

The Sacramento River Riparian Habitat Program is working to ensure that riparian habitat management along the river addresses the dynamics of the riparian ecosystem and the reality of the local agricultural economy. Its goals are to preserve remaining riparian habitat, and to reestablish a continuous riparian ecosystem along the river.

The practice of leaving forested buffer strips on both sides of a stream or river when harvesting timber in order to preserve the functions of riparian forests was first implemented in the United States in the late 1960s. Since then, numerous studies have suggested that ecological values in buffered streams and associated riparian areas are much higher than in unbuffered streams. The riparian corridor along the Sacramento River has some of the best agricultural soil and most productive orchards in the state. The study of Brosofske, et al. (1997) showed that riparian microclimatic gradients existed and such gradients are affected by harvesting.

Because riparian and river ecosystems are all connected, the life forms which will flourish depend on the combined characteristics of these two ecosystems. In the Columbia Basin, alterations to the physical structure of the river by hydroelectric dams, and the resulting challenges to biodiversity have affected kokanee and trout populations, with consequent effects on the social, cultural and economic viability of the region.

In most small tributary streams, even a narrow strip of native trees and shrubs will benefit the ecosystem by shading the channel. Retaining healthy riparian vegetation does not have to be a net loss to farm productivity as the area can be strategically used for grazing or, in some areas for agroforestry or forage production. In many regions, individual landholders and groups are actively replanting native vegetation along the stream banks and riparian lands to protect banks and decrease rates of erosion, and to overcome problems of excessive growth of aquatic weeds and algae. In doing so, they hope to recreate the shade, low temperature and low nutrient conditions under which weeds and nuisance algae can no longer survive.

In some sugarcane regions of Queensland, replanting of native species on the riparian zone could solve two problems at once. It can shade out the para grass which chokes the water channels, causing increased flooding and high water tables, as well as shading out weed species favored by two species of native rats which attack the base of cane shoots. In this case, careful management of the riparian zone could enhance both productivity and ecological sustainability.

Participatory Approach in Riparian Management

Management of the natural resources, including those of river and riparian, continues to pose challenge among environmental managers. In Zanzibar, community-based management and conservation of mangroves yielded positive results. Efforts to educate the community included participatory research, video shows, seminars, and workshops on the linkages between mangrove vegetation and the availability of fish. The instillation of a sense of ownership and value in the local population was the first step towards the rational utilization of this resource (Shunula 2001). In Pakistan, conservation of the mangrove forests was achieved with the participation of the local communities. Activities with the community included formation of an organization, monthly meetings, workshops, networking with NGOs and government organizations, free medical and eye care assistance, supporting communities in lobbying and advocacy and involving the communities in project implementation (Fayyaz, et al. 2001). A community-based project resulted to a sustainable management of Ulugan Bay in Palawan, Philippines (Fortes 2001). The experiences of Walters (1997) revealed that social and economic factors, including peoples' knowledge about trees and tree planting, their patterns of land use and ownership, and their social organization, interacted with ecological variables to affect differently the outcomes of a restoration work for riparian areas in Negros Oriental, Philippines. Consequently, he proposed for the inclusion of socioeconomic or human ecological factors and concerns when planning and implementing tropical restoration projects.

Community Socioeconomic Condition and Environmental Sustainability

Most of the rural poor engage in diversified livelihoods and have different income sources to better secure their survival and level of living (Haggblade, et al. 1989; Sahn 1994; Reardon 1997; Tacoli 1998). The interactions are shown in the "assets-mediating processes-activities" framework used by researchers in studying poverty-environment interactions (e.g., Reardon, et al. 1998), sustainable rural livelihoods (Scoones 1998) and other similar themes like the one developed by Ellis (2002).

Ellis (2002) suggests that the household shall be the unit of analysis, it being *'the social group which resides in the same place, shares in the same meals, and makes joint or coordinated decisions over resource allocation and income pooling'.* Households own, control, claim, or access assets that include stocks of capital - natural, physical, human, financial and social – that they can use to produce, engage in labor markets, and participate in reciprocal exchange with other households or engage in market exchange. The assets are translated into livelihood strategies as mediated by endogenous and exogenous factors. The endogenous factors are social relations, institutions and organizations while the exogenous factors consist of trends and policies, as well as shocks. In this case, social relations refer to the social positioning of households within the community taking into consideration kinship ties, gender, age, class (as indicated by ownership of assets), and ethnicity. Institutions are the formal and informal rules, laws, land tenure arrangements or property rights, and market forces. Organizations are the groups formed to achieve common goals. In the Mt. Malindang context, these are the LGUs and other government organizations, and POs/NGOs. Social relations, institutions and organizations are mediating forces that facilitate or constrain the use of assets by households.

Trends in population growth rates, population density, migration patterns, technological innovations (e.g., irrigation facilities and high yielding varieties), market trends (such as increasing exportation of high value fruits) and regulatory laws and codes (such as the fisheries code), as well as shocks – or those unforeseen events that disturb livelihoods (floods and drought, for instance) – are called by other authors as the "vulnerability context" owing to their capacity to reduce or destroy assets.

The livelihood strategies that result from the assets and mediating factors may be natural resource-based or non-natural resource-based. The former leads to different land uses and can be classified as either farm, off-farm or nonfarm, forest, riverine or coastal activities. The latter pertains to such activities as self-employment or employment in the manufacturing, commercial or services sectors. Employment in any of these sectors outside the municipality (e.g., in major cities within the country and abroad) will provide remittances to those who are left in the rural communities.

The outcome of livelihood strategies can be classified into livelihood security and environmental sustainability. Livelihood security relates to attaining a level of income and keeping it stable, reduction of risks that affect assets, and so on. The livelihood choices households make will determine whether they become less vulnerable or more vulnerable in handling unfavorable trends or in coping with shocks. Environmental sustainability is defined by Ellis (2002) as "the resilience and stability of resources, such as land, forests, water, and biodiversity". The livelihood activities as mediated by endogenous and exogenous factors may result in environmental destruction or rehabilitation. An assessment of these livelihood activities will point to alternative ways by which households and communities increase their welfare while at the same time ensuring environmental sustainability.

There are national codes and local laws and ordinances which serve as regulatory measures to prevent environmental degradation such as those resulting to aquatic and air pollution, forest denudation, flooding, and droughts. Among the relevant national policies are embodied in the Fisheries Code, DAO 17 and the Comprehensive Agrarian Reform Law. There may also be very relevant ordinances at the local level. The many factors that interplay to affect the environment implies the need to identify all the stakeholders of a particular resource so as to examine "the types of pressures on the resource, the vested interests of the different user groups in the evolution of institutional frameworks, and the relative stakes of each user group" (Symes 1996).

People concerned about threats to the environment have good reason to take an interest in world population trends. If population growth does not necessarily cause environmental problems, it surely aggravates them. It is important to note, however, that determining the exact connections between population numbers and environmental problems is a very tricky matter. Pollution is caused by wide-ranging factors such as the amount of fossil fuel consumption it takes to satisfy the demands of a modern lifestyle, the kinds of products people purchase and use, the types of industries in a country, the waste disposal system in place, the amount of "clean" and "dirty" technology that is used, and so on. The demographic connection is further complicated by the fact that as developing countries modernize and population levels off, the standard of living generally goes up and, with it, per capita consumption of energy and manufactured goods. Headlines sometimes overlook these complexities, suggesting, for example, that "population pressures" are destroying tropical rain forests. However, one can also discern other factors at work, such as economic pressures, driving timber cutters into the forests and supplying them with the chainsaw technology that speeds up the devastation.

To feed increasing numbers of people, developing countries usually attempt to increase farm outputs. However, increased agricultural production carries environmental costs. The clearing of large forest tracts and the soil erosion that accompanies intensive agriculture have led to landslides, floods, and silting of reservoirs needed for hydroelectric power. Animal habitats are being endangered as more and more land is turned over to agriculture or the gathering of fuelwood. Agriculture pesticides and fertilizers have polluted waters and pose new health problems for agricultural workers.

It is not hard to understand why land-use policies, pollution control, and protection of endangered wildlife are sometimes low priorities in developing nations. Where children and parents are perpetually hungry, often sick, and without adequate clothing, where there is little hope for people to better themselves, the immediate future of the environment does not seem to matter very much. Until people's primary needs are met, they will have little enthusiasm about seeking a quality environment.

Materials and Methods

Entry Protocols

Although the Langaran River, from its remotest headstream somewhere in Don Victoriano to its mouth in Baliangao, cuts across few municipalities and many barangays, only five barangays within the two municipalities of Calamba and Plaridel were adjudged to best represent the riparian ecosystem and were marked for sampling sites. These barangays were Singalat, Mamalad, and Bonifacio of the municipality of Calamba, and Tipolo and Catarman of the municipality of Plaridel.

The implementation of the project started with a meeting with the municipal officials of the municipalities of Calamba and Plaridel. The meeting with the mayor facilitated contact with the municipal agricultural officers and the barangay captains of the barangays considered in the study. The municipal agricultural officers facilitated the participation and cooperation of some farm and fisheries technicians who, together with the barangay officials, also assisted the project team in ensuring participation of the whole community.

Informal meetings with the barangay captains were also conducted. During these meetings, the most appropriate procedure in informing the community of the project to be implemented was discussed. Upon their suggestion, a general assembly was scheduled by each of the barangay captains; during which the communities were briefed of the project as well as its participatory nature.

The researchers also met with the Provincial Coordinator of the National Commission on Indigenous Peoples (NCIP) to get the permission of the indigenous people (IPs) or the Subanons prior to the actual implementation of the project. The coordinator in turn, presented the agendum to the Banwak Subanon (organization of Subanons), who agreed for the research to be conducted in the selected barangays where Subanons also resided.

Participatory Approach

Implementation of the research was done in a participatory manner. Barangay captains of the five barangays were visited by the team to explain the nature of the research and to request that a barangay general assembly be scheduled. During the assembly, the proposed project and plan of implementation, including the participation of the local researchers, were presented. Barangay leaders (captains and councilors) were then requested to identify from their constituents the local researchers for each major component of the project, namely; soil, plants, animals and socioeconomic. The project team provided the following criteria to guide the leaders in choosing: (1) related educational background and interest of involvement, (2) availability, (3) willingness, and (4) personality (based solely on the recommendation of the barangay captain and the councilors).

In barangays where Subanons were present, additional researchers were chosen. The process of selection started with a discussion with Datu Felipe Ending, the NCIP Provincial Coordinator who is also a Subanon. During the meeting, he insisted that Subanons from his organization, Banwak Subanon, be among the local researchers. He was then given the authority to choose local researchers from his group, based on the same criteria given earlier. As a result, the number of local researchers from Mamalad was twice the number initially planned – one set was recommended by the barangay officials and another set was recommended/ selected by the Banwak Subanon.

An average of eight local researchers (16 from Mamalad) from each barangay including the barangay captain were gathered at the Farmers' Training Center in Panalsalan, Plaridel, Misamis Occidental for the training/workshop on field methods. They were grouped according to project component. With the study leaders facilitating each group, the objectives of the project were presented and the methods to achieve the objectives were discussed. In many instances, the local researchers were consulted on indigenous methods used to collect samples.

For example, when the nets prepared by the group to trap fish did not work because of strong river current, the local researchers suggested that "pahubas" be done. Other traditional methods to trap sample animals were also suggested and eventually implemented. These included the use of "pasgong", "lit-ag" and the use of local baits to attract mammals (e.g., jackfruit, banana, etc.). The local researchers mainly did the work with the study leader acting as facilitator of the group.

At the end of the fieldwork, the team had to decide on the local researchers who would be involved in the data analysis and interpretation. The primary consideration was the local researcher's potential to think scientifically and to lead an environmentally-related activity. An average of four local researchers from each barangay were invited to attend the "Workshop for Local Researchers" in November 2002 at the Farmers' Training Center in Panalsalan, Plaridel, Misamis Occidental. Together with the study leader of each component, the local researchers looked at the data and analyzed them, made a summary of the highlights and prepared visual aids for the community meetings. They were also orientated on how to present the output to the barangay.

A barangay general assembly was again held for the team to deliver the findings of the research project, as well as to validate the results with the community. The local researchers who attended the workshop presented and facilitated the open forum. They emphasized issues that arose from findings regarding biodiversity conservation in the Langaran River and led the whole community to come up with suggestions and recommendations that can be implemented by the community. Agreements related to preserving the river and the riparian areas were verbally forged by the members of the community.

Assessment of Riparian Soils and Biodiversity

The riparian soil shows the history of the river and determines the diversity of plants and animals in the riparian zones. Some soil properties were determined following standard methods for soil analysis.

Soil Sampling

Local researchers from the five barangays were trained to conduct the soil sampling on their respective barangays with the project's soil researcher's guidance. Both riverbanks in each barangay were sampled. The first step of sampling was to set up a transect of about 20 m long (estimated in most cases) parallel to the banks. Each side of the river had its own transect. Each transect was replicated three times, thus bringing the total transects to six per representative barangay. The next step was to collect soil samples from each transect. The main samples collected were composite samples and samples for bulk density determination. Composite samples were obtained using soil augers. Ten auger holes at depths 0-20 and 20-35 were made in each transect. The soils from these ten auger holes were thoroughly mixed to homogenize the samples. The homogenization was separate for depth 0-20 and for depth 20-35. From the thoroughly mixed samples, a bag of about one-kilo soil was retained and brought to the laboratory for analyses. Another set of samples taken from the designated transects were the undisturbed samples collected using a bulk sampler for bulk density analysis.

Laboratory Analyses

The original plan was to work on a number of physicochemical analyses on the soil samples collected from the sites. Due to budgetary constraints, only the analyses of pH, OM and bulk density were considered. Such parameters, however, proved to be quite sufficient for the purpose of the study. They were carried out according to standard methods available followed by the Laboratories of Soil Sciences. Analyses were done on air-dried samples. Details of the analyses are provided below.

Soil pH (pH-H_2O and pH-KCl)

The pH of the soil was measured in the supernatant suspension of a 1:1 soil:liquid mixture. The liquid was either water (pH-H_2O) or a 1 *N* KCl solution (pH-KCl). The methods followed were those adapted by ISRIC (1993) and SSIR No. 42 (1996). A 20-g soil sample was mixed with 20 mL of distilled water or with

20 mL 1 *N* KCL (1:1 w:v). The sample was allowed to stand with occasional stirring or shaking for two hours then stirred again for 30 seconds, then the pH determined with a pH meter (accuracy 0.1 unit).

Organic Matter (Loss on Ignition)

Loss on ignition (LOI) is a method used for direct determination of soil organic matter, following the procedure described by Nelson and Sommers (1996), which is a modification of the method described by Ben-Dor and Banin (1989). Another reference used was SSIR No. 42 Version 3.0 (1996). The organic matter is destroyed, after which the loss in weight of the soil is taken as a measure of the organic matter content. The percent organic matter lost on ignition (400ºC) can be used in place of organic matter estimates by the Walkley-Black organic C method. A 20-g soil sample (fine earth, <2mm) was placed in tarred weighing crucibles and heated at 105ºC for 24 hours. The crucibles were removed from the oven and placed in a desiccator to cool. Weight of the crucible plus sample was determined to the nearest 0.1 mg. The weight of oven-dried sample was obtained by subtraction. The sample in the crucible was then placed in a muffle furnace and the temperature was raised to 400ºC for 16 hours. Then the sample was placed again in the desiccator to cool and the weight was recorded to the nearest 0.1 mg. Weight of ignited sample was calculated by subtraction and the LOI content of the sample was calculated as:

$$\%OM = \frac{[(\text{weight of oven-dried soil - weight of soil after ignition})]}{\text{weight of oven-dried soil}} \times 100$$

Bulk Density

Bulk density is defined as mass per unit volume. Soil bulk density of a sample is the ratio of the mass of solids to the total or bulk volume. This total volume includes both solids and pore space and can help determine if the soil has the physical characteristics necessary for plant growth.

One method of determining bulk density is by using soil core, the method employed in this study. Soil cores were obtained by driving a core sampler into the soil. During coring process, caution was observed to prevent compaction of the sample, a common problem experienced when using this method. Core from the sampling pit was removed, trimmed and placed in an air-tight container and transported to the laboratory. Dried in an oven at 105ºC until weight became constant, soil weight was recorded as oven-dry weight (ODW) and with a known core sampler volume, BD was computed using the formula given below:

$$\text{BD of soil} = \frac{\{(\text{mass of soil + mass of core) - (mass of core})\}}{(\text{volume of core})}$$

where:
volume of core = $\pi r^2 \times h$
r = radius of core
h = the height of core

Floral Diversity

Transect and quadrat methods (Kent and Coker 1994; Brower and Zar 1984) were used to assess the plants in the river and riparian zones.

Establishment of Belts

In each of the five barangay sampling sites, three belts were established in carefully chosen locations. Plastic straw was used in making the belts. The belt was anchored 10 m from the edge of the watermark on each side of the river perpendicular to the riverbank bisecting the actual width of the river. From the anchors, the straw was made to run 5-10 m parallel to the riverbank. Hence, within each station, a belt measured 10 m from the watermark on both sides and 5-10 m wide, which stretched across the actual width of river. The 1 x 1-m quadrats were established alternately within the inner side of the belt.

Collection of Taxonomic Data and Identification of the Plant

Within each belt, all tree species with a height of 10 m or more were counted and where appropriate, the corresponding diameter at breast height (dbh) was measured. For herbs and grasses, sampling was done within the 1 x 1-m quadrats within the belt. The number of individuals for each plant species was counted and recorded. Sampling collection was avoided; hence identification of the vascular plants was done on the field. Field information regarding the locality, common name of the plant, habitat, height, manner of branching, color of the flower and all other taxonomic characters considered vital in the identification of the plant was carefully recorded. Photographs of each plant portraying all its characteristics were taken with the use of a digital camera. For some plants which cannot be readily identified on field, photographs were later scrutinized and features of the plants were compared with already identified plant specimens. Conservation International also assisted the researchers with the identification of specimens.

The local researchers immediately supplied the vernacular names of the plants as well as their corresponding usage. Local terms used in ethnobotany were also translated and described (Appendix 1). Conservation status of each species was determined by consulting several references (e.g., Rojo 1999). Several manuals on taxonomy were used to identify plants (e.g., Merrill 1926; Madulid 1995, 2001; Van Balgooy 1997, 1998).

Analysis of Data

Shannon's and Simpson's community indices were obtained from the data on plants and were used to characterize the landscape of the Langaran River. Because the two indices have different considerations (Shannon's was on proportion while Simpson's was purely on number), both were used to check if a similar trend will be observed. Similarity indices were also obtained and used to compare plant communities between the two barangays included in the study.

Shannon's Diversity Index was obtained using the following formula (Begon, Harper and Townsend 1990):

$$H' = -\Sigma p_i \log p_i$$

H' = Shannon's index

p_i = proportion of species (i.e., number of individuals for species relative to the total number of individuals for all species)

Simpson's Index of Diversity was obtained as:

$$N_2 = \frac{N (N-1)}{\Sigma n (n-1)}$$

where:

N_2 = diversity index

N = total number of individuals of all species

n = number of individuals of a species

Similarity index was obtained as (Odum 1971):

$$S = \frac{2C}{A + B}$$

where

S = similarity index

C = number of species common to the two barangays

A = number of species in barangay 1

B = number of species in barangay 2

Faunal Survey

Captured specimens of some species were examined closely to check the validity of field identifications. These specimens were immediately released back to the wild after taking their measurements. The initial phase of the study was primarily designed to survey the diversity and population of birds found along the five study sites on the Langaran River using transects counts. However, incidental observations of other vertebrates were also recorded (e.g., mammals and reptiles). These sight records were later confirmed and reinforced by collected specimens from live traps and some local indigenous traps.

Survey of Birds

The group used transect count for the survey of birds. Two researchers who were proficient with bird identification walked along the stretch of the Langaran River for three consecutive days in each of the five barangays included in this study, recording number and species of birds. The walk was done for three hours in the morning (7:00 - 10:00) starting from the barangay boundary going upstream, and three hours in the afternoon (2:30 - 5:30) also going upstream and covering around 2 km from the barangay boundary. The following day, the same procedure was followed, but this time the researchers started from upstream going downstream. The next day, direction of the walk was reversed again. Thus, for each barangay, a total of 36 man-hours of observation were accomplished. It was started on one side of the river and when that side becomes impassable, the researchers crossed to the other side. All birds observed along the riverbank and the habitats alongside it, up to about 50 m (effective visual distance) on each side were recorded. Each researcher was equipped with a Tasco 20 x 32 binocular telescope and a field guide on bird identification by Kennedy, et al. (2000) that was used to validate field identification of some unfamiliar species. Each of the two observers did a separate census of birds observed, while following each other on the trail. The three-day record of the two researchers were then pooled, the average of the daily counts for individuals of each species and the average count for three days were taken to get the final record.

The identification of some species was not confirmed in the field, particularly when there was difficulty in observing the bird (e.g., when it was flying against the light or staying in the shadows). However, such birds were still noted in the presentation of the result.

The transect bird survey was started in the middle of April and was completed by the end of May 2002. Based on the number of individuals observed for each species, the bird community in each of the barangays was described by computing the value of Bird Species Diversity (BSD) using the formula given as follows:

$$BSD = - \Sigma \, pi \, (\log pi)$$

where:
BSD = Bird Species Diversity
pi = proportion of i^{th} species in the total sample

Composition of bird species in the five barangays covered by this study was also compared using the Sorensen's Similarity Index that was computed using the formula as follows:

$$SSI = \frac{2C}{(a + b)}$$

where:
a = number of species in one site
b = number of species in another site
C = number of species common to both sites

In this report, residency status of each bird was classified based on the definition used by Kennedy, et al. (2000) as follows:

Endemic = species unique and found only in the Philippines
Near endemic = species found mainly in the Philippines but also occur on a few nearby small islands in neighboring countries
Resident = species that breed or are suspected of breeding in the Philippines
Migrant = species that breed outside the Philippines and migrate only during winter season to the country. Some migrants may stay through the summer, while some, like the area passage migrants may pass through the Philippines enroute to other destinations.
Accidental = species that do not normally migrate, travel to or live near the Philippines

Terrestrial, Amphibian and Aquatic Fauna

Mammals, reptiles and amphibians were surveyed following standard and indigenous methods. Different traps were used to capture live samples. Aquatic animals were also assessed employing both standard and indigenous techniques.

Identification of organisms was done on site with the aid of guides, references and identification books. Specimens captured by the different traps were examined closely (for identification and sex determination when possible) and standard measurements were taken. After such procedures, the animals were released back into the wild.

Terrestrial Fauna

During the transect survey of birds along the Langaran River, incidental observations of nonavian vertebrates were also recorded. These records were later confirmed by specimens collected from live traps that were designed for capturing small mammals and reptiles. The local traps that were deployed included an improvised "green" live cage trap for catching big mammals, commercial snap traps for small mammals and improvised steel live cage traps for medium-sized mammals. These various traps were set up on both sides of the Langaran River and positioned for a period of 48 hours to a week in each barangay. They were regularly checked every three to four hours during the entire sampling period. Indigenous techniques or local traps were also used to capture wild animals. These included the use of “lit-ag” and “pasgong”. The former is a nylon rope with one end tied to a bent bamboo and the other end loosely knotted and placed to the ground with bait at the center. Any animal that would touch the bait would release the loose lock, pulling the nylon rope that would then tightly wrap around its neck or body. The latter is made of bamboo with a hole in the middle of its length. One end of the bamboo, where a piece of rotting meat is placed as bait is kept closed, while the other end is left open for the animal to enter. A nylon rope attached to a bent bamboo pole is loosely knotted at the other end and is placed at the entrance of the “pasgong”. A modified lock made of two small pieces of bamboo is positioned in the knot such that when an animal enters the bamboo to reach the bait, it would touch this lock releasing the knot that in turn would distend the narrow bamboo pole. The animal that is inside the “pasgong” will be inside this knot. When the rope is pulled by the distended pole, the knot tightens around the body of the animal.

Amphibians and Reptiles

Amphibians and small lizards were mostly collected by hand or with use of nets. Collection of herpetofauna was initially confined to a specific area in the riparian zone but later expanded as random captures along the riverbank, underneath rocks and fallen logs.

Local researchers were equipped with pen and notebooks to regularly keep records of the animals they caught and saw during their routine activities.

Despite all the constraints imposed by the difficult terrain and limited accessibility of the study area, the sampling methods used to survey riparian fauna were still employed through modifications of the standard techniques. Based on these results, there was no attempt to express the diversity in terms of density but the results presented were only limited to species richness in order to address the question: “What species are present in the area?”

Aquatic Animals

Nets were used to catch aquatic animals inhabiting the water column of the Langaran River. One particular net used in the four upper barangays (i.e., Singalat, Mamalad, Bonifacio and Tipolo) was a 30 X 6 - meter fine mesh net with a pocket at the center (also made of fine nylon mesh) and supported with floats and weights. A larger net was used, particularly in Barangay Catarman, which measured 500 X 10 m because the Langaran River downstream is wider and deeper. Although the net’s mesh size can be considered illegal as categorized by the Bureau of Fisheries and Aquatic Resources, it was allowed since it will only be used for scientific purposes. The fine mesh size ensured sampling of all animals found in the Langaran River.

The net was set across the width of the river, with a group of local researchers holding the net on both ends and dragging it towards the upstream direction. Where strong water currents increased the amount of drag on the net, it was securely tied to posts on both ends of the riverbank. Several local researchers then waded in the water starting at about 20 m upstream from the net, simultaneously moving towards it, creating heavy water disturbance (splashing) to drive aquatic animals into the net. All trapped animals that were collected in the middle pocket were then transferred into a pail and then sorted by taxa. Representative samples were preserved in 5% formalin and brought to the laboratory for further taxonomic identification. However, the large fine-meshed net still did not effectively catch samples of all aquatic fauna in the river because some fishes seek shelter under the debris at the bottom of the river during the procedure. Samples not collected included those of species known to be active during the nighttime. To increase sampling success, some local fisherfolks were tasked to obtain other aquatic organisms using indigenous methods.

Although day and night collection continued for several days, local fisherfolks still insisted that there were a lot of species that were still not represented in the collection. Thus, they suggested that another indigenous catching method, the “pahubas” which means “drying the river” be used. It involves looking for a shallow part of the river where aquatic organisms are expected to gather, to hide and evade strong water current. Big rocks were piled to create a barrier/wall. Various materials such as plastics, nets, leaves and twigs are then used to patch the holes and crevices in the barrier/wall. The wall diverts the water flow to the middle of the river, and gradually dries the side where organisms are gathered and collected. A “bobo” and “balantak” are placed at the exits of the water channels draining the collection area. These traps are both made out of bamboo sticks tied to each other, but they differ in shape. The bobo is tubular while the “balantak” is square. Both have openings that allow entrance of organisms but bar their exit. Once the water has been fully diverted towards the middle of the river, the collection area is left alone until the water has completely drained. It is expected that as the water is gradually drained towards the exit of the channel, the organisms would move with the flow of water. The bamboo trap that has been set up at the exit will gather all the organisms present in the collection area.

Because of the very strong current and the irregular topography of the bottom of the river (e.g., presence of big rocks), it was very difficult to control the netting activities and manipulate the collection area. Hence, it became impossible to determine the exact abundance of each species. As a result, aquatic animals were reported based on occurrence and their limited relative abundance.

Cryptozoans

Cryptozoans along the river were studied using “drop boards”. About eight 30 x 30 cm wooden boards (of same type) were laid out on both sides of the river in each of the five barangays. The boards were placed in moist and relatively protected areas in the riparian zone and were left in the area for five weeks. Heavy objects such as big pieces of wood or small rocks were placed over the boards to keep them in place. Species of animals that prefer dark, cool, and moist microhabitats collected under these boards. A local researcher was assigned to check the boards during the five-week period.

During sampling, each board was lifted carefully and very quickly. The area covered by the board was marked to insure that samples were taken only from within that area. Most cryptozoans are negatively phototactic and would quickly seek out dark hiding places when exposed to sunlight. Hence, samples were rapidly collected and placed in glass jars. Soils under the boards were also collected, placed in transparent plastic bags and searched for more cryptozoans. Samples were sorted and identified to the highest taxonomic level possible.

Macroinvertebrates

Macroinvertebrates in the river were separately assessed. Their presence or absence can determine the quality of water in the Langaran River.

Benthic macroinvertebrates were collected from riffle areas and moving water from eight sites of the four barangays (Singalat, Mamalad, Bonifacio and Tipolo), within and draining into the Langaran River. Singalat is near the headwaters of the river while Tipolo was the last barangay downstream where the water was still fresh. The river water beyond Tipolo already mixes with the salt water during high tide. The other two barangays are located between Singalat and Tipolo.

Dip net method was employed to collect the macroinvertebrates in the river. Mesh size of the nets was 0.5 microns. Samples were taken by a two-person team. In the dip net method, the net is positioned facing upstream. One person disturbs the area upstream at a distance of about one meter. The seine is then lifted out of the water with a forward scooping motion. The net with all the collections was then carried to the riverbank. Collected debris was emptied into a large plastic tray containing riverwater. Big debris were cleaned of any macroinvertebrate and thrown back into the river. Stones were also picked up, water surface animals scooped, leaves collected, and gravel examined for macroinvertebrates. The process was repeated three to four times in each sampling site to ensure that all the macroinvertebrates in the area were represented in the collection. When all was settled, all macroinvertebrates in the tray were carefully and gently transferred into a white dish. With the help of a magnifying glass, the macroinvertebrates were identified in situ using Kanjanavanit and Tilling’s “Guide to Freshwater Invertebrates of Ponds and Streams in Thailand" (Appendix 2). After identification, the organisms were thrown back into the river.

Using the same guide, the macroinvertebrates were scored using the "Water Quality Index Table". The table gives corresponding points for a particular macroinvertebrate species present, regardless of the species' abundance. After all the animals were scored, the sum was obtained and was then divided by the number of animal types obtained. The resulting value is the Water Quality Index. Water quality is then described based on the following range of scores:

- score 7.6 - 10 *very clean water*
- score 5.1 - 7.5 *rather clean – clean water*
- score 2.6 - 5.0 *rather dirty water – average*
- score 1.0 - 2.5 *dirty water*
- score 0 - *very dirty water (no life at all)*

To test whether the procedure can be easily taught to and replicated by the community, a group of undergraduate students were made to conduct the same study under the supervision of a lead researcher of the project.

Coliform Load

Water samples from the river were collected from upstream to downstream. They were brought to the laboratory for standard coliform analysis.

Collection of Water Samples

Four barangays situated from upstream to downstream along the Langaran River were included in the study. These were: Singalat, Mamalad, Bonifacio and Tipolo. Ten sampling stations were established along the river: two in Barangay Singalat, three in Barangay Mamalad, two in Barangay Bonifacio and three in Barangay Tipolo. Using sterile 100-ml sampling bottles, three water samples from different points within each sampling station were collected. The water samples were collected in spots where local inhabitants obtained their drinking water. Individuals from each study barangay were hired to collect water to ensure that collection was done the same time of the day. Bottles containing water samples were put in a cooler and immediately transported to the laboratory for analysis. The water samples were analyzed within 12 hours after collection.

Laboratory Analysis

Protocols for microbiological analyses were observed in performing coliform analysis. All glassware used were decontaminated in a pressure cooker and washed with liquid detergent aided with disinfectant. Final rinsing was done using distilled water.

Test for Coliform Bacteria

The test is a primary indicator of potability of water because it detects the presence of coliform in the water. It is composed of three stages of tests: presumptive test, confirmed test and completed test.

The presumptive test is based on the fact that coliform bacteria ferment the disaccharide sugar lactose to produce organic acids and certain gases, whereas most natural water bacteria do not. A positive result– that is, the presence of gas in the inverted vial (Durham tube) in any tube- means that coliform might be present or presumed to be present.

The confirmed test is done to verify the evidence of the presumptive test. The completed test is done to determine if the coliform is fecal in origin.

Procedure

In the laboratory, the bottles containing the water samples were shaken up and down at a distance of approximately one foot for about ten seconds. Using sterile pipettes, a 10-ml water sample was transferred into five tubes with prepared double strength lactose bile broth (LB) (Appendix 3). Another 1 ml and 0.1 ml of the sample was transferred to sets of five tubes containing single strength lactose broth (Appendix 4). The tubes were agitated gently and were placed in an incubator set at 35^{O}C for 24 hours. After the 24-hour incubation period, the tubes were gently agitated to check for gas production. The presence of gas is a presumptive evidence of coliform organisms. Tubes that did not produce gas were reincubated for another 24 hours. Those that did not produce gas after reincubation were discarded.

Gassing LB tubes were gently agitated. A loopful of the liquid from each tube was transferred into a tube containing Brilliant Green Lactose Bile (BGLB) medium (Appendix 5). BGLB tubes were then incubated at 35^{O}C for 48 hours, after which they were examined for gassing. The number of tubes that produced gas was recorded. BGLB tubes that did not show gassing were discarded. Gassing tubes in BGLB medium confirms the presence of fecal contaminants.

Positive BGLB tubes were shaken gently. A loopful of the sample was transferred to prepared *Escherichia coli* (EC) broth tubes (Appendix 6). The EC tubes were then incubated at 44^{O}C for 48 hours. The number of tubes that exhibited gassing was recorded while those that did not produce gas were discarded.

A loopful of sample was taken from all positive (i.e., produced gas) EC tubes and streaked on the prepoured Mc Conkey Agar plates (Appendix 7). The inverted plates with the streaked sample were incubated at 35^{O}C for 24 hours, after which they were examined for purplish or pink colonies. These colonies are fecal in origin. The Mc Conkey Agar test completes the test for coliforms.

Based on the number of Durham tubes that exhibited gassing, the density of coliforms in the water, expressed as the most probable number (MPN) of organisms per 100 ml water sample, was determined using the MPN standard table (Appendix 8).

Because fecal coliforms can be a mix of *Escherichia coli* and *Enterobacter aerogenes*, IMViC tests were performed on the pink/purplish colonies from the Mc Conkey agar. These are a series of tests that would distinguish *E. coli* from *E. aerogenes*.

IMViC Tests

Methyl Red Test

Nutrient Broth Glucose (NBG) was prepared according to the manufacturer's guide (Appendix 9). Test tubes of Nutrient Broth Glucose were inoculated with the isolates from Mc Conkey Agar and were incubated for 48 hours at 35^{o}C. From each tube, around 3 ml of sample was obtained and transferred into another test tube. Approximately, one to two drops of methyl red indicator were added. The color red indicates that the sample tested positive for *E. coli*.

Voges-Proskauer Test

To the remaining culture in NBG medium, 10 drops of 5% alpha-naphthol (Appendix 10) and 15 drops of 40% KOH or potassium hydroxide (Appendix 11) were added. The mixture was allowed to stand for 20 minutes. Pink to red color is indicative of non-acidic culture and is considered as positive, indicating the presence of *E. aerogenes*. On the other hand unchanged color medium denotes a negative result which is indicative of the presence of *E. coli*.

Indole Test

Tryptone broth was prepared in the laboratory (Appendix 12). Prepared tubes of tryptone broth were inoculated with an isolated purplish colony from the Mc Conkey agar plates and incubated for 48 hours at 35^{O}C. After the incubation period, two drops of prepared Kovac's reagent were added. The mixture was then allowed to stand for five minutes without mixing. A red ring on the interface of the tryptone solution is a positive indication for indole test. Because prolonged incubation may lead to further utilization of indole that could give a false result, examination of the incubated tubes was done exactly after 48 hours.

Simmon Citrate Test

Slant tubes of Simmon Citrate Agar (Appendix 13) were stabbed and streaked with a straight needle inoculated with the purplish colony from the Mc Conkey Agar plates. Inoculated tubes were incubated at 35^{O}C for 48 hours. Visible growth and change in color from green to blue is a positive reaction and the absence of visible growth denotes a negative result.

The results from IMViC tests to separate *E. coli* from *E. aerogenes* can be summarized using the following IMViC table:

Appendix 14 shows the coliform standards set by the Department of Environment and Natural Resources administrative order for freshwater of different usage.

Socioeconomic Characteristics

Research Strategies

A survey questionnaire was developed to address the project objectives. There were items in the survey that required detailed explanation and cross-checking. To this, focus group discussions composed of key persons in the barangays were organized to probe on some significant issues related to the state of the river. To further supplement the information from the surveys and the FGDs, the team members were made to note down significant information out of their casual conversations with the members of the community and actual observations of the people's daily activities.

Description of the Population and Sample

Local researchers who participated in the training for local researchers were asked to obtain data on the total population and a location map for the barangay they represent. Within each barangay, the *puroks* (a subunit within a barangay) and households were located. Names of the persons in the households were given a corresponding number to facilitate random selection of respondents.

Total population in the five barangays was variable. The upstream-most barangay of Singalat had the lowest population while Barangay Tipolo was the most heavily populated among the study barangays. The location map also showed that houses in Singalat were comparatively more scattered than in the other barangays. In this study, the household was chosen as the unit because it was the "social group which resides in the same place, shares the same meals and makes joint or coordinated decisions over resource allocation and income pooling" (Ellis, 2002). To ensure representation in each barangay, around 30% of the household population was picked as respondents in the survey. The proportion was higher where the population was lower (i.e., 37% in Singalat). A stratified random sampling was employed. Thirty percent of the households within each of the *puroks* in a barangay were randomly chosen to comprise the respondents. The names were located in the map to confirm their random distribution. The short listed individuals that resulted from this selection process were the respondents in the survey using a questionnaire.

The participants for the focus group discussions were selected purposively. Preliminary survey and discussions with the barangay captain revealed that in general individuals in the barangay played multiple roles. For example, a *kagawad* (i.e., an elected member of the barangay council) was also the head of a cooperative or a women's organization. The selection of participants for the focus group discussion was therefore based on the criterion that the person should either be a barangay official or a leader of a barangay-based organization. A maximum of eight participants comprised a group for each barangay.

Instruments Used in the Study

The questionnaire was the basic instrument used in this study. To test its validity, the questionnaire was administered separately to 20 randomly chosen individuals. Comments and feedbacks of these individuals were used to evaluate and improve the questionnaire. The revised questionnaire was revalidated by administering to another 20 individuals who were also chosen randomly. Based on the comments and feedbacks obtained, the instrument was reformulated and reproduced for use in the survey.

Focus group discussions were conducted to explain to or elicit information from key respondents (i.e., FGD participants) in response to questions asked of them. The questions were based on items in the questionnaire that required deeper discussions and clarifications.

Administration of Survey and Conduct of Focus Group Discussions

Questionnaire Survey

Local researchers that underwent the training were tasked to administer the survey in pairs.

One person took charge of asking the questions and the other of recording the answers. At the end of each day, the local researchers sat down with the team to discuss the day's work, go over the completed questionnaires, review the process and discuss problems, if any, to avoid encountering them the following day. The accomplished questionnaires for the day were immediately collected and filed.

Focus Group Discussions

The FGDs were conducted separately for each barangay and tape-recorded. Each group meeting lasted for half a day and was moderated by a member of the team.

Collation and Analysis of Data

Accomplished questionnaires were collated by barangay. A separate manual of codes for all the items in the questionnaire was developed to facilitate collation of data. Using these codes, answers given by the respondents were entered in a database file. The data were analyzed using SPSS and presented in terms of frequency distribution and percentage. For an item that was sequel to a preceding question, the answers tabulated were only from those respondents that provided answers to such preceding question. Thus, in many tabulated items, there was non-correspondence in the total number of respondents.

Tapes used to record the focus group discussions were transcribed. Results for each barangay were synthesized and tabulated in one table. Information from field notes and actual observations were used to supplement these results and those from the survey.

Results and Discussion

Physical, Social and Cultural Settings

Physical Landscape

Langaran River is just one of the rivers that drain the Mt. Ampiro and Mt. Balabag watersheds. It runs in a zigzag fashion from the foot of Mt. Ampiro in the municipality of Concepcion, bisects the municipality of Calamba and courses through the municipality of Plaridel, finally emptying the waters into the coasts of Poblacion, Plaridel. There were three big dams along the river. The first was in Napisik-Sipukat area within the jurisdiction of the municipality of Calamba. The irrigation water was distributed to the rice fields of Baliangao and Calamba. According to the Municipal Agricultural Office of Calamba, around 1,000 hectares of fields in the municipality of Baliangao and approximately 300 hectares in Calamba were served by the waters coming from this dam. The second dam, called Communal Irrigation System, was built in Nazareno of Barangay Tipolo by the Association of Farmers. This was the biggest among the three dams. The water irrigates more than a thousand hectares of rice fields in most of Calamba and Plaridel. The third dam, which was relatively small, was also in Tipolo, serving the rice fields in the remaining parts of Plaridel towards the municipality of Lopez Jaena.

The uppermost sampling station was located in Tingkob, a *sitio* (a political subunit of a barangay) of Barangay Singalat, where the banks were very steep. The river, which had an average width of 20 meters had huge boulders, as well as small rocks. In the summer and dry months, the water becomes shallow and limited to the mid channel-like part. However, during slight rains in the mountains, water can rush heavily, with water level reaching the steepest banks.

On the way to the lower boundary of Singalat, the river widens to an average of 41 meters. The water also becomes deeper. Further downstream, the river becomes even wider and the banks become flatter. There were banks in Mamalad and Bonifacio that remained very steep; but unlike the steep banks in Tingkob, these banks lacked lush vegetation. The hard rocky substrate was exposed. The rocks and stones were much smaller than those seen in the upper Tingkob. Some parts were relatively deeper. The part of the river that went through Mamalad had an average width of 42.5 meters. Going down to Barangay Bonifacio, big and small rocks were observed. Some banks were visibly eroded by the rushing water. As one approached Barangay Napisik in Calamba, the water diverted to the canal leading to the Napisik-Sipukat dam. Further down in Sitio Nazareno of Barangay Tipolo was the biggest of the three dams in the river, the Nazareno dam. A wall had been built across the river to divert the water to the dam canal. The dam was built to trap most of the water, allowing some overflows only when water level was relatively high. During ordinary days, upward movement of aquatic organisms became very difficult.

Approximately one kilometer below the Nazareno dam was the third dam along the river. The dam was constructed by the Philippine National Irrigation Authority. This part of the river had an average width of 43.66 meters, with very shallow water and low banks. Salt intrusion during high tide had been reported below this dam.

The banks of the river down to Barangay Catarman, were even lower. There were vast irrigated rice fields beyond the banks, coconut trees and houses. Water in this part of the river, at the time the study was conducted, was brackish and regularly inundated by tidal waters.

The bottom of the river from Napisik to the mouth was visibly irregular. Quarrying for rocks, stone and sand was a common site. There were a number of quarrying stations, where flat-bottom quarry boats (called ‘bote’) were also docked. There were piles of rocks, sand and gravel in the banks.

Speed of the water was stronger upstream than downstream. When there was no rain, the average speed was 5.0 meters/second, 5.3 m/s, 12.9 m/s and 19.6 m/s in barangays Singalat, Mamalad, Bonifacio and Tipolo, respectively.

Cultural and Political Settings

Langaran River has its headwaters at the foot of Mt. Ampiro and Mt. Balabag where the neighboring sitios and barangays are under the jurisdiction of the municipality of Concepcion. Sitio Tingkob of Barangay Singalat, where the assessment and inventory study started is under the jurisdiction of the municipality of Calamba. The other two barangays in the municipality of Calamba included in this project were Mamalad and Bonifacio. The last two downstream barangays, Tipolo and Catarman, are in the municipality of Plaridel. The barangays on the other side of the river in Singalat and Mamalad, including Burgos and Mabas, are under the jurisdiction of the municipality of Lopez Jaena. Since multiple municipal government units have jurisdiction over the stretch of Langaran River, it is necessary that these municipalities coordinate and cooperate for any management activity to succeed.

At the time this project was conducted, residents of three out of five barangays that participated in the project were predominantly Subanons and half-Subanons. In particular, Mamalad was the home of the NCIP Provincial Coordinator for the Province of Misamis Occidental and was also the home of the leaders of the Subanon organization called “Banwak Subanon”. As such, an activity, including BRP’s research projects should get the approval and/or endorsement of not only the legitimate local government unit (i.e., the barangay) but also the Banwak Subanon through the NCIP Provincial Office. The protocols established by the barangay unit and the Subanon group had to be complied with, to avoid intimidating any group. The presence of these Subanons who had become assertive of their rights over the land as mandated by the Indigenous Peoples’ Rights Act (IPRA) implies that management of the river should also consider the traditional practices and indigenous knowledge of the people.

Consequently, cultural practices required for entry into the community should be respected and observed. In the case of the BRP river project, the Timoay (Subanon chieftain) and Bailan (Subanon priest) required the researchers to make an offering as a way of asking permission to conduct research in the river environment. But since the project team had already started the fieldwork when the notice was given, a ritual and an offering for forgiveness were made instead. The Subanon culture requires that nature should not be disturbed without asking permission from the gods. The Timoay and Bailan performed the ritual in the presence of the team. This culture of the Subanons to ask permission from “kinaiyahan” or nature could have some bearing on the management of the river. If adhered to, the indigenous culture can be a driving force behind conservation and protection of nature.

Physiological Characteristics: Riverine and Riparian Soils

Soil pH

The range of the pH (H_2O) indicated that the soils were between moderately to very slightly acidic. It also showed that the soils upstream (Singalat) were more acidic than the soil downstream (Catarman). Singalat soil had an average pH of 5.7 while Catarman had 6.5. In general, the reaction is alkaline when the pH value is above 7.0; neutral at 7.0; and acidic when below 7.0. In practical terms, soils between pH 6.5 and 7.5 were considered neutral. Soils within the range of 5.6 to 6.0 are moderately acid and below 5.5 strongly acid. Most plants grow best in soils with a slightly acid reaction because in this pH range, nearly all plant nutrients are available in optimal amounts. This must be true for the studied soils. The lush vegetation growing in these areas were indications that the soils were at optimum pH condition.

Soil reaction or soil acidity changes for a variety of reasons. Where there is heavy inorganic fertilizer application, particularly the ammonium containing fertilizers, increased acidity is a likely consequence. Other reasons for increased acidity, although may have not played significantly at the present case, are the acidity contributing soil components such as oxides and hydroxides of Fe and Al, allophanic clays, and humus. These soil components have different mechanisms generating acidity and thus have different acid strengths (Nanzyo, et al. 1993). The probable reason that the soil in Catarman was less acidic compared to Singalat’s was its close proximity to the coastal area, thus a more saline groundwater.

The pH (KCl), as earlier mentioned, is referred to as buffered pH and its value is usually lower than pH (H_2O) (Tan, 1998). Values obtained by this type of measurement are known to be more stable than pH (H_2O). They also provide better information on the chemical properties of the soil, particularly its cation exchange capacity (CEC) and cationic composition of the exchange complex. When pH (KCl) value is compared with pH (H_2O), that is pH (KCl) - pH (H_2O), any difference observed between the two pH values is called ∆pH, and determines whether the net charge of the soil colloid is negative, zero, or positive. The nature and the amount of charge reflect CEC of the soil, which in turn speaks about its fertility.

In this study, the pH (KCl) values of all the studied soils were lower than the pH (H_2O) values (Table 1), an indication that these types of soils were those that would generally have negative net charge. Soils containing high amounts of inorganic constituents that have amphoteric surfaces, such as oxides and hydroxides of Fe and Al and short-range order minerals such as allophane and imogolite are likely to have positive net charge. The soils studied in Langaran were not like these, which can be considered as problem soils.

Organic Matter

Organic matter (OM) influences many soil chemical and physical properties and also enhances biological activity and productivity. It contributes substantially to the total cation exchange capacity (CEC) of the soils. The estimate was 25 to 90% of the total CEC of the surface horizons of mineral soils is due to OM. A not so far-fetched estimate considering that the CEC of OM, as reported by Green (1971), ranges from 100 to 500 $cmol_c\ kg^{-1}$ with a mean value of 300 $cmol_c\ kg^{-1}$. Organic matter maintains the soil structure. It also acts as a buffer for chemical fertilizers, reducing their possible harm. In fact, the organic content and structure of the soil has to be managed as carefully as the nutrient content.

As organic C is the major component soil organic matter, a measurement of organic C can serve as an indirect determination of organic matter. The most routine organic C determination procedure is the Walkley-Black dichromate method (SSIR No. 42, Version 3.0. 1996, p. 219). Values for organic C are then multiplied by 1.724 to calculate organic M. This factor is based on the assumption that organic matter contains 58% organic C.

The loss of ignition (LOI) method was used to determine the soil organic matter of river and riparian soils along the Langaran River. The values obtained through this method for all the soils studied are presented in Table 2. Organic matter of 11% was about the average content of all the soils. The corresponding value in organic C (at 58%) should be 6.38%. For an unexceptional mineral soil in humid tropics, this figure is high. In fact, the BSWM-CARE (2002) study of soils in Mt. Malindang Buffer Zone shows that the organic C contents are mostly within the range of 0.86 to 5.6% only or their organic matter equivalent range of 1.48 to 9.6%. It is suspected that the discrepancy is due to the inherent limitations of the LOI as a method to determine OM. One such problem occurs when weight loss is due to something other than SOM, which is likely to happen when temperature exceeds than is stated in the method. Minerals common in soils such as gypsum, montmorillonite, vermiculite, and gibbsite can be subject to moisture losses of 20-30% of their total weight.

Regardless of the actual values, Table 2 shows that the soils from the five barangays (Barangay Singalat down to Barangay Catarman) were not significantly different in terms of OM content. That no trend can be established can be attributed to the fact that riparian soils were inherently heterogeneous in mineral or organic character by virtue of the influence of water or flooding in these zones. Periodic flooding does not only result to periodic deposition of sediments but also to flushing of organic material from some riparian sites creating differences at microenvironment levels, then increasing heterogeneity. This explains why trend for OM content was difficult to establish. Overall, however, the results proved that deposition enriches soils and suggests accumulation and possible stabilization of organic matter in these soils. High soil OM enhances the role riparian soil plays in filtering out nutrients and other

Table 1. Soil pH of the Langaran River (riparian zones) within the studied five barangays

Barangay	pH (H_2O) (1:1)				pH (KCl) (1:1)			
	Left Bank		Right Bank		Left Bank		Right Bank	
	0-20 cm	20-35 cm	0-20 cm	20-35 cm	0-20 cm	20-35 cm	0-20 cm	20-25 cm
Singalat	5.7 C	5.7 C	5.5 B	5.6 B	4.4 C	4.5 B	4.5 B	4.4 C
Mamalad	5.7 C	5.7 C	5.8 B	5.7 B	4.7 B	4.6 B	4.6 B	4.7 B
Bonifacio	5.6 C	5.3 D	5.5 B	5.6 B	4.6 B	4.6 B	4.5 B	4.6 B
Tipolo	6.2 B	6.1 B	6.6 A	6.2 A	4.9 A	5.0 A	5.0 A	5.0 A
Catarman	6.5 A	6.5 A	6.4 A	6.4 A	5.1 A	5.0 A	5.2 A	5.2 A

* Means with the same letter are not significantly different at 5% level

Table 2. Bulk density and organic matter values between barangays

Barangay	OM (loss of ignition)				Bulk Density (g/cm^3)			
	Left Bank		Right Bank		Left Bank		Right Bank	
	0-20 cm	20-35 cm	0-20 cm	20-35 cm	0-20 cm	20-35 cm	0-20 cm	20-35 cm
Singalat	10.2 A	11.7 A	7.7 A	8.0 A	1.09 C	1.12 A	1.05 C	1.15 A
Mamalad	13.9 A	12.4 A	9.0 A	8.8 A	0.98 C	0.96 B	1.11 B	1.26 A
Bonifacio	13.2 A	13.4 A	9.6 A	12.0 A	1.12 B	0.93 B	1.20 A	1.20 A
Tipolo	10.5 A	10.6 A	6.9 A	9.6 A	1.29 A	1.20 A	1.29 A	1.26 A
Catarman	9.6 A	10.9 A	11.0 A	8.6 A	1.33 A	1.20 A	1.25 A	1.23 A

* Means with the same letter are not significantly different at 5% level

harmful chemicals from surrounding land uses.

Bulk Density

The bulk densities (BD) of the representative soils are presented in Table 2. Catarman soils had the highest BD values given that it was the barangay closest to the coastal area. As such, it was possible, although texture was not determined in the laboratory, that the coarser soil texture in Catarman was what made its BD higher than Bonifacio, Mamalad and Singalat. As stated earlier, sandy soils tend to have higher bulk densities than silt loams, clays and clay loams (Brady and Weil 1999), because sandy soils are less likely to be aggregated as fine textured soils are into porous granules. Hence, as the soil texture gets finer (more so if organic matter content is high), the lower is the soil's bulk density. Consequently, the soils upstream, where the vegetation was more lush, must be more porous, a soil physical condition much more desirable for plant growth and other soil living organisms.

Biological Characteristics: Diversity of Organisms

Vascular Flora

A total of 251 vascular plant species were recorded in the riparian zones but only one species of aquatic plant was found in the stretch of the Langaran River. Of the 251, only 212 species were identified taxonomically. These different plant species belonged to 185 genera and 80 families. Because of the absence of plant structures that bear key identification characters like flowers and fruits, some species were not identified.

Of the five barangays chosen as sampling areas, Singalat (Tingkob and Singalat proper) recorded the most number of plants totaling to 191 different trees, shrubs, undershrubs, herbaceous dicots, epiphytes (orchids, lianas) and grasses (Table 3). Three belts were constructed in Tingkob. The right riparian corridor of Sitio Tingkob where the first belt was placed (going downstream) was a very steep damp slope covered with moist vegetations like ferns, fern allies and aroids. More importantly, it was only in Tingkob that *Medinilla* sp. (family Melastomaceae) was encountered. This plant species was visibly abundant in the area and can be easily confused with the endemic and high-priced ornamental *Medinilla magnifica*. Careful examination of the photographs and field observations of the morphological features of this *Medinilla*, as well as confirmation from Conservation International, finally ascertained the identification of the species to be *Medinilla* sp. and not *Medinilla magnifica.*

the river edge was a ricefield. The bank overlooking the river was covered with species of grass like *Saccharum spontaneum* (bugang), sedge (*Scirpus* sp.) and shrubs like *Diplodiscus paniculatus* (balobo) and *Prunus clementis* (bakan). In the interface of the ricefield and the grassy bank were wasteland small plants.

Table 3. Characteristics of the plant community in each barangay

	Barangay				
	Singalat	Mamalad	Bonifacio	Tipolo	Catarman
no. of species present	191	54	43	53	41
no. of endemic species	15	6	2	6	1
no. of unique species	128	27	14	22	11
Shannon's diversity index	1.28	1.01	1.19	1.36	0.89
Simpson's diversity index	12.5	7.73	9.64	14.7	3.24

The left riverbank in Tingkob had been cleared and patches of agricultural land planted with corn and coconut were readily observed. Some areas were covered with grasses and escaped ornamental plants (e.g., *Odontonema strictum* and *Sanchezia preciosa*). *Cocos nucifera* (coconut) and *Hibiscus tiliaceaus* (malibago), and other trees found in this barangay were utilized by epiphytes like orchids and ferns. Floral species in Tingkob was attributed to habitat diversity in cross-section and periodic disturbances like flooding. Temperature in this area was also lower and human intrusions were very minimal. These conditions potentially permitted survival of many native plants. Soil analysis showed that the bulk density of the soil in Tingkob is low, indicating a less compacted soil that favored rich riparian vegetation. Relatively bigger rocks resulting from the fragmentation of rock boulders characterized the river on this site. The water, at the time the study was done, was very cold and the velocity of its flow, high. This condition of the lotic area of the river makes it difficult for aquatic plants to thrive.

Downstream, a kilometer and half from Tingkob is the center of Barangay Singalat. The width of the river is noticeably broader in Singalat. Both sides had been cleared of natural vegetation and had been planted with rice and other crops. Facing downstream, the right riparian area of the first belt slopes; and just five meters from

The left bank of the river had been cleared and served as backyard gardens of the houses built near the river. Domestic crops like *Musa* (saging), *Artocarpus heterophyllus* (nangka), *Theobroma cacao* (cacao) and *Saccharum* (sugarcane) were planted on this side of the riverbank. A meter or two from the river, on the same side, was eroded soil interspersed between rocks. This part of the river was dry when the water flow was slow. *Homonoia riparia* (amagus) can be seen growing in this area. The second belt was placed a kilometer downstream from the first belt. Coconut trees were planted on the right riverbank. Shaded by the same trees were ferns and fern allies like *Sphaerostephanos unitus* (ginit-ginit) and *Selaginella* together with *Polygala paniculata* and other plants common in waste places and thickets. Bordering the riverwater were *Hibiscus tiliaceus.* The opposite riverbank was occupied by *Wedelia trilobata* (burikat).

Fifty-four plant species were inventoried in Barangay Mamalad, which was more densely inhabited than Barangay Singalat. The barangay folks depended on agricultural crops to a great extent for their source of living. The river, as it passed through this barangay, bifurcated, resulting to the formation of an island-like mass, which at the time the study was conducted, was planted with agricultural crops. The site chosen for the establishment of the first belt was a barren and steep portion of the right bank, which had constantly eroded, increasing the width of the river. Coconut trees and forage grasses like *Paspalum* and *Chrysopogon* (amorseco) occupied the remaining riverbank beside the ricefield. The left riverbank was a flat area often flooded by water from the river. The invasive *Wedelia trilobata* dominated this side of the riverbank. Another belt was placed near the point where the river water bifurcates. Shrubs and *Wedelia* covered the low-lying left side of the bank while grasses and the parasitic *Helixanthera* on an olingon (*Cratoxylum sumatranum*) tree were on the opposite bank. There was no growth of a single vascular plant species.

In Barangay Bonifacio, 43 plant species were encountered. The right bank of the river was mainly ricefield while the left side was planted with *Cocos nucifera* (coconut) and *Zea mays* (corn). The river width was smaller in the sites where the belts were placed. The riverbanks were characterized by small stones and eroded soil where the herbaceous *Amaranthus* (rosas de pasong), *Passiflora foetida* (karnabal) and *Mimosa pudica* can be found.

Barangay Tipolo was the first barangay in the landscape where massive quarrying can be observed. Two dams were also built along the river in this barangay. The first belt in this barangay was placed approximately 10 meters from Nazareno Dam. The riverine floor was heavily silted and muddy and the only riverine flora observed on this belt was *Hydrilla verticillata*. Both sides of the river were low-lying. The left bank was planted with fruit trees like *Lansium domesticum* (lansones). The right bank was dominated by the invasive *Wedelia trilobata*. The riparian portion where the second belt was established was characterized by a sloping bank covered with trees (*Ficus, Cocos, Gmelina*) and shrubs. The third belt was placed within a quarrying area where the river was quite deep. The researchers had to use a *bote* (flat-bottom boat) to cross the river. Wasteland plants and coconut trees occupied the right bank of the river. Across the river, the plants encountered were *Wedelia*, *Solanum* and *Elephantopus scaber.* Fifty-three different species were recorded in Barangay Tipolo.

The last sampling area was Barangay Catarman, where 41 plant species were recorded. The coastal end of the river in Catarman floods during high tide. The river water is deepest in this barangay. The researchers had to use a boat to move around and cross the river. The left riparian area of Catarman was a vast ricefield, while the right was a settlement area. Like in Tipolo, this side of the riverbank was either used for hog-raising or just left idle, thus allowing the prolific *Wedelia* and *Chromoloaena* (hagonoy) to cover the area. Both sides of the river are very steep and when it floods, the riverbanks are constantly eroded by water. In order to stop or minimize the erosion, the barangay folks tried planting *Nypa fruticans* (nipa) on the edge of the riverbank but only a number of plants survived.

The vegetation composition of each barangay was compared with the vegetation of all the other barangays using a similarity index. A high index value implies that two barangays are highly similar in species composition. Adjoining barangays expectedly hosted greater number of similar species.

Similarity index was highest (0.45) in Singalat Barangay Hall and Mamalad. Topography and degree of human disturbance were visibly similar in these two sites. The similarity index in Mamalad and Bonifacio was 0.41, 0.35 for Bonifacio and Tipolo, and 0.40 for Tipolo and Catarman. Unexpectedly, Tingkob of Singalat and Lower Singalat had the lowest similarity index which was 0.22 (Table 4). This could be attributed to the fact that Tingkob is near the headwaters; and the vegetation-covered sloping riverbanks discouraged human activities. Another factor could be the absence of human settlements, considered as primary agents of destruction and loss of biodiversity. But as can be seen from Table 3, all the barangays had very different species compositions compared to Tingkob. This suggested that plant communities in these barangays were in a different stage of plant succession compared to Tingkob.

There were some conspicuous floristic differences in the five barangays where the assessment was made. Singalat had 128 unique species, Mamalad had 27, Bonifacio had 14, Tipolo had 22, and Catarman only had 11 unique species. As seen, Sitio Tingkob, the uppermost barangay assessed, had the most number of

Table 4. Similarity indices to compare the vegetation of barangays along the Langaran River

	Tingkob, Singalat	Lower Singalat	Mamalad	Bonifacio	Tipolo	Catarman
Tingkob, Singalat	1					
Lower Singalat	0.22	1				
Mamalad	0.17	0.45	1			
Bonifacio	0.19	0.39	0.41	1		
Tipolo	0.15	0.34	0.34	0.35	1	
Catarman	0.17	0.36	0.32	0.36	0.40	1

unique species. This finding is parallel to the observation that Tingkob had also the most number of species.

Very prominent in the study sites was the dominance of the introduced *Wedelia trilobata* in the riverbanks of Mamalad down to Catarman. The species covered vast areas of the bank. Local researchers claimed that wherever this species grew, native species eventually disappeared.

Of the total inventoried plant species, 30 were fern and fern allies, while the rest were angiosperms (flowering plants). Not a single gymnosperm species was encountered in the chosen sampling areas. *Gramineae/Poaceae* was the most dominant family, which recorded 16 different species. This finding confirms the pantropic distribution of the grass family and its being opportunistic and invasive in nature. The other families, which included a high number of species, were *Compositae, Moraceae, Euphorbiaceae, Leguminosae/Fabaceae* and *Araceae*. The former two families were represented by 11 species while the latter families were represented by 10 species.

Ten vascular plant species were observed in all the inventoried areas. These included *Melastoma malabathricum* (antotongaw), *Diplazium esculentum* (pako), *Paspalum conjugatum* (balili), *Mikania cordata* (moti-moti), *Leea philippinensis* (malibuaya), *Wedelia trilobata* (burikat), *Pseudoelephantopus spicatus*, *Nauclea orientali*, *Cocos nucifera,* and *Nephrolepis hirsutula*.

Shannon's Diversity Index and Simpson's Index were computed to compare plant community in each barangay (Table 3). Values showed that diversity was highest in Barangay Tipolo (1.36) followed by Tingkob-Singalat (1.28), Bonifacio (1.19), Mamalad (1.01), and Catarman (0.89). These values are misleading in terms of species richness because Tingkob-Singalat had the highest number of species (Table 3) but Tipolo turned out to have the highest Shannon's diversity index. It should be noted that the diversity index takes into consideration not only the number of species but also the number of individuals per species. A closer examination of the data showed that most of the species inhabiting the riparian corridor of Tipolo were small-sized. These were also plants that grow easily in very disturbed habitats. However, in Tingkob-Singalat, while there were many species of plants present, each species was represented by just a few individuals. Hence, diversity index was higher in Tipolo than in Tingkob-Singalat.

Native plants of the riparian zones from Singalat Barangay Hall going downstream were supplanted by invasive plant species. This trend can be attributed to the increasing human disturbance as the number of inhabitants increased as the river progresses downstream. Most striking was the prevalence of woody species like *Dillenia philippinensis* and *Litsea* sp. with some fewer weeds in the pristine and minimally disturbed riparian zones of Barangay Tingkob-Singalat. As one traversed the riverside from upstream to downstream, the vegetation changed in species composition. Trees were still present in the upper riparian zones but as one moved downstream, the big-sized species of plants were replaced by small-sized species, generally characterized as invasive and prolific. In terms of species richness, endemicity and uniqueness of species, the uppermost barangay of Tingkob-Singalat ranked high on top of the other barangays (Table 3).

Ethnobotanical uses of the encountered vascular plants in the area were determined by interviewing the local researchers and some local herbolaryos (Appendix Table 1). More than 50% (51/84) of the plants were used as medicines. Pechay-pechay (*Pentaphragma grandifolium), Pangium edule*, alikway, sinagkolan (*Leea quadrifolia*), and munggay-munggay (*Alysicarpus* sp.) were commonly consumed as vegetables. Other plants were used as ornamentals, while 12 species were commonly harvested as raw materials for handicraft making. Rhizomes of the endangered tree fern (*Cyathea contaminans*) were used as substrate for the cultivation of ornamentals.

Attempts were made to determine the ecological status of all the plants found in the study area. However, because of the limited resources, status of some plants could not be determined. Out of the plants whose status had been strong-minded, 24.04% were found to be endemic to the Philippines (based on the Lexicon of Trees by Rojo 1999 and the Enumeration of Flowering Plants by Elmer Merrill 1926). This low percentage of endemicity revealed diminishing local native plant community diversity. Moreover, attention must be given to the dominance of the invasive non-native species like *Wedelia*. Though claimed by the local inhabitants to be beneficial because of its ability to prevent soil erosion, the presence of this prolific species is also indicative of a long-standing disturbance of the riverbank. Other endemics in the Philippines are *Cyrtandra* (tabako sa unggoy) and *Weinmannia hutchinsonis*. Only a single endemic species (*Premna odorata* Blanco) was observed from among the 41 plant species found in the downstream barangay of Catarman.

Results of the plant survey were presented to the community during the community validation meetings. The communities in Barangays Singalat, Mamalad and Tipolo affirmed the different kinds of vascular plant species encountered by both the local researchers and the team. Moreover, local folks claimed that there were some plants that were not recorded during the teams' fieldwork, thus the need to do field validation. In Barangay Bonifacio, the local community added to the list 13 names of plants that they claimed present in the riparian areas. These plants included amagus (*Homonoia riparia*), banag, malibago (*Hibiscus tiliaceaus* spp. *tiliaceus* L.), hagimit, anonang, tula-tula, ananamsi, burakan, hambabalud, pahiuli, gantao (*Cyathea*), palang palang, and sibucao. Noteworthy among these plants was palang-palang, which was described by the people as a pteridophyte, growing on other plants like *Cyathea*. It was possible that the said plant was the endangered *Tmesipteris*. It should be noted that *Tmesipteris* is oftentimes an epiphyte of *Cyathea* spp. The latter species was also claimed to be present in the banks of Bonifacio.

Community validation in Barangay Catarman brought the total number of species encountered to 46. Thirteen more local plant names were mentioned and claimed to still thrive in the riparian corridors of the said barangay. These plants included ganda, kalabo, pisaw pisaw, hibi-hibi, escobang mihawis, aloloy, abgaw, handilib-on, busikad, bakhaw, buli, kasla and lagnob. Majority of these plants had medicinal value. Kalabo, for instance, is claimed to cure cough, while aloloy and kasla is said to treat gas pains and hibi-hibi is known to cure kidney disorders. Unfortunately, due to logistical constraints, the team was not able to validate species that respondents claimed to be present and not recorded by the team.

The detailed listing of the plant species found in the Langaran River, their local and scientific names, and other relevant information are presented in Appendix Tables 1 to 3.

River and Riparian Fauna of the Langaran River

Birds

A total number of 927 birds belonging to 52 species were observed in the river and riparian zones of the Langaran River in the northeastern slope of Mt. Malindang from the middle of April to the end of May 2002. Their ecological/

residency status (Kennedy, et al. 2000) and distribution by barangay are presented in Appendix Table 4. The species listed as belonging to the genus *Collocalia*, refers to the group of airborne swiftlets that researchers were able to observe. Due to difficulty in determining their specific identity, they were lumped together as *Collocalia* sp. which may include about three species that are common throughout the Philippines. Table 5 summarizes the description of the bird community in each of the five barangays along the Langaran River and of the whole Langaran River itself using some indices.

For Barangay Singalat, 34 species were recorded. The most abundant birds based on the number of individuals (10 or greater) were: *Collocalia* spp., *Pycnonotus goiavier, Nectarinia jugularis, Aethopyga shelleyi, Dicaeum australe, Lonchura malacca,* and *Dicaeum trigonostigma*. Together, these seven species constituted 55% of the total number of individuals observed in the area. Three species (*Alcedo argentata, Halcyon capensis*, and *Copsychus saularis*) were regarded as uncommon. Two of the birds (*Motacilla cinerea* and *Lanius cristatus*) were migrants, while eight species (*Phapitreron leucotis, Loriculus philippinensis, Centropus viridis, Alcedo argentata, Penelopides panini, Dicaeum pygmeum, Dicaeum australe,* and *Aethopyga shelleyi*) were endemics. The remaining 24 species were considered residents. Two of these species *(Penelopides panini affinis* and *Muscicapa griseisticta*) were unique, in that they were observed only in the barangay.

Thirty-six species were recorded in Barangay Mamalad. Of these, seven species (*Loriculus philippinensis, Centropus viridis, Alcedo argentata, Phapitreron leucotis, Aethopyga shelleyi, Dicaeum australe*, and *Dicaeum pygmeum*) were endemic, 27 were exotic residents, while only two were migrants (*Butorides striatus* and *Lanius cristatus*). Of the 36, seven species (*Collocalia* spp., *Pycnonotus goiavier, Nectarinia jugularis, Aethopyga shelleyi, Dicaeum pygmaeum, Lonchura malacca,* and *Lonchura leucogastra*) were regarded to be dominant based on density; as they constituted 50% of total number of individuals observed in the barangay. Three species were uncommon (*Caprimulgus manillensis, Copsychus saularis,* and *Alcedo argentatus*), while two species (*Caprimulgus manillensis* and *Prionichilus*) were unique to the barangay.

A slightly lower number of species were observed in Barangay Bonifacio. There were 32 species, eight of which (*Collocalia* spp., *Halcyon chloris, Copsychus saularis, Rhipidura javanica, Pycnonotus goiavier, Artamus leucorhynchus, Nectarinia jugularis,* and *Dicaeum australe*) were considered to be dominant based on density, constituting 63% of the total number of individuals observed in the area. Three species (*Alcedo argentata, Copsychus saularis,* and *Rhipidura superciliaris*) were uncommon. One migrant species (*Lanius cristatus*) and six endemics (*Phapitreron leucotis, Centropus viridis, Rhipidura superciliaris, Aethopyga shelleyi, Dicaeum australe,* and *Dicaeum pygmeum*) were recorded. The rest of the 25 species observed were non-endemic residents. Two of the species (*Cyornis rufigastra* and *Rhipidura superciliaris*) were unique to this barangay.

Barangay Tipolo was one of the downstream study sites along the Langaran River. Only 18 species of birds were recorded. Of these, three *(Pycnonotus goaivier, Aplonis panayensis,* and *Nectarinia jugularis)* were considered dominant based on density, constituting 55% of the total number of individuals observed in the area. Two (*Alcedo argentata* and *Copsychus saularis*) were uncommon and two (*Dicaeum australe* and *Dicaeum pygmaeum*) were endemics. There was not a single migrant species observed in Tipolo during the survey. Sixteen species in the list were nonendemic residents. Two (*Gorsachius* sp. and *Gallirallus torquatus*) species were unique to the barangay.

Seventeen species of birds were recorded in Barangay Catarman. Five species (*Egretta garzetta, Ardeola speciosa, Hirundo tahitica, Passer montanus,* and *Lonchura malacca*) were dominant based on density, constituting 78% of the total individuals observed in the area. Two (*Ardeola speciosa* and *Rallina eurizonoides*) were uncommon. One migrant species (*Egretta garzetta*) was seen in Catarman but no endemic species was recorded. Most of the 16 species of birds recorded in this barangay were non-endemic residents.

A total of nine endemic species were recorded in the five barangays along the Langaran River. These were: *Phapitreron leucotis, Loriculus philippinensis, Centropus viridis, Penelopides panini affinis, Rhididura superciliaris, Aethopyga shelleyi, Dicaeum australe, Alcedo argentata,* and *Dicaeum pygmeum*. These species represented about 17% of the total observed species in the stretch of the river, which was lower than the typical bird endemicity of 33% in the country. Two of the above species, *R. superciliaris* and *A. argentata,* were considered uncommon (Kennedy, et al. 2000). Together with *P. panini affinis*, they comprised the three restricted range species unique to the Greater Mindanao Faunal region. According to WCSP (1997), *A. argentata* was considered endangered with little or no information on its nesting habit. However, this species was not listed among the threatened birds of the Mt. Malindang IBA (Mallari, et al. 2001). In this study, a total of 25 individuals were observed in Barangays Mamalad, Singalat, Bonifacio and Tipolo, suggesting that this species was fairly common in the riverine areas in the northeastern slope of Mt. Malindang. In fact, two nests of this species were seen (as burrows) along the riverbanks of Mamalad and Singalat. In both cases, parent birds were seen flying to their nests several times with food hanging from their beaks. Residents who were interviewed confirmed that those nests were indeed of *Alcedo argentata*.

Another notable endemic species that was observed in the study area was the Tarictic Hornbill (*Penelopides panini affinis*) considered to be common by Kennedy, et al. (2000). Kemp (1995 as cited by Kennedy, et al. 2000), suggested classifying this species into four, namely; *P. manillae* (Luzon Tarictic), *P. panini* (Visayan Tarictic), *P. mindorensis* (Mindoro Tarictic), and *P. affinis* (Mindanao Tarictic), based on morphological differences and distinct distribution. The species observed in this study was identified as *P. affinis*, which was listed by Collar, et al. (1994) as near threatened endangered. This unique Mindanao endemic species was observed only in the uppermost barangay of Singalat, bordering the forests of Mt. Malindang National Park.

Of the five residents (*Ardeola speciosa, Copsychus saularis, Rallina eurizonoides, Halcyon capensis,* and *Caprimulgus manellensis)* listed as uncommon, two (*C. saularis* and *A. speciosa)* were believed to be locally common in the study area. *A. speciosa* was recorded by Kennedy, et al. (2000) as a migrant whose breeding has been suspected locally but has not yet been observed. In the present survey, all 15 individuals observed had a breeding plumage characterized by white body and wings, black back, and brownish neck and head. This coloration was in contrast to a nonbreeding individual that had gray plumage all over its body with black and white streaks. Furthermore, a nest of this species was found on top of a mangrove tree (*Sonneratia* sp.) along the riverbank of Barangay Catarman, with a clutch of three eggs. When the research team returned to the area approximately three weeks later, the eggs were gone. A local researcher from Barangay Catarman claimed that the eggs had hatched and that one of the birds was kept captive by a local resident. The mangrove area near the mouth of the Langaran River in Barangay Catarman therefore was an important breeding site for *Ardeola speciosa* in the Philippines. Similarly, a total of 21 individuals of *Copsychus saularis* were also recorded in Barangay Catarman. Although treated as uncommon on a wider scale, *C. saularis* and *A. speciosa* were locally common.

The 52 species found in all the five barangays belonged to ten orders and 26 families. Order *Passeriformes* was the biggest group, represented by 27 species in 16 families. Order *Caprimulgiformes*, on the other hand, was represented by only a single species. In terms of relative abundance (i.e., number of individuals recorded), there were 95 *Lonchura malacca,* 86 *Nectarinia jugularis,* and 68 *Pycnonotus goiavier*. These three species are reported to inhabit various types of habitats, according to Kennedy, et al. (2000), including agricultural areas, secondary growths, orchards, gardens and the periphery of forests. In this study, they were also observed in coconut groves adjacent to the Langaran River study area.

A comparison of the five barangays in terms of diversity or bird species diversity (BSD) and similarities revealed a number of trends. The downstream coastal barangay of Catarman had the lowest number of species recorded but had the most number of unique wetland species (i.e., species found in that barangay). Not a single endemic species was recorded in this part of the river, mostly just resident birds. On the other hand, the uppermost barangay of Singalat which is near the border of Mt. Malindang National Park had the highest number of endemic species listed. The upper three barangays (Singalat, Mamalad and Bonifacio) did not differ much from the downstream coastal barangays in the number of species (i.e., species richness) present as well as in terms of their BSD indices. This diversity index takes into consideration not only the number of species in the site but also the number of individuals belonging to each species. Higher richness and diversity indicated a relatively healthier riparian zone in the upper part of the Langaran River. It should be noted however that these three upper barangays did not necessarily share the same species composition (Table 5).

Sorensen's Similarity Index was used to compare similarities in species composition of the bird communities in the five barangays (Table 6). The upper three barangays have quite a number of common species. Similarity between Singalat and Mamalad was at 80%, between Singalat and Bonifacio at 72%, and 73% for Mamalad and Bonifacio (mean of 75%). These values were much higher than what was shown for Tipolo and Catarman (51%). In general, these two downstream barangays had different species composition compared to the upstream barangays, with an average of 50% for Tipolo (42, 51, and 56) and 39% for Catarman (31, 41, 44, and 51). The higher similarity indices between the three barangays in this study are understandable. The three represented the upstream part of the study area along the Langaran River and access by people was relatively difficult due to the lack of a regular passenger vehicle plying the rough road. Barangay Bonifacio was about 15 km from the national highway. This would mean lesser disturbance on the river and the adjoining riparian zones by the people for their domestic uses. The riverbanks in these barangays still harbored patches of original forest, especially along the steep banks, which translated into more habitats for birds. This may account also for the greater number of species observed in these barangays (34, 36, and 32 respectively) compared to the downstream coastal barangays of Tipolo and Catarman (18 and 17). These two coastal barangays which were adjacent to each and bisected by the national highway, essentially were farming communities. Large tracts of ricefield were cultivated right beside the river in these two barangays. The entire west bank of the Langaran River on Barangay Catarman was occupied almost totally by ricefields, whereas the east bank was occupied by houses. The mouth of the river bore a patch of mangroves. These two barangays provided a more uniform type of habitat because of the presence of large farming areas; less varied for

Table 5. Comparison of the barangays in terms of indices (and percentages relative to the total of the barangay) describing bird community

	Barangay					
	Singalat	Mamalad	Bonifacio	Tipolo	Catarman	Langaran River
Species richness	34	36	32	18	17	52
Bird Species Diversity	1.34	1.38	1.31	1.02	0.985	1.466
Number of unique Species	2 (5.88)	2 (5.55)	2 (6.25)	2 (11.11)	4 (23.52)	
Number of endemic Species	8 (23.52)	7 (19.44)	7 (21.87)	3 (16.66)	0 (0)	9 (17.30)
Number of migrant Species	2 (5.88)	2 (5.55)	1 (3.12)	0 (0)	1 (5.88)	4 (7.69)
Number of resident Species	21 (61.76)	23 (63.88)	22 (68.75)	12 (66.66)	16 (94.11)	35 (67.30)
Number of uncommon Species	2 (5.88)	2 (5.55)	2 (6.25)	1 (5.55)	2 (11.76)	7 (13.46)

Table 6. Sorensen's Similarity Index (expressed as %) to compare similarities among bird communities of the barangays

	Singalat	Mamalad	Bonifacio	Tipolo	Catarman
Singalat	x				
Mamalad	80	x			
Bonifacio	72	73	x		
Tipolo	42	51	56	x	
Catarman	31	41	44	51	X
Entire data set	79	81	76	51	49

different species of birds. Hence, the diversity of bird communities in the two study sites were expectedly lower.

Amphibians and Reptiles

Only 17 species of herpetofauna were represented in the specimens observed in the five barangays along the Langaran River, in the northeastern part of Mt. Malindang from the period April to May 2002 (Table 7).

Six species of frogs were recorded. Of these, one was endemic and five were widespread common residents. The Philippine giant frog *Rana magna*, an endemic and locally common in unpolluted freshwater forest streams throughout the Greater Mindanao Faunal Region (Brown and Alcala 1998), was found in all of the barangays except in Barangay Catarman where the river becomes brackish during high tide. However, this same brackish environment encouraged the habitation of the brackishwater frog, *Rana cancrivora*, which can be found in all five barangays, primarily because it can tolerate high salinity values of up to 28 (Alcala 1986). On the other hand, the common ricefield frog, *Rana limnocharis,* was collected only from Barangay Tipolo. This frog was recorded by Alcala and Brown (1998) as a species that inhabit lowland ponds and streams but not mangrove swamps where salinities are higher. The rock frog, *Staurois natator,* was reported by Alcala and Brown (1998) to inhabit clean and clear mountain streams from sea level up to elevations of about 1,300 m. As such, the presence of this species in the river may indicate the quality of the aquatic environment. This species was observed only in the upper three barangays (Singalat, Mamalad, and Bonifacio) and notably absent in the two coastal lower barangays (Tipolo and Catarman). The brackish water environment of the river in Catarman will not permit the presence of the species. However, its absence in the freshwater environment of the river in Barangay Tipolo might indicate its contaminated state. The horned litter toad, *Megophrys monticola,* was recorded only from the two upper riparian sites of Mamalad and Singalat, adjacent to forest habitats. As shown in Table 7, the two uppermost barangays of Singalat and Mamalad exhibited similar amphibian species composition probably due to similar existing environmental factors.

A total of 11 reptiles were either collected or observed in the five barangays along the Langaran River. Seven of these were lizards, three were snakes, and one was a turtle, *Coura amboinensis,* which was found in two of the five barangays. Most of these reptilian species were recorded as common by Alcala (1986). The Philippine sailfin water lizard, *Hydrosaurus pustulatus,* locally called "ibid" in many parts of the Philippines, was recorded by Tabaranza and Mallari (1997) as vulnerable. It is reported to favor unpolluted mountain streams including freshwater swamps (Alcala 1986; Tabaranza and Mallari 1997). As such, it is considered as a valuable indicator of the state of health of both terrestrial and aquatic environment. Table 7 shows the number of species found in all three upper barangays (i.e., Singalat, Mamalad and Bonifacio) suggesting that the riparian habitat in these parts of the Langaran River was at the time this research was conducted, still unpolluted; and the habitat for this species still present. The waterside skink, *Tropidophorus*

Table 7. List of amphibians and reptiles recorded in the river and riparian areas of the five barangays along the Langaran River from April to May 2002

	English Name	Local Name	Ecological Status	Distribution	S	M	B	T	C
AMPHIBIANS									
Order *Anura*									
Family *Pelobatidae*									
Megophrys monticola	Horned pelobated frog	Baki na sungayan	Common	throughout the Philippines	+	+	-	-	-
Family *Ranidae*									
Staurois natator	Rock frog	Pating	Common	throughout the Philippines	+	+	+	-	-
Rana magna	Philippine woodland frog	Baki na bangkilan	Endemic, common	throughout the Philippines	+	+	+	+	-
Rana cancrivora	Brackishwater frog	Bak-bak	Common	all over the Philippines	+	+	+	+	+
Rana limnocharis	Common pond frog	Bak-bak	Common	all over the Philippines	-	-	-	+	-
Rana signata	Variable-backed frog	ikatik	Common	all over the Philippines	+	+	+	-	-
Reptiles									
Family *Varanidae*									
Varanus salvator	Variable Malay Monitor	Halo / Pala-os	Common but endangered	throughout the Philippines	+	+	+	+	-
Family *Agamidae*									
Hydrosauros pustulatus	Sailfin water lizard	Ibid	Vulnerable	all over the Phil. except Palawan	+	+	+	-	-
Draco volans	Malay flying lizard	Hambu-bukad	Common	throughout the Phil.	-	+	-	-	-
Family Scincidae									
Tropidophorus misaminus	Misamis water-side Skink	Manantoy	Endemic; rare	Mindanao, Basilan and Camiguin island	+	+	+	-	-
Mabuya multifasciata	Common mabuoya	Tabili	Common	throughout the Philippines	+	+	-	+	-
Mabuya multicarinata	Two-striped mabouya	Tabili	Common	throughout the Philippines	+	-	-	+	-
Lamprolepis smaragdina	Spotted green tree skink	Tabili	Common	all over the Philippines	-	+	+	-	+
Family *Colubridae*									
Psammodynastes pulverulentus	Dark-spotted mock viper	Halas	Common	all over the Philippines	+	-	-	-	-
Natrix dendrophiops	Spotted water snake	Halas	Endemic and common	throughout the larger islands of the Phil.	+	-	-	-	-
Family *Pythonidae*									
Python reticulatus	Reticulated phyton	Sawa	Common	all over the Philippines	+	-	-	-	-
Family *Enydidae*									
Cuora amboiensis	Malayan freshwater turtle	Bao/ bao-o	Common	all islands in the Philippines	-	+	-	-	-

Legend: S- Singalat M- Mamalad B- Bonifacio T- Tipolo C- Catarman
++ with trapped specimens + observed or seen but no specimen caught - absent

misaminus, was reported as endemic and rare by Alcala (1986), and was similarly found in the three upper barangays. The monitor lizard, *Varanus salvator*, is common throughout the Philippines, with the subspecies *V. s. cumingi* restricted to the Greater Mindanao Faunal Region. It was known to be endangered in some areas, but was found in four out of five barangays along the Langaran River.

The list of reptiles presented in this study is definitely incomplete. Initially, the team had planned to make a thorough survey of snakes, as presented in the proposal since locals also reported seeing many kinds of snakes. Part of the preparation stated the procurement of a first-aid kit for snakebites but unfortunately, not a single drugstore in many parts of Visayas and Mindanao carried the product. Considering the risks involved in carrying out field collection with local researchers, the detailed survey of snakes was cancelled. The snakes included in this collection were based on specimens collected randomly or incidentally captured or killed by the local researchers.

Mammals

Table 8 shows the list of mammals collected and observed in the five study sites along the Langaran River. A total of 11 mammalian species were recorded, of which nine (*Bullimus bagobos, Sundasciurus philippinensis, Rattus everetti, Apomys insignis, Paradoxurus hermaproditus, Macaca fascicularis, Tarsius syrichta, Cynocephalus volans,* and *Urogale everetti*) were endemic and considered fairly common, except for *U. everetti* that is classified by Heaney, et al. (1998) as uncommon to rare. The *U. everetti* was recorded only in the uppermost barangay of Singalat which is adjacent to forests. All 11 mammals were found in the Singalat site, while only eight were found in both Mamalad and Bonifacio. These included *Sundasciurus philippinensis, Rattus exulans, Rattus everetti, Paraduxurus hermaphroditus, Viverra tangalunga, Macaca fascicularis, Tarsius syricht*a, and *Cynocephalus volans*. Only three species (*R. exulans, P. hermaphroditus,* and *V. tangalunga)* were recorded in barangays Tipolo and Catarman, which were also present in the other three barangays. These three species were reported by Heaney (1998) to be present in agricultural areas as well as lowland forests and as such should explain their presence in Tipolo and Catarman that are largely farmed areas and in Singalat, Mamalad and Bonifacio where the riparian region is still forested. Six of the endemic mammals are restricted only to the Greater Mindanao faunal region and to some degree are forest dependent species. These included *T. syrichta, B. bagobus, C. volans, A. insignis, S. philippinensis,* and *U. everetti.* Heaney (1998) recorded their preferred habitat as either primary or secondary growth in either lowland or mountain forest, and sometimes agricultural areas at the forest edge. Their presence in these three barangays indicated relative similarity of the state of the riparian habitat in these three areas.

The list of mammals presented in this study is not complete since the period of collection in each barangay was limited by logistical and financial constraints. It is possible that some other species of small to large mammals were not represented in the collection. Notably, no bats had been collected in any of the sites, considering that almost half of the mammalian fauna in any area was composed of bats. Mist netting methods (the preferred method for collection of bats) were not successfully done in any of the sites.

Aquatic Fauna

The survey of fish showed that Catarman had the highest number of species, with 16 species, followed by Tipolo with 13 species. This high number of species is a combination of freshwater and brackishwater fishes in the lower coastal barangays. However, towards the upper sites where the water is purely fresh, only fewer species of fish were collected. The upper barangay sites Bonifacio, Mamalad and Singalat had only seven, 11, and eight species of freshwater fish, respectively.

Crustaceans were also collected along the five sites of the Langaran River. In Catarman, a species of shrimp and two species of crab that were normally found in brackish waters were collected. Singalat had three crustacean species, Mamalad had five, and Bonifacio had three.

The eight fish species caught in the Singalat

Table 8. List of mammals surveyed in the riparian zones of five barangays along the Langaran River from April to May 2002

Scientific Name	English / Common Name	Local Name	Ecological status	Distribution	S	M	B	T	C
Order Insectivora									
Family Tupaiidae									
Urogale everetti	Mindanao tree shrew	Muro	Endemic and uncommon	Mindanao faunal region only	++	-	-	-	-
Order Rodentia									
Family Sciuridae									
Sundasciurus philippinensis	Philippine tree squirrel	Laksoy	Endemic	Mindanao faunal region only	++	+	+	-	-
Family Muridae									
Bullimus bagobus	Large Mindanao forest rat	Balagtok/ Ilaga	Endemic, Common and widespread	widespread in Mindanao faunal region	++	-	-	-	-
Rattus exulans	Polynesian rat	Ilaga	Non-native and abundant	throughout the Philippines	++	++	++	++	++
Rattus everetti	Common Philippine forest rat	Ilaga	Common and endemic	widespread in the Philippines	++	++	+	-	-
Apomys insignis	Mindanao montane forest rat	Ilaga	Endemic	Mindanao Faunal Region only	++	-	-	-	-
Order Carnivora									
Paradoxurus hermaproditus	Common palm civet	Melo	Endemic and common	throughout the Philippines	++	++	++	+	++
Viverra tangalunga	Malay civet	Tinggalong/ Singgalong	Resident and common	throughout the Philippines and Asia	+	+	++	+	+
Order Primates									
Family Cercopithecidae									
Macaca fascicularis	Long-tailed macaque	Onggoy	Endemic and common	widespread in the Philippines	++	++	++	-	-
Family Tarsiidae									
Tarsius syrichta	Philippine tarsier	Basing	Common and endemic	Mindanao faunal Region only	++	+	+	-	-
Order Dermoptera									
Family Cynocephalidae									
Cynocephalus volans	Philippine Flying Lemur	Kagwang/ Kabal	Endemic and common	Mindanao faunal Region only	++	+	+	-	-
Total no. of species					11	8	8	4	5

Legend: S- Singalat M- Mamalad B-Bonifacio T- Tipolo C- Catarman
++ with trapped specimens + observed or seen but no specimen caught - absent

site belonged to five freshwater families, namely; *Eliotridae, Gobiidae, Anguillidae, Ryacicthyidae,* and *Cyprinidae*. At present, two of these barbs (Family *Cyprinidae*) remained unidentified but were locally called *lubong-lubong* and *paulan.* Six other species were reported by locals to be present in the Langaran River but were not represented among the collected samples. Similarly, the three species of shrimps recorded in Singalat remained unidentified. One of these, was locally known as *dangawan.* The only crab species recorded from the upper Langaran River remained unidentified but was locally called *kalong sa bukong*.

The 11 fish species samples collected in Mamalad represented six families, namely; *Eliotridae, Gobiidae, Kuhliidae, Anguillidae, Ryacichthyidae,* and *Cyprinidae*. During the community validation meeting, seven more species were reported by locals to be present but were not represented in the collection. The three species of crustaceans (Order *Decapoda*) noted in Mamalad also remained unidentified. It included a shrimp locally called *goyod-goyod* and two crabs locally known as *kamangkas* and *kalong sa bukong*. Both the *Goyod-goyod* and *kalong sa bukong* were also collected in Barangay Bonifacio. Except for family *Eliotridae*, the same fish families represented in Mamalad were also represented in the 11 species of fish recorded in Bonifacio.

Of the 13 species of fish collected in Barangay Tipolo, two remained unidentified but were locally called *ilongog* and *lubong-lubong*. In addition to the six families represented in the upstream barangays, the families *Leiognathidae, Ambassidae,* and *Sygnathidae* were also represented in Tipolo. During the community validation meeting, three more species of fish were claimed by locals to be present on the river, but samples of these were not collected.

Barangay Catarman had 16 species of fish representing 13 families (Table 9) including: *Sillaginidae, Gerridae, Megalopidae, Theraponidae, Carangidae, Mugillidae, Mullidae,* and *Engraulidae*. An unknown species of shrimp and crab could not be identified taxonomically but the crab was known as *suga-suga* by the locals. Table 10 shows a summary of the fish species not represented in the collection but were claimed to be present on the Langaran River by the local community during the validation meeting.

An examination of the species composition of fishes on the five sites along the Langaran River (Table 9) revealed that all the 16 species recorded from Catarman were either typically brackishwater or marine inland migrant species. The 13 species of fish caught in Tipolo were a combination of both typically fresh and brackishwater species. This is not surprising considering that the water in Barangay Catarman is brackish and regularly inundated with tidal water from the Sulu Sea. The lower part of Tipolo also occasionally becomes brackish during high tide. Hence, the composition of fish in these two barangays resulted from a combination of both typically marine and freshwater species.

The number of fish species recorded along the Langaran River was generally lower upstream than downstream. Four species, namely; *Sicyopterus extraneus* (anga), *Glossogobius celebius* (iswil), *Ryacichthyis aspro (*pakpakan), and *Anguila* sp. *(ka*sili) were found to be common to Barangays Singalat, Mamalad, Bonifacio and Tipolo. However, these results may be incomplete considering that about seven other fish species were reported but not confirmed during the survey. *S. extraneus* (anga) can be found in unpolluted waters upstream, making use of the big rocks to spawn. The fry is carried downstream by the water current eventually to the mouth of the river, where they undergo further development. The fry is locally collected as a delicacy but the adults are not preferred due to its bitter taste (Escudero, personal communication). At some period of its life cycle, the young move upstream where they develop to maturity. Intuitively, this species should be present in Catarman, the barangay near the mouth of the Langaran River but this species was not represented among the fish samples collected from this barangay. It is possible that at the time field collection was done, this species was not spawning, hence its absence. But it is also possible that the local population of this species has “critically” dwindled making it difficult to catch samples. Incidentally, this species is regarded by the local people in all the five barangays to be very important as food; hence its decline in number did not go unnoticed. The absence of *anga* in Barangay Catarman was notable. Its catadromous behavior suggests that there is a need to study

Table 9. List of fishes caught in the waters within the five barangays along Langaran River from April to May 2002

Name of Species	Local Name	Singalat	Mamalad	Bonifacio	Tipolo	Catarman
Family *Leiognathidae*						
Leiognathus bindus	Palotpot	-	-	-	+	++
Leiognathus equulus	Danglay	-	-	-	-	++
Secutor insidiator	Tabilos	-	-	-	-	++
Family *Cyprinidae*						
Puntius sp. 1	Paitan	++	++	++	++	++
Puntius sp. 2	Lapisan	++	++	++	++	++
Family *Ryacichthyidae*						
Ryacichthyis aspro	Pakpakan	++	+	+	+	-
Family *Anguilidae*						
Anguila sp	Kasili	++	+	+	+	-
Family *Ambassidae*						
Ambassis commersonii	Ibis	-	-	-	++	+
Family *Engraulidae*						
Stolephorus commersonii	Bolinao	-	-	-	-	++
Family *Mullidae*						
Upeneus trangola	Timbongan	-	-	-	-	++
Family Mugillidae						
Valamugil cunnesius	Gisaw	-	-	-	-	++
Family *Carangidae*						
Carangoides sp.	Tarakito	-	-	-	-	++
Family *Theraponidae*						
Therapon jarbua	Buga-ong	-	-	-	-	++
Family *Megalopidae*						
Megalops cyprinoides	Bulan-bulan	-	-	-	-	++
Family Gerridae						
Gerres filamentosus	Puti-an	-	-	-	-	++
Family *Sillaginidae*						
Sillago sihama	Aso-os	-	-	-	-	++
Family *Kuhliidae*						
Kuhlia sp.	Damayan	-	+	+	+	++
Family *Sygnathidae*						
Sygnathus sp.	Tikog-tikog	-	-	-	++	-
Family *Gobiidae*						
Sicyopterus extraneus	Anga	+	++	++	++	-
Glossogobius celebius	Iswil	+	+	+	++	-
Amblygobius sp.	Bunog	-	-	-	+	++
Fish # 8 (unidentified)	Lubong-lubong	++	++	-	++	-
Fish #11 (unidentified)	Ilongog	-	-	-	++	-
Family *Eliotridae*						
Fish # 5 (unidentified)	Tibalas	-	++	-	-	-
Fish # 6 (unidentified)	Paulan	++	++	-	-	-
Fish # 9 (unidentified)	Malapalo	-	++	-	-	-

Legend: ++ with trapped specimens + observed or seen but no specimen caught - absent

Table 10. List of unconfirmed fish species reported to be present in Langaran River by locals during the community validation meeting but were not collected nor observed during fieldwork

Local Name	Singalat	Mamalad	Bonifacio	Tipolo	Catarman
Lambiga	+	+	+	-	-
Banak	+	+	-	+	-
Danlin	+	+	+	-	-
Bakunulan	+	+	+	-	-
Ilabo	+	+	-	+	-
Haluan (mudfish)	+	+	+	+	-
Pantat (native catfish)	-	+	+	+	-

Legend: + claimed to be present - fish is not mentioned

its reproductive biology. Two barb species, *Puntius* sp. 1 (paitan) and *Puntius* sp. 2 (lapisan), were common to the five barangays covered in this project. Their presence from upstream to downstream suggests of these species' wide range of tolerance to salinity.

In all the barangays where collection of samples was done, the local researchers claimed that fish catch was already smaller compared to what they got a few years ago. There were two main factors that may have caused the decline in catch: the presence of dams that impeded migration of species upstream and the occurrence of pyroclastic materials that flowed into the river in the mid 1990s. According to some local researchers, they used to catch a lot of fish before, but when the dams were established, the fish catch had gradually declined, probably because the fish could no longer migrate freely. For example, the young of *S. extraneus* (anga) which were carried downstream, can no longer return because of the dam. Some reported that the pyroclastic materials came from a landslide, while others reported that they were from an underground volcano, given the sulfur-like odor. Regardless of its origin, the pyroclastic materials that flowed into the river caused massive death of aquatic fauna. Accordingly, dead fish were observed everywhere on the river and examination of the carcasses showed that the gills were full of mud. In Barangay Tipolo, local researchers believed that the quarrying activities were also causing the decline in fish catch. The bottom of the river exhibited sunken "holes" wherein the saline tidal waters did not completely recede during low tide because they were trapped in these "holes". Such change in salinity may cause the death of some freshwater fishes.

Macroinvertebrates

Abundance and diversity of macroinvertebrates varied from upstream in Barangay Singalat to downstream in Barangay Tipolo. A total of 32 macroinvertebrate species were collected in Singalat, 23 different kinds in Mamalad, 33 in Bonifacio and 19 in Tipolo as shown in Appendix Table 5. The macroinvertebrates collected were grouped in the order of their tolerance to pollution: good water quality indicators, wide-range tolerant water indicators, fair water quality indicators and poor water quality indicators. Barangay Singalat had seven indicator species of good water quality, Mamalad and Bonifacio had five each, and none in Tipolo. Barangay Bonifacio had the highest number of species of macroinvertebrates but a closer look at the species composition showed that most of these species were poor water quality indicators. Barangay Tipolo, on the other hand, not only had very few macroinvertebrates in its water but also had species that were poor water quality indicators.

The species collected from each barangay were scored and converted to a water quality index. Water quality indices in barangays Singalat, Mamalad and Bonifacio were within the score range for relatively clean water. The water quality index was highest in Singalat (6.42), suggesting that it had the cleanest water, and lowest in Barangay Tipolo (4.56), which is located downstream and had the most impure water (Table 11).

Macroinvertebrates is normally used in biological stream assessment and the corresponding grouping based on the degree of sensitivity of the organism to pollution. Stonefly nymph was consistently present in barangays Singalat, Mamalad and Bonifacio. Stoneflies are commonly used to indicate good water quality (Baumann 1979) as they are very sensitive to pollution. The presence of stoneflies in the three sampling sites of the three study barangays and its absence in Tipolo, indicated that this species is a reliable indicator species for water pollution. On the other hand, Singalat waters had the most number (three out of six) of good water quality indicators but it was Barangay Bonifacio which had the most number (33 species) of different macroinvertebrates. Though water resources with high water quality generally have diverse and rich macroinvertebrate fauna, certain pristine environments have low diversity of macroinvertebrate fauna because of the cold temperature and/or relatively low nutrient levels (Peckarsky, et al. 1990). Headwaters and headwater streams may have only two dominant species. Although all classes of invertebrates may be found in headwater streams, crustaceans, caddisflies, leeches, mollusks, flatworms and blackflies tend to be found in such environments (De Lange 1994; Peckarsky, et al. 1990). A low number of different species can also be an indicator of poor water quality. As shown, Barangay Tipolo recorded the least number (19) of macroinvertebrate species and all of these species were classified as poor water quality indicators. In general, pesticides in the water tend to reduce the diversity of macroinvertebrates, and eutrophic conditions will reduce overall diversity but increase the abundance of few species (http://www.usc.edu/CSSF/Current/Projects/S0601.pdf). The socioeconomic survey conducted in Barangay Tipolo revealed that the farmers used chemicals on their rice fields. Hence, it was not surprising that the number of macroinvertebrates in the area was very low and are of poor quality indicator taxa (pea cockle, water stick insect, kuhol and bugs). In contrast, use of chemicals in the upper barangays was found to be minimal. The potential threat to the upper waters was erosion resulting from Swidden agriculture that is still being practiced by the upland farmers.

Riffle beetle, another good water quality indicator was observed in Singalat and Mamalad. Long-mouthed saucer bugs, which inhabit clean water, were observed only in Mamalad while dragonfly, a wide-range tolerant water quality indicator was observed in all three barangays except in Barangay Tipolo.

Mayflies in Singalat were indicative of waters having high dissolved oxygen (DO) level. Mayfly taxa were widespread and recognized elsewhere as sensitive species which require highly dissolved oxygen (Hilsenhoff 1988). On the other hand, stoneflies are very sensitive to changes in water conditions and require low temperature, and high levels of dissolved oxygen (http://www.usc.edu/CSSF/Current/Projects/S0601.pdf).

Interestingly, the presence of flatworms (*Turbellaria*) in Singalat down to Bonifacio, supports the claim that this species is sensitive to organic pollution and is found in cold water environs. On the other hand, crustacean scuds (Amphipoda) were common to the three barangays which further supported their high water quality indices. Scuds are found in unpolluted waters and would require abundant oxygen. Many species inhabit cold waters (Pennak 1989).

Generally, a wider variety of macroinvertebrates exists in a clean stream. In an unhealthy stream, few species of tolerant macroinvertebrates exist. A healthy ecosystem supports diversity of organisms, so in a healthy stream, the stream-bottom community will include a variety of macroinvertebrates that are pollution-sensitive. Conversely, an unhealthy stream will support only few species of nonsensitive macroinvertebrates.

Results of the socioeconomic survey for the barangays along the Langaran River also suggested that the upstream barangays were relatively less threatened by pollution. Barangay Singalat, for example, had only around 55 households and relatively far from each other. Farming system was generally very traditional, with some farmers still practicing Swidden agriculture. Because of the mountainous terrain, corn, root crops and fruit trees were the

Table 11. Scoring of macroinvertebrates and the Water Quality Index of the four study barangays of the Langaran River

	Singalat	Mamalad	Bonifacio	Tipolo
Good water quality indicators				
Caddisfly (larva)				
Caseless caddisfly (larvae)	10			
Dobsonfly (larvae)		9		
Flattened mayfly	10		10	
Long-mouthed saucer bug		10	10	
Mayfly (nymph)	10			
Prawns	8	8	8	8
Prong-gilled mayfly	10		10	
Riffle beetle (larva)				
Riffle beetle (adult)	*	*		
Snail (opens to the right)				
Stonefly (nymph)	10	10	10	
Wide-range tolerant water quality indicators				
Blackfly (pupa)				
Common damselfly	6	6	6	6
Cranefly (larva)				
Crayfish				
Damselfly (nymph)	6		6	
Dragonfly (nymph)	6	6	6	
Filtering caddisfly (larva)				
Hellgramite (larva)				
Pagoda snail		6	6	6
Scud (adult)	*	*	*	
Snowbug				
Fair poor water quality indicators				
Aquatic worm				
Beetle (larva)	5			
Beetles	5		5	
Bugs				5
Common net spinner	5			
Crabs	3		3	3
Flatworms	5	5	5	
Fly larvae	5			
Golden apple snail				3
Leeches	3	3	3	3
Lesser water boatman	5	5	5	
Midge (larva)		5		
Midge (pupa)				
Pea cockle				3
Planaria	5		5	
Pouch snail (opens to the left)				
River shrimps		4	4	4
Swimming mayfly	5	5		

Table 11. continued

	Singalat	Mamalad	Bonifacio	Tipolo
Other Macroinvertebrates				
Alderfly				
Balloon-tailed damselfly	*	*		
Burrowing mayfly		*		*
Cased caddisfly (larvae)			*	
Common saucer bug	*	*	*	
Dragonfly (adult)			*	
Long-headed caddisfly	*			
Mollusks			*	*
Non-biting midge (larvae)				
Pond skater	*	*	*	*
Prong-gilled waterfly			*	
Segmented worms				
Square Gilled mayfly			*	
Surface animals			*	
Two-tailed demoiselle			*	*
Water cricket	*	*	*	*
Water fleas			*	
Water hoglouse				
Water measurer	*	*	*	*
Water penny (larva)	*			
Water skater	*			
Water stick insect				*
Whirligig beetle	*		*	
Whirligig beetle (larvae)		*		
Non-indicators				
Hairworms				
Hydra				
Mites			*	*
Moth (larvae)	*	*	*	
Spider			*	*
Springtails				
Water fleas				
TOTAL no. of species	32	23	33	18
Total Score	122	82	102	41
No. of animal types scored	19	13	16	9
WATER QUALITY INDEX (Total score/number of animal types)	6.42	6.3	6.375	4.56

*- present but not in guide hence score could not be determined

common farm species. Going downstream to other barangays, the number of households more than doubled. Fertilizers here were used by the farmers in their irrigated farm lots. In addition to farming and quarrying, respondents listed throwing of garbage and defecating in the river and riparian areas. These activities suggested that the quality of water in Tipolo was highly polluted.

The method of using macroinvertebrates to assess water quality was easy and uncomplicated. The students who were made to participate in the assessment appreciated the amount of knowledge they gained about the quality of the water with very minimal work. Accordingly, the water quality indices they obtained matched their visual evaluation of the water quality in each study area. The macroinvertebrates are also easy to handle. These suggest that a basic water quality monitoring system can be developed for use by the local community. The residents can be trained to identify macroinvertebrates, teach them where to find these animals and what their presence or absence meant. If this can be accomplished, monitoring of the river systems in the country can be made a routine activity of the local community. Considering that ecosystems are interconnected, (rivers connect the terrestrial to the coastal ecosystems), it is imperative that a basic monitoring system be developed to increase involvement of the local community in the protection of the river systems.

Cryptozoans

A total of 18 species of cryptozoans were collected in the five barangays along the Langaran River (Table 12). Of these, only two species were common to the five barangays: earthworm of the genus *Lumbricus* and red and black ants of genus *Formica*.

There appeared to be no trend in species richness from upstream to downstream. The uppermost barangay of Singalat had nine species, Mamalad and Tipolo had six each, Bonifacio had seven while Catarman had nine. But species composition in the five barangays was varied. Only two species were widely distributed and were found throughout the stretch of the river: earthworm and ants. Other species that were present included, among others, those of beetles and millipedes. It was very evident that the kinds of cryptozoans present were affected by the nature of habitat. The riparian zones in Barangay Singalat were still relatively rich and had trees that provided shade and leaf litter. In Mamalad and Bonifacio, the areas where the sampling boards were placed, were relatively open and prone to disturbances because of the many human activities conducted in the riparian areas, such as gathering of edible ferns. The worst habitat for cryptozoans was in Tipolo. This was the most heavily populated barangay, where there were houses even near the bank. As such, the soil was heavily trampled and disturbed, a condition that is unfavorable to cryptozoans.

The cryptozoan data collected here may not be sufficient to characterize the soil habitat of each barangay because the number of boards collected during the harvest period already varied from one barangay to the next because of theft. In Barangay Mamalad, most of the boards were stolen. With these limitations, only the kinds and not the density of species were determined.

Cryptozoans indeed revealed a fine-grain representation of the riparians along the Langaran River. It was unfeasible to obtain a high number of cryptozoans in the downstream barangay of Catarman, considering that the land was used mainly for rice farming. The banks were relatively exposed and potentially contaminated with chemicals from farms. In Mamalad, the boards were placed in relatively hidden areas. Still, only three out of eight boards were recovered. The fewer boards recovered may partly explain the low number of cryptozoan species obtained; hence these results should be interpreted with caution.
The absence of a trend in cryptozoan richness may be partly due to the changing conditions in the banks. Frequent flooding deposited all kinds of materials that changed the soil conditions. Only earthworms and ants can be considered as resistant to environmental changes, as shown by their presence from upstream to downstream environments.

Table 12. Cryptozoans found in the five barangays along the Langaran River

Specific Name	Common Name	Singalat	Mamalad	Bonifacio	Tipolo	Catarman
Amphicyrta dentipes	pillbeetle	-	-	-	+	+
Caddo sp.	long-legged arachnids	-	+	-	-	-
Cylisticus convexus	pillbug	+	+	-	-	+
Diaperis maculata	darkling beetle	-	+	-	-	-
Formica sp.	ants	+	+	+	+	+
Glomeris sp.	pillmillipede	+	-	-	-	+
Haemadipsa sp.	leaf leech	+	-	-	-	-
Helicodiscus sp.	land pulmonate	+	+	-	-	-
Helix aspersa	snail	+	-	-	-	+
Lumbricus sp.	earthworm	+	+	+	+	+
Megalodacne heros	fungus beetle	+	_	_	+	_
Narceus sp.	common millipede	-	-	+	+	+
Neoconocephalus sp.	cone-headed grasshopper	-	-	-	-	+
Osmoderma epemicola	hermit flower beetle	+	-	+	-	-
Otoccrytops sexspinnosa	centipede	-	-	+	-	-
Phyllophaga sp.	beetle larvae/grub	-	-	+	-	-
Typhlopsbraminae	"kuto sa yuta"	-	-	+	-	-
Urosalpinx cinerea	oyster drill	-	-	-	+	+
Total Number of Species		9	6	7	6	9

+ present - absent

Coliform Load of the Water in Langaran River

Water samples from all the nine stations in four different barangays tested positive for coliform. However, the number of tubes that exhibited gassing varied; which suggested that the degree of coliform contamination differed among the barangays. The most probable number (MPN) of coliform cells per 100 ml of water samples was therefore determined. Results showed that the number of cells varied among the barangays. In the uppermost barangay of Singalat, contamination was generally low in the upper boundary but high in the lower boundary. The upper boundary of Singalat (Sitio Tingkob) had very few households scattered in hilly and mountainous areas. Vegetation in the relatively steep riparian zones was characterized by a mixture of trees, shrubs and a number of climbing species. Although there were a number of settlements, the vegetation can still be considered generally lush. However, as one moved to the lower boundary, households become concentrated near the river where some parts of the bank were visibly eroded. During the research team's visits to the area, there was always the pervasive odor of feces. Thus, it can be deduced that the water within Barangay Singalat, though seemingly clear, was contaminated with fecal matter. Although the survey of riparian fauna revealed that mammals such as monkeys and tarsiers, as well as birds, were common in the area, these warm-blooded organisms could not have been the only source of fecal materials that were eventually carried into the river. Since the banks had relatively lesser vegetation than the upper part of the barangay, fewer monkeys and other wild animals inhabited the area, as supported by the faunal survey. The large number of coliform cells in the lower boundary must have come from the human feces also. At the time this study was conducted, community officials had not yet passed an ordinance requiring lavatories in households. The socioeconomic data collected from the barangay through interviews showed that respondents in fact defecated in the riverbanks.

Table 13 shows that the waters in barangays Mamalad and Bonifacio were also contaminated with fecal matters. MPN for Station 5 in Mamalad was quite high. This station was below the center of the barangay where most of the people reside. Open hog-raising (i.e., not contained in concrete pens) was the most common alternative livelihood of the people. Since the riparian zones were relatively bare of plants that could be inhabited by wild mammals and birds, the potential primary sources of fecal contamination could only have been humans, pigs, and the carabaos bathing in the river.

Results for Barangay Tipolo revealed massive fecal contamination. All the sampling stations, from upper to lower boundaries, were heavily contaminated with fecal matter. Compared with the other barangays, Tipolo, at the time of the survey, was heavily populated. Houses were built near the riverbank. The banks were eroded and the river basin was used for agriculture. Most of the wild trees had been replaced by fruit trees like lanzones and mangoes. Two of the three dams along the river are in this barangay. One dam was designed such that the area had become a picnic ground where residents and nonresidents went for a swim. Data from the socioeconomic survey of this barangay showed that there was already an ordinance at that time for all households to have a lavatory, or at least a water-seal toilet. The ordinance had stipulated a penalty for violators.

Table 13 shows that in some stations, the MPN of bacterial cells after the confirmed test was not necessarily the same as the MPN after the completed test. These results clearly show that some bacteria, different from the coliform group, had contaminated the waters in the Langaran River.

Results of the IMViC tests (Table 14) showed that the coliform species in most of the stations was *E.coli.* In fact, *E. aerogenes* was found only in Station 9 located in Barangay Tipolo. *Enterobacter aerogenes* is a coliform bacterium that is associated mainly with sewage. The results were not surprising. Station 9 was very near the center of the barangay where most of the houses were located. Garbage and other solid wastes were seen in the banks despite efforts by the local officials to keep the river clean. It was very probable that *Escherichia coli* was also present in this station but *Enterobacter aerogenes* seemed to come in greater number because of the presence of garbage materials hence it dominated the analysis.

The presence of *Escherichia coli* from upstream to downstream of the Langaran River was quite alarming. According to bacteriologic standards, water for drinking should be free from coliforms and contain no more than 10 organisms per milliliter of water (Wilson, et al. 1979). None of the sampling stations showed negative to coliform test suggesting that the water in the whole of the Langaran River was really not safe for drinking. However, if we examined the density of coliforms, water from Singalat to Bonifacio could be recommended for drinking as per biologic standards. The highest MPN in these barangays was 900 per 100 ml water sample (9 per ml water sample) while the standards would say that water for drinking should contain no more than 10 cells per ml. However, the mere presence of coliforms in these barangays should be taken as basis for precautionary measures. Previous studies have shown that where *E. coli* is present, other pathogenic organisms could be present. The coliform density may be low but it is possible for the other pathogens to come in an alarming number.

Standards for water quality, specifically for coliform vary. The Standards administered by the Environmental Protection Agency (EPA) state that any trace of fecal coliforms is unacceptable and should not be used as source of drinking water. In water bodies used for swimming, coliforms must be not more than 200 cells per 100 ml of water. While for boating or other purposes that involve partial contact but not swimming in a water body, an average of not more than 2000 fecal coliforms per 100 ml of water is acceptable. In freshwater, 2000-3000 total coliform bacteria per 100 ml of water

Table 13. Bacterial density (most probable number or MPN per 100 ml water sample) in each of the four barangays

	Confirmed test	Completed test
Barangay Singalat		
Station 1	240	240
Station 2	≥1600	900
Barangay Mamalad		
Station 3	900	220
Station 4	540	47
Station 5	900	900
Barangay Bonifacio		
Station 6	≥1600	30
Station 7	900	350
Barangay Tipolo		
Station 8	≥1600	≥1600
Station 9	≥1600	≥1600
Station 10	≥1600	≥1600

Table 14. Results of IMViC tests for water samples from the Langaran River

	Indole Test	Methyl Red Test	V. Proskauer Test	S. Citrate Test	Coliform present
Barangay Singalat					
Station 1	+	+	-	-	*E. coli*
Station 2	+	+	-	-	*E. coli*
Barangay Mamalad					
Station 3	+	+	-	-	*E. coli*
Station 4	+	+	-	-	*E. coli*
Station 5	+	+	-	-	*E. coli*
Barangay Bonifacio					
Station 6	+	+	-	-	*E. coli*
Station 7	+	+	-	-	*E. coli*
Barangay Tipolo					
Station 8	+	+	-	-	*E. coli*
Station 9	-	-	+	+	*E. aerogenes*
Station 10	+	+	-	-	*E. coli*

may increase the chances of becoming ill.

In the Philippines, allowable MPN value for waters used for drinking is 50 for total coliforms and 20 for fecal coliforms. For water class that will require treatment (e.g., coagulation, sedimentation, filtration and disinfection) for drinking, the allowable value for total coliforms is 1000 MPN and 100 MPN for fecal coliforms. For water supply that is classified for recreational purposes (such as bathing, swimming, skin diving), 1000 MPN for total coliform is allowable and 200 MPN for fecal coliforms. Waters classified as suitable for fish propagation use, as recreational water (boating, etc.), or as industrial water supply (for manufacturing processes after treatment) have allowable total coliforms value of 5000 MPN. There is no standard value indicated for fecal coliforms (DENR-AO 34 s. 1990-Appendix 14).

The results of the study suggest a number of things. River water that is seemingly clear and clean, as in the upper part of the Langaran River, should still be used with caution. Some people in the upstream barangay get drinking water from the river. Even members of the research team experienced drinking water from the river, thinking that it was safe because it was very clear. But this clear water was found positive for coliforms. There is a need to disseminate the information on the quality of water in the Langaran to protect the people from acquiring coliform-associated illnesses. In barangays where households do not have lavatories, ordinances should be passed to ensure that fecal wastes are confined and do not drain into the river. In Barangay Tipolo, where an ordinance to properly dispose wastes and garbage is already in place, a stronger and more effective implementation of this ordinance is a must.

There appeared to be a need to protect the riverbanks. Even in the upper barangays, where most of the houses were situated far from the riverbanks, slight rains can easily bring surface water from the barangay centers to the river. The grounds and the riverbanks, which used to have trees that slowed down water movement, were already bare. Replanting of trees in the riverbanks is suggested, starting from the lower boundary of Barangay Singalat down to Barangay Tipolo. This can slow down the movement of fecal materials through surface runoff and in the long run, protect the quality of water in the river.

The differences in coliform load along the Langaran landscape strongly indicated that microbial indicators can be used to determine the quality of flowing bodies of water like streams and rivers. Proactive endeavors at the barangay level are a must in the protection of the river to maintain good water quality suitable for swimming, bathing, washing of clothes and drinking.

Socioeconomic Characteristics

Demographic Profile

Among the sample barangays, Tipolo was the most heavily populated. As such, a bigger percentage of the total respondents came from this barangay. The distribution of the population is reflected in Table 15.

A closer look at the age distribution of the respondents per barangay reveals a generally young population. The average age of the population of the five barangays was 46 years. However, there was a significant proportion of the respondents in Barangay Mamalad that was 65 years old and above, as well as those in their early 30s (Table 16).

The survey also revealed that 69.5% of the respondents were born in the same municipality where they were residing. Although, some relocated from one barangay to another within the municipality, 45.5% of the population had lived in the same barangay since birth.

Religion

Majority of the sample population (51.8%) belonged to the Roman Catholic denomination while the remaining 49.2% belonged to non-Catholic sects.

Ethnicity

Interestingly, 62.7% of the aggregate sample population described themselves as Cebuanos. However, a look at their ethnic affiliations per barangay revealed that the Cebuanos were concentrated in the downstream barangays of Tipolo and Catarman. Those in the upstream barangays of Singalat, Mamalad and Bonifacio were mainly Subanons. Migrants from the island of Bohol also comprised a relatively large proportion of the population (Table 17).

Education

Majority of the respondents from all barangays finished elementary only. It was only in barangays Tipolo and Catarman where greater number of the population finished high school (Table 18).

Sources of Income

Information on income and livelihood of people in the five communities is reflected in Appendix Tables 6 to 10. Based on the pooled data, the major occupation of the people was farming (122 or 48.2 %) while 66 or 26.1% worked as laborers that were either hired by landowners or by private companies. Some were employed in the government (22 or 8.6%) while others (12 or 4.7%) were "gabasero" (those who used chain saw to cut logs). A few were engaged in sari-sari stores (11 or 4.3%), quarrying (6 or 21.4%), carpentry (5 or 2%); copra dealing and handicraft making (Appendix Table 7). When evaluated by barangay (Table 19), it was very evident that the proportion of farmers in Barangay Bonifacio was a lot smaller than the other barangays. FGDs and actual observations confirmed this survey result. Farming activity in this barangay was limited to the small river valley because the rest of the barangay was characterized by hard soil and poor water supply. To compensate for low crop production, fruit trees like mangosteen and lanzones were planted in hilly areas instead. (Note: agricultural situation in this barangay may already have changed. During the community validation meetings of the project, the barangay just finished installing water pipes that would bring water to most houses that were only dependent on rainwater for domestic needs).

Majority of the people had very low monthly incomes. A total of 82 respondents or 33.5% had a monthly income of between P70 to P500; while 76 or 31% earned P600 to P1000 a month. Only three had earned more than P3,000 and only two had earned over P4,000 a month.

Other Sources of Income

Aside from getting monthly incomes from their main occupation, the respondents claimed to derive incomes from other sources such as selling of domesticated animals (pigs, chickens, ducks, goats, etc.), allowances from working sons and daughters, and from rentals of properties. The incomes they got from other sources were sometimes equal or higher than the income they derived from their main occupations.

Of the 115 respondents that indicated getting additional incomes from selling domesticated animals, 58 or 50.4% earned only between P600 to P2,500. Sixty-two of the total respondents indicated that their other income came from their employment in public or private offices. Ten or 16.1% reported that they earned additional incomes of P6,000 to P24,000 a year. There were employees (15 or 24.2%) who earned between P30 to P500 pesos and between P600 to P1,500 (16 or 25.8%). These amounts were the honorarium they got for serving the local government. The barangay captain, barangay officials and barangay health worker who were mainly farmers received such honoraria every time the barangay council held sessions (Appendix Table 9).

Appendix Table 10 shows that 11 or 4.3% of the respondents earned only between P440 to P3,000, but 84 or 33.0% earned from P10,153 to P19,500 in 2001. Only four or 1.6% claimed to have earned an annual income between P64,000 to P143,652. The average annual income was P18,372.10.

The major occupation of the people in the five communities was farming (122 or 48.2%). In Singalat, farmers planted abaca, corn, rice, and coffee. Mamalad was mainly a rice-producing barangay, but a number of farmers also planted coffee using seedlings and technology provided by CARE (Philippines) to gradually replace the old coconuts. In Bonifacio, fruit trees were the main species planted. Appendix Table 11 shows the plants and crops planted in the riparian zones of the Langaran River.

In Singalat, aside from farming, some residents sold vegetables and made handicrafts (baskets). Rattan gathering was a major alternative source

Table 15. Household population of the five barangays

Barangay	Number of Households
Tipolo	403
Bonifacio	150
Catarman	123
Mamalad	92
Singalat	68

Table 16. Age distribution of respondents per barangay

Age	Singalat	Mamalad	Bonifacio	Tipolo	Catarman
<20	0	4	0	0	1
20-24	5	0	5	3	6
25-29	9	4	9	3	5
30-34	14	24	14	11	8
35-39	11	18	11	15	12
40-44	7	4	7	14	12
45-49	17	7	17	11	12
50-54	7	4	7	11	14
55-59	16	14	16	14	10
60-64	7	4	7	3	8
65 and over	7	21	7	15	12

Table 17. Ethnic affiliation of respondents per barangay

Ethnic Affiliation	Singalat	Mamalad	Bonifacio	Tipolo	Catarman
Tagalog	0	0	0	1	0
Cebuano	16	32	16	87	92
Subanon	38	43	38	3	5
Ilonggo	0	4	0	1	0
Muslim	0	0	0	0	0
Boholano	32	21	32	5	32
Mixed Subanon and Cebuano	0	0	0	0	0
Siquijodnon	14	0	14	3	14

Table 18. Educational attainment of respondents per barangay

Educational Attainment	Singalat	Mamalad	Bonifacio	Tipolo	Catarman
No schooling	9	4	9	0	5
Primary	18	29	18	5	0
Elementary	45	56	45	38	52
High School	23	7	23	46	38
College	5	0	5	10	5
Vocational	0	4	0	1	0

Table 19. Main occupation of people per barangay

	Singalat	Mamalad	Bonifacio	Tipolo	Catarman
None	0	0	7	3	0
Farmer	72	89	16	39	66
Laborer	0	0	52	35	5
Gov't Employee	6	11	2	7	16
Gabasero	8	0	9	4	3
Sari-sari store owner	0	0	7	5	5
Quarrying	0	0	0	5	0
Driver	0	0	0	0	0
Carpenter	0	0	2	2	5
Copra Dealer	0	0	5	0	0
Handicraft	4	0	0	0	0

of income for people in Barangay Mamalad. Animal-raising (e.g., pigs) was also a viable source of income. None of the participants in the FGD considered fishing as an alternative source of income, and only five of the total respondents considered it as one. This was contrary to the survey results where the respondents acknowledged fishing in the river (Appendix Table 12). Evidently, although fishing was a common and major activity, it was not considered as a source of income. In most barangays, the catch may be too little that it may just be enough for subsistence. In Tipolo, for example, quarrying was considered a more feasible alternative source of income than fishing.

Activities of the Communities

Dynamics of riverine communities state that activities of the people tend to revolve around the river. These activities are done on either the water environment itself or the riparian areas. Expectedly, the Langaran River was the domestic abode of the families in the five barangays. Activities included washing of clothes, and bathing. It was also where domestic animals wallowed, and where some people threw their wastes. In Bonifacio, water was very scarce because of the absence of a functioning water system that people had no other option but to bathe and wash their clothes in the river (Appendix Tables 13 and 14).

Fishing for Subsistence

Langaran River, according to the inhabitants of the five barangays, teemed with aquatic life, especially fishes and crustaceans. It was the source of food for the people especially those living close or along it. Of the 164 respondents who fished in Langaran River, 99 or 66.4% said they went fishing once a week; 38 or 23.2% went fishing twice a week, 11 or 6.7% went fishing thrice a week, while 16 or 9.7% went four times a week or more.

Of the 171 respondents, majority (83 or 48.5%) mentioned *anga* to be most common catch. This was followed by i*swil* (17 or 9.9%), *palotpot*, *gisaw*, (16 or 9.4%), *pait-pait* (15 or 8.8%), *ulang* (14 or 82%) and *bunog* (5 or 2.9%). Fifty-two or 30.7% had caught fish between 1-5 kilos; 7 or 27.6% caught only less a kilo of fish; others caught between 6-11 kilos (42 or 24.7%); 13 or 7.6% said that they were able to catch fish between 20 to 30 kilos (Appendix Table 15).

Different fishing gears were employed to catch the fish from the river. Of the 255 respondents, only 14 provided information on the types of tools or methods used. The most popular method was the "pahubas". This method is done by piling rocks around an area of a river (usually along the riverbank) to trap the fish and drain the water, as the water flows downstream. Three used *bingwit* (hook and line); while three respondents used fishnets. The others used *bobo* (a kind of fish trap) and "kuryente" (use of battery-run gadget that stuns the fish). The use of illegal fishing methods was confirmed by the participants in the FGD. These included the use of "tubli" (a poison from *Derris* root extract), "kuryente" and pesticides in the guise of tank and hand washing (Appendix Table 16).

Farming

Size of Farm

Majority (111 or 63.4%) claimed that the size of the farms ranged from 0.125 to 0.330 hectares; 45 or 25.7 % had farms from 0.500 to 0.750 hectares; while 10 or 5.7 % had 1.25 to 2.0 hectares of land in and adjacent the riparians (Appendix Table 17).

Farming Techniques Used

Farming techniques were generally traditional. More than half of the 172 respondents (93 or 54.1%) claimed that they still used the "demano" technique (manual), while 34 or 19.8% employed the bunglay system (the use of *bolo* in cultivating the land). Some (23 or 13.4%) used the *daro* or plow. Only a few used the tractor (9 or 5.2%) and practiced *kaingin* or "slash and burn" technique (7 or 4.1%) (Appendix Table 18).

Majority of the farmers (110 or 67.9%) claimed that they used chemicals for their crops to obtain better harvest. Only 52 or 32.1% did not use chemicals. Of the chemicals listed, inorganic fertilizer seemed to have been most frequently used (49 or 45.4%). Only 9 or 8.3% indicated using organic fertilizer, which was misconstrued to be a chemical (Appendix Table 19).

Participation in Farming Activities

To obtain information on the extent a family was engaged in farming, respondents were asked of individuals other than themselves who participated in farming activities. Only 30 or 17.8% of the respondents claimed of doing everything themselves without the participation of other people. Majority (139 or 82.2%), however, claimed working with other people. They were usually assisted by household members (80 or 57.6%), by paid laborers (15 or 10.8%) and/or by their wives (22 or 15.8%). A few of the respondents were engaged in "hunglos" (a bayanihan type), a practice of helping another farmer in exchange for the help the other farmer gave him during the planting or harvesting season. They trade services when they could not afford to hire additional manpower (Appendix Table 20).

Quarrying

Quarrying was one of the major livelihoods of the residents along the Langaran River wherein sand, gravel and rocks were obtained and sold to building contractors for use as building materials or manufacturing of hollow blocks. As shown in Table 20, quarrying was confined to one barangay only. In Tipolo, a significant proportion of the respondents indicated quarrying as a major activity. Visits to this barangay confirmed the presence of quarrying sites in various spots along the river. Majority of the respondents (36 or 39.1%) said that quarrying activities were done in the riverbanks; although some quarried in the middle of the river or where there was sand (Appendix Table 21).

The survey, visits and actual observations showed that quarrying was done by hand or with the use of a shovel. There was no sign of a mechanized activity or the use of a backhoe (Appendix Table 22).

The quarry materials were then transported, as reported by 86 respondents, through different conveyance. Majority (35 or 40.7%) used carts, while others merely carried the load (30 or 35.0%). Some used the *bote* (small flat-bottomed boats), while only two used animals (carabaos or horses) to carry the load (Appendix Table 23).

Seventy-one or 80.7% of the respondents hauled sand/gravel once to twice a day, 13 or 14.8% three to four times a day, and only 4 or 4.5% five or more times a day.

Environmental Condition of the River

The communities in the five barangays were consistent in stating that the state of the river has dramatically changed over the years. Then, it was narrow, deep, very clean, and fishery resources were very abundant. Participants in Catarman even claimed that crocodiles were seen in the river. At the time the study was done, the river was already shallow and wide, the water already turbid and very few trees were visible. The banks were already eroded and denuded. The kinds and number of fish also declined, making it difficult for the residents to get a large catch. The participants mentioned a number of factors that could have affected the status of the river and its riparians. These were: illegal fishing activities (e.g., tubli and use of the pesticide decis, kuryete), absence of trees in the bank, (illegal) logging activities in the uplands, quarrying, irrigation, throwing of domestic and municipal wastes into the river, extraction of water by the National Waterworks and Sewerage Authority (NAWASA), and natural phenomena like landslides and floods. The presence of illegal activities and the perception of the respondents on such activities were evaluated in the survey (Appendix Tables 24 to 29).

One hundred eighty or 70.6% out of the 255 respondents said that they had observed illegal activities in the river. The activities mentioned included the use of poison to stun the fish, the practice of electric fishing, quarrying, cutting of trees or "kaingin" (slash-and-burn) and disposal of household garbage into the river. One of the respondents mentioned the use of dynamite.

It is worthy to note that the few respondents who admitted that electric fishing was one of the methods they used (Appendix Table 16) also considered the use of poison and electric fishing as illegal. While the survey also showed that these same respondents considered the effects of these illegal activities as negligible, they were aware that these methods were illegal and not considered as typical fishing methods by the majority.

When respondents were asked to rate how rampant the illegal activities were, garbage disposal was considered very rampant by three of 10 or 30.0% of the respondents, while 22 of 78 or 28.2% considered quarrying as rampant. As revealed by both the survey and FGDs, those involved in these illegal activities were people from within and outside the barangay (Appendix Tables 24 and 25).

During the surveys, attempts were made to separate illegal activities going on in the river and those occurring in the riparian areas; but the respondents perceived the two as same or inseparable, having mentioned the same set of illegal activities. When asked to rank the activities according to which they thought was most destructive to the river and the riparians, 76 or 43.4% of the 175 respondents considered quarrying as the most destructive. The other destructive activities included using poison to stun the fish (57 or 32.6%), cutting of trees (16 or 9.15%), *pahubas* or drying up of an area to catch fish (11 or 6.3%) and the use of mild electricity (10 or 5.7%). Disposal of garbage into the river was also thought to be destructive to the river and the riparians.

Community Environmental Awareness

Two hundred sixteen respondents were asked which activities of theirs could possibly affect the river. One hundred sixty-two (75%) responded, while 54 (25%) gave no reply. Among those mentioned were farming (83 or 51.2%), quarrying (32 or 19.8%), and cutting down of trees (18 or 11.1%). Some mentioned hunting, throwing of wastes and defecating in the riparian areas (Appendix Table 30).

The use of "tubli" was especially prevalent in Barangay Catarman. Majority of the respondents (63.1%) believed that this method could greatly affect the river, other respondents believed that the effect could be little to very little and only three of the 157 respondents thought that this method could not affect the river at all (Appendix Table 31).

When the respondents were asked as to how their quarrying could affect the riparians, their answers indicated environmental awareness. A great majority (31 or 73.8%) said that these would destroy the river. Some said that the activities can contribute to the dwindling of aquatic life and to constant flooding that could lead to erosion of the riverbanks.

Environmental Laws and Regulations

Research revealed the presence of municipal and barangay ordinances to stop illegal activities in the river and its riparians. In most of the barangays, these ordinances were printed on boards and posted in the barangay halls. Respondents differed in opinion with regard to the effectiveness of implementation of the ordinances. Majority (99 or 55.3%) believed that the ordinances were not effectively implemented, while 39.7% said that the ordinances were effectively implemented (Appendix Table 26). Only a few (9 or 5.0%)

stated that the ordinances were very effectively implemented. The rest gave no response. Respondents believed that the ordinances were not effectively implemented because: (1) people had ignored the ordinances (31 or 35.2%), (2) it was difficult to stop illegal activities (24 or 27.3%), (3) the ordinances were never followed (24 or 27.3%), (4) some offenders can easily pay the fine for the violation (5 or 5.7%), and (5) some illegal activities like quarrying was a source of livelihood of many (4 or 4.5%) (Appendix Table 27).

While the majority thought that the ordinances were not effective, they were also interested in stopping the illegal activities. A total of 76 or 43.7% of the 174 respondents were pushing for the strict implementation of the ordinances and policies. Some of the respondents (37 or 21.3%) suggested that offenders be strongly reprimanded, 24 or 13.8% said that more disciplinary actions were needed, while others said that the government should formulate more ordinances (19 or 10.9%) (Appendix Table 28). A great majority of the respondents (136 or 76.4%) believed that the LGUs would be most instrumental in stopping the illegal activities. Some suggested that the military could effectively do the job (22 or 12.4%) while others said that NGOs (15 or 8.4%) should stop the illegal activities. There were a few who believed that the New People's Army (NPA) and the Department of Environment and Natural Resources (DENR) can stop illegal activities in the barangays (Appendix Table 29).

Community Problems

Education

Majority of the respondents finished elementary education only. The low educational attainment of the upstream communities implies a need for alternative avenues for learning like training, which respondents expressed in the survey.

There were some efforts to increase access to both formal and informal education. In Mamalad, some groups (e.g., Banwak Subanon) had literacy programs. A Subanon teacher was tasked by the tribe to teach the Subanon dialect and culture, including that related to the environment, to interested groups. In general, there was a need to put up more schools at the elementary and secondary level. Barangay Singalat, for example, offered education up to the second grade only. The children had to commute or move to the next barangay to continue elementary education. In Barangay Mamalad, a complete elementary education was offered but a teacher handled two grade levels simultaneously and classrooms were shared by the two levels of students. Hence, while children had the opportunity to obtain an elementary diploma, the quality of education had to be evaluated because of the system being adapted by the school.

On the other hand, the people in the lower barangays had better access to elementary and high school education but the families' poor economic status prevented most of them from pursuing higher education.

Lack of Available Information and Training

Through the media, the whole population can be made aware of issues such as deforestation, soil erosion and the loss of biodiversity. Some were probably already aware of these problems but had not yet understood the causes and effects and how they can change them. The whole community, whether involved in management or not, can therefore benefit from being more fully informed.

Many of the respondents expressed the need for training on special issues. However, there was still a need to educate the general population. Farmers, for example, needed information on climate and soil, crops that can be grown, available varieties, and particular yields that can be expected from alternative production systems and levels of fertilizer application. They also needed to know what products could be sold, where, at what prices, as well as the costs of production inputs and transport. There appeared to be a need to develop an information delivery system most appropriate for the community, given the educational background of the people, as well as the state of communication networks. Information is an essential input to efficient use of resources, to mutual agreement, and to sustainable management of the environment.

Growing Population

Many children of the original settlers in the communities near Langaran River got married and settled in the area. They stayed in the same barangay either with their parents or in their own houses and farms.

The relationships among available land, population, food production and living standards are fundamental. As population increases, the initial response is to occupy additional land. When all the available and sustainable land had been used, and if the population continues to increase, two sets of possibilities occur. One is a continuously increasing food supply from the same amount of land through the invention or adoption of improved production technology. This is more likely to take place where the physical environment is favorable (which is less likely in some of the barangays like Singalat and Bonifacio). If introduction of improved technology occurs faster than rate of population increase, then the standard of living rises. The second possibility is that population increases but resource management systems remain essentially the same, due to lack of information or social resistance to change. In this case the production base will be degraded, standards of living will fall, and part of the population may attempt to migrate elsewhere or the exploited area is expanded. The latter was observed to be the case in the upstream barangays. The constraints imposed by lack of infrastructure, inputs and information on recent technology prevented the people from increasing production from the same land area. As a result, a married son or daughter would clear a tract of forest land to build a house on and to use for agriculture.

However, even updated farming technologies seemed inadequate to raise enough production for the rising population. For example, the municipality of Plaridel, which included barangays Catarman and Tipolo, was the demonstration site and/or a recipient of modern farming technologies introduced by local and international agencies. By their introduction, it was expected that the agricultural activities in these areas would improve and would generate income enough to raise the living standards of the people. However, the resulting farm produce using the new technologies were still not enough to provide for the whole family. In Catarman, residents clamored for the establishment of processing plants and factories that could generate employment for the people. In all the five communities, children of many families had gone to other places like Manila and Cebu to seek employment to help raise the living standards of their families left in the barangays.

Low Production and Income

Agricultural production especially in the upstream barangays was low. In general, aside from natural causes of low production (e.g., poor soil type, flash floods), there were vast interrelated factors that led to low productivity, hence low income. These factors ranged from unattractive economic and social rewards, insecurity in land tenure, lack of infrastructures and communication facilities and even political crisis. People were not motivated to increase production because market price was not attractive and did not pay off their efforts in production and the cost of marketing. All these factors created complacency among the people in Singalat and Mamalad with regard to production.

Lack of Infrastructure

The barangays along the river lacked basic physical infrastructure like adequate tracks, roads and bridges, as well as markets where extra production can be taken. In Singalat, respondents believed that the absence of even a rough road was bringing the barangay to poverty. The only way to reach the nearest part of the barangay was to walk for an hour and-a-half to two hours, crossing the river at least seven times. However, even the river becomes impassable during heavy rains. The only alternative was a very rugged pathway, impassable even by motorcycle. The distance was twice that of the river route and entailed going up and down hills. A trek with a load at the back was therefore very difficult.

Difficulty in Marketing Farm Produce

As a result of the infrastructure problem, marketing of farm products was a big difficulty. In Mamalad, farmers were forced to sell their products at very low prices. The modes of transport were by either old *jeepneys* or a *motorelas* (a motorcycle with a side car) which operated on an *alas-puno* basis (the vehicle leaves only when all seats are filled). A *habal-habal* (single motorcycle) can be hired to travel from Mamalad to Calamba and back but was rather expensive. A trip cost P60, an amount considered high by farmers in the area. Oftentimes, the sales of the farm products were not even enough to cover transportation expenses.

Insufficient Farming Equipment

While farming was the main activity in Mamalad, the farmers did not have enough farming equipment and materials. Some residents resorted to illegal cutting of trees to compensate for the low agricultural production.

Rights to the Land or Property

Many studies revealed that poor cultivators are often settlers, squatters on government or private lands, or tenants. They are therefore not motivated to care for the land in the same way that they would have if they had rights to use it. Where the farmer owns the land, even when the holdings are very small and the farm family is poor, production is often very high per unit area, and the greatest care is given to conserving and improving productive potential because the land is the family's most treasured possession and means of livelihood. In other words, production is encouraged when users are secure of their land rights.

Majority of the residents along Langaran River were tenants and received only small shares of the land's total earnings because production was usually low. It was a typical set-up for the real owners of the land to live in another barangay or municipality. In most cases, the legal owners of the land had their children and their offsprings to manage the land. After the harvest, the owners or their kin either picked up their shares or had the tenant deliver it to their residence. In general, the owners or their kin only provided the needs of the tenants (e.g., fertilizers) but were not particularly interested on how the land was tilled. One reason for their lack of interest was the uncertainty in future ownership of the land, as the case was in Mamalad. Big tracts of land still owned by grandparents of potential heirs remained undivided. Unsure of their future standing in estate inheritance, family members remained disinterested and refused to invest in the property's development until it becomes clear they will benefit from it.

Lack of Economic and Social Fulfillment

There were no social rewards for high levels of production. Some members of the Banwak Subanon were involved in a region-wide program where highest-producing backyard gardens were recognized and awarded. However, the program was not sustained because there was no change in the people's social status. They remained economically poor. Participation by the members gradually dwindled.

Lack of Telecommunication Facilities

Furthermore, as a result also of poor infrastructure, the barangays became even more isolated. People lacked information from the outside, including that on farming technology. Because the barangay did not have electricity either, dissemination of information and communication by electronic media was also impossible.

Basic communication networks were lacking as well. The barangay captains were issued two-way band radios but the frequency only covered short distances. This difficulty in communication further limited the exchange of information. Because getting information was very difficult, barangay leaders were seldom aware of services some government and nongovernment agencies offered, which they could have shared to their respective barangays.

Unfavorable Political Conditions

Unstable political conditions tend to go hand in hand with poor delivery of services and poor maintenance of infrastructures like roads. But political conditions could change very fast while many aspects of land- and resource-use are long-term in nature, like establishment of permanent crops or tree plantations and investment in market roads. Hence, the decision to have these long-term investments is influenced by the people's expectations of future political conditions. Indeed, the political atmosphere had influenced many activities of the communities along the river. In some of the barangays, political affiliations divided the community. Programs initiated by the newly-elected barangay captain were not supported by the followers of the former captain, regardless of how beneficial the program appeared to be.

There was also a political struggle between the Subanons and the non-Subanons. In Mamalad, some Subanons had been trying to take control of the political leadership. The position of barangay captain had been vied for by a Subanon and non-Subanon during the past elections. The incumbent captain was not a Subanon. Consequently, some members of the Subanon community did not participate in a number of programs initiated by the incumbent captain.

Faulty Implementation of Laws and Ordinances

The respondents believed that the river was destroyed because of weak implementation of ordinances, which they considered as the major problem. In Singalat and Mamalad, people considered the laws and ordinances as the main problem. They believed that these denied them access to the forests that were traditionally the source of their livelihoods.

Gambling and Drug Addiction

A large segment of barangay constituents, especially the women and the youth, were hooked to gambling activities like *jai alai* and *tong-its* (akin to poker). A good segment of the youth, particularly in Catarman, were not only into gambling but were also into drugs.

Conflict between Groups

The objectives of different stakeholder groups in Mt. Malindang (or the Langaran River in particular) often conflicted. Conflicts of interest arose due to competition for access to resources or their control. Some examples encountered were: (1) when cultivated coffee or abaca land, as part of a development project implemented in the area, encroached the land traditionally used for corn or coconut; (2) when people were denied access to forests traditionally necessary to their livelihoods like gathering of firewood and rattan; and (3) when there was competition for water for irrigation and fishing, swimming, bathing and washing of clothes.

Conflict may have also risen because of the impacts of resource use, or when one stakeholder's actions affected another party's interests. Conflict arose when a group cleared vegetation or destroyed habitats in the expense of the livelihoods or lives of other groups. In Tipolo, for example, the fisherfolks blamed the quarrying activities for the reduction in their fish catch.

Certain stakeholder groups were often gravely disadvantaged because they did not have access to information, were less educated, or had weak social positions. While all participating groups needed access to the appropriate information, disadvantaged groups required special assistance and training to enable them to participate effectively in the negotiating process. For example, many of the residents in upper Singalat preferred to remain quiet during deliberations on environmental issues because they felt that others who had higher educational attainment were more knowledgeable than they were.

There was also conflict of interest between the objectives of the individual and those of the community in general. The objectives of the government and the community as a whole were usually more long term, and typically included conservation of natural resources, including water, land, plant resources and wildlife, and protection of the environment and the quality of life for the present and future generation. On the other hand, the individual focuses on his immediate needs. The head of a family, for example, would cut a tree in the riparian zone, even if the government prohibits such an action, because he needs the money for his ailing wife's medication. Oftentimes, the long-term objectives would give way for the short-term objectives.

Opportunities

Despite the absence of access roads, Singalat residents found opportunities for livestock farming, establishment of plant nurseries, production of ginger, establishment of fishponds and handicraft making. There were also opportunities for vegetable and tilapia farming. In Mamalad, the practice of *bayanihan* or *pahina* were considered as opportunities in the barangay.

Surprisingly, quarrying was perceived as an opportunity in Barangay Bonifacio. According to the participants, construction of the road to the quarry site was started a few years ago but was suspended for lack of funds. They were hoping that construction of the road would be pursued to give people the opportunity to earn a living from quarrying.

The people of Barangay Catarman cited several income-generating opportunities. Because of its coastal location, the people were looking forward to the establishment of factories and processing plants for fishery products that could generate employment for the local residents. There were processing plants for banana chips but not a lot of people were encouraged to plant more banana trees. There were also good opportunities for livestock farming and duck production.

The five barangays were also optimistic of their livelihood in the next five years. As long as the government will support the barangays' initiatives and the interventions (e.g., coffee production and abaca plantation) will continue, they remained hopeful.

Information Dissemination

Respondents were asked about information disseminated to the community regarding protection of environment, farming, livelihood projects and other information needed by the people.

There appeared to be insufficient dissemination of information in the barangays. One hundred twenty-three or 57.2% of the respondents wanted information on farming, 17 or 7.9% on livelihood projects or trainings, 15 or 7.0% on fishing, few wanted to learn how to use fertilizer and how to make a compost pit, 56 of the 215 respondents were not interested to obtain information on anything (Appendix Table 32). Conversations with some members of the community revealed that some felt self-sufficient and did not want to be involved in any activity related to environment, while others seemed doubtful that interventions from outsiders can really improve their lives. From their experience, many groups tried but none had successfully made an economic impact on the community.

How new information is handled by an individual would determine the impact it would have on the community. Results of the survey showed that there was sharing of information on fishing and farming in the five communities. When the respondents in each barangay were asked with whom they would share the information or issues on fishing and farming, 55 or 29.6% of the respondents said they would share new information with their neighbors; 50 or 26.9% said with the community; 26 or 14.0% said with their family members; and 10 or 5.3% with public officials, 45 or 24.2% said they had no one to share the information with (Appendix Table 33).

At the community level, majority of the respondents (165 or 70.5%) claimed to discuss new information about farming and fishing in the barangay while 69 or 29.5% said they did not. New information were discussed through sharing (70 or 45.8%) and in meetings and seminars (45 or 29.4%). The information shared was usually on planting of trees (28 or 18.3%) and enhancement of natural resources (10 or 6.5%). Few respondents indicated that they could not discuss new information because they were busy (29.4%) or there was no organization in their barangay that facilitated such discussions. The latter claim may be true because when respondents were asked of the existence of farming-related organizations in their barangay, 144 or 56.5% were aware that such organizations existed but 111 or 43.5% were not. The organizations listed by those who were aware of them included, among others, integrated pest management (IPM) groups, farmers' group and farmers' cooperative.

Improving the State of the River

The participants from the five barangays saw reforestation as the best way to improve the state of the river. It would bring back wildlife and ensure sustainability of the environment. Majority suggested that bamboos be used; as well as fruit trees; because aside from the fact that these trees could prevent soil erosion, they can likewise be a source of income for the people (Appendix Table 6).

In the meantime, some parts of the riverbanks in Catarman were fast eroding. Although there had been several attempts to reforest these banks, flooding washed away the seedlings. Seedlings of different bamboo species did not withstand the strong water current. The people suggested the construction of river walls on vulnerable banks to arrest further erosion. They wanted to try using mangrove species to reforest the banks in Catarman but mangrove seedlings were difficult to obtain.

Resolutions, ordinances and strict implementation of laws were seen to be necessary in improving the state of the river. These should be directed towards stopping illegal cutting of trees, illegal fishing activities, quarrying and improper disposal of wastes and garbage. According to the five communities, existing laws and ordinances were not strictly implemented. There were violators with strong government connections who were able to evade penalties.

There is a need to educate the people on the relationship between trees and the state of the river. The public needed to be informed on the importance of having and keeping trees in the riverbanks and in their surroundings. In Mamalad, the participants were emphatic in saying that having alternative livelihoods would minimize, if not stop, the dependence of people on the river resources.

A closer look at the results of the focus group discussions and the survey showed that quarrying was massive in the lower barangays. There was a need therefore to improve the understanding of the people on the connectedness of the waters in the river and that both upstream (e.g., cutting of trees) and downstream activities (e.g., quarrying) were equally responsible for the state of the river.

Government Support

While convinced that the state of the environment can be improved, all the five barangays claimed that the government was not supporting efforts to reforest the riverbanks and to protect the river from further destruction. The reason was perceived to be economic and political in nature.

The participants in Barangay Bonifacio would like the government to facilitate the establishment of processing plants and the like that would generate employment for them. In doing so, dependence of the people on the river will be minimized. They also saw the need to intensify the information drive on the rehabilitation of the Langaran River, including reforestation of denuded areas.

The Barangay Council of Bonifacio passed resolutions and ordinances to protect the river. These included, among others, specific penalties (fines and imprisonment) for people caught fishing with the use of mild current and poisons from *Derris* root extract. Despite these ordinances, destructive activities ensued and participants expressed the need to hire watchmen to arrest violators. This would require financial cooperation in the municipal level since barangay funding will not be able to support it alone.

To implement a program geared towards the protection of the river, the communities believe that help is needed for the following:

1. seedlings for tree planting
2. information drive
3. financial assistance for labor
4. implementation of laws and ordinances
5. monitoring of trees planted in privately-owned lands

The communities along the Langaran River have the potentials for eco-governance (i.e., to self-manage their environment). Majority believed that if the laws and ordinances were enforced, illegal and destructive activities can be stopped. The people were confident that the LGU, not the military nor the NGOs or the other groups, can stop the illegal activities in the river and its riparians. A community-based activity is not totally new to the ears of many people in the area. The respondents were open to interventions that would improve or enhance their livelihood and their environment. Many of them were willing to participate in community-based activities, an indication that the local communities can be empowered to manage the environment instead of just relying on the top levels of government.

People's Perceptions on Community-Based Management

Recently, there was a paradigm shift in the management of natural resources from a top-bottom approach to community-based. But while the community-based approach succeeded in many areas, using it to manage resources in the Langaran River was yet to be seen. Hence, an assessment of the communities' attitudes and perceptions towards community-based management was included in the survey. Respondents' perceptions and understanding of community-based management projects, their information sources, and their willingness to learn more about and participate in such projects are presented in Appendix Tables 34 to 42.

More than half of the 250 respondents (130 or 52.0%) said that they had not heard of community-based management; while 120 or 48.0% said they had. Those who had heard about it widely differed in their understanding of the concept but none appeared to have accurate understanding of it as reflected in Appendix Table 34.

About 15.3% wanted to know more about it. Those who claimed to understand what a community-based project was cited NGOs as their main source of information. Other sources mentioned were public officials, special assemblies, research, cooperatives and even tradition (Appendix Table 35).

In general, there was a big interest on community-based management. When asked if they would like to know more about community-based management of resources, 150 or 83.3% indicated their willingness; while only 30 or 16.7% did not. Interested respondents related their desire to know more about community-based management of resources as it relates to the rehabilitation of the river. Other matters they wanted to learn and accomplish through community-based management included livelihood/training, tree planting and fish culture (Appendix Tables 36 and 37).

To approximate the people's participation should a community-based project be initiated in the area, respondents were asked their willingness to be involved in the project. Data indicated that 143 or 91.7% respondents were willing; while only 13 or 8.3% were not. Those who were willing said that they can be involved in a number of ways: (1) by being a member (69 or 48.3%); (2) by participating in the learning process (39 or 27.3%); (3) by helping in the project (23 or 16.1%); (4) by guarding the river (7 or 4.8%); (5) by coursing it through the tribe or in whatever way he can be involved. Those who were unwilling to be involved gave the following reasons: (1) they are old; (2) they do not have time for the project; (3) they do not understand it, and (4) they have no interest to learn (Appendix Tables 38 and 39).

When respondents were asked what activities could be undertaken in the barangay, whether initiated by the project or by other groups, livelihood projects were on top of the list (43 or 26.5%). Others mentioned animal dispersal (13 or 8.0%), fishpond development (11 or 6.8%) and acquisition of fruit orchard, solar dryer, water system, and river flood control (Appendix Table 40).

When respondents were asked whether or not a community-based project would succeed in their barangay, 149 or 78.4% of the 190 that responded believed it would succeed if people were properly guided and supported, if the people were mobilized, if the people were made to understand it, and if the people were to cooperate. The remaining 41 or 21.6% respondents who gave negative responses said that it would fail because there was no dedicated leader and people did not know enough about it, and they simply cannot rely on others.

Roles of Women

Of the 255 respondents, 235 or 92.2% indicated the participation of women in activities. Women were involved in hog raising, selling, raising chicken, sewing, gardening, food processing and other livelihood activities. Their activities in farming and fishing included harvesting (214 or 83.9%), planting (211 or 82.7%) and marketing (136 or 53.3%). However, their participation in fish and farm products processing and in crop protection (against pests) were minimal (Appendix Table 45).

Respondents, however, believed that women should also participate in other areas. For example, they should have active roles in community activities, such as involvements in organizations and NGOs, participation in trainings and seminars, assembly meetings and sports. This suggested that respondents believe that women can have active roles in major planning and decision-making (Appendix Tables 43 to 48).

Forty-one percent (103) of the respondents said that the roles played by women were rarely recognized. Hence, almost the same proportion said that women should be encouraged to participate in barangay activities. Only 20 or 8.0% mentioned that women should not be encouraged to participate in barangay activities.

If women were to be involved in river and riparian management, the specific roles they could play, as listed by the respondents, included tree planting (89 or 42.4%), guardians against destruction of trees (83 or 39.5%), livelihood activities (18 or 8.6%) and others (Appendix Table 43). However, to increase women's participation in the management of the river and riparian resources, they had to attend trainings on: education, handicrafts for livelihood, planting of trees and flowers, protecting the river and matters related to cooperatives (Appendix Table 47). Respondents suggested that trainings be provided by the local government (68 or 31.9%), government line agencies such as the Department of Environment and Natural Resources (DENR), the Department of Agriculture (DA), or the Department of Agrarian Reform (DAR) (59 or 27.7%), researchers (47 or 22.1%), NGOs (25 or 11.7%), Department of Trade and Industry (DTI) (7 or 3.3%), skilled members or tribal leaders (Appendix Table 48).

Attitudes toward Conservation and Management of the River and Riparian Areas

Table 20 presents the results of the survey concerning the people's attitudes on conservation and management of the river and riparian areas. Respondents were asked to react to 15 statements on the topic.

Although there were some respondents who were not sure of their stand with regard to the statements, majority gave their beliefs, opinions and values on matters related to management of natural resources. Majority (83.9%) believed that education is required for people to take responsibility in managing resources. This indicated that the people were aware of the significance of education in the conservation of river and riparian resources. Around 60% of the respondents thought it difficult to demand active participation and obtain consensus among the people in the barangay. Most people lacked the motivation to participate and most had learned to accept the existence of conflict in resource use. According to them, trust is vital in the management of resources. More than half of the respondents felt that decision-making was limited to those in power. They did not trust the government officials and believed that local politics hampered the success of people's organizations. Around half of the respondents believed that the idea of managing the resources was not clear to the members of the community. The municipality should then be responsible for improving the state of the river and riparian resources.

Although 43.9% of the respondents agreed to the statement that the people of the barangay were accountable for the destruction of the resources, 39.2% felt otherwise. Forty percent of the respondents did not agree that outsiders were responsible for the destruction of resources, 31.8% were not certain, and only 28.2% agreed.

Table 20. Attitude and value orientation of the respondents on the conservation and management of river and riparian resources

	Agree		Disagree		Not Sure	
	F	%	F	%	F	%
1. Extensive education required for people to take responsibility managing resources	214	83.9	15	5.9	26	10.2
2. Difficult to enjoin active participation of the barangay	162	63.5	37	14.5	56	22.0
3. Difficult to obtain consensus on how to manage resources	161	63.7	33	12.9	61	23.9
4. People lack motivation to take advantage of resources	160	62.7	41	16.1	54	21.2
5. People had learned to leave the existence of conflict about resource use	160	62.7	35	13.7	60	23.5
6. Trust vital to resource conservation	157	61.6	52	20.4	46	18.0
7. Decision-making limited to in power	150	58.8	47	18.4	57	22.4
8. People had learned to live with existence of conflict about resources use	146	57.3	61	23.9	48	18.8
9. People do not trust government officials	142	55.7	47	18.4	65	25.5
10. Local politics hamper successes of PO	134	52.5	68	26.7	53	20.8
11. Managing resources not clear to community members	132	51.8	58	22.7	65	25.5
12. The municipality has the responsibility of improving the state of the river and riparian resource	129	50.6	4	29.0	52	20.4
13. People are accountable for destruction of resources	112	43.9	100	38.2	43	16.9
14. People don’t know about different organizations	89	34.9	83	32.5	83	32.5
15. Outside people responsible for destruction of resources	72	28.2	102	40.0	81	31.8

Summary and Conclusions

The Langaran River represents a typical natural ecosystem. Its state was a result of the interplay of factors that transcended many different fields which is diagrammatically presented in Figure 1. The key issues, which have interlocking effects and caused by interconnected factors, fall on either loss of biodiversity or destruction of habitat from upstream to downstream. But since the causes are identifiable, solutions can also be devised and can be translated into actions.

Conservation and Rehabilitation Issues and Concerns

Results of the studies on the river and riparian ecosystems in this project reveal a number of issues. The river was very important to the communities because it was the source of irrigation water for the agricultural lands. A big proportion of the population obtained their means of living from this river. The riparian habitats possessed floral and faunal species that were economically and ecologically important. The respondents in the survey were consistent in saying that their lives were largely dependent on the river. But the river and its riparian ecosystems were being threatened; biodiversity was low and illegal and destructive activities proliferated. The growing population was putting more pressure in the bio-physical environment. The combined forces from the various sectors of the community brought forth issues that needed to be addressed to protect the river and its riparian zones.

In all the barangays covered, agricultural activities were being intensified, combined with heavy application of fertilizers and pesticides as the local government tried to meet the growing need for food. The municipality of Plaridel was a demonstration site for supposedly sustainable agricultural technologies like organic farming and IPM. Despite this, fertilizers and pesticides were used. In the upper barangays of Singalat and Mamalad, kaingin farming which already reached the edges of the river was still expanding. In many cases, married children of landed families decided to remain in the same barangay. To support their growing families, they opened new forest patches for crop plants. The increasing households engaging in slash and burn farming increased the mountainous and hilly areas opened for agriculture. While survey of population growth rate was not conducted, population continued to grow at alarming rates, as indicated by the proportion of small children in the barangays. This created more pressure on limited resources as the demand for more food kept on increasing. At the time this study was conducted, human settlements were already encroaching into the uplands, particularly the open areas opened up by barangay roads. Indiscriminate hunting, trapping and fish catching had become widespread. These activities destroyed the environment by increasingly polluting the natural habitats with chemicals and by converting more and more of them into open areas. Added to all of these was the presence of three concrete dams in different parts of the river that were built to bolster agricultural production. The dams affected the state of the river when water was diverted to farm lands. They also impeded downstream-ward and upstream-ward movement of aquatic faunal species.

The Langaran River was known for risks of natural disasters caused by flash floods, landslides and massive erosion during rainy season. These were indicators of degraded watersheds and forests. Results of the survey showed that the watersheds and forests of Langaran River were threatened by the development of human settlements, collection of firewood and other forest products, hunting and extraction of other resources.

The riparian areas of the Langaran River were home to a number of plants and animals endemic to the Philippines. The plant survey component of this project revealed that many plant species were economically important to the communities, especially to the Subanons in the upper barangays. The native species were sources of food and medicines. But these native species were diminishing due to human activities and the invasion of exotic species. *Wedelia trilobata* had invaded coconut plantations and riverbanks, choking whatever species were present. Plant endemicity in the area was only about 24%, a rate lower than the typical endemicity of 40%

in the Philippines. The plant *Donnax cannaeformis* had been harvested excessively for handicraft making. Except for some riparian areas in upper Singalat that still had some trees, the banks in general were already denuded of trees resulting to massive erosion. These, together with expanding kaingin activities in the surrounding hilly areas and the absence of a clear reforestation program for the river, threatened the vegetation in the Langaran River.

The faunal survey revealed presence of species considered to be in the critical state as well. There were threatened and restricted-range species of the Greater Mindanao Faunal Region that had been recorded in the area. Many individuals of silvery kingfisher, which thrives only in clear waters of forested areas, were recorded in the upper barangays. There were recorded evidences of breeding of the bird *Ardeola speciosa* in Barangay Catarman. The rock frog *Staurois notator* and the lizard *Hydrosauros postulatus,* described by Alcala and Brown (1998) to inhabit only clear mountain streams, were still found abundant in the upper barangays of Singalat, Mamalad and Bonifacio. *Tarsius syrichta*, an endangered mammal (but recently removed from the Red List) was found in Singalat. Forest species of mammals like the Mindanao tree shrew (*Urogale everetti*), white-tailed rat (*Bullimus bagobus*), flying lemur (*Cynocephalus volans*) were still found in the upper barangays. The presence of these critical species was key indicator to the ecological state of the Langaran River and the communities surrounding it. The riparian forests upstream appeared to be still relatively healthy as indicated by the presence of these forest species. Consequently, the water was still clean, clear and unpolluted as indicated by the existence of bird, amphibian and reptilian species that thrive only in clear waters. These species of animals that can be considered indicators of a healthy environment will continue to thrive in the area only if their habitats were preserved. The fact that they were found only in the upstream areas and not in the downstream areas signals to stakeholders an urgent need to conserve and preserve the areas.

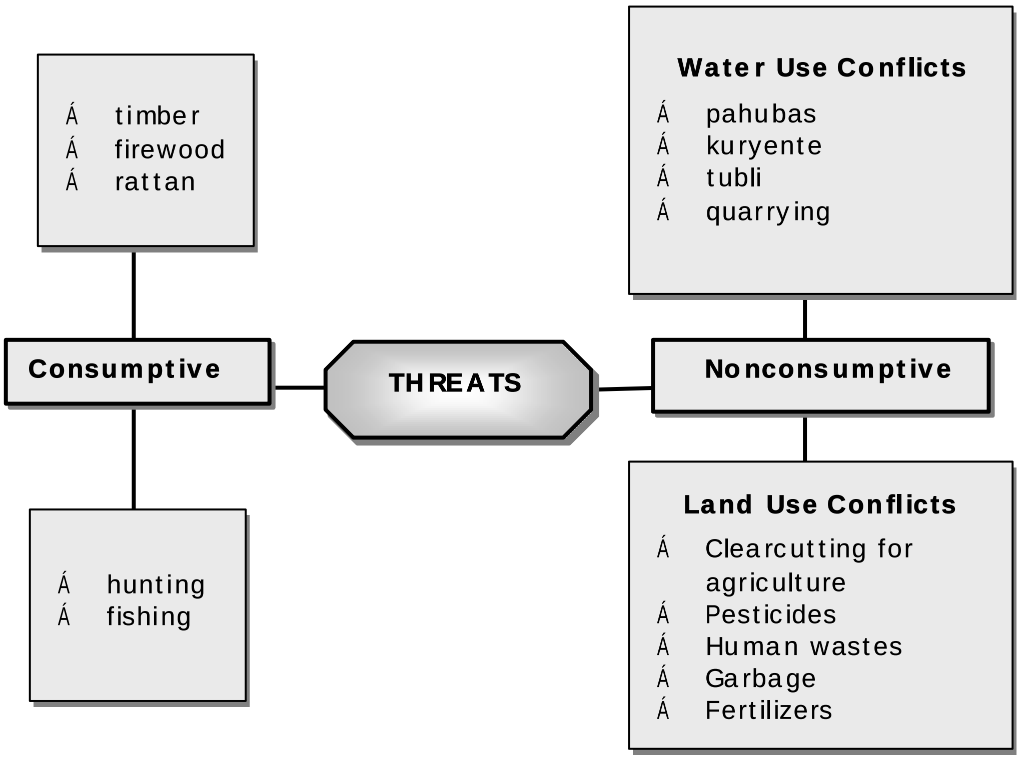
The differences in the state of the water from upstream to downstream based on the vertebrates present were confirmed by the results of the studies on macroinvertebrates and coliform load. Macroinvertebrates found in the upper barangays of Singalat, Mamalad and Bonifacio were good water quality indicators while those found in the lower barangay, specifically in Tipolo were poor water quality indicators. Similarly, coliform load of the water in Tipolo was massive making it unfit for domestic use. The water in the upper barangays was also contaminated with *E. coli* but the MPN index indicated that it was still fit for human use.

It must be recognized that the degradation of the environment and the depletion of natural resources are inextricably linked to poverty and conflict. The problem arises from the fact that, while the natural resource base is fixed, the population is rapidly increasing. Since the economy of the municipalities surrounding Langaran River cannot provide alternative livelihood sources for everyone, an increasing population readily translates to increased rates of natural resource depletion. Degraded natural resources means declining income for those whose livelihood sources directly depend on them. As their incomes fall, the people are forced to increase the rate of exploitation of natural resources, thereby accelerating degradation. This could be seen happening to the Langaran River as a whole. As the cycle continues, people will experience increasing poverty and powerlessness, which will in turn trap them within natural-resource dependent livelihood activities and render them vulnerable to conflict. While it maybe pessimistic to say that the communities in the Langaran River were vulnerable to conflicts, there were already unconfirmed reports that feelings of dissatisfaction were pervading the people and conflicts were resurging.

Information on the activities in the river suggests that the river is under threat. The threats are either consumptive or nonconsumptive in nature and are from many sectors of the society, as graphically presented in Figure 2.

The threats will continue for as long as the economy of the people remains dependent on the resources in the Langaran River. While the communities' and the LGUs' immediate concerns were focused on increasing food production and income generation, there is a high probability that lack of awareness on environmental

Figure 2. Diagram showing the activities that threaten the Langaran River



concerns will further deplete the natural resources and subsequently impact on the communities' source of livelihood.

The species in the Langaran River with critical conservation status should be protected. The aquatic and riparian habitats in the upstream part should be preserved while many habitats downstream needed to be rehabilitated. Due to the depleted natural resources downstream, people started moving upstream where natural resources and space were still available.

The conflicting issues in the Langaran River indicate one urgent and critical need that requires concerted assistance from various agencies: a sustainable livelihood program with an environmental protection dimension. The concern is of critical importance given the need to bolster efforts to protect the environment and ensure sustainability of natural resources. This is particularly true for barangays along the Langaran River where immediate and practical concerns of the people on food security and income generation may lead to overexploitation and gradual (and continued) depletion of natural resources.

Recommendations

Management Options and Strategies

Langaran River poses great challenges to environmental managers because of its unique political, cultural, biophysical and economic characteristics. But just like any place in the map, the critical factors for a durable peace and sustainable development in the Langaran River are the protection of the environment and the conservation of natural resources, as these provide the base for people's livelihood, shelter and security. The area is not spared from the cycle involving population, economy and environmental degradation. While some non-government organizations like CARE and ZPEP have worked in the area by opening up alternative livelihood activities for the communities, the greater majority of the population is still dependent on the natural resources in the Langaran River. There is therefore a need to formulate a long-term plan of action for the protection of the river environment and its biodiversity, a project that will contribute to the restoration and protection of the natural resources. The main objective of this project is to protect the environment and to preserve its biodiversity from the consequences of unsustainable exploitation of its natural resources. The need for environmental protection and proper management of natural resource is especially relevant for communities in the Langaran River whose livelihoods and incomes are mainly derived from resources within. But a purely environmental protection program may not be the best approach because the growing population will continue to put pressure on the environment. A management program should therefore be one that is geared towards creating and/or enhancing sustainable livelihood activities with an environment protection and management dimension. The assistance for a sustainable livelihood program will ensure that the communities will not be dependent on the natural resources for their incomes. A livelihood program that is in place would create social and economic conditions under which the necessary technical and management solutions towards environmental protection will be applied.

The environmental management project envisioned for the Langaran River should include a package to promote the awareness of communities living in the area on critical environmental issues including the importance of environmental management and sustainable livelihoods, and to build their own managerial capacity to protect their environment. This will be achieved through awareness raising, building the capacity of rural communities in sustainable management of natural resources, initiating the rehabilitation of environmentally-at-risk areas, and strengthening the capacity of government and nongovernment stakeholders to support environmental protection activities. The objective relative to livelihood activities will be achieved through the conduct of workshops on policy-making and project planning, and the conduct of participatory demonstration and training activities on alternative livelihoods.

More specifically, there were indications of a community-based management effort. Throughout the implementation of the project, there were no problems in getting the participation of the communities. The barangay leaders and the community were enthusiastic in making their environment sustainable. This participation is not only a perception of the team but was seen during project implementation. The Subanons and the non-Subanons had some common understanding on the value of sustaining environmental integrity when they tried to come up with agreements to protect their immediate environment. There were programs by the government and NGOs that were directed to either group but there was the common belief that an integrated and holistic approach to protecting the environment should do away with tribal or group affiliations. It should transcend multiple groups. There is therefore big hope for eco-governance to succeed in the area, if pursued.

An option is to bring technical assistance to communities to address environmental problems related to people's encroachment of forests and riparian habitats while enabling communities to maintain sustainable livelihoods. Among the activities that can be done are the following: (1) introduction and development of sustainable agro-forestry management techniques by (a) promotion of alternative production systems to include integrated agro-forestry systems and integrated hillside farming systems or (b) promotion of alternative income generating options like coffee production (as promoted and supported by CARE), bamboo production and processing, fruit production and tree farming, (2) promotion of reforestation, and (3) construction of anti-erosive infrastructures and other related structures.

Assistance is greatly needed to reforest many riparian habitats. While planted seedlings in some areas like Catarman were prone to being washed out by flash floods, many parts of the river can be successfully reforested. Fruit trees, locally called “bungahoy” were strongly recommended by the respondents. According to them, using pure tree species is not a sustainable approach. People are often tempted to cut down the trees after 10 or 15 years, when the trees have grown big and would already command a high selling price. But if fruit trees were to be used, people might care for them more as they mature because of their potential to bear more fruits that can be sold. In other words, using fruit trees to reforest denuded riparian habitats not only protects the banks from erosion but also provides alternative incomes to the people.

In Catarman, and even in the other barangays, people claim that no amount of reforestation will work in many riverbanks. There had been several attempts to reforest these banks but even minimal flooding would already wash away the seedlings planted. Bamboo and nipa species had been tried but even these did not withstand the strong water current. Banks continued to erode at a significantly fast rate. The people suggested the construction of a river wall or concrete dikes in vulnerable banks to arrest further erosion and destruction. They also wanted to reforest the banks in Catarman with mangrove species but these were difficult to obtain.

Development covers a host of aims and objectives, such as eliminating poverty and raising standards, strengthening women’s rights, increasing food production, improving the quality of human settlements, halting erosion, preventing deforestation, preserving biodiversity, and many others. Each gives rise to different and often competing programmes with different objectives, budgets and institutional aspirations. There is therefore a need to coordinate the efforts being given to the Mt. Malindang area. Several groups (e.g., CARE, ZPEP, Paglaum, RIC), each with specific goals, had started programs that may or may not conflict with each other, hence the need for more coordination and networking. Shared resources can be sustainably managed when institutional arrangements exist through which all stakeholders are represented in an agreed management plan that has a long-term interest to all. Women should be given equal opportunity as men to manage the environment. Participation of women could be facilitated by making women’s organizations a legitimate recipient of projects and training on environmental protection and sustainable management of natural resources.

Overall, the communities along the Langaran River were receptive to new management technology. A good strategy would be to build upon people’s interests and capacities to effectively and efficiently manage their natural resources. Many of the respondents were willing to undergo training hence activities could be programmed to build partnerships between the LGU and the community and resource managers from different groups. The strong support given by the leaders and the community during project implementation indicates that a community-based management of the river and riparian resources is achievable. There is only a need to negotiate pathways for policy support and provide incentives to the communities probably in the form of livelihoods for the greater majority or sustainable and productive alternative farming and fishing technology for the upland farmers and the fishermen, respectively.

BRP-Supported Strategies

There are activities and institutional arrangements that can be initiated and supported by the BRP:

Trainings on Alternative Technologies

The research revealed significant tracts of forested land in Mamalad and Singalat that had been converted to agricultural farms (primarily through slash and burn). These areas could potentially grow in size considering that the number of farmers engaging in slash and burn are increasing. An exposure trip and training on sloping agriculture for upland farmers in barangays Mamalad and Singalat and their neighboring barangays is therefore recommended with the aim of creating a change in land use pattern by the farmers as they adopt the agricultural technology they will learn from the trip. A Landcare group, a group that cares for a better land, similar to that spearheaded by the International Center for Research on Agro-Forestry (ICRAF) in Claveria, Misamis Oriental can be organized from among the upland farmers in Barangays Mamalad and Singalat to ensure sustainability in the adoption of the alternative technology.

Linkages with Government Agencies

Close linkages between the LGUs and other concerned government agencies are strongly recommended to come up with a well-planned, coordinated and systematic and dynamic river management program. The participants called for a ban on the cutting of trees along the bank and/or pass a resolution/ordinance that would ban the use of illegal fishing method and quarrying activities. This is to address the rampant use of tubli (Derris root extract), pesticide and mild electricity to catch fish. BRP can provide inputs to the passage of such an ordinance, or the full implementation where an ordinance is already in place. Another approach is to tap the Bantay Langaran group that was conceived and organized by DENR. The group became dormant after the initial meeting and should be revitalized. Otherwise, one approach is to institutionalize a river-wide task force to manage the river, represented by all the stakeholders. Often, the source of funds for meetings of bodies like this is crucial but this potential problem could be remedied by including its sustainable existence in the plans.

Development of Appropriate Information Systems

Information systems that will be accessible to all should be created. While televisions are very attractive to people of all ages, electric power was, at the time this study was conducted, not available in some barangays (like Singalat) and most of the households in many powered barangays. Information delivery system for the situation in the barangays should be developed. The BRP project on delivery systems should be enhanced to undertake this activity. Developing a conscious awareness of the state of the river is important in the drive for its preservation, conservation or rehabilitation. Continuous information dissemination on the matter is vital. To this end, the BRP can link up with the local education organization to ensure that biodiversity conservation becomes a component of a comprehensive education program that will look into relevant social factors in the area.

The recommendations made here are not unique, nor in a sense new, since most of the components have been around for some time. But some major problems that emerged from the focus group discussions and the survey are failure to integrate issues, especially the threats, at the level of policy formation, programme development and implementation, and failure to integrate government and people. What is needed therefore is to combine the recommendations and options made here into one integrated and logical framework acceptable to all the stakeholders in the Mt. Malindang environs, specifically in the Langaran River area. The framework should be the basis for groups, including BRP, to embark on sustainable livelihood programme for the rural communities and an environmental protection programme to support it.

References

Alcala, A.C. 1986. Guide to Philippine Flora and Fauna Vol. X. Amphibians and Reptiles. Natural Resources Management Center – MNR and University of the Philippines. 195 pp.

Alcala, A.C. and W.C. Brown. 1998. Philippine Amphibians: An Illustrated Field Guide. Bookmark Inc. Makati City.

Alcamo, E. 1991. Fundamental Microbiology. 3rd Ed. The Benjamin/Cummings Publishing Company, Inc.

agrolink.moa.my/did/river/books_flora.html

Amoroso, V. and J. Arances. 2002. Participatory Inventory and Assessment of Floral Resources and Livelihood Development in Malindang Range, Misamis Occidental. (unpublished)

Baert, G. 1995. Properties and Chemical Management Aspects of Soils on Different Parent Rocks in the Lower Zaire. Ph.D. Thesis. Faculty of Sciences, Ghent University. Belgium. 318 pp.

Barnes, R.D. 1974. Invertebrate Zoology. 3rd ed. W.B. Saunders Company. Philadelphia, PA.

Baumann R.W. 1979. Nearctic stonefly genera as indicators of ecological parameters (Plecoptera: Insecta). Gt Basin Nat. 39:241-244.

Begon, M.J., J.L. Harper, and C.R. Townsend. 1990. Ecology: Individuals, Populations and Communities. Blackwell Scientific Publications. Massachussetts, USA.

Ben-Dor, E. and A. Banin. 1989. Determination of organic matter content in arid-zone soils using a simple 'loss-on-ignition' method. Commun. Soil Sci. Plant Anal. 20:1675-1695.

Blum, W.E.H. 2002. The role of soils in sustaining society and the environment: Realities and challenges for the 21st century. In: Keynote Lectures. 17th World Congress of Soil Science. August 14-21, 2002. Bangkok, Thailand. pp 65-86.

Borror, D.J., D.M. de Leong, and C.A. Triplehorn. 1964. An Introduction to the Study of Insects. 4th ed. Holt, Rinehart & Winston. NY. pp-159-184.

Brady, N.C. and R.R. Weil. 1999. The Nature and Properties of Soils. 12th edition. Prentice Hall (Singapore) Pte Ltd. Singapore.

Brams, E.A. 1971. Continuous Cultivation of West African Soils: Organic Matter Diminution and Effects of Applied Lime and Phosphorus. Plant Soil, 35: 401-414.

Briscoe, J., R. Feacher, M. Rahaman, and O. Ottawa. 1986. Evaluating Heath Impact: Water Supply, Sanitation and Hygiene Education. IDRC.

Brosofske, K.B., J. Chen, R.J. Naiman, and J.F. Franklin. 1997. Harvesting effects on microclimatic gradients from small streams to uplands in western Washington. Ecological Applications 7(4):1188-1200.

Brower, J.E. and J.H. Zar. 1984. Field and laboratory methods for general ecology. Second ed. W.C. Brown Publishers, Iowa.

Brown, V.K. 1982. The phytopagous insect community and its impact on early successional habits In: Proceedings of the 5th international symposium of insect-plant relationships. Wageningen, The Netherlands. Centre for Agricultural Publishing and Documentation: 205-213.

Bryan, A.H., C.A. Bryan, and C.G. Bryan. 1962. Bacteriology: Principles and Practice. 6th Ed. Barnes and Nobles, Inc.

BSWM-CARE Philippines. 2002. Soils and Land Resource Evaluation: Mt. Malindang National Park Buffer Zone. Vol 3. BSWM, Quezon City and CARE Philippines, Ozamis City, Philippines.

Buffaloe, N. and D. Ferguson. 1976. Microbiology. Houghton Mifflin Company.

Carballo, J.L.O., L.C. Gregorio, L.A. Villanueva, and R.R. Villavicencio (eds.). 1983. Guidebook to Grassland Plants. Resource Material for Biology Teachers. Pundasyon sa Pagpapaunlad ng Kaalaman sa Pagtuturo ng Agham, INK.

Christiansen, T., R. Lavigne, and J. Lockwood. 1992. Litter arthropod forest communities after the 1998 Yellowstone Park fires. Park Science. 12(3):24-25.

Coleman, D.C., E.P. Odum, and D.A. Crossely, Jr. 1992. Soil biology, soil ecology and global change. Biology and Fertilized Soils. 14:104-111.

Collar, N.J., M.J. Crosby, and A.J. Statterfield. 1994. Birds to Watch 2: The World List of Threatened Birds. Birldlife International. Cambridge U.K.

Collar, N.J., N.A.D. Mallari, and B.R. Tabaranza Jr. 1999. Threatened Birds of the Philippines: The Haribon Foundation/Birdlife Internation Red Data Book in Collaboration with the DENR and the Environment Agency of Japan. Bookmark. Makati City.

Concepcion, R.N. and N.H. Batjes. 1997. A farmer-guided soil classification system for the Philippines: A case study for Barangays Triala and Santa Rosa, Nueva Ecija, Central Luzon. Bureau of Soil and Water Management, Manila, and ISRIC. Report 97/03. ISRIC, Wageningen.

Davis, B., R. Dulbecco, H. Eisen, and H. Ginsberg. 1980. Microbiology. 3rd Ed. Harper and Ron, Publishers Inc.

Davis, J. and F. Christidis. 1997. A Guide to Wetland Invertebrates of South-Western, Western Australian Museum, Australia.

De Lange, E. 1994. Manual for simple water quality analysis. International Water Tribunal (IWT) Foundation, Amsterdam, the Netherlands.

Department of Environment and Natural Resources. Administrative Order No. 34, series of 1990.

Dunne, T. and S. McGinnis. 2002. Riparian Zones in the Upper Delaware Watershed. A Technical Report for the Upper Delaware Watershed Management Project. North Jersey Resource Conservation and Development. Annandale, New Jersey.

duPont, J.E. 1971. Philippine Birds. Delaware Museum of Natural History. Greenville, Delaware.

ecr.ac.wk/freshwater/state.taxas.htm

Ellis, F. 2002. *Rural Livelihoods and Diversity in Developing Countries*. Oxford University Press. Oxford.

Fayyaz, R.S., A. Hasnain, and E. Ahmad. 2001. Mangrove Conservation along the Coast of Sonmiani, Balochistan, Proceedings International Symposium on Mangroves University of Tokyo, Tokyo, Japan. pp. 59-82.

Fortes, Miguel. 2001. An Ecological Assessment of Ulugan Bay, Palawan, Philippines. CSI info Vol. 12, UNESCO, Paris. 46 pp.

Frest,T.J. and E.J. Johannes. 1995. Interior Columbia basin mollusk species of special concern. Seattle, WA: Dexis Consultants; a contract report prepared for the U.S. Department of Agriculture, Forest service; US Department of the Interior, Bureau of Land Management, Upper Columbia River Basin Ecosystem Management Project. 274 p.

Funk, A.L. 2000. Water quality study addresses pollution questions at Chattahoochee River National recreation Area: in Selleck, Jeff (ed.), Natural Resources Year in Review - 1999: National Park Service, Lakewood, Colorado, pp.40-41.

Gilliam, J.W. 1994. Riparian wetlands and water quality. Journal of Environmental Quality 23:896-900.

Green, H. 1971. Some Recent Works on Soils of the Humid Tropics. Soils Fert. 24:325-327.

Gregory, M.B. and E.A. Frick. 2000. Fecal-coliform bacteria concentrations in streams of the Chattahoochee River National Recreation Area, Metropolitan Atlanta, Georgia, May-October 1994 and 1995: U.S. Geological Survey Water-Resources Investigations Report 00-4139, 8 p.

Greisheimer, E. and M. Weidenman. 1971. Physiology and Anatomy. 9th Ed. Lippincott Company.

Guyton, A.C. 1991. Textbook of Medical Physiology. 8th Ed. W.B. Saunders Company. Philadelphia.

Haggblade, S., P. Hazell, and J. Brown. 1989. “Farm-nonfarm linkages in rural Sub-Saharan Africa,” World Development, Vol. 17, no. 8, (1989), pp. 1173-1201.

Harvey, A.E., et al. 1994. Biotic and abiotic processes in eastside ecosystems: the effects of management on soil properties, processes and productivity. Gen. Tech. Rep. PNW-GTR-323. Portland, OR: US Department of Agriculture. Forest Service, Pacific Northwest Research Station.71 p. (Everett, Richard L., assessment team leader: Eastside forest ecosysytem health assessment; Hessburg, Paul F., Science team leader and tech. ed.; Volume III: Assessment).

Heaney, L.R., D.S. Balete, M.L. Dolar, A.C. Alcala, A.T. Dans, P.C. Gonzales, N.R. Ingle, M.V. Lepiten, W.L.R. Oliver, P.S. Ong, E.A. Rickart, B.R. Tabaranza, Jr., and R.C.B. Utzurrum. 1998. A Synopsis of Mammalian Fauna of the Philippine Islands. Fieldiana: Zoology 88: 1–61.

Hilsenhoff, W.L. 1988. Rapid field assessment of organic pollution with a family level biotic index. *North American Benthological Society* 7(1): 65-68.

http://talgov.com/citytlh/stormwater_man/lakes/lakewqp.htm

Hunsaker, C.T. and D.A. Levine. 1995. Hierarchical approaches to the study of water quality in rivers. Bioscience. 45:193-203.

Hutchens, T. 1998. Riparian Buffer. Best Management Practices for Water Quality. Cooperative Extension Service. University of Kentucky.

Hynes, H.B.N. 1970. The Ecology of Running Waters. University of Toronto Press. Toronto.

Ingham, E.R. 1994. Soil organisms: bacteria, fungi, protozoa, nematodes and rotifers. Walla Walla WA: (Publisher unknown); a contract report prepared for the US Department of Agriculture, Forest Service; US Department of the Interior, Bureau of Land Management, Upper Columbia River Basin Ecosystem Management Project.

ISRIC. 1993. Procedures for Soil Analysis. International Soil Reference and Information Centre. 4th Ed. AJ. Wageningen, The Netherlands.

IUCN. 1996. IUCN Red list of threatened animals. Gland, Switzerland: IUCN-The World Conservation Union.

James, S.W. 1995. Columbia basin Ologochaeta. Walla Walla, WA: (Publisher unknown); a contract report prepared for the US Department of the Interior, Bureau of Land Management, Upper Columbia River Basin Ecosystem Management Project.

Jenkinson, D.S. 1988. Soil organic matter and its dynamics. In: Wild, A., ed., Russels. Soil Conditions and Plant Growth. London, Longman, 564-607.

Joklik, W. and D. Smith. 1972. Microbiology. 15th Ed. Meredith Company.

Kanjanavanit, O. and S. Tilling. 2000. A Guide to Freshwater Invertebrates of Ponds and Streams in Thailand.

Karr, J.R. 1991. Biological integrity: A long-neglected aspect of water resource management. Ecological Applications 1:66-84.

Keeton, W. and C.H. McFadden. 1983. Elements of Biological Science. 3rd Ed. W.W. Norton and Company Inc.

Kelly, M.G., C.J. Penny, and B.A. Whitton. 1995. Comparative performance of benthic diatom indices used to assess river water quality. Hydrobiologia 302:179-188.

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

Kent, M. and P. Coker. 1994. Vegetation description and analysis – a practical approach. John Wiley & Sons, Chichester, UK.

Knapp, R.A., V.T. Vredenburg, and K.R. Matthews. 1998. Effects of stream channel morphology on golden sprout spawning habitat and recruitment. Ecological Applications 8(4): 1104-1117.

Le Sann, A. 1998. A Livelihood from Fishing. Intermediate Technology Publications. London.

Levy, C. 1992. Gender and the Environment: The Challenge of Cross-cutting Issues in Development Policy and Planning. Environment and Urbanization 4 (1).

Madulid, D.A. 2001. A Dictionary of Philippine Plant Names. 2 vols. The Bookmark Inc. Makati, Manila.

Madulid, D.A. 1995. A Pictorial Cyclopedia of Philippine Ornamental Plants. 2nd ed. The Bookmark Inc. Makati, Manila. 388 pp.

Mallari, N.A.D., B.R. Tabaranza, Jr., and M. Crosby. 2001. Key Conservation Sites in the Philippines: A Directory of Important Bird Areas. Haribon Foundation and Birdlife International in Collaboration with the DENR and Bookmark Inc. Makati City.

McKinney, R.F. 1962. Microbiology of Sanitary Engineers. McGraw-Hill Company Inc. New York.

Mekaru, T. and G. Uehara. 1972. Anion Adsorption in Ferruginous Tropical Soils. Soil Sci. Soc. Am. Proc. 36:296-300.

members.tripod.com/philmuseum/botany.htm

Merrill, E.D. 1912. A Flora of Manila. The Bookmark Inc. Escolta, Manila. 491 pp.

Merrill, E.D. 1926. An Enumeration of Philippine Flowering Plants. Volumes 1-4. Manila Bureau of Printing.

Miller, R. 1983. Freshwater Invertebrates. Gould League of Victoria. Globe Press, Victoria.

Moore, J.T. and R.H. Loeppert. 1987. Siginificance of Potassium Chloride pH of Calcareous Soils. Soil Sci. Soc. Am. J. 51:908-912.

Murdoch, W.W. 1971. Environmental Resource, Pollution and Society. Sinauer Associates. Stamford, Conn.

Naiman, R.J. and E.C. Anderson. 1997. Streams and rivers: Their physical and biological variability. Pages 131-148 *in* P.K. Schoonmaker, B. von Hagen, and E.C. Wolf (eds.). The Rain Forests of Home: Profile of a North American Bioregion. Island Press, Washington, D.C.

Nanzyo, M., Dahlgren, R.A., and S. Shoji. 1993. Chemical Characteristics of Volcanic Ash Soils. In: Shoji, S., M. Nanzyo and R. Dahlgren (eds), Volcanics Ash Soils: Genesis, Properties and Utilization. Elsevier, Amsterdam. pp 145-188.

Nelson, D.W. and Sommers, L.E. 1996. Total Carbon, Organic Carbon, and Organic Matter. In: Methods of Soil Analysis: Part 3, Chemical Methods. # 5 SSSA book series. eds., Sparks et al., Madison, Wisconsin, USA.

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

Patrick, R. and D.M. Palavage. 1994. The value of species as indicators of water quality. Proceedings of the Academy of Natural Sciences of Philadelphia. 145:55-92.

Peckarsky, B., L. Pierre, R. Fraissinet, M.A. Penton, and D.J. Conklin, Jr. 1990. Freshwater Macroinvertebrates of Northeastern, North America. Cornell Univ. Press. 442 pp.

Pelczar, M.J. and R.D. Reid. 1965. Microbiology. 2nd Ed. McGraw-Hill Company Inc. New York.

Pennak R.W. 1989. *Freshwater Macroinvertebrates of the United States*. 3rd edition. John Wiley & Sons, New York, NY, USA.

Phillips, M.J., L.W. Swift Jr., and C.R. Blinn. 2000. Best Management Practices for Riparian areas. In: Verry, E.S., Hornbeck, J.W.; Dolloff, C.A. (eds). Riparian management in forests of the continental Eastern United States. Lewis Publishers, CRC Press LLC. Boca Raton, FL. 273-286.

Pilmore, D.E. 1996. Recolonization of burned aspen groves by land snails. Yellowstone Science. Summer: 6-8.

Plafkin, J.L., M.T. Barbour, K.D. Porter, S.K. Gross, and R.M. Hughes. 1989. Rapid bioassessment protocols for use in streams and rivers: Benthic macroinvertebrates and Fish. EPA/444/4-89-001. U.S. Environmental Protection Agency, Office of Water, Washington.

Prescott, L., J. Harley, and D. Klein. 1990. Microbiology. 2nd Ed. W.M.C. Brown Publisher.

Reardon, T. 1997. "Using Evidence of Household Income Diversification to Inform Study of the Rural Nonfarm Labor Market in Africa," World Development, 25 (5), 735-748.

Reardon, T., K. Stamoulis, A. Balisacan, M.E. Cruz, J. Berdegue, B. Banks. 1998. Rural Nonfarm Income in Developing Countries, Special Chapter in The State of Food and Agriculture 1998, Rome: Food and Agricultural Organization of the United Nations.

Rojo, J.P. 1999. Revised Lexicon of Philippine Trees. Forest Products Research and Development Institute, DOST, College, Laguna.

Sahn, D. 1994. The contribution of income to improved nutrition in Côte d' Ivoire. Journal of African Economies 3(1): 29-61.

Sangpradub, N., Y. Inmuong, C. Hanjavanit, and U. Inmuong. 1997. Effect of Headwater Catchment Degradation on Water Quality and Benthic Macroinvertebrate Community in Northeast Thailand. Proceedings International Symposium on Hydrology and Water Resources for Research and Development in Southeast Asia and The Pacific, 17-19 December 1997, 161-179; Nong Khai, Thailand.

Schowalter, T.D. 1995. Coarse woody debris chewers in the Columbia river basin. Walla, WA: (Publisher unknown); a contract report prepared for the US Department of the Interior, Bureau of Land Management, Upper Columbia River Basin Ecosystem Management Project. 12 p.

Scoones, I. 1998. Sustainable Rural Livelihoods: A Framework for Analysis, IDS Working Paper 72. Institute for Development Studies, University of Sussex, Brighton UK.

Shunula J.P. 2001. Public Awareness, the Key to Community Based Management and Conservation of Mangroves: The Case of Zanzibar. Proceedings International Symposium on Mangroves University of Tokyo, Tokyo, Japan. pp. 22.

Soil Survey Investigations Report (SSIR) No. 42. Version 3.0. 1996. Soil Survey Laboratory Methods Manual. USDA NRCS, NSSC, Washington, USA.

Southwood, T.R.E., et al. 1979. The relationships of plant and insect diversities in succession. Biological Journal of the Linnaues Society. 12:327.

Syers, J.K. and E.T. Craswell. 1995. Role of soil organic matter in sustainable agricultural systems. Soil Organic Matter for Sustainable Agriculture. eds., Lefroy, et. al., Australian Centre for International Agricultural Research, Canberra.

Symes, D. 1996. Fishing in troubled waters. p3-16. In Fisheries Management In Crisis, ed. by K. Crean and D. Symes. Fishing News Books: London, UK. 222pp.

Tabaranza, B.R. and N.A.D. Mallari. 1997. Birds. In: Philippine Red Data Book: Red List of Threatened Animals. Wildlife Conservation Society-Bookmark, Makati City.

Tacoli, C. 1998. Bridging the divide: Rural-urban interactions and livelihood strategies. Gatekeeper Series no. 77.

Tan, B.C., E. Fernando, and J.P. Rojo. 1986. An updated list of endangered Philippine plants. Yushania. 3:1-5.

Tan, K.H. 1998. Principles of Soil Chemistry. 3rd ed. Marcell Dekker. New York. 521 pp.

Uehara, G. and G.P. Gillman. 1981. The mineralogy, chemistry and physics of tropical soils with variable charge clays. Westview Press, Boulder, CO.

USDA/NRCS. 1998. NRCS Natural Resources Conservation Service: Conservation Practice Standard Riparian Forest Buffer (Acre) CODE 391. NRCS, Minnesota, USA.

Van Balgooy, M.M.J. 1997. Malesian Seed Plants-Spot Characters. Vol. 1. Rijksherbarium, Hortus Botanicus, Leiden, Netherlands. 154 pp.

Van Balgooy, M.M.J. 1998. Malesian Seed Plants-Portraits of Tree Families. Vol. 2. Rijksherbarium, Hortus Botanicus, Leiden, Netherlands. 307 pp.

Van Dijk, H. 1971. Colloid Chemical Properties of Humic Matter. A.D. McLaren and J. Skujins (eds). Biochemistry, Vol. 2. Marcel Dekker, NewYork, pp. 16-35.

van Wambeke, A. 1992. Soils of the Tropics, Properties and Appraisal. McGraw-Hill, Inc. New York. 343p.

Walters, B.B. 1997. Human ecological questions for tropical restoration: experiences from planting native upland trees and mangroves in the Philippines. Forest Ecology and Management 99:275-290.

water.ur.state.ky.us/ww/bugs/intro.htm

Welch, E.B., J.M. Jacoby, and C.W. May. 1998. Stream quality. In R.J. Naiman and R. Bilby, editors. River ecology and management: Lessons from the Pacific Coastal Ecoregion. Springer-Verlag, New York, New York USA.

Welsh, H.H. and L.M. Ollivier. 1998. Stream amphibians as indicators of ecosystem stress: a case study from California's redwoods. Ecological Applications 8(4): 1118-1132.

wetlab.hypermart.net/headwater/abstract.html

wetlab.hypermart.net/headwater/discuss.html

Wildlife Conservation Society of the Philippines. 1997. Philippine Red Data Book. WCSP and Bookmark Inc. Makati City.

Williams, W.D. 1980. Australian Freshwater Life: The Invertebrates of Australian Inland Waters. 2nd edition, Macmillan Company, Melbourne Australia.

Wilson, E.O. 1998. The current state of biological diversity. Wilson, E.O. and F.M. Peter, eds. Biodiversity. Papers from the National Forum on Biodiversity. Washington, DC: National Academy Press: 4-5. Cosponsored by: The National Academy of Sciences and the Smithsonian Institution.

Wilson, M., H. Wiesburd, H.E. Meizer, and J. Morello. 1979. Laboratory Manual and Workbook in Microbiology. 2nd Ed. McMillan Publishing Co., Inc.

www.accessexcellence.org/AE/AEC/AEF/1994/bartsch benthic.html

www.biblio.tu-bs.de/geobot/lit/okerpage.html

www.britannica.com/eb/article

www.earthscape.org/r2/scb/scb14_5/scs01/scs01.html

www.ecn.ac.uk/freshwater/state_taxa.htm

www.epa.nsw.gov.au

www.fairfieldct.org/waterquality.pdf

www.haribon.org.ph/saving_sites/default.asp

www.hotcity.com/~vladimir/malay.htm

www.mlit.go.jp/river/english/bio-d1.html

www.nature.ca/rideau/b/b8-e.html

www.natureali.com/plants.htm

www.naturebase.net/national_parks/previous_month/fitzgerald.html

www.usc.edu/CSSF/Current/Projects/S0601.pdf

www.usc.edu/CSSF/History/Projects/S0601.pdf

Zamora, P. and L. Co. 1986. Guide to Philippine Flora and Fauna. Goodwill. Quezon City. Vol. IV.

Appendices

Appendix 1. Description of the local terms used by the local folks in Ethnobotany

Bughat - a term which refers to the consequential pain suffered if overworked after giving birth. This disorder is usually characterized by hemorrhage, headache and muscle cramps.

Talimughat – used to treat bughat

Lo-as – infection resulting to sore formation in the upper or lower lip especially at the mouth corner

Kabuhi - usually described as some sort of an air/gas that moves within the body.

Paursa – any substance that alleviates an illness

Hampol - to cover/place after subjecting to heat

Dupang – a transient edematous growths of the skin accordingly suffered if hit by a bad wind. An allergenic reaction due to hypersensitivity to some particles in air.

Appendix 2. A Guide to Freshwater Invertebrates of Ponds and Streams in Thailand

Adapted by Oy Kanjanavanit & Stephen Tilling, from the original to British Freshwater Animals by Richard Orton, John & Anne Bebbington

Most of us are aware of ponds and streams near us. Some of us know something about the animals and plants that live in them, but very few know how important these things are. This guide will help you to become a water detective and unlock many of the secrets which are held in our ponds and streams. It will show you how to use this information to tell whether your stream is very healthy or not.

How to Use this Guide

The guide is simple to use. It will help you to name some of the small animals which do not have backbones. They are called invertebrates. We are only interested in the animals which are bigger than 2 mm across; any smaller and they would be too difficult to see.

When you have caught animals, try looking at them with a magnifying lens. You will see the features that are described in this guide. Then start at the beginning (orange box) and work your way along the lines, answering their YES or NO to each of the questions which asks you about the appearance or the behavior of the animal. Some will be easy to answer, while others are more difficult and you will need to look carefully. Keep going. Eventually, you will arrive a name of the group of your animal (black box).

Next to it are pictures of the representatives of the animal group. See if they can be compared to your animal, and find the name of its kind. However, sometimes you will find the details do not exactly match, as we cannot include all the different kinds of animals there are in this guide. In such a case, stick to the name of the animals on the next pages.

But if you really cannot find the name of the animal's group, make a record of its appearance, habit, location and date of find. Then ask your local scientist. With very little study done in our country, who knows, you may have found an animal new to science.

Why the animals are important

Why should we bother about tiny animals? The truth is: they are very important. Because they need air, food and places to live just like us, studying them can tell us about the quality of water where they live. There are several things which are particularly important to their lives.

Oxygen

All animals need air. Some absorb this straight through their skin, sometime using special gills to make this more efficient. Others breathe air from the surface, either by swimming to the surface, or through long tubes.

Temperature

Anybody who has paddled in a mountain stream or swam in a low land river will know that these places can have very different temperature. This is also important to small invertebrates. Some are able to live in colder places; others in a warmer places. Most prefer a certain range of temperatures. If the water temperature changes (by adding warm water from factories, or deepening the river for example), this can affect the animals that live there. Temperature also affects the amount of oxygen dissolved in water. The higher temperature, the less oxygen will be dissolved.

Flow rate

Freshwater animals live in different places in the streams and rivers. Some like slow-flowing water, others prefer fast-flowing places with lots of oxygen. They often have different body shapes to enable them to do this most effectively. Activities which affect the flow rates can also affect the animals that live there.

Minerals

Most animals need minerals to live. They get these from their food and the surrounding water. For the animals to live, the mineral balance needs to be just right, not too much or too little of each thing.

Food

Some invertebrates feed on plants, others on other animals. They can form links in a big food web. This means that anything that affects one group of animals (such as pollution) may also lead to changes in another group. Look at the food links below. Can you imagine what would happen if something affect the young dragonflies in this area?

What types of animals will you find?

There are four main groups: worms (including leeches); mollusks (snails, bivalves and limpets); crustaceans (prawns, crabs and relatives); and insects. There are lots of different types of insects living in water, but most of them are young stages.

Life Cycle

Freshwater invertebrates, in particular insects, often leave the water when they grow into adults. There are two types of life cycles. The first type has a three-stage cycle like this:

The *nymph* often looks like the adult, but its wings are not fully developed. As it feeds and grows bigger, the insect has to shed its skin. When it does so, the wing-buds increase in size. Eventually, it sheds its skin for the last time and emerges as an adult insect. Dragonfly is an example.

The second type has four-stage life cycle:

The *larva* looks nothing like the adult; it feeds and sheds until it reaches its largest size. The last time it sheds its skin, it turns into a *pupa,* which is a resting stage, during which all the body tissues are recognized and the insect then emerges as the adult. Mosquito is an example.

So by affecting the ecology of the water, we are also affecting the numbers of adult insects that emerge and fly. In our given example, the killing of dragonfly nymphs through pollution may result in a higher number of disease-carrying mosquitoes.

ANIMAL FACT FILES

Indicator Animals

Most animals living in the stream can tell us about the levels of pollution. They are called 'pollution indicator'. Many of them can also be found in ponds. Here the groups are arranged in order of pollution tolerance, from those that can only live in the cleanest water to those that can put up with dirty water. Look for the signs of water quality:

Some groups have a mixture of these indicators.

Stonefly nymphs (Insects of Order Plecoptera) breathe through gills and need lots of oxygen. Found mainly in fast flowing streams. They may do push ups to increase water flow if oxygen supply gets a bit low, and soon disappear with pollution. Some eat plants; others eat animals.

Mayfly nymphs (Insects of Order Ephemeroptera) feed on plants growing on weeds and stones. They all have gills, and most need good water quality with lots of oxygen. When these animals go missing, this is a sign that water quality is changing. But beware, the swimming mayfly and the square-gilled mayfly are particularly tolerant.

Caddisfly larvae (Insects of Order Trichoptera) are of two types. One type lives in a case, the other does not. Caseless caddisfly larvae are often meat-eaters, which spin nets to catch small animals floating in the water. The cased caddisflies use stones, silt or plant materials to make their cases and are mostly plant eaters. Both groups do not like high levels of pollution, except for the common net-spinner, which is particularly tolerant.

Prawns (Crustaceans of Order Decapoda) are animals feeding on tiny plants and animals. The river prawns are quite sensitive to pollution, but shrimps can be more tolerant.

Dragonfly & Damselfly nymphs (Insects of Order Odonata) are very active hunters with large jaws. They feed on insects, tadpoles and even small fish, and are probably important natural pest controllers of animals such as mosquitoes and blackflies. They can live for several years before turning into adults. Most do not like high levels of pollution.

Molluscs (Phylum Mollusca) are plant eaters with different types of shells. Between them they are able to live in a wide range of habitats and pollution. Some have a single shell. These include limpets which are flattened for living in fast flowing streams, feed on plants and do not like pollution. Other single-piece shell is like spires or coils, sometimes with a "trapdoor" (operculum) which protects the body when the snails are inside. Some have shells in two halves like mussels.

Bugs (Insects of Order Hemiptera) are a big group which includes animals that live on the surface, and in the water. Most are meat eaters which use their needle-like mouths to prick and suck the juices of other animals. Although most bugs can live in medium levels of pollution, one— the long mouthed saucer bag— needs very clean water.

Beetles (Insects of Order Coleoptera) are a very mixed group of meat eaters and plant eaters. The adults breath from an air bubble which they trap under the tiny hairs on their bodies or under their wings.

Flatworms (Worms of Order Tricladida) are found in many places. These are meat-eaters, mainly feeding on small insects and dead animals.

Fly larvae (Insects of Order Diptera) is a huge group including animals which can survive in most conditions. Even the most polluted waters will often contain some fly maggots. The most tolerant groups are red non-biting midge larvae and rat-tailed maggots—the young of a hoverfly. The red non-biting midge larvae can survive because of their oxygen-absorbing "blood" which gives them the red colour, but the rat-tailed maggots survive because they breath fresh air through long extending "tails". Most fly larvae eat dead or dying plant and animal material.

Alderfly and Dobsonfly larvae (Insects of Order Megaloptera) are large insects (up to 70 mm) that are ferocious hunters and feed on other insects. They can live for a long time (up to 3 years). Dobsonfly fly are quite sensitive to pollution, while alderfly can be quite tolerant. Some can breath fresh air above the water through short tubes in their tails.

Water Hoglouse (Crustaceans of Order Isopoda) is an animal that feeds on dead leaves and can live in very polluted water.

Crabs (Crustaceans of Order Decapoda) feed on tiny plants and animals as well as dead material, and are able to live in many places. They can move across land— so can move home if needed.

Leeches (worms of subclass Hirudinea) is another group of meat eaters. Unlike blood-sucking land leeches, the water leeches mostly feed on small insects and snails.

Segmented Worms (Worms of subclass Oligochaeta) is a big group which usually lives in silt and mud, mostly feeding on dead plants. They can live in very polluted water where no other animals can survive, especially the "blood worms" which are able to live on very small amounts of oxygen. In such cases, they can be found in large numbers.

Non-Indicator Animals

Hydra (Class Hydrozoa) are small clean-water animals which attach themselves to an object and catch small animals with tentacles.

Hairworms (Phylum Nematomorpha) are worms laying eggs in water. When these hatch they will usually be eaten by, and live inside, insects.

Water fleas (Crustaceans of Order Cladocera and Cyclopoidea) are very small animals (usually less than 2 mm) which float in ponds and lakes eating tiny algae.

Spiders and Mites (Class Arachnida) are both spiders and mites and are tiny meat-eaters. Water spiders have very hairy legs and may be distinguished from land spiders (which can be found moving on the water surface).

Springtails (Insects of Order Collembola) are water surface animals living on plant and animal fragments that fall on the water. They are not too affected by pollution.

Moths (Insects of Order Lepidoptera) are sometimes found in silky cases, or rolled leaves. These caterpillars are plant eaters.

POLLUTION

Nearly all pollution causes harm to the environment in some way. Most kinds of pollution in water affect the amount of dissolved oxygen. For example fertilizers, detergents, sewage and other organic wastes, as well as warm water from factories, all decrease the amount of oxygen in water. Because different kinds of animal need different amounts of oxygen, their presence or absence in stream can indicate the levels of pollution.

Scientists from all over the world have used this information in different ways to measure pollution. One way is to give “pollution” scores to animals. For example, animals which need a lot of oxygen dissolved in the water and cannot bear pollution may be given a high score (10 in the table); those that can live in highly polluted water are given a low score (1-2.5 in the table). There are a lot animals which fall in between.

Be careful. The scores in the table here will work in streams and rivers with running water. They are NOT designed for still water like ponds and lakes. Neither can they be used in brackish streams near the sea.

Also note that these scores do not measure pollution from some chemicals such as mercury or some pesticides. These are poisons which may harm or kill animals directly. Some “high score” animals like stonefly nymphs may even be able to tolerate this kind of pollution better than others. It is therefore very important to note the number of animal types. In clean water, you are likely to find many kinds of animals, but only a few in polluted water.

The wonderful thing about streams and ponds is they will recover quickly on their own if no more pollution is being added. So, all you have to do is see that both you and other people stop polluting the water. Then nature will take care of the rest.

How to Find Animals

It is best to find animals in a shallow stream during the dry season when animals tend to be bigger than during the rainy months. Here are the most basic equipment you will need.

When you have chosen a site, fill a large aluminum tray with stream water. Place a large square net across the stream, and disturb the streambed in front of the net. Empty all the debris collected in the net into the tray. When all is settled, look carefully for any movement. Spoon an animal gently into a small white dish and look at it with a magnifying glass. Make sure there is enough water here. When you have noted its name, look for other animals in the tray.

Try to collect animals from different spots in the area. Look around gravel. Look among dead leaves. Try to pick up a stone. Don’t forget the animals on the water surface. You can scoop them up directly with a net. Do not forget to put the animals back in the stream.

How to Use the Table

If you find animal (even if it is only once) in any category, mark its score in the box. You can only count each type once. After you have looked at all your animals, add the scores for each of the boxes, and then take the average by dividing the total score by the number of the animal types you have noted in the table. It is important to calculate an average score as this will reduce any error we may have made from sampling. The result is the Water Quality Index (next page).

Use the **Water Quality Index** to assess the water quality where:

Score 7.6 - 10	very clean water;
Score 5.1 - 7.5	rather clean - clean water;
Score 2.6 - 5.0	rather dirty water - average;
Score 1.0 - 2.5	dirty water;
Score 0	very dirty water (no life at all)

The Water Quality Index Table

Animal	Score
Stonefly nymphs	10
Flattened mayfly nymphs	10
Prong-gilled mayfly nymphs	10
Spiny crawling mayfly nymphs	10
Caddisfly larvae with sand/gravel cases	10
Caseless caddisfly larvae (except *)	10
Long mouthed saucer bugs	10
Dobson larvae	9
River prawns	8
Caddisfly larvae with cases made from leaf	7
Dragonfly nymphs	6
Damselfly nymphs	6
Freshwater limpets	6
Swan mussels	6
Pagoda snails	6
Lesser water boatmen	5
Greater water boatmen	5
Other water bugs	5
Adult beetles	5
Beetle larvae	5
Flatworms	5
Other fly larvae (except *)	5
Common net spinner larvae *	5
Swimming mayfly nymphs	5
Square-gilled mayfly nymphs	4
Freshwater shrimps	4
Alderfly larvae	4
Other snails	3
Pea cockles	3
Water hoglouse	3
River crabs	3
Leeches	3
Rat-tailed maggots *	3
Non-biting midge larvae *	2
Segmented worms	1
TOTAL SCORE	
Number of Animal Types	
Water Quality Index	

Appendix 3. Preparation of Double Strength Lactose Bile Broth (LB)

1. The media is prepared as per instruction by the manufacturer.
2. Double strength LB is made by doubling the amount of the media that is to be dissolved in distilled water desired by the solution.
3. The LB solution is then dispensed into tubes that are arranged in the rack into 5's. Sterile pipettes and a respirator are used in this process.
4. After such prepared cotton plugs are placed into each tube. These are now ready for sterilization.

Appendix 4. Preparation of Single Strength LB

1. The amount of LB to be rehydrated is stated in the manufacturer's guide.
2. Unlike the double strength LB, this is no need to double the amount of LB to be dissolved in distilled water.

Appendix 5. Preparation of Brilliant Green Lactose Broth (BGLB)

1. The media is prepared as per instruction by the manufacturer.
2. The BGLB solution is then dispensed into tubes arranged in the rack into 5s. Sterile pipettes and a respirator are used in this process.
3. After such prepared cotton plugs are placed into each tube. These are now ready for sterilization.

Appendix 6. Preparation of *E. coli* Broth (EC)

1. The media is prepared as per instruction by the manufacturer's guide.
2. The medium is dissolved in distilled water.
3. The EC solution is then dispensed into tubes arranged in the rack into 5's. Sterile pipettes and a respirator are used in this process.
4. Prepared cotton plugs are placed into each tube. These are now ready for sterilization.

Appendix 7. Preparation of Mc Conkey Agar Plates

1. Mc Conkey Agar is prepared according to the manufacturer's guide.
2. It is mixed with distilled water and heated in the steam bath until the agar is dissolved.
3. The solution is sterilized in the pressure cooker.
4. Sterilized agar is then stored in the oven at 35^{O}C to prevent the medium from cooling.
5. Medium is now ready for dispensation in the prepared inverted plates.

Appendix 8. MPN (Most Probable Number) Index for Various Combination of Positive Results when Five Tubes are Used per Dilution (10 ml, 1.0 ml, .01 ml)

Combination of Positives	*MPN / 100 ml*	**Combination of positives**	*MPN / 100 ml*
0-0-0	<2	4-3-0	27
0-0-1	2	4-3-1	33
0-1-0	2	4-4-0	34
0-2-0	4	5-0-0	23
1-0-0	2	5-0-1	30
1-0-1	4	5-0-2	40
1-1-0	4	5-1-0	30
1-1-1	6	5-1-1	50
1-2-0	6	5-1-2	60
2-0-0	4	5-2-0	50
2-0-1	7	5-2-1	70
2-1-0	7	5-2-2	90
2-1-1	9	5-3-0	80
2-2-0	9	5-3-1	110
2-3-0	12	5-3-2	140
3-0-0	8	5-3-3	170
3-0-1	11	5-4-0	130
3-1-0	11	5-4-1	170
3-1-1	14	5-4-2	220
3-2-0	14	5-4-3	280
3-2-1	17	5-4-4	350
4-0-0	13	5-5-0	240
4-0-1	17	5-5-1	300
4-1-0	17	5-5-2	500
4-1-1	21	5-5-3	900
4-1-2	26	5-5-4	1600
4-2-0	22	5-5-5	Greater than or equal to 1600
4-2-1	26		

Appendix 9. Preparation of Nutrient Broth Glucose (NBG):

1. NBG is used as indicator for methyl red test.
2. The broth is dissolved in distilled water and dispensed in test tubes.
3. The test tubes are then sterilized in the pressure cooker for 15 minutes at 15 lbs.
4. After sterilization, it is cooled at room temperature and set aside.
5. Five percent of glucose is added on to the broth.
6. This is now ready for use in the methyl red test.

Appendix 10. Preparation of 5% Alpha Naphthol:

1. Five grams of Alpha Naphthol is dissolved in 100 ml absolute ethanol.
2. This solution is ready for the methyl red test.

Appendix 11. Preparation of 40% Potassium Hydroxide (KOH):

1. Forty grams of potassium hydroxide (KOH) is dissolved in 100 ml of distilled water.
2. This is now ready for use.

Appendix 12. Preparation of Tryptone Broth (Indole):

1. Tryptone broth is prepared by dissolving in distilled water.
2. Dissolved medium is dispensed in test tubes and sterilized in the pressure cooker for 15 minutes at 15 lbs.
3. The medium is then ready for Indole analysis.

Appendix 13. Preparation of Slants for Simmon Citrate Test:

1. The Simmon Citrate Agar is dissolved in distilled water.
2. The medium is heated in the water bath to dissolve the agar evenly.
3. Dispense 10 ml of unsterilized agar media into tubes.
4. Plug cotton tightly into tubes.
5. Sterilize the agar.
6. After sterilization, cool at room temperature.
7. Place in trays designed for slants.
8. These are now ready for the Citrate test.

Appendix 14. DENR-AO 34 s. 1990. Coliform Standards (MPN/100 ml of water) for freshwater of different usage

Usage	Total Coliform	Fecal Coliform
For drinking and general usage	50	20
For drinking (that requires complete treatment)	1000	1000
For recreation (primary contact, e.g., bathing, swimming)	1000	200
For fishing and activities that do not involve primary contact	5000	-

Appendix Tables

Appendix Table 1. List of plants found along the Langaran River

Code	Local name	Family	Scientific Name	Ecological status	Ethnobotany
Sing001	balobo	*Tiliaceae*	*Diplodiscus paniculatus*	common	talimughat
Sing002	bakan	*Rosaceae*	*Prunus clementis*		sinda
Sing003	langala	*Euphorbiaceae*	*Acalypha amentaceae*	common	fruit is fed to chickens
Sing004	ananamsi	*Urticaceae*	*Villebrunea* sp.		boils, skin diseases
Sing005	antotongaw	*Melastomataceae*	*Melastoma malabathricum*	widespread common	kidney disorders, lip sores (young leaves)
Sing006		*Commelinaceae*	*Commelina benghalensis*	widespread common	
Sing007	hansaw	*Labiatae*	*Hyptis capitata*	widespread common	kabuhi, diarrhea, wounds
Sing008	kukog banog	*Compositae*	*Elephantopus scaber*		gas pains, kabuhi
Sing009	balili	*Gramineae*	*Digitaria setata*	widespread common	bughat, used in landscaping
Sing010	baling-baling	*Caryophyllidae*	*Drymaria cordata* var. *dianthus*	common pantropic	
Sing011	bulak-manok	*Compositae*	*Ageratum conyzoides*	common	for wounds
Sing012	busikad	*Cyperaceae*	*Cyperus kyllinga*	common	fever
Sing013	ginit-ginit	*Thelypteridaceae*	*Sphaerostephanos unitus*	common widespread	
Sing014	hibi-hibi	*Leguminoseae*	*Mimosa pudica*	common pantropic	kidney disorder, toothache
Sing015	tigsim		unidentified 1		ornamental
Sing016	mani-mani/tulog-tulog	*Leguminoseae*	*Desmodium heterocarpum*	common	fever
Sing017	mardium	*Rubiaceae*	*Hedyotis philippinensis*	common	
Sing018	bugang	*Gramineae*	*Saccharum spontaneum* L. subsp. *indicum*		
Sing019	daat	*Cyperaceae*	*Scirpus* sp.		paursa, supo
Sing020	hagonoy	*Compositae*	*Chromolaena odorata*		boils, kabuhi, wounds, bughat
Sing021	kaya-kaya	*Fabaceae*	*Derris elliptica*	abundant	
Sing022	baric	*Dipterocarpaceae*	*Parashorea malaanonan*		
Sing023	lakatan	*Musaceae*	*Musa paradisiaca*	common	food
Sing024	nangka	*Moraceae*	*Artocarpus heterophyllus*	common	food
Sing025	alikway	*Malvaceae?*	unidentified 2		vegetable, boils
Sing026	cacao	*Sterculiaceae*	*Theobroma cacao*		
Sing027	tubo	*Gramineae*	*Saccharum officinarum*		food
Sing028	romblom	*Pandanaceae*	*Pandanus* sp.	endemic	raw material for handicraft
Sing029	salimbagat/ talimughat	*Amaranthaceae*	*Cyathula prostrata*		talimughat (roots)
Sing030	pako	*Athyriaceae*	*Diplazium esculentum*		food
Sing031	carabao grass	*Gramineae*	*Paspalum conjugatum*	common pantropic	landscape plant, food for ruminants
Sing032	tulay-tulay	*Compositae*	*Bidens pilosa*	common pantropic	talimughat, sakit sa mata
Sing033	gabi/parayo	*Araceae*	*Colocasia esculentum*		rootcrop

Legend: Sing – Singalat, Mam – Mamalad, Bon – Bonifacio, Tip – Tipolo, Cat – Catarman

Appendix Table 1. continuation

Code	Local name	Family	Scientific Name	Ecological status	Ethnobotany
Sing034	yahongyahong	*Umbilliferae*	*Centella asiatica*	common pantropic	paursa, talimughat
Sing035	limbas-limbas	*Cyperaceae*	*Cyperus pilosus*	common	banig
Sing036	moti-moti	*Compositae*	*Mikania cordata*		vegetable, talimughat
Sing037			unidentified 3		
Sing038	dila-dila	*Asteraceae/ Compositae*	*Pseudoelephantophus spicatus*	common	wounds, diarrhea
Sing039		*Euphorbiacae*	*Phyllanthus urinaria*	common	dislocation, rashes
Sing040	katagbak	*Zingiberaceae*	*Costus speciosus*		pain reliever
Sing042		*Compositae*	*Spilanthes acmella*	common	
Sing043	tikog-tikog	*Cyperaceae*	*Fimbristylis* sp.		banig
Sing044	bila-bila	*Gramineae*	*Eleusine indica*	common	diarrhea, paursa
Sing045	amagus	*Euphorbiaceae*	*Homonoia riparia*	abundant	diarrhea, stomachache, talimughat
Sing046	tapalak	*Loganiaceae*	*Fagraea auriculata*	widely scattered	cancer, bughat, edema
Sing047	malibago	*Malvaceae*	*Hibiscus tiliaceus* ssp. *tiliaceus*	pantropic abundant	young leaves hampol
Sing048	sinagkolan	*Leeceae/Vitaceae*	*Leea quadrifolia*	endemic	vegetable
Sing049	lombilan/ mana-mana	*Sapindaceae*	*Guioa bicolor*	endemic	
Sing050	saloot	*Moraceae*	*Ficus guyeri* var. *guyeri*	endemic, recorded in Ifugao & Benguet	
Sing051	lagnob	*Moraceae*	*Ficus septica* var. *septica*	common	skin diseases, and buni
Sing052	alagasi	*Urticaceae*	*Leucosyke capitellata*	widely distributed	hepatitis, cough
Sing053	balitarhan	*Euphorbiaceae*	*Bridelia glauca*	endemic	lo-as
Sing054	wild pandan	*Pandanaceae*	*Pandanus* sp.		
Sing055	lalapaw	*Menispermaceae*	*Hypserpa cuspidata*		bughat
Sing056	gulayan		unidentified 4		fruits are used in games
Sing057	takoling balago/ tanaman	*Araceae*	*Scindapsus*		
Sing058	bukog-bukog	*Selaginellacae*	*Selaginella*		
Sing059	otap		unidentified 5		herbicidal
Sing060	cover crop	*Leguminosae*	*Centrosema pubescens*	pantropic	fertilizer
Sing061	malibuaya	*Leeaceae*	*Leea philippinensis*		pain reliever
Sing062	burikat	*Compositae*	*Wedelia trilobata*	widespread	
Sing063	dila sa iro	*Asteraceae*	*Elephantopus scaber* var. *scaber*		
Mam062	bugna	*Euphorbiaceae*	*Glochidion woodii*	endemic	skin diseases, dalinog kiskison
Mam063	mahogany	*Meliaceae*	*Swietenia macrophylla*	common	
Mam064	guava	*Myrtaceae*	*Psidum guajava*	common	
Mam065	konsensi		unidentified 6		
Mam066	unidentified		unidentified 7		
Mam067	busikad laki	*Cyperaceae*	*Cyperus kyllinga*		
Mam068	lagitlit	*Gramineae*	*Isachne miliaceae*	endemic	

Legend: Sing – Singalat, Mam – Mamalad, Bon – Bonifacio, Tip – Tipolo, Cat – Catarman

Appendix Table 1. continuation

Code	Local name	Family	Scientific Name	Ecological status	Ethnobotany
Mam069	nito	*Schizaceae*	*Lygodium circinnatum*	common	basket, *makaniwang sa hayop*
Mam070	pisik-pisik	*Asteraceae*	*Centipeda minima*	widespread	for eye diseases
Mam071	pulbos-pulbos	*Pteridaceae*	*Pityrogramma calomelanos*	common	
Mam072	olingon	*Clusiaceae*	*Cratoxylum sumatranum*	endemic	*iligo sa bata*, fever
Mam073	alipata	*Euphorbiaceae*	*Excoecaria agallocha*	common	white sap is reputed to cause blindness
Mam074	hambabalud	*Rubiaceae*	*Nauclea orientalis*	common	headache, bughat, dislocation
Mam075	mangagaw	*Loranthaceae*	*Helixanthera parasitica*	common	used as raw material in making fishing gear
Mam076	salapid	*Gramineae*	*Themeda villosa*	frequently abundant	
Boni077		*Polypodiaceae*	*Pyrrosia lanceolata*	common	
Boni078		*Amaranthaceae*	*Celosia cristata*		
Boni079		*Gramineae*	unidentified 8		
Boni081	tangulamas	*Rutaceae*	*Melicope* sp.		
Boni082	bunot-bunot	*Euphorbiaceae*	*Glochidion camiguinense*	endemic in Babuyan and Camiguin	
Boni083			unidentified 9		
Boni084		*Acanthaceae*	unidentified 10		
Boni085		*Thelypteridaceae*	*Pneumatopteris ligulata*		
Boni086		*Gramineae*	*Pogonatherum paniceum*	common	
Boni087	karnabal	*Passifloraceae*	*Passiflora foetida*	common	
Boni088	sigbinsigbin	*Fabaceae-Papil*	*Crotalaria mucronata*		
Boni089		*Commelinaceae*	*Aneilema* sp. (now in *Murdannia*)		
Boni090			unidentified 11		
Tip091		*Hydrocharitaceae*	*Hydrilla verticillata*	often abundant	
Tip092	terramycin	*Solanaceae*	*Solanum* sp.		fruit is fed to chickens
Tip093	sagusahis	*Moraceae*	*Ficus involucrata*		scrub
Tip094	apatot/ bangkoro	*Rubiaceae*	*Morinda* sp.	common	talimughat
Tip095	buyo-buyo	*Araceae*	unidentified 12		
Tip096		*Dioscoreae*	*Dioscorea* sp.	endemic	
Tip097	bulyabod/ hagdan sa uwak	*Sapindaceae*	*Harpullia arborea*	common	
Tip098			unidentified 13		
Tip099			unidentified 14		
Tip100	langkatan	*Gramineae*	*Cyrtococcum sp.*	common	
Tip101		*Compositae*	*Synedrella nodiflora*	common pantropic	
Tip102		*Araceae*	*Typhonium* sp.		
Tip103		*Acanthaceae*	*Andrographis paniculata*	endemic	stomachache
Tip104	tulog-tulog balagon	*Leg-Pap.*	*Milletia* sp.		sinda

Legend: Sing – Singalat, Mam – Mamalad, Bon – Bonifacio, Tip – Tipolo, Cat – Catarman

Appendix Table 1. continuation

Code	Local name	Family	Scientific Name	Ecological status	Ethnobotany
Tip105	tapak-tapak	*Moraceae*	*Ficus* sp.		lumber
Tip106	sagusahis	*Euphorbiaceae*	*Macaranga* sp.		
Tip107		*Pteridaceae*	*Pteris ensiformis*		
Tip109		*Euphorbiaceae*	*Antidesma montanum*	common	
Tip110	handalupang	*Malvaceae*	*Urena lobata*	common	boils, treats dupang
Tip111	lilium	*Amaryllidaceae*	unidentified 15		edema
Tip112	bitan-ag	*Sterculiaceae*	*Kleinhofia hospita*		
Cat113		*Urticaceae*	*Pouzolzia zeylanica*	common	
Cat114			unidentified 16		
Cat115	pagaypay	*Pteridaceae*	*Acrostichum aureum*		ornamental
Cat116	baho-baho	*Labiatae*	*Hyptis suaveolens*	common	kabuhi, stomache, diarrhea
Cat117		*Gramineae*	*Paspalum* sp.	common	*iligo sa bata*
Cat118	agbaw	*Verbenaceae*	*Premna odorata*	endemic	*kabuhi udlot*
Cat119			unidentified 17		
Cat120	hagonoy	*Compositae*	*Wedelia biflora*	common	
Cat123			unidentified 18		
Sing124	maglarino	*Apocynaceae*	*Alstonia macrophylla*	common	lumber
Sing125	gibo	*Sapindaceae*	*Pometia pinnata*	common	wood, talimughat
Sing126	malabuaya	*Bignoniaceae*	*Radermachera* sp.	common	pain reliever
Sing127	malakopa	*Anacardiaceae*	*Semecarpus cuneiformis*	endemic	lumber
Sing128	pulayo/ tagilumboy	*Myrtaceae*	*Eugenia* sp.		lumber
Sing129	tubog	*Moraceae*	*Ficus* sp.		lumber
Sing130	mana-mana		unidentified 19		
Sing131	amomompong	*Euphorbiaceae*	*Acalypha* sp.		toothache
Sing132	balagon duguan	*Rubiaceae*	unidentified 20		anemia
Sing133		*Myrsinaceae*	*Dioscalyx* sp.		
Sing134	tungaw sa anot	*Melastomataceae*	*Astronia apoensi*	endemic, Misamis	lumber
Sing135	binlod-binlod/ bakhaw-bakhaw	*Rubiaceae*	*Urophyllum* sp.	common	
Sing136	gibo baye	*Sapindaceae*	*Dictyoneura acuminata* (formerly *Blume* spp. *acuminata*)	common	
Sing137	tagibulok	*Flacourtiaceae*	*Homalium oblongifolium*	endemic, Zamboanga	lumber
Sing138	sagusahis/ catmon	*Dilleniaceae*	*Dillenia philippinensis*	endemic	food, fruit
Sing139		*Moraceae*	*Ficus virgata* var. *virgata*		
Sing140	salunglunay	*Burseraceae*	*Canarium asperum* var. *asperum*	common	bughat
Sing141		*Dipteridaceae*	*Dipteris conjugata*		
Sing142		*Orchidaceae*	unidentified 21		ornamental,
Sing143	munggay-munggay	*Fabaceae*	*?Alysicarpus*		vegetable, food
Sing144	lubi-lubi	*Amaryllidaceae*	*?Curculigo*	widespread	ornamental
Sing145	kawayan		unidentified 22		

Legend: Sing – Singalat, Mam – Mamalad, Bon – Bonifacio, Tip – Tipolo, Cat – Catarman

Appendix Table 1. continuation

Code	Local name	Family	Scientific Name	Ecological status	Ethnobotany
Sing146		*Maranthaceae*	unidentified 23		
Sing147		*Dioscoreaceae*	*Dioscorea hispida*	common	food
Sing148		*Orchidaceae*	unidentified 24		
Sing149		*Orchidaceae*	*Dendrobium* sp.		ornamental
Sing150		*Orchidaceae*	*Eria* sp.		ornamental
Sing151		*Orchidaceae*	*Appendicula* sp.		ornamental
Sing152		*Orchidaceae*	*Coelogyne* sp.		ornamental
Sing154		*Polypodiaceae*	*Microsorium punctatum*		
Sing155		*Aspleniaceae*	*Asplenium tenerum*		
Sing156		*Polypodiaceae*	*Loxogramme* sp.		
Sing157		*Orchidaceae*	unidentified 25		ornamental
Sing158		*Gesneriaceae*	unidentified 26		
Sing159	tagilaway	*Lycopodiaceae*	*Urostachys salvinioides*		
Sing160	psilotum like	*Vittariaceae*	unidentified 27		
Sing161	orchid	*Orchidaceae*	*Thrixspermum* sp.		ornamental
Sing162	potat sa bukid	*Lauraceae*	*Litsea garciae*		
	alingatong nga puti	*no number*	unidentified 28		cure to talimughat
Sing 163	bagitlong puti	*Euphorbiaceae*	*Acalypha* sp.		
Sing164	begonia	*Urticaceae*	*Elatostema* sp.		
Sing165	balite	*Moraceae*	*Ficus* cf. *aurita*		
Sing166	tambok-tambok	*Urticaceae*	*Pilea* sp.		
Sing167	banban	*Marantaceae*	*Donnax cannaeformis*	common	basket, nigo
Sing169	kalubi	*Palmae*	*Calamus* spp.		
Sing170	payaw	*Araceae*	*Homalomena philippinensis*		*hampol sa buros dahon*
Sing171	lablab	*Marattiaceae*	*Angiopteris evecta*		
Sing172	pangi		*Pangium edule*		food, fruit, *tambal sa ulod sa kalabaw*
Sing173	fern	*Dryopteridaceae*	*Tectaria decurrens*		
Sing174	tambangalan	*Palmae*	unidentified 29		vegetable
Sing175	labid	*Araceae*	unidentified 30		
Sing176		*Orchidaceae*	*Adenostylis* (senso lato)		ornamental
Sing177	pusaw	*Araceae*	*Schismatoglottis* sp.		
Sing178		*Cecropiaceae*	*Poikilospermum* sp.		
Sing179		*Urticaceae*	unidentified 31		
Sing180		*Acanthaceae*	unidentified 32		
Sing181		*Polypodiaceae*	*Microsorum scolopendria*		
Sing182	wild mandalosa	*Gramineae*	*Centotheca latifolia*	common	
Sing183		*Melastomataceae*	*Medinilla* sp.		ornamental
Sing184		*Orchidaceae*	*Bulbophyllum* sp.		ornamental
Sing185			unidentified 33		
Sing186		*Verbenaceae*	*Clerodendrum* sp.	common	
Sing187	kamaog	*Orchidaceae*	unidentified 34		ornamental
Sing188		*Polypodiaceae*	*Lepisorus longifolius* (syn. *Pleopeltis longifolius*)		fruit used as paste

Legend: Sing – Singalat, Mam – Mamalad, Bon – Bonifacio, Tip – Tipolo, Cat – Catarman

Appendix Table 1. continuation

Code	Local name	Family	Scientific Name	Ecological status	Ethnobotany
Sing190		*Cyatheaceae*	*Cyathea* sp.		rhizomes as medium for bromeliads
Sing191	bugnay	*Xanthophyllaceae*	*Xanthophyllum* sp.		
Sing192		*Selaginellaceae*	*Selaginella cupressina*		ornamental
Sing193	rasras, sagatap	*Pandanaceae*	*Freycenetia* sp.	endemic	ornamental
Sing194		*Selaginellaceae*	*Selaginella* cf. *magnifica*		ornamental
Sing195		*Orchidaceae*	*Spathoglottis plicata*		ornamental
Sing196	pechay-pechay	*Pentaphragmaceae*	*Pentaphragma grandifolium*	endemic	vegetable
Sing197		*Lauraceae*	*Litsea garciae*		
Sing198	tabako sa unggoy	*Gesneriaceae*	*Cyrtandra* sp.	endemic	
Sing200		*Sapotaceae*	*Palaquium* sp.		
Sing201		*Cunoniaceae*	*Weinmannia hutchinsonis* (=*W. camiguensis*)	endemic	
Species found outside the belts					
	ipil-ipil	*Leguminosae/ Fabaceae*	*Leucaena leucocephala*		
	hendang sa anot		unidentified 35		
	hagimit		unidentified 36		deworming
	lokdo-lokdo	*Davalliaceae*	*Nephrolepis hirsutula*		
	cogon	*Gramineae*	*Imperata cylindrica*		
	magtalisay	*Combretaceae*	*Terminalia nitens*	endemic	ornamental
	dahik		unidentified 37		forage
	eba	*Oxalidaceae*	*Averrhoa bilimbi*	pantropic	
	guralo		unidentified 38		
	anihop		unidentified 39		food
	anopol		*Poikilospermum suaveolens*		
	hagikhik	*Marantaceae*	*Phacelophrynium bracteosum*		
	pako sa binaw		unidentified 40		
	menthol	*Polygalaceae*	*Polygala paniculatus*		
		Moraceae	*Ficus benjamina*	common	
		Verbenaceae	*Stachytarpheta jamaicensis*		
		Malvaceae	*Sida rhoimbifolia*	common	ornamental
		Verbenaceae	*Lantana camara*		
		Polypodiaceae	*Drynaria quercifolia*		
		Anacardiaceae	Mangifera indica	commonly cultivated	medicine
		Meliaceae	*Sandoricum koetjapi*	common	
		Araceae	*Caladium bicolor*	cultivated	food
		Rubiaceae	*Morinda citrifolia*	common	food

Legend: Sing – Singalat, Mam – Mamalad, Bon – Bonifacio, Tip – Tipolo, Cat – Catarman

Appendix Table 1. continuation

Code	Local name	Family	Scientific Name	Ecological status	Ethnobotany
		Rubiaceae	*Ixora* sp.		food
		Rubiaceae	*Nauclea* sp.		ornamental
		Davalliaceae	*Nephrolepis cordifolia*		ornamental
		Gleicheniaceae	*Sticherus laevigata*		
		Gleicheniaceae	*Dicranopteris linearis*		ornamental
		Lycopodiaceae	*Lycopodium cernuum*		
		Lycopodiaceae	*Lycopodium* sp.		tying material
		Selaginellaceae	*Selaginella plana*		ornamental
		Selaginellaceae	*Sellaginella delicatula*		ornamental
		Schizaceae	*Lygodium circinnatum*		ornamental
		Acanthaceae	*Graptophyllum pictum*	widely planted	ornamental
		Acanthaceae	*Odontonema strictum*	common	tying material
		Acanthaceae	*Sanchezia speciosa*		ornamental
		Agavaceae	*Cordyline fruticosa*		ornamental
		Araceae	*Alocasia* sp.		ornamental
		Araceae	*Philodendrom lacerum*		ornamental
		Araceae	*Philodendrom microstichum*		food
		Araceae	*Philodendrom scandens*		ornamental
		Araliaceae	*Schefflera elliptica*	endemic	ornamental
		Araliaceae	*Schefflera insularum*	endemic	ornamental
		Balsaminaceae	*Impatiens montalbanica*		ornamental
		Caprifoliaceae	*Sambucus javanica*	common	ornamental
		Poaceae	*Cordyline fruticosa*		ornamental
		Hypoxidaceae	*Curculigo capitulata*		
		Moraceae	*Artocarpus blancoi*	endemic	ornamental
	apatot	*Rubiaceae*	*Anthocephalus chinensis*		ornamental
	tagbak	*Zingiberaceae*	*Kolowratia elegans*	endemic	food
		Zingiberaceae	*Zingiber* sp.		ornamental
		Leguminosae	*Clitoria ternatea*	common	flower for arrangement
		Palmae	*Cocos nucifera*	commonly cultivated	food, medicine
		Gramineae	*Oryza sativa*	pantropic	fertilizer
		Meliaceae	*Lansium domesticum*	common; cultivated	food
		Gramineae	*Coix lachryma-jobi*		food
	gmelina	*Verbenaceae*	*Gmelina arborea*		food
					ornamental

Legend: Sing – Singalat, Mam – Mamalad, Bon – Bonifacio, Tip – Tipolo, Cat – Catarman

Appendix Table 2. Plant families and their component species found in the riparian zones of the Langaran River

Families	Component Species
ANGIOSPERMAE	
Acanthaceae	*Andrographis paniculata*
	Graptophyllum pictum "tricolor"
	Odontonema strictum
	Sanchezia speciosa
	unidentified
	unidentified
Agavaceae	*Cordyline fruticosa*
Amaranthaceae	*Celosia argentea*
	Cyathula prostrata
Amaryllidaceae	*?Curculigo*
Anacardiaceae	*Mangifera indica*
	Semecarpus cuneiformis
Apocynaceae	*Alstonia macrophylla*
Araceae	*Alocasia* sp.
	Caladium bicolor
	Colocasia esculenta
	Homalomena philippinensis
	Philodendrom lacerum
	Philodendrom microstichum
	Philodendrom scandens subsp.
	Oxycardium sp.
	Schismatoglottis sp.
	Scindapsus sp.
	Typhonium sp.
	unidentified (labid)
	unidentified
Araliaceae	*Schefflera elliptica*
	Schefflera insularum
Balsaminaceae	*Impatiens balsamina*
Bignoniaceae	*Radermachera* sp.

Appendix Table 2. continuation

Families	Component Species
Burseraceae	*Canarium asperum* var*. asperum*
Caprifoliaceae	*Sambucus javanica*
Caryophyllidae	*Drymaria cordata* var. *dianthus*
Cecropiaceae	*Poikilospermum*
Clusiaceae	*Cratoxylum sumatranum*
Combretaceae	*Prunus clementis* *Terminalia nitens*
Commelinaceae	*Aneilema* (now in *Murdannia*) *Commelina benghalensis*
Compositae / Asteraceae	*Ageratum conyzoides* *Bidens pilosa* *Centipeda minima* *Chromolaena odorata* *Elephantopus scaber* var*. scaber* *Mikania cordata* *Milletia* sp. *Pseudoelephantophus spicatus* *Spilanthes acmella* *Syndrella nodiflora* *Wedelia biflora* *Wedelia trilobata*
Convulvulaceae	*Ipomea aquatica* *Syndrella nodiflora*
Cunoniaceae	*Weinmannia hutchinsonis* (previously known as *W. camiguensis*)
Cyperaceae	*Cyperus kyllinga* *Cyperus pilosus* *Cyperus rotundus* *Fimbristylis* sp. *Scirpus* sp.
Dilleniaceae	*Dillenia philippinensis*

Appendix Table 2. continuation

Families	Component Species
Dioscoreaceae	*Dioscorea hispida*
	Dioscorea sp.
Dipterocarpaceae	*Parashorea malaanonan*
	Swietenia macrophylla
Euphorbiaceae	*Acalypha amentaceae*
	Acalypha sp.
	Antidesma montanum
	Bridelia glauca
	Excoecaria agallocha
	Glochidion camiguinense
	Glochidion woodii
	Homonoia riparia
	Macaranga sp.
	Phyllanthus urinaria
Flacourtiaceae	*Homalium oblongifolium*
Gesneriaceae	*Cyrtandra* sp.
	unidentified
Gramineae	*Bambusa vulgaris*
	Centotheca latifolia
	Coix lachryma-jobi
	Cyrtococcum
	Digitaria setata
	Eleusine indica
	Imperata cyclindrica
	Isachne miliaceae
	Oryza sativa
	Paspalaum conjugatum
	Pogonatherum panicum
	Saccharum officinale
	Saccharum spontaneum
	Themeda villosa
	Unidentified
Hydrocharitaceae	*Hydrilla verticillata*
Hypoxidaceae	*Curculigo capitulata*

Appendix Table 2. continuation

Families	Component Species
Labiatae	*Hyptis capitata*
	Hyptis suaveoleus
Lauraceae	*Litsea garciae*
Leeceae / Vitaceae	*Leea philippinensis*
	Leea quadrifolia
Leguminoseae	*Alysicarpus*
	Centrosema pubescens
	Clitoria ternatea
	Crotolaria mucronata
	Desmodium heterocarpum
	Derris elliptica
	Erythrina orientalis
	Gliricidia sepium
	Leucaena leucocephala
	Milletia
	Mimosa pudica
Loganiaceae	*Fagraea auriculata*
Loranthaceae	*Helixanthera parasitica*
Malvaceae	*Hibiscus tiliaceus* spp. *tiliaceus*
	Sida rhoimbifolia
	Urena lobata
	unidentified
Maranthaceae	*Donnax cannaeformis*
	Phacelophrynium bracteosum
	unidentified
Melastomataceae	*Astronia apoensi*
	Medinilla sp.
	Melastoma malabathricum
Meliaceae	*Lansium domesticum*
	Sandoricum koetjapi
	Swietenia macrophylla

Appendix Table 2. continuation

Families	Component Species
Menispermaceae	*Hypserpa cuspidata*
Moraceae	*Artocarpus blancoi*
	Artocarpus heterophyllus
	Ficus cf. *aurita*
	Ficus benjamina
	Ficus guyeri var. *guyeri*
	Ficus involucrate
	Ficus septica var. *septica*
	Ficus sp.
	Ficus virgata var. *virgata*
	Pangium edule
	Poikilospermum suaveolens
Musaceae	*Musa paradisiaca*
Myrsinaceae	*Dioscalyx* sp.
	Semecarpus cuneiformis
Myrtaceae	*Psidium guajava*
	Eugenia
Orchidaceae	*Adenostylis* (senso lato) sp.
	Appendicula sp.
	Bulbophyllum sp.
	?Coelogyne sp
	Dendrobium sp.
	Eria sp.
	Spathoglottis plicata
	Thrixspermum sp.
	unidentified
	unidentified
	unidentified (kamaog)
Oxalidaceae	*Averrhoa bilimbi*
Palmae	*Calamus* sp.
	Cocos nucifera
	Nipa fruticans
	unidentified (tambangalan)
Pandanaceae	*Freycenetia*
	Pandanus sp.

Appendix Table 2. continuation

Families	Component Species
Passifloraceae	*Passiflora foetida*
Pentaphragmaceae	*Pentaphragma grandifolium*
Polygalaceae	*Polygala paniculatus*
Rosaceae	*Prunus clementis*
	Fragaria sp.
Rubiaceae	*Anthocephalus chinensis*
	Hedyotis philippinensis
	Ixora sp.
	Morinda citrifolia
	Morinda sp.
	Nauclea/Neonauclea
	Nauclea orientalis
	Urophyllum sp.
	unidentified
Rutaceae	*Melicope* sp.
Sapindaceae	*Guioa bicolor*
	Harpullia arborea
	Pometia pinnata
	Dictyoneura acuminata (formerly *Blume* spp. *acuminata*)
Sapotaceae	*Palaquium* sp.
Solanaceae	*Solanum* sp.
Sterculiaceae	*Kleinhofia hospita*
	Theobroma cacao
Tiliaceae	*Diplodiscus paniculatus*
Umbilliferae	*Centella asiatica*
Urticaceae	*Elatostema* sp.
	Leucosyke capitellata
	Pilea sp.
	Pouzolzia zeylanica
	Villebrunea sp.
	unidentified
	unidentified

Appendix Table 2. continuation

Families	Component Species
Verbenaceae	*Clerodendrum* sp.
	Lantana camara
	Premna sp.
	Stachytarpheta jamaicensis
	Unidentified
Vittariaceae	Unidentified
Xanthophyllaceae	*Xanthophyllum* sp.
Zingiberaceae	*Costus speciosus*
	Kolowratia elegans
	Zingiber sp.
PTERIDOPHYTA	
Aspleniaceae	*Asplenium tenerum*
Athyriaceae	*Diplazium esculentum*
Cyatheaceae	*Cyathea* sp.
Davalliaceae	*Nephrolepis cordifolia*
	Nephrolepis hirsutula
Dipteridaceae	*Dipteris conjugata*
Dryopteridaceae	*Tectaria decurrens*
Gleicheniaceae	*Dicranopteris linearis*
	Sticherus laevigata
Lycopodiaceae	*Lycopodium cernuum*
	Lycopodium sp.
	Urostachys salvinioides
Marattiaceae	*Angiopteris evecta*
Polypodiaceae	*Lepisorus longifolius* syn. *Pleopeltis longifolius*
	Loxogramme sp.
	Microsorium punctatum
	Microsorium scolopendria

Appendix Table 2. continuation

Families	Component Species
Pteridaceae	*Acrostichum aureum*
	Pteris ensiformis
	Pityrogramma calomelanos
Schizaceae	*Lygodium circinnatum*
	Selaginella cupressina
Selaginellaceae	*Selaginella delicatula*
	Selaginella cf. *magnifica*
	Selaginella plana
	Selaginella sp.
Thelypteridaceae	*Pneumatopteris ligulata*
	Sphaerostephanos unitus

Appendix Table 3. Checklist of riverine and riparian vascular flora found in the study barangays traversed by the Langaran River

Code	Local name	Family	Scientific Name	S	Tk	M	B	Tp	C
Sing001	balobo	*Tiliaceae*	*Diplodiscus paniculatus*	+					
Sing002	bakan	*Rosaceae*	*Prunus clementis*	+					
Sing003	langala	*Euphorbiaceae*	*Acalypha amentaceae*	+					
Sing004	ananamsi	*Urticaceae*	*Villebrunea* sp.	+					
Sing005	antotongaw	*Melastomataceae*	*Melastoma malabathricum*	+	+	+	+	+	+
Sing006		*Commelinaceae*	*Commelina benghalensis*	+					
Sing007	hansaw	*Labiatae*	*Hyptis capitata*	+	+	+	+		+
Sing008	kukog banog	*Compositae*	*Elephantopus scaber*	+			+		+
Sing009	balili	*Gramineae*	*Digitaria setata*	+		+			
Sing010	baling-baling	*Caryophyllidae*	*Drymaria cordata* var. *dianthus*	+		+	+		
Sing011	bulak-manok	*Compositae*	*Ageratum conyzoides*	+		+			+
Sing012	busikad	*Cyperaceae*	*Cyperus kyllinga*	+		+	+	+	
Sing013	ginit-ginit	*Thelypteridaceae*	*Sphaerostephanos unitus*	+	+	+	+	+	
Sing014	hibi-hibi	*Leguminoseae*	*Mimosa pudica*	+		+	+	+	
Sing015	tigsim		unidentified 1	+		+		+	
Sing016	mani-mani/tulog-tulog	*Leguminoseae*	*Desmodium heterocarpum*	+	+				
Sing017	mardium	*Rubiaceae*	*Hedyotis philippinensis*	+					
Sing018	bugang	*Gramineae*	*Saccharum spontaneum* L. subsp. *indicum*	+			+		
Sing019	daat	*Cyperaceae*	*Scirpus* sp.	+	+	+	+		
Sing020	hagonoy	*Compositae*	*Chromolaena odorata*	+		+			+
Sing021	kaya-kaya	*Fabaceae*	*Derris elliptica*	+		+			
Sing022	baric	*Dipterocarpaceae*	*Parashorea malaanonan*	+		+			+
Sing023	lakatan	*Musaceae*	*Musa paradisiaca*	+					
Sing024	nangka	*Moraceae*	*Artocarpus heterophyllus*	+					
Sing025	alikway	*Malvaceae?*	unidentified 2	+					
Sing026	cacao	*Sterculiaceae*	*Theobroma cacao*	+					
Sing027	tubo	*Gramineae*	*Saccharum officinarum*	+					
Sing028	romblom	*Pandanaceae*	*Pandanus* sp.			+			
Sing029	salimbagat/ talimughat	*Amaranthaceae*	*Cyathula prostrata*	+			+		
Sing030	pako	*Athyriaceae*	*Diplazium esculentum*	+	+	+	+	+	+
Sing031	carabao grass	*Gramineae*	*Paspalum conjugatum*	+	+	+	+	+	+
Sing032	tulay-tulay	*Compositae*	*Bidens pilosa*	+					
Sing033	gabi/parayo	*Araceae*	*Colocasia esculentum*	+					

Legend: S– Singalat 1 Tk– Tingkob M– Mamalad B– Bonifacio Tp– Tipolo C– Catarman

Appendix Table 3. continuation

Code	Local name	Family	Scientific Name	S	Tk	M	B	Tp	C
Sing034	yahongyahong	*Umbilliferae*	*Centella asiatica*					+	
Sing035	limbas-limbas	*Cyperaceae*	*Cyperus pilosus*			+			
Sing036	moti-moti	*Compositae*	*Mikania cordata*	+	+	+	+	+	+
Sing037			unidentified 3	+					
Sing038	dila-dila	*Asteraceae/ Compositae*	*Pseudoelephantophus spicatus*	+	+	+	+	+	+
Sing039		*Euphorbiacae*	*Phyllanthus urinaria*	+		+		+	
Sing040	katagbak	*Zingiberaceae*	*Costus speciosus*	+	+				+
Sing042		*Compositae*	*Spilanthes acmella*	+					
Sing043	tikog-tikog	*Cyperaceae*	*Fimbristylis* sp.	+					
Sing044	bila-bila	*Gramineae*	*Eleusine indica*	+					+
Sing045	amagus	*Euphorbiaceae*	*Homonoia riparia*	+		+			
Sing046	tapalak	*Loganiaceae*	*Fagraea auriculata*	+					
Sing047	malibago	*Malvaceae*	*Hibiscus tiliaceus* ssp. *tiliaceus*		+				
Sing048	sinagkolan	*Leeceae/Vitaceae*	*Leea quadrifolia*	+					
Sing049	lombilan/ mana-mana	*Sapindaceae*	*Guioa bicolor*	+					
Sing050	saloot	*Moraceae*	*Ficus guyeri* var. *guyeri*	+					
Sing051	lagnob	*Moraceae*	*Ficus septica* var. *septica*					+	
Sing052	alagasi	*Urticaceae*	*Leucosyke capitellata*	+					
Sing053	balitarhan	*Euphorbiaceae*	*Bridelia glauca* Blume			+			
Sing054	wild pandan	*Pandanaceae*	*Pandanus* sp.	+					
Sing055	lalapaw	*Menispermaceae*	*Hypserpa cuspidata*	+					
Sing056	gulayan		unidentified 4	+					
Sing057	takoling balago/ tanaman	*Araceae*	*Scindapsus*	+					
Sing058	bukog-bukog	*Selaginellacae*	*Selaginella*	+	+				
Sing059	otap		unidentified 5	+	+				
Sing060	cover crop	*Leguminosae*	*Centrosema pubescens*	+		+	+	+	+
Sing061	malibuaya	*Leeaceae*	*Leea philippinensis*	+	+	+	+	+	+
Sing062	burikat	*Compositae*	*Wedelia trilobata*	+	+	+	+	+	+
Sing063	dila sa iro	*Asteraceae*	*Elephantopus scaber* var. *scaber*			+			
Mam062	bugna	*Euphorbiaceae*	*Glochidion woodii*					+	
Mam063	mahogany	*Meliaceae*	*Swietenia macrophylla*			+			
Mam064	guava	*Myrtaceae*	*Psidum guajava*			+		+	+
Mam065	konsensi		unidentified 6			+			
Mam066	unidentified		unidentified 7			+			
Mam067	busikad laki	*Cyperaceae*	*Cyperus kyllinga*			+	+		
Mam068	lagitlit	*Gramineae*	*Isachne miliaceae*		+	+	+	+	+

Legend: S– Singalat 1 Tk– Tingkob M– Mamalad B– Bonifacio Tp– Tipolo C– Catarman

Appendix Table 3. continuation

Code	Local name	Family	Scientific Name	S	Tk	M	B	Tp	C
Mam069	nito	*Schizaceae*	*Lygodium circinnatum*			+			
Mam070	pisik-pisik	*Asteraceae*	*Centipeda minima*			+		+	
Mam071	pulbos-pulbos	*Pteridaceae*	*Pityrogramma calomelanos*			+			
Mam072	olingon	*Clusiaceae*	*Cratoxylum sumatranum*			+			
Mam073	alipata	*Euphorbiaceae*	*Excoecaria agallocha*			+			
Mam074	hambabalud	*Rubiaceae*	*Nauclea orientalis*	+	+	+	+	+	+
Mam075	mangagaw	*Loranthaceae*	*Helixanthera parasitica*			+			
Mam076	salapid	*Gramineae*	*Themeda villosa*			+			
Boni077		*Polypodiaceae*	*Pyrrosia lanceolata*				+		
Boni078		*Amaranthaceae*	*Celosia cristata*				+		
Boni079		*Gramineae*	unidentified 8				+		
Boni081	tangulamas	*Rutaceae*	*Melicope* sp.				+		
Boni082	bunot-bunot	*Euphorbiaceae*	*Glochidion camiguinense*				+		
Boni083			unidentified 9				+		
Boni084		*Acanthaceae*	unidentified 10				+		
Boni085		*Thelypteridaceae*	*Pneumatopteris ligulata*				+		
Boni086		*Gramineae*	*Pogonatherum paniceum*				+		
Boni087	karnabal	*Passifloraceae*	*Passiflora foetida*				+		
Boni088	sigbinsigbin	*Fabaceae-Papil*	*Crotalaria mucronata*				+		
Boni089		*Commelinaceae*	*Aneilema* sp. (now in Murdannia)					+	+
Boni090			unidentified 11				+		
Tip091		*Hydrocharitaceae*	*Hydrilla verticillata*					+	
Tip092	terramycin	*Solanaceae*	*Solanum* sp.					+	+
Tip093	sagusahis	*Moraceae*	*Ficus involucrata*					+	
Tip094	apatot/ bangkoro	*Rubiaceae*	*Morinda* sp.					+	
Tip095	buyo-buyo	*Araceae*	unidentified 12					+	+
Tip096		*Dioscoreae*	*Dioscorea* sp.					+	
Tip097	bulyabod/ hagdan sa uwak	*Sapindaceae*	*Harpullia arborea*					+	
Tip098			unidentified 13					+	
Tip099			unidentified 14					+	
Tip100	langkatan	*Gramineae*	*Cyrtococcum sp.*					+	
Tip101		*Compositae*	*Synedrella nodiflora*					+	
Tip102		*Araceae*	*Typhonium* sp.					+	
Tip103		*Acanthaceae*	*Andrographis paniculata*					+	
Tip104	tulog-tulog balagon	*Leg-Pap.*	*Milletia* sp.	+				+	+

Legend: S– Singalat 1 Tk– Tingkob M– Mamalad B– Bonifacio Tp– Tipolo C– Catarman

Appendix Table 3. continuation

Code	Local name	Family	Scientific Name	S	Tk	M	B	Tp	C
Tip105	tapak-tapak	*Moraceae*	*Ficus* sp.					+	
Tip106	sagusahis	*Euphorbiaceae*	*Macaranga* sp.					+	
Tip107		*Pteridaceae*	*Pteris ensiformis*					+	
Tip109		*Euphorbiaceae*	*Antidesma montanum*					+	
Tip110	handalupang	*Malvaceae*	*Urena lobata*						+
Tip111	lilium	*Amaryllidaceae*	unidentified 15					+	
Tip112	bitan-ag	*Sterculiaceae*	*Kleinhofia hospita*					+	
Cat113		*Urticaceae*	*Pouzolzia zeylanica*						+
Cat114			unidentified 16						+
Cat115	pagaypay	*Pteridaceae*	*Acrostichum aureum*						+
Cat116	baho-baho	*Labiatae*	*Hyptis suaveolens*						+
Cat117		*Gramineae*	*Paspalum* sp.				+	+	+
Cat118	agbaw	*Verbenaceae*	*Premna odorata*						+
Cat119			unidentified 17						+
Cat120	hagonoy	*Compositae*	*Wedelia biflora*				+		+
Cat123			unidentified 18						+
Sing124	maglarino	*Apocynaceae*	*Alstonia macrophylla*		+				
Sing125	gibo	*Sapindaceae*	*Pometia pinnata*		+				
Sing126	malabuaya	*Bignoniaceae*	*Radermachera* sp.		+				
Sing127	malakopa	*Anacardiaceae*	*Semecarpus cuneiformis*		+				
Sing128	pulayo/ tagilumboy	*Myrtaceae*	*Eugenia* sp.		+				
Sing129	tubog	*Moraceae*	*Ficus* sp.		+				
Sing130	mana-mana		unidentified 19		+				
Sing131	amomompong	*Euphorbiaceae*	*Acalypha* sp.		+		+		
Sing132	balagon duguan	*Rubiaceae*	unidentified 20		+				
Sing133		*Myrsinaceae*	*Dioscalyx* sp.		+				
Sing134	tungaw sa anot	*Melastomataceae*	*Astronia apoensi*		+				
Sing135	binlod-binlod/ bakhaw-bakhaw	*Rubiaceae*	*Urophyllum* sp.		+				
Sing136	gibo baye	*Sapindaceae*	*Dictyoneura acuminata* (formerly *Blume* spp. *acuminata*)	+					
Sing137	tagibulok	*Flacourtiaceae*	*Homalium oblongifolium*		+				
Sing138	sagusahis/ catmon	*Dilleniaceae*	*Dillenia philippinensis*		+				
Sing139		*Moraceae*	*Ficus virgata* var. *virgata*		+				
Sing140	salunglunay	*Burseraceae*	*Canarium asperum* var. *asperum*		+				
Sing141		*Dipteridaceae*	*Dipteris conjugata*		+				
Sing142		*Orchidaceae*	unidentified 21		+				
Sing143	munggay-munggay	*Fabaceae*	*?Alysicarpus* sp.		+		+		
Sing144	lubi-lubi	*Amaryllidaceae*	*?Curculigo* sp.		+				
Sing145	kawayan		unidentified 22		+				+

Legend: S– Singalat 1 Tk– Tingkob M– Mamalad B– Bonifacio Tp– Tipolo C– Catarman

Appendix Table 3. continuation

Code	Local name	Family	Scientific Name	S	Tk	M	B	Tp	C
Sing146		*Maranthaceae*	unidentified 23		+				
Sing147		*Dioscoreaceae*	*Dioscorea hispida*		+				
Sing148		*Orchidaceae*	unidentified 24		+				
Sing149		*Orchidaceae*	*Dendrobium* sp.		+				
Sing150		*Orchidaceae*	*Eria* sp.		+				
Sing151		*Orchidaceae*	*Appendicula* sp.		+				
Sing152		*Orchidaceae*	*Coelogyne* sp.		+				
Sing154		*Polypodiaceae*	*Microsorium punctatum*		+				
Sing155		*Aspleniaceae*	*Asplenium tenerum*		+				
Sing156		*Polypodiaceae*	*Loxogramme* sp.		+				
Sing157		*Orchidaceae*	unidentified 25		+				
Sing158		*Gesneriaceae*	unidentified 26		+				
Sing159	tagilaway	*Lycopodiaceae*	*Urostachys salvinioides*		+				
Sing160	psilotum like	*Vittariaceae*	unidentified 27		+				
Sing161	orchid	*Orchidaceae*	*Thrixspermum* sp.		+				
Sing162	potat sa bukid	*Lauraceae*	*Litsea garciae*		+				
	alingatong nga puti		unidentified 28		+				
Sing 163	bagitlong puti	*Euphorbiaceae*	*Acalypha* sp.		+				
Sing164	begonia	*Urticaceae*	*Elatostema* sp.		+				
Sing165	balite	*Moraceae*	*Ficus* cf. *aurita*		+				
Sing166	tambok-tambok	*Urticaceae*	*Pilea* sp.		+				
Sing167	banban	*Marantaceae*	*Donnax cannaeformis*		+				
Sing169	kalubi	*Palmae*	*Calamus* spp.		+				
Sing170	payaw	*Araceae*	*Homalomena philippinensis*		+				
Sing171	lablab	*Marattiaceae*	*Angiopteris evecta*		+				
Sing172	pangi		*Pangium edule*		+				
Sing173	fern	*Dryopteridaceae*	*Tectaria decurrens*		+		+		
Sing174	tambangalan	*Palmae*	unidentified 29		+				
Sing175	labid	*Araceae*	unidentified 30		+				
Sing176		*Orchidaceae*	*Adenostylis* (senso lato)		+				
Sing177	pusaw	*Araceae*	*Schismatoglottis* sp.		+		+		
Sing178		*Cecropiaceae*	*Poikilospermum* sp.		+				
Sing179		*Urticaceae*	unidentified 31		+				
Sing180		*Acanthaceae*	unidentified 32		+				
Sing181		*Polypodiaceae*	*Microsorum scolopendria*		+				
Sing182	wild mandalosa	*Gramineae*	*Centotheca latifolia*		+				
Sing183		*Melastomataceae*	*Medinilla* sp.		+				
Sing184		*Orchidaceae*	*Bulbophyllum* sp.		+				
Sing185			unidentified 33		+				
Sing186		*Verbenaceae*	*Clerodendrum* sp.		+				
Sing187	kamaog	*Orchidaceae*	unidentified 34		+				
Sing188		*Polypodiaceae*	*Lepisorus longifolius* (syn. *Pleopeltis longifolius*)						

Legend: S– Singalat 1 Tk– Tingkob M– Mamalad B– Bonifacio Tp– Tipolo C– Catarman

Appendix Table 3. continuation

Code	Local name	Family	Scientific Name	S	Tk	M	B	Tp	C
Sing190		*Cyatheaceae*	*Cyathea* sp.	+					
Sing191	bugnay	*Xanthophyllaceae*	*Xanthophyllum* sp.		+				
Sing192		*Selaginellaceae*	*Selaginella cupressina*		+				
Sing193	rasras, sagatap	*Pandanaceae*	*Freycenetia* sp.		+				
Sing194		*Selaginellaceae*	*Selaginella* cf. *magnifica*		+				
Sing195		*Orchidaceae*	*Spathoglottis plicata*		+				
Sing196	pechay-pechay	*Pentaphragmaceae*	*Pentaphragma grandifolium*		+				
Sing197		*Lauraceae*	*Litsea garciae*		+				
Sing198	tabako sa unggoy	*Gesneriaceae*	*Cyrtandra* sp.		+				
Sing200		*Sapotaceae*	*Palaquium* sp.		+				
Sing201		*Cunoniaceae*	*Weinmannia hutchinsonis* (=*W. camiguensis*)		+				
Species found outside the belts									
	ipil-ipil	*Leguminosae/ Fabaceae*	*Leucaena leucocephala*		+				+
	hendang sa anot		unidentified 35		+				
	hagimit		unidentified 36		+				
	lokdo-lokdo	*Davalliaceae*	*Nephrolepis hirsutula*	+	+	+	+	+	+
	cogon	*Gramineae*	*Imperata cylindrica*	+	+				+
	magtalisay	*Combretaceae*	*Terminalia nitens*		+			+	
	dahik		unidentified 37		+				
	eba	*Oxalidaceae*	*Averrhoa bilimbi*	+	+				
	guralo		unidentified 38	+	+				
	anihop		unidentified 39		+				
	anopol		*Poikilospermum suaveolens*		+				
	hagikhik	*Marantaceae*	*Phacelophrynium bracteosum*	+					
	pako sa binaw		unidentified 40		+				
	menthol	*Polygalaceae*	*Polygala paniculatus*			+			
		Moraceae	*Ficus benjamina*			+			
		Verbenaceae	*Stachytarpheta jamaicensis*				+		+
		Malvaceae	*Sida rhoimbifolia*						+
		Verbenaceae	*Lantana camara*						+
		Polypodiaceae	*Drynaria quercifolia*				+		
		Anacardiaceae	Mangifera indica			+			
		Meliaceae	*Sandoricum koetjapi*					+	+
		Araceae	*Caladium bicolor*			+			
		Rubiaceae	*Morinda citrifolia*					+	

Legend: S– Singalat 1 Tk– Tingkob M– Mamalad B– Bonifacio Tp– Tipolo C– Catarman

Appendix Table 3. continuation

Code	Local name	Family	Scientific Name	S	Tk	M	B	Tp	C
		Rubiaceae	*Ixora* sp.					+	
		Rubiaceae	*Nauclea* sp.					+	
		Davalliaceae	*Nephrolepis cordifolia*			+			
		Gleicheniaceae	*Sticherus laevigata*			+			
		Gleicheniaceae	*Dicranopteris linearis*			+			
		Lycopodiaceae	*Lycopodium cernuum*			+			
		Lycopodiaceae	*Lycopodium* sp.		+				
		Selaginellaceae	*Selaginella plana*		+				
		Selaginellaceae	*Sellaginella delicatula*		+				
		Schizaceae	*Lygodium circinnatum*		+				
		Acanthaceae	*Graptophyllum pictum*		+				
		Acanthaceae	*Odontonema strictum*		+				
		Acanthaceae	*Sanchezia speciosa*		+				
		Agavaceae	*Cordyline fruticosa*		+				
		Araceae	*Alocasia* sp.	+	+				
		Araceae	*Philodendrom lacerum*		+				
		Araceae	*Philodendrom microstichum*	+					
		Araceae	*Philodendrom scandens*		+				
		Araliaceae	*Schefflera elliptica*		+				
		Araliaceae	*Schefflera insularum*		+				
		Balsaminaceae	*Impatiens montalbanica*		+				
		Caprifoliaceae	*Sambucus javanica*		+				
		Poaceae	*Cordyline fruticosa*		+				
		Hypoxidaceae	*Curculigo capitulata*		+				
		Moraceae	*Artocarpus blancoi*					+	
	apatot	*Rubiaceae*	*Anthocephalus chinensis*				+		
	tagbak	*Zingiberaceae*	*Kolowratia elegans*			+			
		Zingiberaceae	*Zingiber* sp.		+	+			
		Leguminosae	*Clitoria ternatea*			+			
		Palmae	*Cocos nucifera*	+	+	+	+	+	+
		Gramineae	*Oryza sativa*	+		+	+	+	+
		Meliaceae	*Lansium domesticum*	+		+		+	
		Gramineae	*Coix lachryma-jobi*	+					+
	gmelina	*Verbenaceae*	*Gmelina arborea*						
		Rosaceae	*Fragaria* sp.		+				

Legend: S– Singalat 1 Tk– Tingkob M– Mamalad B– Bonifacio Tp– Tipolo C– Catarman

Appendix Table 4. Residency status, diversity index and total number of bird species observed in the riparian zones per barangay from April to May 2002

	English / Local Name	Status	S	M	B	T	C	Total
Ciconiiformes								
Ardeidae								
1. *Gorsachius* sp.?						1		1
2. *Egretta garzetta*	Little egret/talabong	migrant, common					22	22
3. *Butorides striatus*	Little heron/yoho	resident migrant, common		1		1		2
4. *Ardeola speciosa*	Javan pond-heron/ talabong	resident, uncommon					15	15
5. *Ixobrychus cinnamomeus*	Cinnamon bittern/ Yu-hong pula	resident, common	1	1	1		1	4
Falconiformes								
Accipitridae								
6. *Haliastur indus*	Brahminy kite/ banog	resident, common	4	2	2		1	9
7. *Spilornis cheela*	Crested serpent-eagle/bankas	resident, common	1		1			2
Gruiformes								
Rallidae								
8. *Gallirallus torquatus*	Barred rail/ tikling	resident, common				1		1
9. *Rallina eurizonoides*	Slaty-legged crake/ manhak, uwang	resident, uncommon					1	1
10. *Amaurornis phoenicurus*	White-breasted waterhen/bagwak, korwakwak	resident, common	1	3			4	8
Columbiformes								
Columbidae								
11. *Phapitreron leucotis*	White-eared brown-dove/alimucon	endemic, common	6	2	1			9
12. *Macropygia phasianella*	Reddish cuckoo-dove/tukwao	resident, common			1			1
13. *Chalcophaps indica*	Common emerald-dove/manatad	resident , common	3	2	3			8
14. *Streptopelia chinensis*	Spotted dove/ tukmo	resident, common	2	2				4
15. *Geopelia striata*	Zebra dove/ kurukutok	resident, common		3		1	4	8

Legend: ?- doubtful identification S- Singalat M- Mamalad B- Bonifacio T- Tipolo C- Catarman

Appendix Table 4. continuation

	English / Local Name	Status	S	M	B	T	C	Total
Psittaciformes								
Psittacidae								
16. Loriculus philippinensis	Colasisi/kolasisi	endemic, common	3	2				5
Cuculiformes								
Cuculidae								
17. Centropus viridis	Philippine coucal/ kukok	endemic, common	6	8	7			21
Caprimulgiformes								
Caprimulgidae								
18. Caprimulgus manillensis	Philippine nightjar/ tuktor, tagolilong	resident, uncommon		1				1
Apodiformes								
Apodidae								
19. Collocalia sp. ?	Kalogay, sayao		15	19	28	9		71
Coraciiformes								
Alcedinidae								
20. Alcedo argentata	Silvery kingfisher/ kibid, uwak-bata	endemic, uncommon	8	8	7	2		25
21. Halcyon capensis	Stork-billed kingfisher/bakaka	resident, uncommon	1					1
22. Halaycon smyrnensis	White-throated kingfisher/uwak-bata	resident, fairly common	3	2	6			11
23. Halaycon chloris	White-collared kingfisher/tikarol	resident, common		2	15	7	2	26
Bucerotidae								
24. Penelopides affinis	Tarictic hornbill/ tagiptip, talusi	endemic, fairly common	2					2
Passeriformes								
Hirundinidae								
25. Hirundo tahitica	Pacific swallow/ Sayaw	resident, common		4	3	2	12	21
Campephagidae								
26. Lalage nigra	Pied triller/ pago, bugaungon	resident, common	2		3			5

Legend: ?- doubtful identification S- Singalat M- Mamalad B- Bonifacio T- Tipolo C- Catarman

Appendix Table 4. continuation

	English / Local Name	Status	S	M	B	T	C	Total
Oriolidae								
27. Oriolus chinensis	Black-naped oriole/ antolihao	resident, common		6	9			15
Corvidae								
28. Corvus macrorhynchus	Large-billed crow/ uwak	resident, common	7	2	5	3	1	18
Turdidae								
29. Copsychus saularis	Oriental magpie-robin/asisihol	resident, uncommon	2	5	12	2		21
Muscicapidae								
30. Cyornis rufigastra	Mangrove blue flycatcher/ kamantigon	resident, common			1			1
31. Rhipidura superciliaris	Blue fantail	endemic, uncommon			2			2
32. Rhipidura javanica	Peid fantail/ Pitsa-pitsa, bilad-bilad	resident, common	6	9	13	3	2	33
33. Hypothymis helenae?	Balialang asul	resident, common	1	1				2
Pycononotidae								
34. Pycnonotus goiavier	Yellow-vented bulbul/ tagul-ol, tagul-ola	resident, common	11	11	30	12	4	68
Sylviidae								
35. Megalurus palustris	Striated grassbird/ tigso	resident, common	1					1
Motacillidae								
36. Motacilla cinerea	Grey wagtail/ ananakyod	migrant, common	7	9				16
Artamidae								
37. Artamus leucorhynchus	White-breasted wood-swallow/git-git	resident, common		5	19		3	27
Laniidae								
38. Lanius cristatus	Brown shrike/ Tibalas	migrant, common	2	1	1			4
Sturnidae								
39. Aplonis panayensis	Asian glossy starling/ galansiang	resident, common			4	30	3	37
40. Sarcops calvus	Coleto/sal-ing	near endemic, common	1	3	4			8

Legend: ?- doubtful identification S- Singalat M- Mamalad B- Bonifacio T- Tipolo C- Catarman

Appendix Table 4. continuation

	English / Local Name	Status	S	M	B	T	C	Total
Nectariniidae								
41. Anthreptes malacensis	Plain-throated sunbird/pitpit	resident, common	6	7	6	4		23
42. Nectarinia jugularis	Olive-black sunbird/tamsi	resident, common	10	20	32	22	2	86
43. Nectarinia sperata	Purple-throated sunbird/tamsing pula	resident, common	3	2	2			7
44. Aethopyga shelleyi	Lovely sunbird/ tamsi	endemic, locally common	10	11	7			28
Dicaedae								
45. Dicaeum australe	Red-keeled flowerpecker/ panagoto	endemic, common	16	7	15	7		45
46. Dicaeum pygmaeum	Pygmy flowerpecker/ panagoto	endemic, common	8	10	9	4		31
Ploceidae								
47. Passer montanus	Eurasian tree sparrow/langam sa simbahan	resident, common					20	20
Estrildidae								
48. Lonchura malacca	Chestnut munia/ maya	resident, common	34	24	2	5	30	95
49. Lonchura leucogastra	White-bellied munia/ mayang bungol	resident, common	3	14				17
Dicacidae								
50. Dicaeum trigonostigma	Orange-bellied flowerpecker/tikby	resident, common	19	7	7			33
51. Prionichilus sp.*?*				1				1
Musicapidae								
52. Muscicapa griseisticta?			4					4
Total number of individuals			**209**	**217**	**258**	**116**	**127**	**927**
Total species			**34**	**36**	**32**	**18**	**17**	
Bird Species Diversity (H)			**1.34**	**1.38**	**1.31**	**1.02**	**0.985**	

Legend: ?- doubtful identification S- Singalat M- Mamalad B- Bonifacio T- Tipolo C- Catarman

Appendix Table 5. List of macroinvertebrates found in the sampling stations along the Langaran River

		Singalat		**Mamalad**			**Bonifacio**			**Tipolo**	
	Ting-kob	Upper	Centro Brgy. Hall	Boun-dary	Prenza	1st	2nd	3rd	Before the Dam	After the Dam	Bridge
Good H2O Quality Indicators											
Caddisfly (larva)											
Mayfly (nymph)		*									
Riffle Beetle (larva)											
Riffle Beetle (adult)		*	*	*							
Snail (opens to the right)											
Stonefly (nymph)		*	*	*	*	*		*			
TOTAL		3		2			1			0	
Wide-range tolerant water quality indicators											
Blackfly (larva)											
Blackfly (pupa)											
Cranefly (larva)											
Crayfish											
Dragonfly (nymph)	*	*	*		*	*		*			
Filtering Caddisfly (larva)											
Hellgramite (larva)											
Scud (adult)			*	*		*					
Snowbug											
TOTAL		2		2			2			0	
Fair and poor water quality indicators											
Aquatic Worm											
Midge (larva)					*						
Midge (pupa)											
Pouch Snail (opens to the left)											
TOTAL		0		1			0			0	

Appendix Table 5. continuation

	Singalat			Mamalad		Bonifacio			Tipolo		
	Ting-kob	Upper	Centro Brgy. Hall	Boun-dary	Prenza	1st	2nd	3rd	Before the Dam	After the Dam	Bridge
Others											
"Kuhol"									*		
Alderfly											
Balloon-tailed Damselfly	*	*		*							
Beetle (larva)	*	*	*								
Beetles		*	*					*			
Bugs			*							*	
Burrowing Mayfly					*					*	
Cased Caddisfly (larvae)								*			
Caseless Caddisfly (larvae)		*									
Caseless Caddisfly (larvae)											
Common Damselfly		*			*		*	*	*		
Common Net Spinner	*	*	*								
Common Saucer Bug	*	*		*	*	*					
Crabs	*		*			*			*		*
Damselfly (nymph)			*			*					
Dobsonfly (larvae)					*						
Dragonfly			*				*				
Flattened Mayfly	*	*					*	*	*		
Flattened Mayfly						*					
Flatworms	*	*	*		*	*					
Fly larvae	*										
Leeches	*			*			*			*	
Lesser Water Boatman		*	*	*		*	*				
Long-headed Caddisfly	*										
Long-mouthed Saucer Bug				*		*					
Molluscs								*	*		
Nonbiting Midge (larvae)											
Pagoda Snail					*	*	*	*			*
Pea Cockle											*
Planaria	*						*	*			
Pond Skater	*	*		*		*	*	*			*
Prawns	*	*	*	*			*				*
Prong-gilled Mayfly	*	*				*	*				
Prong-gilled waterfly								*			
River Shrimps			*		*		*		*		*
Segmented Worms											

Appendix Table 5. continuation

		Singalat		Mamalad			Bonifacio			Tipolo	
	Ting-kob	Upper	Centro Brgy. Hall	Boun-dary	Prenza	1st	2nd	3rd	Before the Dam	After the Dam	Bridge
Square Gilled Mayfly						*					
Surface Animals							*				
Swimming Mayfly	*	*			*						
Two-tailed Demoiselle						*	*		*		
Water Cricket	*			*	*			*			*
Water Fleas						*					
Water Hoglouse											
Water Measurer		*		*	*		*	*			*
Water Penny (larva)	*										
Water Skater		*									
Water Stick Insect											*
Whirligig Beetle	*	*						*			
Whirligig Beetle (larvae)			*	*							
Non-indicators											
Hairworms											
Hydra											
Mites						*					*
Moth (larvae)		*		*				*			
Spider	*	*	*					*			*
Springtails											
Water fleas											
TOTAL score of macroinvertebrates found		27		18			30			19	
TOTAL no. of species found		32		23			33			19	
REMARKS	**rather clean**	**rather clean**	**rather clean**	**rather clean**	**very clean**	**rather clean**	**rather clean**	**rather clean**	**rather dirty**	**rather dirty**	**rather dirty**

Appendix Table 6. Summary of the transcribed results from the focus group discussions

TOPICS	SINGALAT	MAMALAD	BONIFACIO	TIPOLO	CATARMAN
1. Sources of income	• Farming: abaca, corn, rice, mangosteen, coffee • Marketing vegetables • Handicrafts (basket)	• Farming: rice, corn, coconut vegetables, coffee, rattan	• Barangay permits • IRA • Sari-sari stores • Farming coconut, lanzones, durian, mangosteen	• Farming: lanzones, rice, swine • Quarrying • Teaching • IRA • Copra production • Gardening • Taxes	• Farming: rice, coconut, banana, lanzones, mango, nipa • Teaching • Taxes • IRA • Toll fee (bridge)
2. Problems in the barangay	• No access roads • Lack of information on farming techniques • Pests (rats, wild pigs, and monkeys) • Health problems • Calamities and other natural phenomena	• Marketing problems • Lack of farming inputs (seedlings, fertilizers, pesticides) • Lack of farming materials (carabao, tractor) • Lack of capital • Low price of farm products • Cannot switch to livestock farming due to presence of illness and deadly diseases	• Weak implementation of ordinances • Trees in the mountains were cut off, affecting the river • Floods and other calamities affect farmlands resulting to damage and low income	• Partisanship • Illegal practices, gambling, jai-alai, tong-its • Unemployment • Low price of farm products • Frequent rain	• Lack of finances • Marketing of farm products • Price of rice is controlled by one businessman • Unemployment • Illiteracy • Youth not cooperative in barangay activities • Drug addiction of youth • People hooked on gambling (especially the women)

Appendix Table 6. continuation

TOPICS	SINGALAT	MAMALAD	BONIFACIO	TIPOLO	CATARMAN
3. Oppor-tunities	• Livestock farming: goat, native swine, chicken ("saso") • Nursery • Ginger production • Fishpond (GIFT) • Handicrafts	• Vegetable farming • Training seminars for organic farming • Practice of "bayanihan" system or "pahina" • Tilapia farming	• Quarrying • Cooperative • Livestock farming (swine) • Tilapia culture • Gardening (root crops, flowers)	• Livelihood projects • Government assistance	• Establishment of factories to employ the people • Processing plants for banana chips (since the barangay was capable of producing such product) • Processing plants for the fishing industry • Livestock farming (pigs, goat) • Production of "bebe"
4. Fore-seen changes in the barangays in the next 5 years	• Improved livelihood projects • More trees and crops grown • Fish readily available for the community • Improved source of income	• Development will be inevitable unless hindered by health problems, financial constraints and natural calamities • Improved coffee production • Established dressmaking industry			

Appendix Table 6. continuation

TOPICS	SINGALAT	MAMALAD	BONIFACIO	TIPOLO	CATARMAN
5. Status of the River					
A. Before	• Abundant fish population • Clear water • Hook and line fishing was applicable • Deep and narrow	• Abundant fishery resources • Clean and healthy river • Deep and narrow	• Abundant fishery resources, especially the anga • Deep and narrow • Steep banks • Clear water	• Deep and narrow • Steep banks • Clear and clean waters • Abundant fishery resources • Nice and conducive for relaxation	• Deep and narrow • Clear and cold waters • Presence of crocodiles • Abundant fishery resources
B. Now	• Shallow and wide • Turbid waters • Fish species and number declined	• Trees in the riparian declined • Fish population declined • Riverbank destroyed	• Illegal fishing exists (*tubli, decis*) • Difficult to catch fish • Shallow and wide • No trees left in the riparian • Logging in the upland exists, affecting the river	• Illegal fishing exists (*tubli, kuryente*) • Quarrying practices exists	• Wide river-bank • Massive erosion and sedimentation, making the river narrow • Problems related to irrigation
6. Prob-lems that affect the river	• Denuded forest • Irrigation • Extraction of water by the NAWASA • Natural phenomena (e.g., landslides and floods)	• Illegal fishing (*tubli, kuryente, pahubas*) • No trees left in the riparian • Logging in the upland • Quarrying	• Food shortage • Malnutrition • Low income • No accessible secondary schools	• Garbage were thrown in the river • Human wastes disposed of in the river	• Problems related to irrigation • Illegal practices such as *kuryente* and *tubli* • Washing of pesticide tanks killed fishes • Irresponsible disposal of domestic and municipal waste

Appendix Table 6. continuation

TOPICS	SINGALAT	MAMALAD	BONIFACIO	TIPOLO	CATARMAN
7. Things that can be done to improve the state of the river	• Reforest the riparian (government-sponsored) • Educate the public • Formulate and implement ordinances to ban cutting down of trees (even those on privately owned lands) • Encourage planting of fruit-bearing trees • Reforest using bamboo species	• Make resolutions/ ordinances • Support river-related projects • Maintain/ protect the objective of the project • Provide fingerlings for the river • Conduct information drive • Launch livelihood projects • Provide training/ projects (handicrafts using indigenous species, “bukag”) • Acquire financial assistance and management	• Ban cutting of trees • Reforest the riparian/ riverbank • Encourage legal fishing only	• Reforest to bring back wildlife and sustainability of the whole environment • Acquire unity and full cooperation of the whole barangay • Strict implemen-tation of rules • Construction of the river wall • Plant seedlings from the LGU with stringent monitoring and supervision • Introduce fruit-bearing trees instead of plain trees • Conduct information drive for the farmers so they will cease cutting down trees on their lands • Establish a solid waste management program • Encourage the community to use comfort rooms	• Ban quarrying activities • Implement rules and regulations efficiently • Coordinate with other barangays to stop improper disposal of wastes and garbage

Appendix Table 6. continuation

TOPICS	SINGALAT	MAMALAD	BONIFACIO	TIPOLO	CATARMAN
8. Govern-ment support	• No support extended: officials were not aware of the river's real condition • Government did not have enough budget to rehabilitate the river	• No support at all • Proposal for tree planting not realized • Trees planted during the planting project conducted by the LGU were washed away by flood • "Big time" violators were able to escape from the authorities	• Linkage with organizations/ groups • Processing plants and other establish-ments to employ people • Organize people • Appoint *tanods* to watch for violators • Reforest the riverbanks with full commitment • Conduct an information drive so the public will realize the need to rehabilitate the river	• Weak support - will not spend for the rehabilitation of the river because it will cut-off other funds for the whole municipality • There was weak implemen-tation of rules due to the political crisis	• There was no attempt to reforest the side of the river • There was no action from the agencies directly responsible for the subject matter
9. Help needed to improve the river's state	• Provision of seedlings for tree planting • Information drive • Stringent monitoring and supervision of projects related to river's sustainability	• Strict implemen-tation and enforcement of rules and regulations • Conduct of information drive about the importance of trees and their relationship with the river	• Provision of seedlings • Financial assistance for labor (tree planting) • Acquiring full support of the whole community • Banning of illegal activities • Conduct of information drive	• Maintenance from the owner of the lands within the riparian, must be efficient and provided with complete monitoring • Commitment of the land owners to propagate the trees and not to cut them down.	• Provide financial assistance to projects related to the rehabilitation of the river • Provision of mangrove seedlings to be planted along the riverbank

Appendix Table 7. Main occupation of the respondents

Occupation	Frequency	Percent
Farmer	122	48.2
Laborer	66	26.1
Government employee	22	8.7
Gabasero	12	4.7
Sari-sari store owner	11	4.3
Quarry site worker	6	2.4
Carpenter	5	2.0
Others	3	1.2
None	6	2.4
Total	253	100.0

Appendix Table 8. Monthly income of the respondents

Monthly Income	Frequency	Percent
70-500	82	33.5
600-1000	76	31.0
1600-2000	34	14.0
1025-1500	16	6.5
2125-2500	5	2.0
2700-3000	13	5.3
3025-3600	3	1.2
4000-4500	10	4.1
4800-5000	2	0.8
5000+	4	1.6
Total	245	100.0

Appendix Table 9. Other sources of income

Income in Pesos	Animals		Fishing		Employment		Allowance		Rental from Properties	
	F	%	f	%	f	%	f	%	f	%
30-500	21	18.3	5	-	15	24.2	30	58.8	12	35.3
600-1,500	29	25.2	1	-	16	25.8	-	-	-	-
1,600-2,500	29	25.2	-	-	10	16.1	5	9.8	8	23.5
2,600-3,500	19	-	-	-	5	8.1	6	11.8	-	-
3,600-4,500	7	-	-	-	3	4.8	-	-	6	17.6
4,600-5,500	2	1.7	-	-	3	4.8	5	9.8	4	11.8
Over 6,000	8	-	-	-	10	16.1	5	9.8	4	11.8
Total	115	-	6	-	62	100.0	51	100.0	34	100.0

Appendix Table 10. Respondents' total income for the year 2001

Income	Frequency	Percent
440-3,000	11	4.3
3,400-5,000	12	4.7
5,200-9,600	64	25.1
10,153-19,500	84	33.0
21,600-30,000	38	14.9
30,600-40,600	24	9.4
43,200-50,000	10	3.9
51,200-61,500	8	3.1
64,000-143,652	4	1.6
Total	255	100.0

Appendix Table 11. Plants and crops planted in the riparian zones of Langaran River

Plant/crop	Frequency	Percent
Rice	55	31.4
Corn	41	23.4
Vegetables	25	14.3
Rootcrops	27	15.4
Coconut	12	6.9
Banana	6	3.4
Fruit trees	5	2.9
Abaca	3	1.7
Coffee	1	0.6
Total	175	100.0

Appendix Table 12. Number of times in a week respondents go fishing

Number of times in a week	Frequency	Percent
Once	99	60.4
Twice	38	23.2
Thrice	11	6.7
Four and over	16	9.7
Total	164	100.0

Appendix Table 13. List of activities in the riparian zones other than farming

Activities	Frequency	Percent
Quarrying	21	31.3
Laundering/fetching water/bathing	19	28.4
Cleaning riverbank	8	11.9
Washing the carabao	6	9.0
Fishing	5	7.5
Throwing of wastes	5	7.5
Planting trees on riverbank	3	4.5
Total	67	100.0

Appendix Table 14. Responses on how often the activities were done in the river

Responses	Frequency	Percent
Always/often/everyday	31	57.4
Seldom	23	42.6
Total	54	100.0

Appendix Table 15. Kinds of fish caught in the river

Kind of fish	Frequency	Percent
Anga	83	48.5
Iswil	17	9.9
Lampisan, palotpot, gisaw, ilabo	16	9.4
Pait-pait	15	8.8
Ulang	14	8.2
Banak, casili, tikog	9	5.3
River fish, *bonsalaw, paul, ambak-ambak, antaan, labong*	6	3.5
Bunog	5	2.9
Kamangtas, bangus	6	3.5
Total	171	100.0

Appendix Table 16. Gears or methods used to catch fish in the river

Type of fishing gear	Frequency	Percent
Pahubas	4	28.7
Bingwit	3	21.4
Fishnet	3	21.4
Balantak	1	7.1
Bobo	1	7.1
Kamot dimano	1	7.1
Kuryente	1	7.1
Total	14	100.0

Appendix Table 17. Size of farm tilled by the respondents

Size of farm (ha)	Frequency	Percent
0.125-0.330	111	63.4
0.500-0.750	45	25.7
1.250-2.000	10	5.7
Not mentioned	9	5.1
Total	175	100.0

Appendix Table 18. Techniques employed in farming

Technique	Frequency	Percent
Demano (Manual)	93	54.1
Bunglay	34	19.8
Plow (daro)	23	13.4
Tractor	9	5.2
Slash/Burn	7	4.1
Others	6	3.4
Total	172	100.0

Appendix Table 19. Chemicals used in vegetable / plant farming

Responses	Frequency	Percent
Inorganic fertilizer	49	45.4
Karate (brand name)	17	15.7
Complete (14-14-14)	16	14.8
Organic fertilizer	9	8.3
Insecticide	7	6.5
Chicken manure	5	4.6
Bullseye (a brand name)	3	2.8
16-20-0 (a fertilizer composition)	2	1.9
Total	108	100.0

Appendix Table 20. Other individuals involved in farming

Individuals Involved in Farming	Frequency	Percent
Household members	80	57.6
Wife	22	15.8
Paid laborers	15	10.8
Household members and hunglos members (a bayanihan type)	21	15.1
Organization	1	0.7
Total	139	100.0

Appendix Table 21. Location of quarrying activities

Location	Frequency	Percent
Riverbank	36	39.1
Place where the river passes	22	23.9
Middle of the river	17	18.5
Sandy area	11	12.0
Boulders	6	6.5
Total	92	100.0

Appendix Table 22. Methods used in quarrying activities

Method/Ways of Quarrying	Frequency	Percent
Used shovel	73	80.2
Manual	18	19.8
Total	91	100.0

Appendix Table 23. Mode of transport of quarrying materials

Type of Vehicle	Frequency	Percent
Cart	35	40.7
Manual	30	35.0
Bote (flat bottom boat)	19	22.0
Animal	2	2.3
Total	86	100.0

Appendix Table 24. Illegal activities in the river

Activity	Negligible		Rampant		Very Rampant		Total
	f	%	f	%	f	%	
Dynamite fishing	1	0.4	-	-	-	-	1
Pahubas	5	83.3	1	16.7	-	-	6
Kaingin	52	92.9	1	1.8	3	5.4	56
Panghilo	118	95.2	1	0.8	5	4.0	124
Pangoryente	75	85.2	10	11.4	3	3.4	88
Quarrying	49	62.8	22	28.2	7	9.0	78
Throwing of garbage	6	60.0	1	10.0	3	30.0	10

Appendix Table 25. Kinds of people commonly involved in illegal activities

Kinds of People	Frequency	Percent
People in and out of the barangay	115	64.2
People from other barangays	32	17.9
People from the barangay	32	17.9
Total	179	100.0

Appendix Table 26. Opinions on the effectiveness of ordinances in stopping illegal activities

Opinion	Frequency	Percent
Not effective	99	55.3
Effective	71	39.7
Very effective	9	5.0
Total	179	100.0

Appendix Table 27. Reasons why ordinances were not effectively implemented

Reasons	Frequency	Percent
Ignored by the people	31	35.2
Difficult to stop	24	27.3
Law never materialized	24	27.3
Enforcers can be bribed	5	5.7
Source of income	4	4.5
Total	88	100.0

Appendix Table 28. Suggestions given to stop illegal activities in the barangay

Responses	Frequency	Percent
Enforce the law	76	43.7
Reprimand violators	37	21.3
Discipline the people	24	13.8
Make more laws	19	10.9
Help one another	13	7.5
Guard the barangay	3	1.7
Inform the assembly	2	1.1
Total	174	100.0

Appendix Table 29. Agencies that respondents perceive can stop illegal activities in the barangay

Responses	Frequency	Percent
LGU	136	76.4
Military	22	12.4
NGO	15	8.4
NPA	2	9.1
Tanan	2	1.1
DENR	1	0.6
Total	178	100.0

Appendix Table 30. Activities that respondents perceive can directly or indirectly affect the riparian

Activity	Frequency	Percent
Farming	83	51.2
Quarry	32	19.8
Fishing	19	11.7
Cutting down of trees	18	11.1
Disposal of animal cadavers and other wastes	6	3.7
Hunting	2	1.2
Defecating	1	0.6
Nipa planting	1	0.6
Total	162	99.9

Appendix Table 31. Opinions as to how much river-related activities can affect the river

Responses	Frequency	Percent
Very much	99	63.1
Much	36	22.9
Greatly	16	10.2
Do not affect	3	1.9
Little	2	1.3
Very Little	1	0.6
Total	157	100.0

Appendix Table 32. Information needed by the respondents (by topic)

Topics	Frequency	Percent
Farming	123	57.2
Livelihood project/training	17	7.9
Fishing	15	7.0
Fertilizers	2	0.9
Compost pit making	2	0.9
None	56	26.0
Total	215	100.0

Appendix Table 33. People with whom respondents shared farming and fishing issues

People	Frequency	Percent
Neighbors	55	29.6
Community	50	26.9
Family	26	14.0
Public officials	10	5.3
None	45	24.2
Total	186	100.0

Appendix Table 34. Respondents' understanding of a community-based project

Responses	Frequency	Percent
Good for all	59	52.7
People should accomplish things with a leader	18	16.1
Want to know more	17	15.3
Assembly of people	5	4.5
Help one another	4	3.6
Help in the farm	3	2.7
Make medicine	3	2.7
Plant coffee	1	0.8
Underdevelopment	1	0.8
Earn money	1	0.8
Total	112	100.0

Appendix Table 35. Sources of information about community-based projects

Source	Frequency	Percent
WVI/NGO	38	34.9
Public officials/Gov't servant	28	25.7
Special assembly	26	23.8
From research	9	8.3
Cooperative	6	5.5
Tradition	2	1.8
Total	109	100.0

Appendix Table 36. Things respondents would like to know about community-based management of resources

Response	Frequency	Percent
Benefits of the project	59	42.4
All	33	23.7
Orientation/livelihood/training	27	19.4
Tree planting	13	9.4
How to raise fish	4	2.9
Others	3	2.2
Total	139	100.0

Appendix Table 37. Reasons for lack of interest to learn about community-based management of resources

Response	Frequency	Percent
Do not have enough energy	6	60.0
Do not understand it	3	30.0
No time	1	10.0
Total	10	100.0

Appendix Table 38. Reasons why respondents were willing to be involved in community-based management project

Responses	Frequency	Percent
To become a member	69	48.3
To learn	39	27.3
To help the project	23	16.1
To help guard the river	7	4.8
Do it through tribal	3	2.1
For whatever reason	2	1.4
Total	143	100.0

Appendix Table 39. Reasons for lack of willingness to be involved in a community-based project

Responses	Frequency	Percent
Too old	9	69.2
No time	2	13.4
Do not understand	1	7.7
Do not want to learn	1	7.7
Total	13	100.0

Appendix Table 40. What people want the project to undertake in their barangays

Responses	Frequency	Percent
Livelihood projects	43	26.5
Project accomplishment	35	21.6
Planting/reforestation	25	15.4
All/everything	17	10.5
Animal dispersal	13	8.0
Fishpond	11	6.8
Any help will do	10	6.2
Preserve the river	2	1.2
None	1	0.6
Others	5	3.1
Total	162	99.9

Appendix Table 41. Reasons given by respondents as to why a community-based project will succeed in their barangay

Responses	Frequency	Percent
Because of cooperation	25	46.3
It can guide and support residents	16	29.6
It can mobilize people	12	22.2
It can help people understand	1	1.9
Total	54	100.0

Appendix Table 42. Reasons given by respondents as to why a community-based project will not succeed in their barangay

Responses	Frequency	Percent
A leader is needed	6	50.0
People lack knowledge	4	33.3
People cannot rely on others	1	8.3
All	1	8.3
Total	12	99.9

Appendix Table 43. Roles that women can play in the management of Langaran River

Responses	Frequency	Percent
Tree planting	89	42.4
Guard against destruction of trees	83	39.5
Livelihood	18	8.6
Help as much as they can	10	4.8
None	4	1.9
Orient people on the project	3	1.4
Whatever	3	1.4
Total	210	100.0

Appendix Table 44. Livelihood and community activities where women generally participated

Livelihood activities	Frequency	Percent
Hog raising	67	39.4
Vending	66	38.8
Poultry	9	5.3
Tailoring/sewing	9	5.3
Propagation/gardening	9	5.3
Food processing	5	2.9
Livelihood/RIC/Women	5	2.9
Total	170	100.0

Appendix Table 45. Farming and fishing activities where women were generally involved

Farming and fishing activities	Yes		No	
	Frequency	Percent	Frequency	Percent
Harvesting crops	214	83.9	36	14.1
Planting crops	211	82.7	39	15.3
Marketing activities	136	53.3	113	44.3
Processing of fish and farm products	23	9.0	227	89.0
Guarding crops against monkeys	21	8.2	229	89.8

Appendix Table 46. Barangay activities that respondents thought women should have active roles in

Barangay activities	Frequency	Percent
Organizations/NGO	61	27.1
Community cooperation	36	15.9
Seminars/trainings	30	13.3
Meetings/assemblies	29	12.8
All	19	8.4
Farming	18	8.0
Home management/ beautification/sanitation	14	6.2
RIC/Coop	12	5.3
Sports	3	1.3
Others	3	1.3
None	1	0.4
Total	226	100.0

Appendix Table 47. Trainings that should be given to women to increase their participation in the community-based management effort to save Langaran River

Responses	Frequency	Percent
Seminar/training/organization	54	24.2
Livelihood handicrafts	49	22.1
Planting of trees and flowers	37	16.6
Sewing	19	8.5
River preservation	18	8.1
Organizational management	17	7.6
Project orientation	15	6.7
Farming/fishing	4	1.8
Cooperative	3	1.3
All	2	0.9
Others	2	0.9
None	3	1.3
Total	223	100.0

Appendix Table 48. Suggested agencies or individuals who can conduct trainings for women

Agencies/individuals	Frequency	Percent
Government Employees	68	31.9
DENR/DA/DAR	59	27.7
Research team member	47	22.1
Private organization	25	11.7
DTI	7	3.3
Tailor	4	1.9
Tribal leadership/group leader	3	1.4
Total	213	100.0

Project Leader: **Proserpina Gomez-Roxas**
Study Leaders: **Renato D. Boniao, Erlinda M. Burton, Annabella Gorospe-Villarino, Sherwin S. Nacua**
Research Assistants: **Jayrald Santamina, Sarah France Edubos, Mary Jane Castro**

Editing/Layout: **Claudia Svetlana Z. Cabrera**
Overall Coordinator: **Mariliza V. Ticsay**
Production Assistants: **Carina S. Fule, Gerlie D. Rivera**

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 971-560-116-2