



NATURAL RESOURCES
MANAGEMENT PROGRAM

Identification of Environmental Threats to the Tondano Watershed

Proposed Follow-up Activities
through September, 2001



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Discussion Paper

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1. Introduction/ Summary of Findings and Recommendations

This report presents the findings of a reconnaissance survey carried out to identify the main threats to the Tondano watershed and to determine future priority areas of work to improve the management of this ecosystem. The work has been carried out as a cooperative effort between the Natural Resources Working Group in Kabupaten Minahasa and NRM/EPIQ. The activities completed in preparing this report have included: a review of existing maps, data bases, reports and studies relating to the Tondano watershed; discussions with residents of the watershed; discussions with staff of government and non-government institutions; field visits to sites within the watershed; and discussions among the members of the Working Group. The purpose of this report is to establish a framework for initiation a one year program of work in four villages to test approaches to increase community participation of natural resource management.

The main threats to the productivity of the watershed as an ecological unit identified through this process are:

- The increasing the rate of eutrophication of Lake Tondano which would lead to increased production of algae and water hyacinths in the lake which would in turn lower the productivity of the lake for fish, increase the cost of maintaining hydroelectric facilities on the Tondano River, and a decline of tourism to the lake;
- The increasing sediment loads the Tondano River and its tributaries would result in loss of productivity of the lake, degradation of the coastal environment and the capacity of the Manado harbor; and
- Increasing contamination of the Tondano River with mercury which would become a health hazard to the people of Manado and both the terrestrial and marine environments of the region.

To follow up on the findings of this report during the next twelve months the Working Groups plans to:

- carry out public consultations regarding environmental threats in a sample of four rural villages in the watershed;
- test approaches to reduce threats to the watershed with the active participation of the communities of the four villages;
- test approaches to increase public awareness on environmental issues of the watershed;
- identify low input technology packages appropriate to the watershed;
- provide training to government and non-government personnel on topics relating to watershed management; and

- carry out surveys of water quality to better evaluate hazards to public health and to determine points of origin of contamination by mercury;

It is expected that these activities will contribute to preparation of a more detailed and comprehensive assessment of threats to the Tondano watershed as well as to establish action plans, programs, new policies, and appropriate provincial, district and village regulations for improved management of this important natural resource.

2. The Tondano Watershed

The watershed of the Tondano Lake and its associated tributaries covers an area of about 50,000 hectares on the northeast extremity of the island of Sulawesi. The highest point in the watershed is the peak of Mount Soputan (1825 meters) which is located about 40 kilometers from the mouth of the Tondano River at Manado. Other peaks of volcanic origin that comprise the rim of the upper catchment include Mount Tonderukan (1,400 meters), Mount Maniporok (1,661 meters), Mount Kawatak (1191 meters), Mount Simbel, Mount Kaweng, Mount Kamington, Mount Kaluta, Mount Lengkoan (1,026 meters), Mount Masarang and Mount Tintingán (1,311 meters).

Tondano translated from the Minahasan language means “the people of the lake” and Tondano is not only the name of the lake but also the name of lakeside capital of Kabupaten Minahasa and the name of river flowing from the lake to the sea.

The Tondano watershed supported a total population of 307,000 residents in 1997¹. The upper watershed is the heartland of the Minahasan culture and has a population of some 111,938. The lower watershed includes the provincial capital at Manado and lowland agricultural areas and had a population of 194,912 in 1997. The population growth rate of the upper watershed was only 0.4 % per year during the last decade as there has been considerable out-migration from this area. The lower watershed area grew at a rate of 1.2 % per year during the same time period. Population densities in villages in the upper watershed were estimated to average 391/ square kilometer while those in rural villages in the lower watershed were significantly lower at 268/ square kilometer.

¹ See Attachment 1 for more detailed information on the demography of the watershed.

Administratively the region lies within Kabupaten Minahasa and Kota Manado. There are a total of 15 sub-districts and 146 villages in the watershed (see Map 2). Basic Law 22 of 1999 provides that districts, municipalities and villages are autonomous administrative units with democratically elected assemblies/ councils which are empower to adopt and provide for enforcement of policies and regulations.

Land use of the watershed in 1991 is presented as Table 1, Attachment 2 and as Map 8. Only about 5% of the total area of the watershed remains forested. The dominant land use type is tree crops which occupy about 49 % of the total area. Tree crops are maintained in a system of agro-forestry.

For purposes of the study the watershed was divided into two parts: the upper watershed which includes all minor catchments flowing into Lake Tondano; and the lower watershed with are those areas below Lake Tondano. Most of this forest is found in the lower watershed rather than the upper watershed.

Lake Tondano is a significant asset in the environment of the catchment with area of about 4,335 hectares or about 8 % of the total area. The surface of the lake varies in elevation due to rainfall variation. The variation during the last 20 years has been from 691.3 meters to 684 meters. During peak rainy seasons the waters of the lake inundate some of the surrounding paddy cultivation areas.

The Tondano watershed plays a central role in the economy of North Sulawesi. It is the agricultural production center for the region and about 38,280 hectares or +74 % of the total area of the catchment is devoted to various agricultural land uses. The Tondano River is used to generate a significant portion of the electric power used by the region. The catchment also provides the main source of drinking water for residents of the city of Manado. Tondano Lake is also a center for local tourism.

Table 1. Land Use in Tondano Watershed

Type of Land Use:	Upper Watershed		Lower Watershed		Totals (Ha.)	
	Area (Ha.)	%	Area (Ha.)	%	Area (Ha.)	%
Forest	630	2	2,961	10	3,591	7
Sago	0	0	12	-	12	-
Brush	2,346	11	3	-	2,349	5
Tree Crops	3,213	15	21,952	75	25,166	49
Fields/ Shifting Cultivation	5,204	24	1,500	5	6,704	13
Wetland Rice	5,030	23	1,261	4	6,291	12
Dryland Rice	26	-	93	-	119	-
Villages/Towns	1,076	5	1,563	6	2,639	5
Lake Tondano	4,335	20	0	-	4,334	8
Totals	21,861	100	29,347	100	51,208	100

(Based on Peta Rupa Bumi-1991).

3. Identification of Strengths, Weakness, Opportunities and Threats to the Environment of the Tondano Watershed

3.1 Strengths

High Agricultural Productivity

The levels of agricultural yields and household incomes for agriculture of the residents of the watershed are among the highest in the province of North Sulawesi and above the national average for rural households. Yields for most crops grown in the Tondano are comparable to yields in Java and higher than the national averages. The soils of the Tondano catchment are volcanic soils of generally high fertility and rainfall is adequate (1,442 to 2,738 mm per year) to support high yield. The main soil types are Andosols (9.7 %), Glumusols (17.8 %), Latosols (17.1 %) and Regosols (55.4 %). Map 5 presents the distribution of these soil types in the watershed. About 50 % of the study area has slopes of less than 50 % and these are the location of most agricultural activities. However, some steep upland areas such as Rurukan have high fertility and are used for intensive vegetable production.

The waters of Lake Tondano are highly productive as a fishery resource. The total catch is reported to have reached more than 2,000 tons of fish in 1998 of which 1,357 were from floating nets culture system while 776 tons were use of traditional fishing practices on the lake. Production of fish using fish culture techniques grew significantly in the 1990s.

Hydroelectric Power Generation

The Tondano River provides the energy to drive hydroelectric turbines with an installed capacity of 34 megawatts of power. This power is adequate to supply about 30 % of the energy needs of the province. The total value of the electricity sold in 1999 is reported by PLN as Rp 80,000,000,000. PLN has estimated that the use of hydroelectric power on the Tondano River results in a savings in expenditures for oil of Rp 47,500,000,000 per year.

Source of Drinking Water

Tondano River is a primary source of drinking water for the urban population of the provincial capital of Manado. It is estimated that the total population which benefits from water from the Tondano River to satisfy daily needs is about 120,000. The water used for the municipal water

supply is tested regularly for bacteria and sediment loads. Only one test for mercury content of the water has been carried out (October, 1999). This test measured that mercury levels were 0.147 parts per billion, which is below the WHO and DEPKES standard for drinking water of 1 parts per billion.

High Recreational Use

Tondano Lake is the main center for domestic tourism in the province. Many local residents consider that the best way to spend a Saturday is to relax at the lake. A recent study by UNSRAT estimated the total number of visitors to Lake Tondano to be 250,000 per year of whom 78 % were recreational tourists. The willingness to pay of the recreational tourists was estimated to Rp 1,443,000,000 per year.

High Level of Education of Residents and Openness to Change

The level of education of the residents of the watershed is among the highest in the province of North Sulawesi and above the national average. The residents of the region also are known for their openness and willingness to adapt their lifestyles to changing times and technologies.

3.2 Weaknesses

Degradation of Land Resources/ Sedimentation of Lake and Marine Environments

Only about 5 % of the Tondano catchment remains forested. An unstable pattern of agricultural land and construction activities result in high rates of sedimentation. Land use planning has been completed for the region (see Map 10), but enforcement is weak and actual land use does not correlate with the existing plans. Farmer practices in cultivating upland hillsides frequently accelerate the pace of sedimentation. Intensive vegetable cultivation in the uplands, harvest techniques for cloves and land preparation of paddy lands all contribute to increasing sediment loads.

High sediment loads in the catchment are reflected in the data compiled by the municipal water supply agency at Manado which show that sediment loads at their treatment plant on the Tondano river have increased from 15-20 ppm in 1970 to 25 ppm in 1980 to 30 ppm in 1990 to 30-50 ppm at present. Lake Tondano is reported to have had a maximum depth of 40 meters in 1934, but a recent (2000) survey found the maximum lake depth to be 20 meters. The discharge of sediments

into the coastal area at the mouth of the Tondano River is also having a negative impact on the coastal marine environment. Impacts include the siltation of the main harbor at Manado to the point where larger boats have difficulty entering the harbor at low tide.

Eutrophication of Lake Tondano

Eutrophication is a process whereby the concentration of nutrients in a lake is increased resulting in blooms of algae and microscopic organisms which prevent light penetration and oxygen absorption necessary for underwater life. This process occurs naturally, but in the case of Lake Tondano it has been accelerated by changes in the level of nutrients in the water flowing into the lake. Several sources contributing to the change in water quality have been identified as follows:

- **High Use of Chemical Fertilizers by Area Farmers** – The use of fertilizers by local farmers, especially on the +5,000 hectares of paddy land surrounding the lake, has increased rapidly in recent decades. At present farmers use in excess of 150 kilograms of urea per year and 50 kilograms of phosphates per year per hectare. This results in about 750 tons of urea and 250 tons of phosphates entering the ecosystem from the paddy lands surrounding the lake.
- **Disposal of Detergents and Solid Waste** – Of the total of 4,000 households in the upper watershed few have installed septic tanks and considerable amounts of detergents are released directly into the tributaries of the lake. Most of the detergents are biodegradable, but they degrade to phosphates that are nutrients in the aquatic ecosystem of Tondano. It is estimated that the households in the upper watershed release as much as 50 tons per year of detergents into the local environment. Plastics are also frequently thrown into the streams and rivers of the watershed and contribute to degradation of both the lake environment, the operation of the hydroelectric generating plant and the marine environment.
- **Wastes from Fish Farming** – Fish farming is a common economic activity on Lake Tondano. There are more than 50 enterprises raising carp and tilapia in nets on the lake. These enterprises use concentrated pellets to feed the fish. The excrement of the fish and any wasted feed become nutrients in the aquatic environment. Each fish enterprises uses about---tons of concentrates per year or a total of---tons of organic matter that are added directly to the lake.
- **Wastes from Duck Husbandry** – More that 42,000 Manila ducks are raised along the shores of the Lake. They are fed on corn and snails. The manure from the ducks goes directly into the lake, becoming another source of nutrients in the aquatic ecosystem.

- **Organic Matter from Other Sources** - Organic matter is also a component of physical erosion processes and contributes nutrients to the waters of the lake.

Water Quality for Public Consumption

There is no routine monitoring system in place to evaluate changes in mercury or agrochemical content of the water in the Tondano River despite the expansion of illegal placer mining using mercury in areas adjacent to the watershed and the significant increase in the use of agrochemicals in recent years.

Irregular Stream Flows and Seasonal Flooding

The elevation of the surface of Lake Tondano is reported to have varied by 2.7 meters during the last 20 year due to fluctuations in rainfall. At peak rainy season water much of the paddy areas are inundated and the some settlement areas in the north of the lake are flooded. In the city of Manado flooding is reported at the Kairagi bridge where water levels have been reported to rise one meter over the banks of the river.

Low Levels of Biodiversity

When Alfred Russel Wallace visited the region in 1859, he enjoyed the climate at Tondano and Rurukan but was disappointed to find a paucity of wildlife. In the years since his visit the stocks of terrestrial wildlife have declined further and the area is not known for a high level of terrestrial biodiversity. Local residents use local wildlife as a source of food.

Introduction of carp and tilapia species into Lake Tondano have also reduced the populations of endemic fish species in the lake. The catch of the traditional fishery in Lake Tondano has decreased with the expansion of fish culture operations.

Institutions

The environmental impacts of environmental degradation spillover from Kabupaten Minahasa to Kota Manado. The impacts of environmental degradation of the watershed affect the welfare and economy of the region. The provincial government has responsibility for coordination of activities among the districts, but there is no special institutional arrangement to coordinate activities in the Tondano watershed. The lack of institutional arrangement is considered a

weakness given the important role that this watershed plays in the region and the need for coordination of activities among sectors and among levels of government.

District and village governments and representative assemblies are often poorly informed regarding environmental issues in their territories. Decision making at the local level regarding the use of natural resources is not always based on empirical documentation. Representatives of the media lack information to better inform the public with regard to issues relating to the environment of the Tondano watershed.

3.3 Opportunities

Opportunities to Reduce the Likelihood of Contamination of the Tondano River

Facilities are available in Indonesia to test water samples for heavy metal content and contamination by agricultural chemicals. Budget requirements for sampling and testing of water quality are not prohibitive (Rp 50,000 per sample).

Opportunities to Reduce Sedimentation of the Tondano Watershed

Technologies packages to reduce soil erosion in upland areas have been tested and developed in many areas of Indonesia. This experience could be used as a reference in developing conservation technology packages for the Tondano watershed. A JICA funded project, The Study on Critical Land and Protection Forest Rehabilitation at Tondano Watershed, is working in cooperation with the Directorate General of Land Rehabilitation and Social Forestry to prepare a program to support improved land use management practices in the future.

Improved spatial planning and enforcement of such planning offers the potential to reduce soil erosion in environmentally critical upland areas.

Initiative to increase community based land conservation offer potential to increase participation of the residents of the watershed in its management. Basic Law 22 of 1999 provides a basis for expansion of village level participation in management of village resources.

Opportunities to Slow the Eutrophication Process

Eutrophication is referred to as either natural eutrophication or cultural eutrophication. In the case of Lake Tondano both types of eutrophication are taking place, but the dominant type is cultural eutrophication as most increases in the nutrient flow into the lake are the result of human actions. The communities of the Tondano watershed are generally open to change and building their awareness of the issues involved in eutrophication could establish a basis for community based initiatives to reduce cultural eutrophication.

Institutional Opportunities

Basic Law Number 22 provides the scope for provincial agencies and autonomous districts and villages to adopt policies and regulations to improve environmental management in their territories. These levels of local government are interested in testing new approaches to increase community participation in environmental management.

3.4 Threats

The Tondano Watershed is an ecological unit that is threatened by various human activities. The main threats to the environment have been identified as the following:

Contamination of the Manado Water Supply and the Aquatic Environment

The municipal water supply of Manado draws a large portion of its water from the Tondano River. There is potential for toxic wastes to enter the aquatic system, thus presenting a clear health hazard for area residents. Wastes and sedimentation become a threat to health of the community consumers of the water.

This review did not identify any PETI (placer gold miners using mercury) operating in the Tondano watershed, although there are many in the neighboring sub-district of Tatelu. There is the danger that mercury processing be carried out within the watershed and this would pose an immediate threat to the health of those consuming the water as well as those consumers of fish from the lake, rivers and marine areas. Health problems could include: damage to the central nervous system; kidney damage; lung damage; birth defects; and increases in the incidence of cancer.

The expansion of use of high input technology packages in the agricultural production areas raises the threat of contamination of the water supply by insecticides as well as by fertilizers. No quantitative measurements of toxicity were available to the working group at present, but this is an obvious concern. It appears that the monitoring of water quality for chemical contamination is not adequate at present and this is a clear threat to the consumers of water in Manado and other parts of the catchment.

There is a need to expand and regularize monitoring of water quality in the catchment. A system should be established which could be used to identify sub-regions of the watershed which are the origins for any contamination.

Increasing Eutrophication of Lake Tondano

Eutrophication of Lake Tondano has resulted in the spread of water hyacinths on the lake. Some of the hyacinths and sediments from the lake enter the Tondano River which drives five sets of turbine owned by PLN. The turbines must be unclogged on a daily basis. The threat is that advancing eutrophication of the lake could result in greater production of hyacinths resulting in greater costs to PLN and eventually the public for production of electricity.

In 1998 many of the fish in the Lake Tondano died. Various possibilities for the widespread fish losses in the lake were identified at the time, but the primary cause was attributed to a critical lack of oxygen in the water of the lake. In the future losses of fish could increase as eutrophication process is accelerated and if toxic wastes enter the aquatic system.

The eutrophication of the lake may result in its degradation as a cultural and tourism asset. Algae blooms and water hyacinths are not attractive to visitors or area residents.

Increasing Sedimentation

Sedimentation from the watershed has contributed to the decline capacity of the main harbor at Manado to accommodate large ships and is a threat to local sea transportation services.

Further sedimentation of the lake also poses a threat to electrical generation as dry season flows in the Tondano River would be reduced. The greater the retention capacity of the lake the less fluctuation in seasonal flows.

4. Summary of SWOT Analysis

The following table summarizes the findings of the Working Group within the SWOT framework:

SWOT	Type:	Main Indicators:
Strengths	High Agricultural Productivity	Crop yields high; agricultural incomes higher than provincial average
	Hydroelectric Power Generation	34 megawatts installed capacity on Tondano River
	Source of Drinking Water	+150,000 people in Manado use water from Tondano R. as main source of domestic water
	High Recreational Use	+250,000 visitors per year
	High Level of Education of Residents/ Openness to Change	Low level of illiteracy
Weaknesses	Degradation of Land Resources/ Sedimentation of Lake and Marine Environments	Depth of Lake Tondano has been reduced from 24 meters to 16 meters in last 65 years
	Eutrophication of Lake Tondano	Algae blooms, expansion of water hyacinth, widespread fish losses in 1998 High N and P levels
	Quality of Water for Public Water Supply	Water quality samples in the Tondano River were low in Hg – 0.170 ppb to 0.520 ppb as compared to the WHO water quality standard of 1 ppb
	Irregular Stream Flows and Seasonal Flooding	Damage to settlement and cropping areas
	Systems of Disposal/Recycling of Solid Waste	Plastics are present in the lake and coastal zone
	Low Levels of Biodiversity	Low populations of endemic mammals and endemic fish in Lake Tondano
	Institutions	No provincial coordinating body District and village institutions poorly informed
Opportunities	Reduction of the Contamination of the Tondano River	Testing services available at moderate price
	Reduction of Sedimentation of Lake Tondano and Manado Harbor	Technology packages are available
	Opportunities to Improve Solid Waste Disposal/Recycling	
	Slowing down Eutrophication	Reduction of N and P Reduction of algae and water hyacinth
	Increasing Environmental Awareness	Local institutions committed to building public awareness
	Institutional Strengthening	Local institutions are now involved in reform process
Threats	Increased Sedimentation of Aquatic Systems.	1. Increase in sediment loads of Tondano River and tributaries. 2. Decrease in depth of Lake Tondano and Manado Harbor 3. Irregularity in seasonal stream flows on the Tondano River.

	Environmental Degradation by Solid Wastes/Plastics	Observed plastics in the lake and the coastal environment
	Flooding of Settlement Areas	Seasonal inundation of settlement areas
	Increased Contamination Sedimentation of Tondano River/Lake with Mercury and other chemicals	<ol style="list-style-type: none"> 1. Increase of mercury in the lake/ rivers 2. Increase of agrochemicals in the lake / rivers 3. Increase of mercury in fish and aquatic plants
	Increased Eutrophication of Lake Tondano	<ol style="list-style-type: none"> 1. Increase in algae and hyacinths 2. Decline of fish production 3. Increase in cost of electricity generation 4. Decline of tourism

5. Origin of Threats

The rural inhabitants of the region have considerable responsibility for the threats to their environment. No threats were generated from outside the region. The conclusion from this report is the communities must come to a better understanding of the forces at work in their environment, adopt more appropriate technologies to reduce or eliminate negative environmental impacts and reduce conflicting uses of natural resources in the watershed.

6. Future Priorities to Reduce Environmental Threats

The challenge for the future is to harmonize the competing uses of the lake so as to preserve the ecologic balance of the watershed. Can the multiple stakeholders cooperate to optimize benefits to the people of the region? Will the “people of the lake” develop the commitment necessary to achieve a reversal of the process of eutrophication of Lake Tondano? Previous sectoral efforts at greening and improvement of water management have proven to be less than adequate to affect the process of environmental decay, perhaps because they have been narrowly focused on achievement of physical targets for tree planting and infrastructure development. In the future a more comprehensive and community based approach is indicated.

In the short term the highest priority should be given to increasing community awareness concerning the threats to the local environment. Some actions proposed to be implemented by the Kabupaten Minahasa Working Group during the next year include the following:

- a. Village Consultations, Community Meetings and Provision of Information to the Public** – Improvements in the quality of the environment of the Tondano watershed will start at the community level with active citizen participation. The Working Group will identify four villages representing the major agro-ecosystems in the upper watershed and will hold a series of consultations with the communities in these villages. The villages will include:
- A lakeside village where wetland rice cultivation and fish culture are sources of income of the people.
 - A upland village where tree crops provide the core activity in the village economy.
 - An upland village where vegetable production is the main economic activity.
 - A village located in the lower watershed where tree crop production is the dominant economic activity.

The subject of these consultations will be to assess the communities' perceptions of environmental threats and to identify possibilities to reduce or eliminate these threats through improvement in village planning, through community-based initiatives and community conservation agreements. Some of the remedial actions that might be tested in these four villages would be adjustments in agricultural production technology packages; re-greening activities; establishment of latrines and clothes washing areas away from the river; changes in duck husbandry, reduction in the intensity of fish cultivation, relocating economic activities to reduce contamination of water through surface run-off. After a process of consultations with village assemblies, focus groups and community leaders in each village, it is hoped that the communities through their village assemblies would adopt community regulations (*peraturan desa*) to achieve improved environmental quality at the local level. These might include village regulations relating to: prohibition of the use of mercury in mining; disposal of wastes from the community; agricultural practices; re-greening; fish cultivation; spatial planning, etc.

- b. Public Awareness Campaign** – Education of the community regarding the threats to the Tondano Watershed is a high priority of the Working Group and approaches to improve public awareness will be tested in the four study villages. The main topics of public education are expected to be: hazards of use of mercury in gold mining; what eutrophication is and how village activities contribute to this process; and land use practices and how agricultural practices contribute to sedimentation of rivers, the lake and the sea.

- c. Community Mapping and Spatial Planning** – The working group will cooperate with local NGOs to assist the four villages to carry out community mapping and to complete village spatial plans. Village spatial plans will be used as an input to review and update *Kabupaten* and Provincial Spatial Plans.
- d. Development and Extension of Low Input Technology Packages for Area Farmers** – The agricultural extension service has been promoting high input technology packages to area farmers. There is an urgent need to test low input packages that are both financially attractive to area farmers and environmentally friendly. In cooperation with the JICA funded study and the Directorate General of Land Rehabilitation and the local agricultural extension service, technology packages appropriate to the local environment of the four villages would be identified and discussed with local farmer groups.
- e. Stakeholders Consultation** – The working group will conduct a series of public consultations with stakeholders to work towards resolution of natural resource management issues and to improve the formulation of district regulation.
- f. Improvement of the Data Base and Monitoring System on the Physical Environment of the Catchment** – There is an urgent need to retest the quality of water at the Tondano River and throughout the catchment area. A sampling system would be established to test for toxicity from heavy metals and agricultural chemicals. Based on an initial survey, a monitoring program would be established to regularize on-going sampling of water quality to protect the public from health hazards. There is also a need to test the fish produced in the lake and the Manado bay for contamination by these same substances. A recent study by the irrigation department identified a high concentration of mercury in fish in Manado Bay.
- g. Prepare a More Detailed Threats Assessment for the Tondano Watershed**- A more detailed assessment of the threats to the Tondano Watershed would be prepared by the Working Group during the coming year. This report would be presented to the Governor, Bupati, Mayor and the public through the local media.
- h. Training** – Training of the staff of local government agencies, non-government organization and village communities on a variety of topics relating to environmental management of the watershed is a priority.

There is also a need to improve the institutional and regulatory framework for management of the resources of the Tondano watershed. This initial threats assessment identified the following possibilities to improve the regulatory framework:

- a. **Establish a Coordinating Institution for Improved Management of the Tondano Watershed** – The Tondano watershed lies within Kabupaten Minahasa and Kota Manado. Current decentralization policies place responsibility for resource planning at the district level, but there is a need for cross-district and vertical coordination of activities within the watershed. The fact that the benefits of improvement of the management of the watershed accrue to populations outside both of these district underlines the importance of establishing a coordinating authority to better coordinate development planning and environmental monitoring of the watershed. At present the main economic asset of the catchment (the hydro electric plant) is managed by a central government agency so any coordinating institution should include this agency as well as those from the district and provincial levels.
- b. **Review and Adjust Spatial Plans and Local Government Regulations Relating to Resource Use** – There is a need to review land use regulations of the catchment area as these are based on forestry land use classifications. The need for improved zoning of agricultural lands, wetlands and green belts in the watershed should be examined as these offer potential to contribute to reduction of sedimentation and nutrient run-off.
- c. **Prepare a *Kabupaten* Action Plan** – The BAPPEDA Minahasa with support from the Working group will prepare an action plan for a community-based natural resource management program in the watershed.
- d. **Review Appropriateness of “Green Taxes”** - The potential to consider the use of green taxes on activities that contribute to the eutrophication of Lake Tondano such as fish cultivation, upland land use and use of wetlands. At present these activities are not directly taxed although they are having a negative impact on the environment.
- e. **Review Regulations on Detergents** – Many governments have legally restricted the level of phosphates which manufacturers may use in detergents and soaps to low or zero tolerance levels. Indonesia has apparently not established such regulations and there is a need at the provincial or national levels to review the need for such regulations to reduce the level of phosphate nutrients entering the environment.

These activities would be carried out during the next year and based on the experience of implementation of these activities a more comprehensive and community-based Action Plan to improve management of the Tondano watershed would be adopted. Activities carried out would be coordinated with other ongoing donor assisted projects in the region including the JICA funded projects for Critical Land Rehabilitation and the Coral Reef Management Project as well as future CIDA assistance to DGWRD. During the coming year the NRM/EPIQ program would provide technical assistance and training to contribute to the Working Groups program. A key element of the program would be to build local capacity for improved planning of natural resource management programs.

7. Initial Lessons Learned for the Review of Environmental Threats

Previous studies of the area have not provided an overview of the problems of the Tondano catchment and did not address the multiple causes of eutrophication. All the studies to date have been sectoral studies (irrigation, reforestation/ re-greening, tourism, fisheries, etc) which have not addressed the critical issues related to multistakeholder use of the ecological system. One advantage of the decentralization in the reform era is that the concerned regional government authorities are in a better position to examine cross-sectoral issues, consult with local communities and to develop community based initiatives to overcome environmental problems.

A weakness at the district level is a low level of technical capacity to analyze and evaluate natural resource issues. There is a need to utilize technical assistance to monitor and evaluate environmental quality. The district governments need to develop better linkages to the local University, other research institutions, non-government organizations and other groups offering technical assistance to better utilize the expertise of these organizations.

The comparative advantage of local government at the district level is its closeness to the people, but local governments have not yet developed effective systems for community consultations on environmental issues. This is partly due to the bureaucratic culture evolved from the New Order years as well as a lack of training in approaches to foster greater community participation. Greater attention should be given to development of this capacity in order to better achieve the objectives of local government.

Although the decentralization provides the *Kabupaten/Kota* level with far greater authority than in the New Order Era, there are still some central agencies which maintain a critical role in the

regions. In this case, a centrally managed institution (PLN) is the main user of the water resources of the catchment area. There is a need for district government institutions to collaborate with this agency.

There is also a critical lack of accurate information at the district level on the natural resources of the district. Mapping and information on natural resources tends to be compartmentalized by sectoral agency and not available to the public. There is a need to develop a more comprehensive data base which is easily accessible to all government agencies and to the public.

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Attachment 1: Demographic Data for DAS Tondano

Table 1.1 Demographic data in the DAS TONDANO by District and Sub-district, 1997

District	Sub-district	Village	Area (ha)	Household	Population	Growth	Population Density	Ave. # of family members
Minahasa	Langowan	21/28	6,488	9,272	34,992	0.41%	539	3.77
	Kakas	14/20	5,178	4,162	16,018	-0.75%	309	3.85
	Tompaso	9/11	2,208	2,479	9,318	0.20%	422	3.76
	Remboken	11/11	3,830	2,613	9,768	0.41%	255	3.74
	Tomohon	3/34	769	878	3,491	0.52%	454	3.96
	Tondano	17/17	5,367	7,928	30,889	0.67%	576	3.90
	Toulimambot	14/14	4,520	4,223	16,251	0.67%	360	3.85
	Eris	6/7	2,986	2,552	9,707	1.28%	325	3.80
	Kauditan	3/19	1,788	1,135	4,218	1.36%	236	3.72
	Airmadidi	20/20	15,611	9,581	37,359	1.36%	239	3.90
	Pineleng	6/17	5,418	2,342	8,985	2.06%	166	3.84
	Sub-total	124/198	54,161	47,165	181,006	0.78%	334	3.84
	Manado	Wenang	13/19	1,477	15,377	74,798	2.00%	5,064
Molas		6/21	735	5,988	29,383	0.30%	3,998	4.91
Sario		1/12	122	3,937	16,833	-1.00%	13,798	4.28
Mapengat		2/11	588	1,194	5,018	0.90%	853	4.20
Sub-total		22/63	2,922	26,496	126,032	1.20%	4,313	4.76
Total		146/261	57,083	73,661	307,038	0.40%	538	4.17

Source: Sensus Penduduk 1990, Manado in Figures 1998 and Minahasa in Figures 1997

Table 1.2: Demographic Data in the DAS Tondano by District and Sub-district, 1997 (Upper Watershed)

District	Sub-district	Village	Area (ha)	Household	Population	Growth	Population Density	Ave. # of family members
Minahasa	Langowan	21/28	6,488	9,272	34,992	0.00%	539	3.77
	Kakas	14/20	5,178	4,162	16,018	0.00%	309	3.85
	Tompaso	9/11	2,208	2,479	9,318	0.00%	422	3.76
	Remboken	11/11	3,830	2,613	9,768	0.00%	255	3.74
	Tondano	11/17	3,916	5,250	19,709	0.00%	503	3.75
	Toulimabot	11/14	4,009	3,350	12,426	0.00%	310	3.71
	Eris	6/7	2,986	2,552	9,707	0.00%	325	3.80
	Sub Total	83/108	28,615	29,678	111,938	0.40%	391	3.77

Table 1.3: Demographic Data in DAS Tondano by District and Sub-district, 1997 (Lower Watershed)

District	Sub-district	Village	Area (ha)	Household	Population	Growth	Population Density	Ave. # of family members
MInahasa	Tomohon	3/34	769	878	3,491	0.00%	454	3.98
	Tondano	6/17	1,361	2,772	11,128	0.00%	818	4.01
	Toulimambot	3/14	770	956	3,699	0.00%	480	3.87
	Kauditan	3/19	1,786	1,135	4,218	0.00%	236	3.72
	Airmadidi	20/20	15,611	9,581	37,359	0.00%	239	3.90
	Pineleng	6/17	5,418	2,342	8,985	0.00%	166	3.84
	Sub-total	41/121	25,715	17,664	68,880	1.03%	268	3.90
Manado	Wenang	13/19	1,477	15,377	74,798	2.00%	5,064	4.86
	Molas	6/21	735	5,988	29,383	0.30%	3,998	4.91
	Sario	1/12	122	3,937	16,833	-1.00%	13,798	4.28
	Mapanget	2/11	588	1,194	5,018	0.90%	853	4.20
	Sub-total	22/63	2,922	26,496	126,032	1.20%	4,313	4.76
	Total	63/164	28,637	44,160	194,912	0.40%	681	4.41

Attachment 2: Land Use in the Tondano Watershed (1991)

Table 2.1: Land Use in the Tondano Watershed (1991) by Region and Sub-districts

District	Sub-district	Land Use											Jumlah	
		Hutan	Sagu	Belukar	Kbn.Kelapa	Kbn.Cengkeh	Kbn. Kelapa&Cengkeh	Tegalan	Sawah Irigasi	Sawah Tadah hujan	Pemukiman	Danau/ Telaga		
Minahasa	Langowan	217.00	-	1,505.00	-	-	250.25	1,458.25	1,132.50	-	645.00	10.00	5,218.00	
	Kakas	144.50	-	325.00	-	502.25	-	131.50	1,732.25	-	137.00	1,126.25	4,098.75	
	Tompaso	-	-	451.00	-	55.25	-	630.00	608.00	-	95.00	-	1,839.25	
	Remboken	-	-	65.25	-	79.00	-	1,592.50	322.50	22.50	109.75	715.25	2,906.75	
	Eris	-	-	-	-	1,110.75	-	-	143.75	-	52.25	1,282.50	2,589.25	
	Tondano	42.50	5.00	-	1,135.25	173.25	-	1,546.75	1,103.75	33.00	287.75	727.75	5,055.00	
	Toulimambot	329.50	7.25	-	-	1,897.75	-	-	833.75	-	61.25	473.00	3,602.50	
	Airmadidi	1,885.25	-	-	5,404.00	2,407.25	3,950.00	653.25	316.25	9.50	314.25	-	14,939.75	
	Pineleng	338.50	-	-	-	-	4,152.25	99.50	15.25	-	73.00	-	4,678.50	
	Kauditan	335.75	-	-	836.75	-	884.00	-	-	-	48.50	-	2,105.00	
	Tomohon	158.25	-	2.75	15.50	4.00	-	447.75	-	43.00	31.25	-	702.50	
	Dimembe	131.00	-	-	388.75	-	-	-	-	-	-	-	519.75	
	Kawangkoan	3.50	-	-	-	45.75	-	55.75	83.00	-	3.00	-	191.00	
	Sonder	5.75	-	-	-	18.00	-	38.75	-	11.50	-	-	74.00	
		Sub-total	3,591.50	12.25	2,349.00	7,780.25	6,293.25	9,236.50	6,654.00	6,291.00	119.50	1,858.00	4,334.75	48,620.00
	Manado	Wenang	-	-	-	896.00	-	303.75	50.50	-	-	560.50	-	1,810.75
		Mapangat	-	-	-	459.25	-	-	-	-	-	58.00	-	517.25
Molas		-	-	-	101.75	-	-	-	-	-	151.25	-	253.00	
Sario		-	-	-	12.00	-	83.75	-	-	-	11.50	-	107.25	
		Sub-total	-	-	-	1,469.00	-	387.50	50.50	-	-	781.25	-	2,688.25
TOTAL		3,591.50	12.25	2,349.00	9,249.25	6,293.25	9,624.00	6,704.50	6,291.00	119.50	2,639.25	4,334.75	51,208.25	

Table 2.2: Land Use in the Tondano Watershed (1991) by Region and Sub-district (Upper Watershed)

District	Sub-district	Land Use											Jumlah	
		Hutan	Sagu	Belukar	Kbn.Kelapa	Kbn.Cengkeh	Kbn. Kelapa&Cengkeh	Tegalan	Sawah Irigasi	Sawah Tadah hujan	Pemukiman	Danau/ Telaga		
Minahasa	Langowan	217.00	-	1,505.00	-	-	250.25	1,458.25	1,132.50	-	645.00	10.00	5,218.00	
	Kakas	144.50	-	325.00	-	502.25	-	131.50	1,732.25	-	137.00	1,126.25	4,098.75	
	Tompaso	-	-	451.00	-	55.25	-	630.00	608.00	-	95.00	-	1,839.25	
	Remboken	-	-	65.25	-	79.00	-	1,592.50	322.50	22.50	109.75	715.25	2,906.75	
	Eris	-	-	-	-	1,110.75	-	-	143.75	-	52.25	1,282.50	2,589.25	
	Tondano	38.50	-	-	366.00	173.25	-	1,392.00	683.00	3.75	33.50	727.75	3,417.75	
	Toulimambot	229.75	-	-	-	676.50	-	-	408.25	-	3.50	473.00	1,791.00	
		Sub-total	629.75	-	2,346.25	366.00	2,597.00	250.25	5,204.25	5,030.25	28.25	1,076.00	4,334.75	21,860.75

Source: Peta Rupa Bumi Indonesia (RBI), 1991

Table 2.3: Land Use in the Tondano Watershed (1991) by Region and Sub-district (Lower Watershed)

District	Sub-district	Land Use											
		Hutan	Sagu	Belukar	Kbn.Kelapa	Kbn.Cengkeh	Kbn. Kelapa&Cengkeh	Tegalan	Sawah Irigasi	Sawah Tadah hujan	Pemukiman	Danau/ Telaga	Jumlah
Minahasa	Tondano	4.00	5.00	-	769.25	-	-	154.75	420.75	29.25	254.25	-	1,637.25
	Toulimambot	99.75	7.25	-	-	1,221.25	-	-	425.50	-	57.75	-	1,811.50
	Airmadidi	1,885.25	-	-	5,404.00	2,407.25	3,950.00	653.25	316.25	9.50	314.25	-	14,939.75
	Pineleng	338.50	-	-	-	-	4,152.25	99.50	15.25	-	73.00	-	4,678.50
	Kauditan	335.75	-	-	836.75	-	884.00	-	-	-	48.50	-	2,105.00
	Tomohon	158.25	-	2.75	15.50	4.00	-	447.75	-	43.00	31.25	-	702.50
	Dimembe	131.00	-	-	388.75	-	-	-	-	-	-	-	519.75
	Kawangkoan	3.50	-	-	-	45.75	-	55.75	83.00	-	3.00	-	191.00
	Sonder	5.75	-	-	-	18.00	-	38.75	-	11.50	-	-	74.00
	Sub-total	2,961.75	12.25	2.75	7,414.25	3,696.25	8,986.25	1,449.75	1,260.75	93.25	782.00	-	26,659.25
Manado	Wenang	-	-	-	896.00	-	303.75	50.50	-	-	560.50	-	1,810.75
	Mapangat	-	-	-	459.25	-	-	-	-	-	58.00	-	517.25
	Molas	-	-	-	101.75	-	-	-	-	-	151.25	-	253.00
	Sario	-	-	-	12.00	-	83.75	-	-	-	11.50	-	107.25
	Sub-total	-	-	-	1,469.00	-	387.50	50.50	-	-	781.25	-	2,688.25
TOTAL		2,961.75	12.25	2.75	8,883.25	3,696.25	9,373.75	1,500.25	1,260.75	93.25	1,563.25	-	29,347.50













