Lake Toba

Experience and Lessons Learned Brief

*Haryatiningsih Moedjodo**, LakeNet Country Director-Indonesia, ning@worldlakes.org
Payaman Simanjuntak, Lake Toba Heritage Foundation, Jakarta, Indonesia
Peter Hehanussa, Indonesian Institute of Sciences, Cibinong, Indonesia
Lufiandi, West Java Environmental Impact Management Agency, Bandung, Indonesia

* Corresponding author

1. Introduction

Lake Toba is Indonesia's largest lake, located in the province of North Sumatra, 176 km to the west of the provincial capital, Medan. Lake Toba can be reached by car from Medan within three hours. By plane, Medan is 40 minutes away from Singapore and two hours from Jakarta, the capital city of Indonesia.

As the largest volcano-tectonic lake in the world, Lake Toba is 87 km long in the northwest to southeast direction, and has a width of 27 km. Located 904 meters above sea level, and with a maximum depth of 505 meters, the lake is one of the country's important tourist destinations. The natural beauty of Lake Toba has been internationally recognized. The lake's blue waters, gracious residents and fascinating Batak culture draw tourists from all over the globe to the remote destination of Lake Toba (Souder 1999). Figure 1 shows details of the Lake Toba basin.

In the middle of the lake lies the wedge-shaped island (actually a peninsula with a very thin neck) called Samosir Island, thought to have been created by subsequent upheavals from the older lake bottom between 0.6 to 0.1 million years ago. This spectacular island is one and a half times larger in size than the entire Republic of Singapore, and traveling from the lake's shore to the island of Samosir is a great adventure for visitors.

The Lake Toba catchment area covers 3,658 km², of which the lake surface accounts for 1,103 km². The remainder of the catchment area can be classified as hilly (43%) and mountainous (30%), with peaks over 2,000 m above sea level. Biophysically, the cool, refreshing environment, clean air, and fertile soil of the region make it an ideal place for human settlement. It is no surprise, therefore, that the ancestors of the Batak ethnic minority chose it as their permanent site for settlement centuries ago. It was here that their descendants developed into the five ethnic Batak groups; namely, the Angkola-Mandailing, Karo, Pakpak-Dairi, Simalungun and Toba. Samosir Island and the Toba lakeside is the site of the original Batak culture, containing invaluable historical objects and artifacts, art and culture. In fact, Batak culture is still alive and present here, preserved in its original form.

The unique geographical position of the lake facilitates a range of economically-significant sources of livelihood for the population, mainly derived from the abundant freshwater resources and the dense tropical rain forests. The number of human settlements scattered throughout the Lake Toba

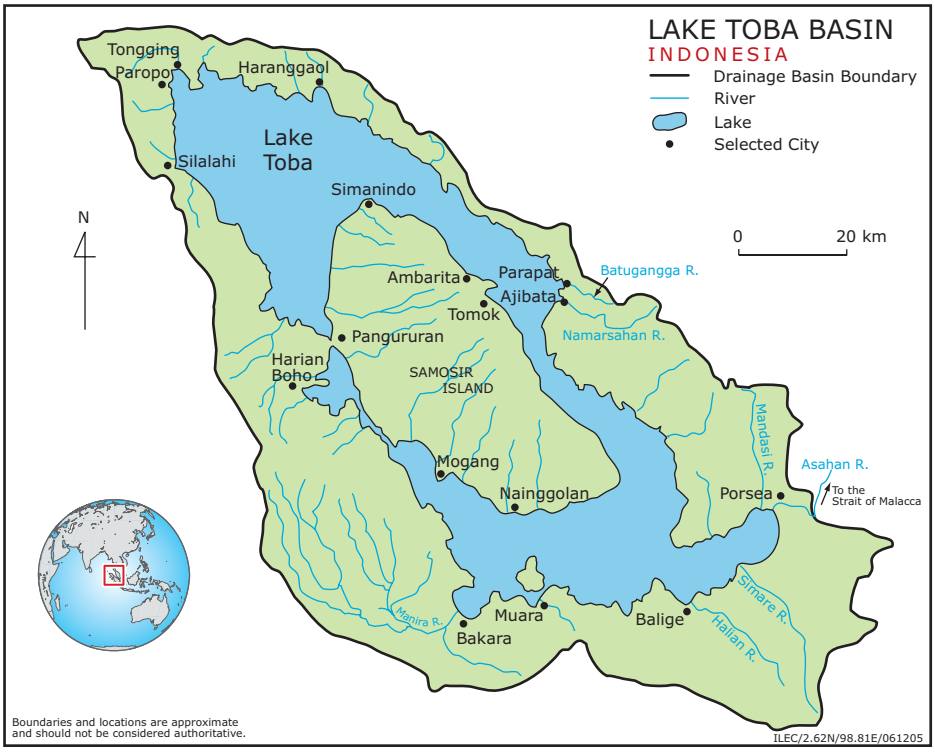

Figure 1. The Lake Toba Basin.

watershed today is about 366 settlements, mainly in the form of small villages to medium towns (EIMA, undated).

2. Background

Lake Toba is located at the center of a topographic culmination some 300 km long in North Sumatra. This topographic culmination is called the Batak Tumor, and runs parallel to Sumatra Island, with Lake Toba located at its very center. The 300 km long Batak Tumor is dissected a little west of its center by the 1,625 long Sumatra Fault which stretches from the Sunda Strait to Banda Aceh. The origin of Lake Toba was first explained as a volcano-tectonic depression (Bemmelen 1949), and later explained as the result of a series of caldera formations combined with faulting activity (Nishimura 1984; Hehanussa 2000). The lake covers an area of 1,103 km^2, Samosir Island has a land area of 647 km^2, and the smaller Pardapur Island is 7 km^2. The length of the lake is 87 km, and its circumference measures 294 km.

The lake basin area is surrounded by precipitous cliffs with elevations ranging between 400 to 1200 m above the lake surface. The latitude and longitude of the lake's water surface range between 98°30' E; 3°05' S and 99°20' E; 2°40' S. The surface water temperature ranges between 24°C to 27.6°C.

One single large river, the Asahan River, drains the lake to the Strait of Malaka in the east. The lake water surface is 904 meters above sea level. Using the cable method, Stehn reported a maximum water depth of 529 meters in 1939, while recent measurements based on an acoustic echo sounder method indicated a maximum depth of 505 meters (Hehanussa and Takara 2003). This 24-meter discrepancy in the water depth could be due to the measurement method used for its determination, since the echo-sounding method used in 2003 is considered more accurate than the cable method used in 1939. During this last (2003) measurement, it was observed that many parts of the lake bottom showed a broad and flat bottom, relatively deeper in the north, while shallower in the south. The annual lake water level fluctuation is 1.5 meters, although a lake level drop of 2.5 m (due to extensive hydropower production) was reported in the late 1980s. The water discharge from Lake Toba through the Asahan River was measured up to a value of 102 m^3/second.

Evaporation is a critical factor in the water balance calculations for a lake. It was measured at three stations, Palipi, Gurgur Balige, and Pulau Tao (Anonymous 1990). Measurements at Pulau Tao showed an average evaporation varying between 3.5-5.5 mm/day. In contrast, evaporation at Haranggaol was lower because of the wind velocity, temperature and humidity that differ from the Palau Tao station.

2.1 Biophysical Features

Overall, information on the biophysical features of the lake and its drainage basin is scarce, being restricted to several field measurements conducted in the past. Nevertheless, the following text provides a summary of organisms identified in the lake and other measured parameters.

2.1.1 Flora

Emerged macrophytes: *Nelumbo nucifera, Nymphaea sp.*

Floating macrophytes: *Eichhornia crassipes, Lemna minor, Azolla pinnata, Spirodella polyrhiza*

Submerged macrophytes: *Patamogeton malaianus, P. polygonifolius, Myriophyllum spicatum, Ceratophyllum demersum, Hydrilla verticillata, Chara sp.*

Phytoplankton: *Amphora, Cocconema, Asterionella, Synedra, Gomphonema, Orthosira, Navicula, Mastogloia, Pleurosigma, Nitzschia, Genicularia, Botryococcus, Synechococcus, Anabaena, Oscillaoria*

2.2.2 Fauna

Zooplankton: *Cyclops, Cladocera*

Benthos: *Macrobrachium sintangensis, Brotia costula, Thiara scabra, Melanoides tuberculata, Melanoides granifera, Anentome helena, Lymnaea brevispira, L. rubiginoca, Physastra sumatrana, Corbicula tobae*

Fish: *Tilapia mossambica, Aplocheilus pachax, Lebistes recticulatus, Osphronemus goramy, Trichogaster trichopterus, Channa striata, C. gachua, Clarius batrachus, C. nieuhoffi, C. sp., Nemachilus fasciatus, Cyprinus carpio, Puntius javanicus, P. binotatus, Osteochilus nasselti, Lissochilus sp., Labeobarbus sora, Rasbora sp.*

2.2.3 Biomass

Table 1. Submerged Macrophytes [g (wet. wt.)/m^2].

Station	Potamo-geton sp.	Myriophylum spicatum	Others	Total
Lotung	2,470	130	‹ 25	2,600
Onan Runggu	2,800	150	0	2,950
Parbaloan Urat	1,833	310	520	2,663
Tongging	1,947	157	‹ 25	2,104
Lumban Sitorus	150	1,640	0	1,750

2.2 Hydrometeorological Features of the Lake and its Drainage Basin

The pattern of wind speed and direction varies for the lake. During January to April, the wind speed can reach 4 m/s, in June 8.8 m/s, and in October 7.1 m/s. If strong winds blow during June to October, large waves as high as 1.8 m may be induced.

Table 2. Climate Data at Balige.

	Mean Temp. (°C)	Precipitation (mm)
January	19.1	174
February	20.1	167
March	20.9	187
April	20.5	193
May	21.0	133
June	20.7	104
July	21.2	71
August	21.0	116
September	21.0	132
October	20.4	215
November	20.5	188
December	20.2	199
Annual	20.6	1,879

Source: Based on Nontji (1990).

Surface water temperatures at various locations (°C): Haranggaol: 27; Tigaras: 27; Tomok: 26; Simanindo: 27; Pangururan: 27; Nainggolan: 27; Parapat: 27; Porsea: 26. Solar radiation averages 15.7 MJ m^2/day.

Measurements for pH and chemical oxygen demand (COD_{Cr}; mg/L), respectively at seven stations along the coast of Lake Toba: Lotung: 8.4 and 6.7; Situmeang: 7.9 and 6.8; Bukit: 8.4 and 9.3; Tongging I: 7.0 and 6.3; Tongging II: 7.9 and 7.0; Onan Runggu: 7.6 and 7.0; Parapat: 8.2 and 8.0.

2.3 Geophysical Features of the Lake and its Drainage Basin

The geology of Lake Toba has been a challenging topic to study. The formation of this lake is the result of mega-volcanic activity during the Quaternary Era (the last two and a half million years of the earth's geological history). From a very broad analysis, this phenomenon was the result of two major plates colliding, beginning during the Eosen Era (about 65 million years ago); namely the Indian Ocean or the Australian plates in the southwest and the Asian Plate in the northeast. This plate collision produced a long subduction zone, accompanied by a volcanic chain along Sumatra-Jawa-Nusa Tenggara, up to the Moluccas Islands. In Sumatra, it resulted in a large, long transform fault, the Sumatra Fault Zone (SFZ). This 1,700 km long fault is exposed from the Bay of Lampung in the south, to the Aceh region in the northern end of Sumatra Island. Lake Toba is not dissected by this SFZ, being located about 20 km northeast of this fault. In contrast, the Batang Toru and Renun Rivers are located and flow along the fault.

Two major explanations of the lake's geohistory suggest it was either (a) the product of one single gigantic explosion, or (b) a product of multiple events. Each of these two major hypotheses also has smaller sub-explanations. There have been lively debates on the geological timing of the events; namely whether or not they occurred recently (i.e., less than 75,000 years ago) or whether they resulted from a series of geological up-doming, blasting, faulting, sedimentation, and up-wrapping that took place since two million years ago.

Lake Toba has lately been reported as being the largest caldera lake in the world. This conclusion was based on a report by van Bemmelen, who described the lake as a volcano-tectonic depression. According to van Bemmelen's hypothesis, the lake history began with the formation of a Batak Tumor, with an oval-shaped, 300 km by 150 km region, located between the present Wampu River in the north, and the Barumun River in the south. The up-doming produced a region with elevations up to 2,000 m, as shown by the tops of such mountains as Mt. Sibuatan (2,457 m) in the northwest, Mt. Pangulubao (2,151 m) in the east, Mt. Surungan (2,173 m) in the SE, and Mt. Uludarat (2,157 m) in the west.

Combined with previous scientific studies by Marel (1947), Tjia and Kusnaeny (1976), Karig et al. (1979), and Hamilton (1978), we concluded that the formation of Lake Toba was not a single event, but rather a combination of complex events. It was the product of a series of events occurring east of the Sumatra Fault. Similar results were encountered in study sites in the Lampung area and Maninjau. These series of events are closely related to the deep-seated occurrence of the Sumatra Fault, starting about two million years ago.

2.4 The Watershed and Jurisdictional Features

The Lake Toba watershed covers an area of 3,704 km^2, embracing a part of the areas of five Kabupaten (district) level government administrations (i.e., the Kabupatens), named Tapanuli Utara, Toba Samosir, Simalungun, Dairi and Karo. Land use (as of 1999) is dominated by scrub (41%), followed by forest (22%), paddy field (14%), settlements (11%), grass (8%) and dry land (4%). Within the Lake Toba region, there are areas reserved specifically for conservation purposes, including such functions as water re-absorption, air pollution control, ground stabilization and soil erosion prevention.

Kabupaten Toba Samosir, with its twelve kecamatans (subdistricts) governs the largest portion of the watershed (64%), followed by four kecamatans of Kabupaten Tapanuli Utara (21%), five kecamatans of Kabupaten Simalungun (10%), one of Kabupaten Karo (3%) and one of Kabupaten Dairi (2%). The twenty-three kecamatans of the five districts included in the Lake Toba watershed are: Sianjur Mula-mula, Harian, Simanindo, Pangururan, Palipi, Onanrunggu, Onanrunggu Timur, Lumbanjulu, Porsea, Silaen, Laguboti and Balige of Kabupaten Toba Samosir; Silimakuta, Purba, Dolok Pardamean, Sidamanik and Girsang Sipanganbolon of Kabupaten Simalungun; Doloksanggul, Muara, Lintongnihuta and Siborong-borong of Kabupaten Tapanuli Utara; Merek of Kabupaten Karo; and Sumbul of Kabupaten Dairi.

2.5 The Past Social and Economic Development History and Trends

The Lake Toba drainage basin contributes a sizeable share of the regional, if not the national, economy. The natural beauty and the richness of Batak culture have given rise to the tourism industries that provide economic benefit to the communities living in and around the lake. The unique geographical position of Lake Toba preserves many economic potentials for the benefit of the wider range of the lake basin communities, especially as a source of bountiful fresh water and lush tropical forests, which attract the interest of big industries to invest in these areas.

2.5.1 The Watershed Population

The communities in the Lake Toba watershed are part of the group of 366 villages within five kabupatens. Based on 1999 statistics, the population living in the watershed is 590,861. The lowest population density of 18 persons/km^2 is recorded for the sub-district (kecamatan) Sumbul of District (Kabupaten) Dairi, while the highest density of 355 person/km^2 is in kecamatan Balige of Kabupaten Toba Samosir. A population density higher that 200 persons/km^2 is recorded in kecamatans along the routes of major economic activities, especially along the trans-Sumatra highway. There is no clear indication of how it was determined, but the North Sumatra provincial government states that the majority (63%) of the Lake Toba basin population belongs in a poor category.

2.5.2 Agricultural Activities

Farming, cash crops production, fishery, raising animals, and the tourism industry are the main economic activities in the Lake Toba basin. The sector that has proven capable of supporting the livelihood of the population is food crop production. The agricultural sector remains the mainstay of the majority of people living in the Lake Toba basin. The rice fields within the watershed cover an area of 41,123 hectares (1999). With an average yield of 5.2 tons of dry rice per hectare, the basin could reach a production level of approximately 250,000 tons of dry rice annually. Rice growing is common in all the kecamatans, but the production centers are in kecamatans Porsea, Lumbanjulu, Balige and Silaen of Kabupaten Toba Samosir; kecamatan Doloksanggul of Kabupaten Tapanuli Utara and kecamatan Sidamanik of Kabupaten Simalungun. During the economic crisis of 1997, the agricultural sector was the mainstay for the population, especially when the tourism industry also declined.

The communities living on dry lands grow cash crops, particularly coffee, coconut, cloves, pili nut and cinnamon bark. The total cash crop production area in the basin is 8,640 hectares. Coffee is the most important crop, since it is grown in all the kecamatans and is to some extent the primary income source upon which the livelihoods of families depend. It is estimated that coffee growing provides job opportunities for more than 27,000 families, with a production of 4,000 tons of coffee beans annually. Raising animals, especially pigs, cows, buffaloes, and poultry is done by families as a side job.

2.5.3 Fishery

Fishing is an activity of communities of five kecamatans located directly on the shoreline. It is undertaken in two ways, mainly fishing in open waters and fish culture in floating cages/nets. The total catch from the open waters is close to 1,500 tons per year, consisting mostly of six fish varieties (Cyprinus, Tilapia, Oreochromis, Puntius, Clarias, Ophyocephalus). Since 1996, the total fish catch has been declining by 5.13% annually, probably due to an increasing number of fish predators, and a decrease in the natural fish sustenance in the lake.

Fish culture in floating cages ('karamba' in the local language) is practiced by individual farmers, as well as private enterprises, mostly foreign investment companies. It is suspected that the leftover pelletized feed used in the fish culture (by individuals and companies) has polluted the lake water. There were once 1,382 floating cages owned by domestic and foreign companies, of which 862 (62%) were in Kabupaten Simalungun, with the remaining 520 (38%) in Kabupaten Toba Samosir. The fish cages owned by the individual farmers of the five kabupatens included in the Lake Toba watershed comprise 1,694 units, mostly located in the Kabupaten Toba Samosir (75%). The number of fish cages has increased sharply over the last few years, especially those owned by foreign investors. There is an estimated 150,000 fish cages floating in the lake today. The average size of the cages owned by domestic and foreign companies is 6x6 meters, whilst those owned by individual farmers averages 2x2 meters.

2.5.4 Tourism

From an aesthetic point of view, the attractiveness of Lake Toba lies in its internationally renowned natural beauty. Seen from almost any angle, it is said that the charm of the lake can make a person become enchanted with a feeling of ecstasy. The beauty of each corner of Lake Toba, the array of green hills that make up the Bukit Barisan mountain range, dressed with adorning waterfalls, are nothing new to this North Sumatra tourist attraction. The island of Samosir and the coastline of Lake Toba are the birthplace of Toba Batak culture, and home of invaluable historical and cultural relics. It is in this place that the Batak culture is alive and manifested in its genuine form. Modernization has caused population migration and there are more Batak living outside the region today than those who remained in the vicinity of Lake Toba. Yet, this hometown remains the core of their identity as Batak in spite of their living in distant places (Lake Toba Heritage Foundation 1999).

The total population of the five main tourist spots in Lake Toba, consisting of Tomok/Simanindo, Balige, Porsea, Ajibata and Parapat, is 102,477 persons, about 17% of the total population of the entire Lake Toba watershed. The tourism industry has enhanced the development of 168 hotels from the traditional Batak home-stay up to four-star hotels. Although no systematic record was made, the crisis that later impacted the Indonesian economy caused the number of tourists visiting Indonesia to plunge drastically, bringing with it a reduction in corollary businesses, both in trade and in services.

2.5.5 Industry

The Lake Toba basin industrial potential was revealed since 1982, with the development and operation of PT Inalum, an aluminum smelting plant, which needs a great quantity of electric power produced cheaply from the Asahan River hydroelectric generator. PT Inalum is a joint venture company between the Government of Indonesia and Nippon Asahan Aluminum Co. Ltd. of Japan, with an initial capital of 411 billion yen (approximately US$2.4 billion equivalent at the time). The share ownership composition is 41.8% by the Indonesian government and 58.2% by the Japanese company.

PT Inalum has two headquarters, one at Kuala Tanjung downstream of the smelting plant, and one at the power generator at the Asahan River. The company produces 225,000 tons of aluminum per year, while the power generator produces a total of 603 MW of electricity in two plants (Sigura-gura - 286 MW; Tangga - 317 MW). To produce 450 MW of electricity and to propel the eight turbines in the two generating plants, a water discharge of 105 m^3/second must be provided by Lake Toba. At the same time, PT Inalum provides at least 2,500 job opportunities for the local population.

The exploitation of the basin's forests began in 1985, when PT Inti Indorayon Utama (IIU) established a pulp-and-rayon processing plant, taking the needed raw materials from the forests in six kabupatens (Dairi, Karo, Simalungun, Tapanuli Utara, Toba Samosir, Tapanuli Selatan). The capital investment for the plant totaled US$40 million, with the plant being located in the village of Sosorladang, Kecamatan Porsea, Kabupaten Toba Samosir. The selection of the plant location was made at the central government level. Indorayon is 62% owned by the Singapore-registered Asia Pacific Resources International Holdings Ltd., which is listed on the New York Stock Exchange. The remaining 38% of Indorayon is owned by the investing public, cooperatives and a number of shareholders from Finland.

The operation of Indorayon was based-on the Joint Decree signed by the Research Minister and Environmental Minister, which gave the green light for the plant's construction and operation in 1986. Indorayon has produced 1.8 million tons of pulp over the ten-year period from 1988 to 1998. It also produced 0.25 tons of rayon fiber as the raw material for textiles between 1993 and 1998. Production of these two materials was estimated to have consumed around 10 million cubic meters of wood.

For its business operation, PT Indorayon secured a total of 269,060 hectares of forest concession, covering forest areas in Kabupatens Tapanuli Utara/Toba Samosir (167,943 hectares), Tapanuli Selatan (41,818 hectares), Dairi (31,627 hectares), Simalungun (22,533 hectares), and Tapanuli Tengah (5,139 hectares). It is not clear what portion of the concession area belongs within the Lake Toba watershed. However, what is obvious is that the total concession area awarded to PT Indorayon is four-fold the area of the Lake Toba watershed forests, while the total number of laborers employed from within the basin is only 7,294 persons, a mere 3% of the population of Kabupaten Toba Samosir that lives within the lake's watershed.

2.6 Institutional and Managerial Features

Based on Act No. 22 Year 1999 on Regional Autonomy, the North Sumatra Province is responsible for coordinating certain issues involving two districts or more. In this case, the management of Lake Toba involves five districts sharing the watershed (Toba Samosir, Tapanuli Utara, Simalungun, Karo, Dairi), plus two other districts located downstream on the Asahan River but that have indirect influences on Lake Toba (namely Asahan and Tanjung Balai).

2.6.1 The Level of Institutional Development and Managerial Capacity

The official institutions that are supposed to be responsible for the preservation of the Lake Toba region are the provincial government of North Sumatra and the local governments of the five districts in Lake Toba region; namely, the BAPEDALDA of North Sumatra (provincial-level Environmental Impact Management Agency) and the BAPEDALDAs of the five districts. To the present time, BAPEDALDAs' activities focus on the study of the environmental condition of the Lake Toba region, although efforts to coordinate the preservation efforts and initialize partnerships with other organizations have not yet been performed.

2.6.2 The Level of Interest Group and Community Awareness and Involvement

Environmental problems concern all stakeholders. Cooperation at the local level between the communities, NGOs and other environmentalists has to be supported with community empowerment, as the foundation of the preservation efforts in the Lake Toba region. There are a number of successful implementations of community programs at the local level, supported by local government, national and international NGOs, and international agencies such as UNESCO. The pilot project of the community-based watershed management, conducted by LakeNet in association with Lake Toba Heritage Foundation (LTHF, or in Indonesian, YPPDT), is one example. Other examples include the cooperation between the BAPPEDA (Planning Board) of the Kabupaten Tapanuli Utara with the Hanns Seidel Foundation (HSF) in reforestation of critical land with the planting of coffee and cinnamon trees in a nine-hectare area in Palipi village; the use of water hyacinth for cattle food and composting in Pangururan village, Samosir Island; and solid waste management of Muara town in the southern part of Lake Toba. All these activities involve the local community, and have contributed to the improvement of both the environment and community income.

Over the past few years, UNESCO has supported three local NGOs in the Lake Toba region (i.e., YAPIDI (the Pijer Podi Foundation), YES (the Sumatra Eco-tourism Foundation), and GKPS (the Simalungun Protestant Church Organization)). YAPIDI worked on the 'Human resources participatory

development in Sikodon-kodon and Tongging villages' project, which focused on micro-credit, organic farming, tree planting and training for women's groups. This NGO has prepared to get involved in the development of community radio under a UNESCO communication project in Indonesia. YES proceeds with its activity in improving the local economics through the conservation of critical land in Paropo village, a town in the northern part of the lake shoreline that was also included in LakeNet's watershed management pilot project. GKPS made good progress in its 'Environmental preservation in Nagori Sihalpe village'. The success of the village's tree planting activities won the first award in the Kabupaten Simalungun's Environment Day, receiving a badge of appreciation from the President of Indonesia. Successful outcomes also appear to be occurring with organic farming, cage fishing and waste management in the villages.

There are certainly more activities at the grassroots level in Lake Toba region than have been implemented by other NGOs or community groups. Unfortunately, there is no record of the numbers of active NGOs in the Lake Toba region. Moreover, there is no adequate documentation or reporting system of their programs that could serve as a reference. For these reasons, UNESCO sponsored a national workshop in early 2000 on 'Strengthening communication and local capacities for community-based participatory environmental management of Lake Toba' on Samosir Island. This workshop was administered by LTHF, with 20 out of 70 participants being local NGO representatives. The remaining participants were representatives of universities, LIPI (Lembaga Ilmu Pengetahuan Indonesia, also known as the Indonesian Institute of Sciences), local government agencies, press and international agencies (e.g., UNDP, UNESCO).

3. Biophysical Environment

Changes in the Lake Toba region, such as reduction of the lake's water level and pollution of the lake, directly affect the social and economic situation of the region and, most importantly, pose a great threat to the biophysical environment, often seen most clearly in localized areas.

3.1 Past and Current Conditions

The first topographic sketch map of the lake region was made in 1887 by F. van Brenner and van Mechel. In 1909 and 1913, the Porsea and Siruar regions (regions around the Asahan River draining the lake) were washed by severe floods. In conjunction with these events, the Batu Bongbong near Siruar that obstructed the Asahan river outflow was blasted away in 1915. Next, the Dienst voor Waterkracht en Electriciteit first planned in 1918 to construct a hydropower plant in the Asahan River.

Currently only 70 out of 202 rivers discharging into Lake Toba flow continuously all year round. According to historical studies by Sastromijoyo (1990), the discharge from Lake Toba has shown a decrease during three phases:

- Period 1920-1932: Average inflow discharge to Lake Toba = 110.4 m^3/s
- Period 1957–1975: Average inflow discharge to Lake Toba = 104.4 m^3/s
- Period 1976–1988: Average inflow discharge to Lake Toba = 90 m^3/s

The water level of Lake Toba has suffered a continuous decline. Statistical data from 1982-1998 recorded by the Provincial Office of the Department of Mining and Energy in North Sumatra indicated a drop in the lake's water level, although perhaps not as great as the community indicated. In January 1984, the water level reading was 905.14 m above sea level; in September 1998 it was 902.66 m, a drop of only 2.48 m. Even in July 1998, the water level was as low as 902.28 m, a drop of 2.86 m.

The rainfall data are discontinuous, thereby offering only poor proof of whether or not there has been any significant change. Nevertheless, the indications are that a decline on the order of 10% may have occurred (Anonymous 1990). Other factors, such as land use changes, may have contributed to an important part to the change.

3.2 History of Lake Degradation

Pollution from domestic wastes has affected the lake's water quality. In the 1970s, there were no signs of water hyacinth on the lake. Since the 1990s, however, they have been observed floating in the Parapat area. The Secchi disk reading of the water column in the center of the lake in 2001 was 11 m, while in the Bay of Parapat near the Ajibata harbor it was less than 2.8 meters.

Local government/farmers have introduced "alien species" of fish that can infiltrate (swim) into the entire lake area. These alien species may have to adapt to their new environment. Adapting, however, might also mean 'will dominate' the ecosystem. An additional problem is cage aquaculture. The fish food poured into the lake increases the water pollution problems. Fish cage culture started to develop in the mid-1990s and has contributed to the pollution of the lake water. In 2003, extensive fish cage culture developments existed along the northern Bay of Sigapiton, in Tomok, Simanindo, and Pangururan at Samosir Island, and in Haranggaol.

The water quality in Lake Toba during the last few years has suffered obvious deterioration. The oil content of the lake water has reached a concentration of 7.5-35 mg/l. The lake also has suffered biological water pollution, as indicated by the presence of pathogenic bacteria such as fecal coliform at levels of 1,000 mpn/100 ml, and total coliform at 20,000 mpn/100 ml of water (Parlagutan Siahaan 1999).

A water quality measurement study conducted by the Environmental Impact Management Agency (BAPEDAL) in

1993, in collaboration with the Bogor Institute of Agriculture, indicated degradation of water quality at several beach areas, particularly the water in the vicinity of Tigaraja-Ajibata, Tomok and Pangururan (on the island of Samosir), and at the kecamatan of Balige (in Kabupaten Balige). In 1994, the water quality in the surrounding rivers exhibited excessive pollution, with a measured biochemical oxygen demand (BOD) of 28 mg/l BOD (5 mg/l is considered good). It is estimated that this level will increase 1.5 times by the year 2010. The pollution level in the lake along the shore is evidenced with a BOD value ranging between 6.9 mg/l to 52.2 mg/l, and also estimated to increase 1.5 times by 2010.

It also was found that, in Ajibata and Tomok, oil slicks were spreading up to a radius of 150 meters from the beaches. From an aesthetic point of view, this has made the beaches less attractive. Although the pollution caused by fuel and oil residues from water transportation does not produce a major water quality impact, it is estimated that about 14.2 m^3 of oil is spilled into the lake annually. There are about 190 boats operated in Lake Toba, with an average capacity of 40 persons per boat. Another indicator suggesting water quality degradation in the lake is the growth of aquatic plants, especially water hyacinth, in a number of places. Water hyacinth and other aquatic plants indicate that the eutrophication process in the lake water is progressing, especially near the shorelines.

The provincial government has identified major problem areas to be considered in the Lake Toba region, as follows (Coordinating Board for Lake Toba Basin Ecosystem Conservation 2003):

- *Water quality and water balance due to the operation of industries and water use by inhabitants* — Due to the low level of hygienic behavior by the basin inhabitants, untreated domestic wastes are channeled directly into the lake.

- *Land use and land tenure* — Land use changes have been initiated that disregard conservation principles, causing the condition of the land to become more critical and more susceptible to erosion. Farming practices that disregarded conservation technology aspects lead to the production of fertilizer and pesticide residues from agricultural activities. Land tenure by the marga (clan) has made it difficult to practice soil conservation measures and sustainable land use.

- *Air pollution due to toxic gas emission from industrial plants and smoke produced by forest fires and trash burning for land clearing* — During the dry season, forest fires occur frequently and trash burning is generally practiced in land clearing activities for estate crop development, industrial forestry concession, animal shepherding, etc. These activities produce air pollution and degrade land and water systems, ultimately causing natural disasters in the form of flooding and landslides, and in the extinction of flora and fauna.

3.3 Lake and Drainage Basin Resource Conflicts

Two major industries in the Lake Toba drainage basin have been identified, especially by the communities living around the lake, as being the most responsible parties for the observed decrease in the water level of the lake. The traditional fishermen suffer most from the declining lake water level. The aquatic plants and shrubs in the shoreline that comprise fish habitat wilt and die because of the lack of water. The fish go farther into the deeper water of the lake, making it difficult for fishermen to catch fish with the traditional hooks or nets. The community fish cages do not function under such conditions, because they now hang in the open air. Fishermen can catch one to two kilograms of fish daily, in contrast to the previous level of five to seven kilograms. This condition has caused an increase in the number of poverty enclaves throughout the lake basin.

3.3.1 Deforestation

Forest clearing by PT Indorayon for raw materials in its industrial activities has been identified as the main reason for the lake's decreasing water level. As an example, the lake community pointed out that the company cleared up to 3,000 out of 4,000 hectares of pine forest in the kecamatan Ronggur Ni Huta, Samosir. In its place is young Eucalyptus growth about three to four years old. The community claims that eucalyptus consumes water more greedily; thus, it does not behave like a water catchment area, rather being the other way around. This conclusion, however, was denied by the Forestry Research Center at Pematangsiantar, which instead suggested that broad-leafed plants, such as eucalyptus, with a smaller number of stomata, are using less water, compared to the needle-leafed ones (e.g., pine trees). The impact, however, has not been studied comprehensively and deserves further attention in the future. One important aspect to evaluate pertains to the changes in soil quality due changes in land use.

During its operational decade, Indorayon has a rather poor record in regard to matters concerning pollution and environmental hazards, including the social-economic aspects affecting the surrounding community. A number of examples can be cited, including the leakage from tanks containing toxic gaseous chemicals in 1993, whereby approximately 5,000 people from the neighboring villages had to flee their villages; uncontrolled disposal of waste materials from the plant with a strong nauseating smell has drawn thousands from Porsea community to urge that the plant operation be closed down. The downstream communities claim that yields from rice fields and freshwater fish culture are continuously declining, because the Asahan River on which their economic activities depend is heavily polluted. The rejection by the local population of the smell produced by the factory has temporarily closed the plant. It is now reducing its total activity to only producing pulp, with a promise to provide better wastewater treatment.

The Indorayon plant required 400,000 cubic meters of water per day for processing, taken from the Asahan River. The used water was then returned to the Asahan River, undoubtedly mixed with various toxic materials derived from the processing chemicals and substances originating from the wood, as well as substances produced from the reaction of both sources of chemicals. Of particular concern are toxic substances of the AOX category (Absorbable Organic Halides), such as dioxin, pentachlorophenol and trichlorophenol. These are the sources of substances in the liquid effluent (Lake Toba Heritage Foundation 2000).

Apart from the above-noted toxic substances, various gases and vapors were released into the atmosphere during the processing of pulp, rayon, and the production of process chemicals the majority of which were toxic and foul smelling. Although the most objectionable effect felt by the community at that time was the odor, the toxic effect is the most alarming aspect over the long term. The majority of gasses released from the pulping process are collectively known as Non-Condensable Gasses (NCG), especially H_2S and MMC (methylmercaptan).

3.3.2 Water Use

In addition to Indorayon, the lake community and other lake stakeholders also accused PT Inalum hydroelectric as being another party responsible for the decreased lake water level. Electricity is the critical element for PT Inalum activities. Aluminum smelting needs a great deal of electric power generated from the Sigura-gura and Tangga plants, which rely solely on the Asahan River, Lake Toba's only discharge outlet. The problem is that the discharge of the Asahan River cannot be arbitrarily increased without detrimental effects on the water level in the lake.

From a technical perspective, to operate eight turbines to generate 450 MW of electricity, the Asahan hydroelectric plant requires a water discharge of 105 m^3/second, which requires that the lake water level stay at 905.5 m above sea level. In mid-July 2002, the water level was as low as 902.5 m, a critical level for Lake Toba. To prevent further decreases in water level, the Asahan hydroelectric used only 80 m^3/second of water, which means idling some of the turbines. The generated electricity becomes less than 450 MW, thereby causing the ingot production to drop to 180,000 tons per annum, or about 80% of capacity. For this reason, the company claims that it is operating at a financial loss because they are unable to produce at full capacity.

The biggest advantage obtained by the communities in North Sumatra from the existence of Inalum is the improvement of the infrastructure which, in turn, encourages regional development in several support sectors. When the hydroelectric plant was under construction, the only access for heavy machinery and the giant turbines was through the port of Belawan. As a consequence, major improvements to the road connecting Belawan and the upper part of the Asahan river were made. To enable them to hold big trucks and trailers lugging heavy containers and machinery, new bridges with hundreds of tonnes of capacity were built. The construction of the PT Inalum site was accompanied by the development of a new, 200-hectare town called Tanjung Gading, some 16 km from the smelting plant at Kuala Tanjung. Tanjung Gading was built from nothing on a swampy land area. With a total of 1,340 housing units, Tanjung Gading helped develop the east coast of North Sumatra. Presently, the approximately 10,000 people of the new town have been provided employment in a location that used to be secluded and very lonely.

Apart from the aforementioned advantages, the hope for the communities around Lake Toba to obtain cheap electricity to enable them to develop small scale and home industries is seemingly difficult to materialize. The Asahan hydroelectric plant was expected to deliver the excess energy to the communities of Porsea, Parapat and Balige, in addition to selling it to the state-owned electric company PLN II (Perusahaan Listrik Negara Region II), which is responsible for providing electricity for North Sumatra Province including Lake Toba region. However, as a result of the decreased water level in Lake Toba, the reverse is happening; PT Inalum buys 60 MW of electricity from PLN every month. It has been twenty years since PT Inalum started operation in 1982, and the Toba communities remain unchanged with their home economy still dependent on rice cultivation.

3.3.3 Cage Aquaculture

Cage aquaculture in Lake Toba over the last couple of years continues to expand and intensify, with most cages being owned by foreign investors. From an economic perspective, especially considering the recent economic crisis in Indonesia, it is often viewed as desirable to generate employment, income and food, and support for other activities, while also increasing local government income. On the other hand, cage aquaculture also has its disadvantages. Wastes from the cages are freely released into the environment, potentially interacting with the entire lake. Intensive cage culture, when unregulated, can cause severe environmental problems. Cage farms in lakes and reservoirs are thus vulnerable, both to general pollution and to self-inflicted water quality-related problems, in addition to social conflict due to social inequity. Appropriate regulation, based on a better understanding of the technical, environmental and socio-economic conditions is needed. Participants at several previously-held community meetings, especially the boat owners and drivers, questioned the existence of 'karamba' in five locations of Kabupaten Simalungun and Kabupaten Toba Samosir. They also estimated that about 10 tons of fish food per day is poured into the lake.

3.3.4 Domestic Wastes

Maintaining a clean environment is one aspect of the Lake Toba watershed management, being highly related to the behavior of the people in the surrounding communities. The way the community treats its environment depends on its level of understanding and knowledge. Due to the low level of hygienic behavior, the lake community channeled household waste directly into the lake, including most of the hotels and

restaurants located in the shoreline of the tourist area. The scene of a family using the lake water for drinking, washing, bathing and defecating at the same spot is common in many areas. From research on Lake Toba water quality in 1993, it was concluded that human settlements are the dominant source of pollutants, ranging from 47% to 58% in all four potentially-polluted zones. The pollution of the lake from untreated domestic wastes is a household and community issue, thereby requiring recognition of specific situational social and cultural factors.

4. Management Environment

4.1 Lake Management Programs and Processes

In recent years, a management committee concept has been suggested several times by many parties, including the government, private sector, NGOs and even community groups, all for the purpose of improving management and environmental preservation in the Lake Toba basin. However, turning this concept into reality has proven difficult because of differing perceptions and conflicts of interest among the stakeholders. The establishment of a management committee in Lake Toba is very important if a coordinated preservation and collaborated effort among the various parties is to be achieved.

In the absence of such a management committee it will be difficult to develop a common vision among the stakeholders and, as a result, the environmental preservation effort will only partially work, regardless of who takes the initiative, whether it is the government, NGO, private sector or the community groups. The impact of the efforts, therefore, will be negligible or nonexistent. The nature of the activities, which generally comprise a crash program, indicate the absence of a planned, sustainable program implementation.

4.1.1 Establishment of Coordinating Board for Lake Toba Basin Ecosystem Conservation (CBLTEC)

Apart from the pros and cons for establishing a management committee, in May 2002, the Governor of North Sumatra, through a Letter of Decision No. 062.05/245/K/2002, named a Coordinating Board for Lake Toba Basin Ecosystem Conservation. The Board consists of the related government agencies, both provincial and kabupaten, and the representatives of two NGO's, including LTHF at the national level and Yayasan Peduli Samosir Danau Toba (YPSDT) or 'the Samosir Lake Toba Foundation' at the provincial level. Two kabupaten level administrative governments are included among the membership, together with the five kabupatens within the Lake Toba drainage basin area. The latter two are Kabupaten Asahan and the municipality of Tanjung Balai. The responsibility of the Coordinating Board includes the formulation of the general policy and coordination of efforts and initiatives taken by the different stakeholder components, including monitoring of environmental impacts, rehabilitation efforts, and mobilization of community participation.

To assist the Coordinating Board, the Governor also formed a Technical Advisory Committee, with members consisting of representatives from provincial level technical agencies, a number of universities and research institutes, and the Asahan River Authority. It is hoped that the Coordinating Board can help solve the possible conflicts arising from the different interests among different stakeholders in the Lake Toba drainage basin. Figures 2 and 3 illustrate the organization structure of the Coordinating Board and the Technical Advisory Committee. A well-planned, comprehensive program and systematic implementation of needed efforts in the Lake Toba basin does not yet exist. The newly-appointed Coordinating Board for Lake Toba Basin Ecosystem Conservation, however, has formulated a general policy for conservation of the lake ecosystem, which is intended as a reference and guideline for the stakeholders in planning and implementing pollution control and environmental rehabilitation programs. The General Policy for Lake Toba Basin Ecosystem Conservation was formulated on the basis of the Governor's Letter of Decision No. 660/067.K. Whether the programs as formulated in the general policy are applicable will remain a question for a certain period of time because a preparatory process also is needed, which will itself take time to complete. At the very least, the formation of the Coordinating Board and the general policy are indications that the regional government's political will hopefully can be regarded as the initial step towards Lake Toba conservation efforts.

4.2 Reduction of Lake Stresses

4.2.1 Legislative Framework

Although seemingly small and preliminary, the efforts toward environmental preservation of Lake Toba are beginning to take place with the issuance of a number of regulations at the central and regional government levels. At the national level, Law No. 23 Year 1997 on Environmental Management serves as the umbrella for the formulation of environmentally-related regional level regulations. This Law stipulates the right, the role and responsibility of the community, the authority in environmental preservation, the requirements for environmental arrangements, solutions to environmentally-related disputes, and investigations and stipulations pertaining to violations and the related consequences.

In 1999, an inter-departmental team from the central government, led by the Department of Tourism, Art and Culture, completed a draft of a Presidential Decree on Lake Toba Basin Management. LTHF was invited as a resource and reference party. Unfortunately, however, the Presidential Decree failed to get presidential signature because the draft was met with a variety of different perceptions regarding its future implications when it was introduced to the stakeholders.

At the provincial level, the government has issued a regional Government Regulation No. 1 Year 1990 on Lake Toba Basin Management, which stipulates a prohibition on construction within a radius up to ten meters from the shoreline.

In order to limit the fast-growing aquaculture enterprises owned mostly by foreign investors, the government had issued Presidential Decree No. 96 of the year 1998 concerning the prohibition of foreign investment for aquaculture in inland waters.

4.2.2 Limitations in Water Use

To counter the accusations of being the main cause for the decreasing Lake Toba water level, PT Inalum indicated it was using water within the prescribed quantity limits. The hydroelectric generator is activated only if the water reaches a level of 902.40 m above sea level and higher. To determine this level, PT Inalum built a regulating dam at Siruar, 12 km from the mouth of the Asahan River at Porsea. The Siruar gate also helps regulate the water level so as not to exceed 905.50 m above sea level, at which point many villages along the lake shoreline would be inundated. The Asahan Authority, as the governmental representative, is strictly controlling water use within the limit of 80m^3/second.

4.2.3 Changes in the Management of PT Indorayon

PT Indorayon later changed its name to PT Toba Pulp Lestari (PT TPL). The name change is in compliance with the central government decision made in May 2000 to close down the plant's rayon production, while continuing the pulp industry. PT TPL agreed to change its management style to be more sensitive to environmental concerns and more willing to work with the local community, by allowing them to practice mutually-beneficial intercropping. PT TPL also is willing to accept and support an independent institution with the needed expertise to supervise the use of natural resources. Above all, PT TPL will set aside 1% of its net revenue from the sales of its product for the Toba Samosir government, to be used for environmental management. If the annual pulp production is 200,000 tons, at a price of US$350 per ton, the Kabupaten Toba Samosir government will receive US$700,000 per year. This sum is well above the genuine regional revenue, a clearly tempting offer in this time of economic crisis.

4.2.4 Construction of Parapat-Ajibata Wastewater Treatment Plant

Parapat is one of the busiest tourist centers in the Lake Toba region. The relevant Parapat tourist area located on the shores of Lake Toba comprises about 140 hectares. The total resident population of about 21,000 people, not including the tourists, increases the problems of sewage production from households and businesses. Almost all the untreated household waste is discharged directly into the lake. As a result, the quality of the lake water has been reduced to the point that it was necessary to construct a wastewater treatment plant to address this problem.

Development of the sewerage system was necessary because of the dense population around the lake, and the number of hotels and restaurants, using a conventional system. The wastewater from households, hotels and restaurants is channeled to a main wastewater pipe. From that point, it is processed and put into aeration ponds. Through the Department of Public Works, construction of the Parapat-Ajibata wastewater treatment plant began in October 1994, with funds from an OECF sector loan. Most of the constructed 1.5 km main and secondary sewer pipes are located at Parapat town of Kabupaten Simalungun, with a 2,010 m^3 capacity sewage treatment plant with an aerated lagoon system located at Ajibata town of Kabupaten Tapanuli Utara. This facility is equipped with pump lifts at three sites, each with a capacity of 60 L/s and a hydraulic head of 5.3 m, and with a pressure pump with a capacity of 60 L/s and a hydraulic head of 41.94 m at one site.

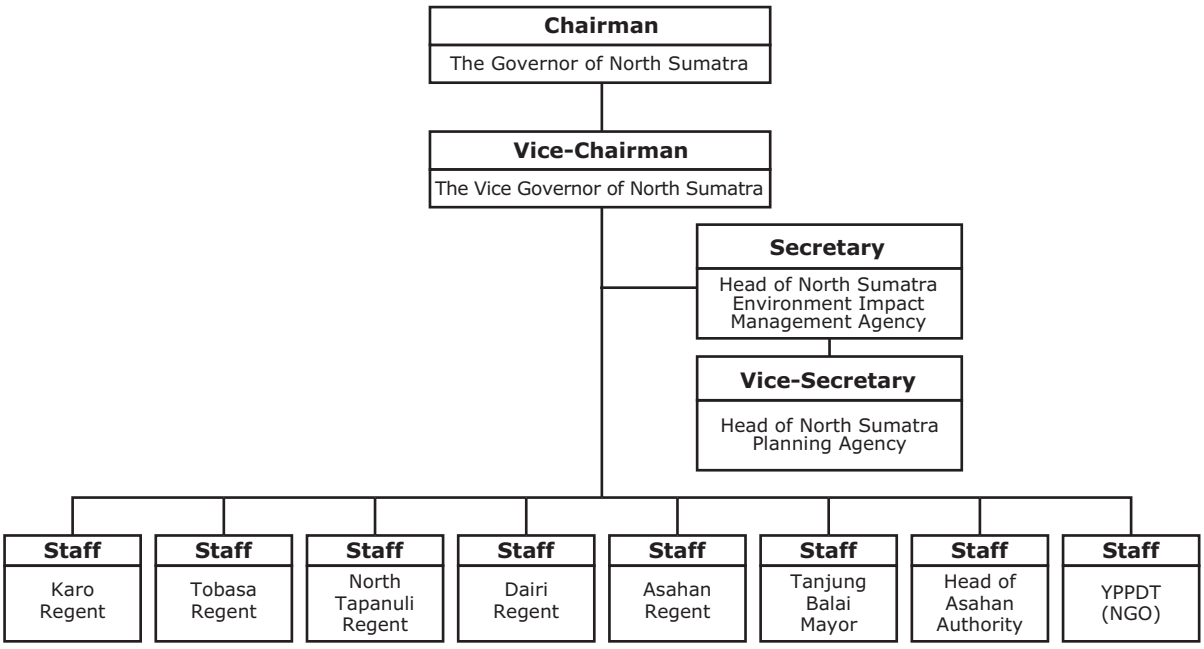

Figure 2. Organization Structure of the Coordinating Board for Lake Toba Ecosystem Conservation.

The Parapat-Ajibata treatment plant was constructed with the capacity to serve 17,400 people, and an additional 4,500 tourists per day during the high season. Until 2001, however, only 14 households and 2 hotels were hooked up to the plant, due to a lack of social marketing of the facility.

4.2.5 Critical Land Rehabilitation Program

The availability of Lake Toba water has been disturbed, particularly during the last few decades, due to the disruption in the hydrologic cycle resulting from the extensive clearing of forest cover around the lake. Thus, a priority action for the rehabilitating the environmental conditions is the reforestation of the basin, which includes 50,192 hectares of highly eroded (critical) lands (29% of the watershed area). The North Sumatra provincial government has a program to rehabilitate the vegetative cover of over 104,570 hectares of critical lands in the Lake Toba watershed. The program is divided into two parts, one being the rehabilitation of 50,192 hectares into complete forest cover, comprising production and conservation forests. The other part is the replanting of 54,378 hectares of critical lands with perennial crops (estate crops and mountain horticultural gardens). The perennial crops have two advantages; namely, serving as ground cover and also increasing land productivity to improve farmer's incomes. It is hoped that, through this program, the critical lands will turn green again, thereby also increasing the soil water-holding capacity, reducing run-off, erosion and sedimentation, and eventually improving Lake Toba's water quality and quantity and at the same time maintain soil fertility in the farmlands.

4.2.6 Community-based Management of Lake Toba

In 2001, LakeNet partnered with the LTHF to implement a pilot project on community-based watershed management program for Lake Toba. The one-year demonstration program was conducted as part of a six-year old sister lakes exchange partnership with Lake Champlain in the United States. The Lake Toba-Lake Champlain Sister Lakes Partnership began in 1996 with an exchange visit to Indonesia by the coordinator of the Lake Champlain Basin Program (LCBP), at the invitation of the Lake Toba Heritage Foundation (LTHF). The program was coordinated by LakeNet.

The Vermont Agency for Natural Resources (VTANR), in collaboration with LakeNet, applied for and was awarded a second grant of US$40,000 through a CSG/US-AEP initiative to bridge exchange programs into an implementation phase. With this bridge funding, the project partners conducted a pilot program to demonstrate ways of developing and implementing a community-based watershed action plan. The implemented project activities include:

- Selection and training of 10 environmental cadres to serve as local leaders on environmental initiatives related to Lake Toba;
- A two-week in-country study tour for environmental cadres in East and Central Java to observe and study community mobilization efforts and commitment-building in constructing, financing, managing and maintaining low-cost community-based sewer systems, a low-cost composting technique in Malang, and the harvesting and utilization of water hyacinths in Cirebon and Yogyakarta;
- Completion of clean lake activities along 5 km of the lake's shoreline in five communities. More than 770 people participated in these activities, some of which involved strenuous labor and difficult working conditions;

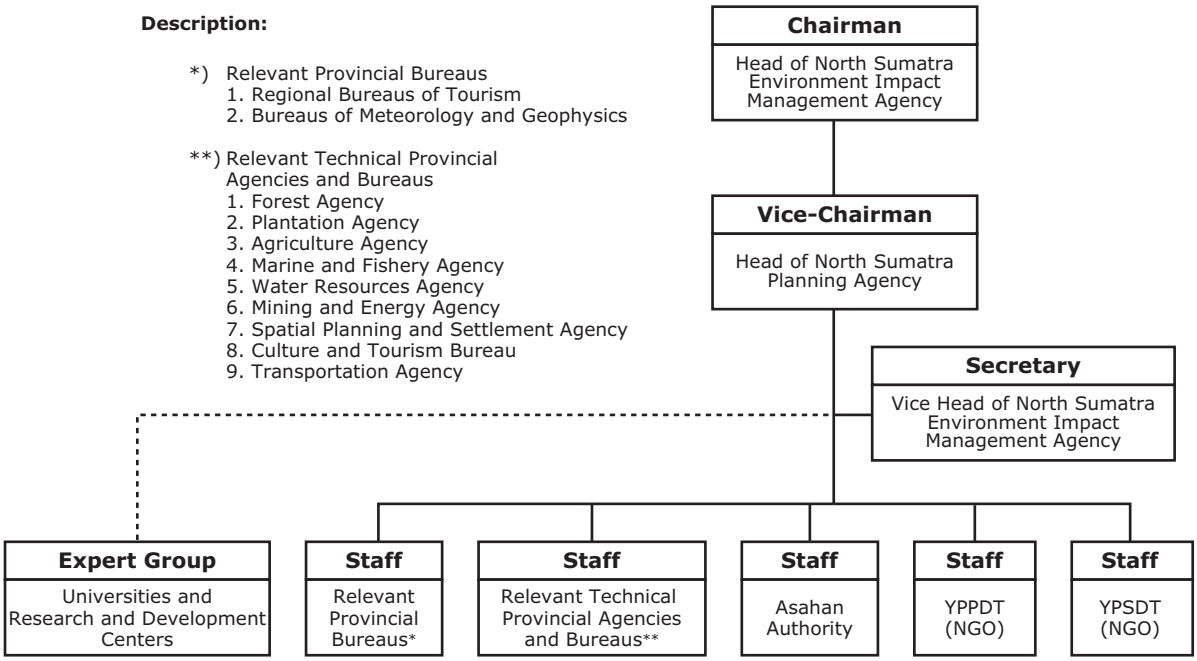

Figure 3. Lake Toba Technical Advisory Committee.

- Training in environmental education and awareness for teachers from six districts in the Lake Toba area, using a specifically developed 'hands-on learning' Water Module;

- Formulation of community action plans through community meetings involving 188 community members in identifying and discussing environmental problems and concerns of Lake Toba; and,

- An awareness campaign involving the distribution of 25,000 copies of an information brochure in the Indonesian language to promote environmental awareness.

The most important results of the implemented actions included:

- The lake cleaning activities by volunteers, including the removal by hand of large patches of water hyacinths, opened up landing areas for local fishing and ferry boats that had been inaccessible for almost three years, and at the same time reducing the invasive plant populations;

- The study tour and on-the-job training (through participation in community meetings, clean lake activities, teacher's training and brochure distribution) resulted in effective in-country transfer of knowledge to the environmental cadres. Many have demonstrated their ability to help implement and sustain activities begun during this project;

- Teachers and representatives of three universities in the Lake Toba region gained important environmental knowledge and educational materials;

- Detailed resource inventory maps and action plans were completed in five communities, using a participatory approach;

- New Lake Toba issues were identified for the first time, including the increase in the number of fish farms on the lake and their potential impacts on its water quality;

- Citizens and the community as a whole gained increased awareness of lake problems by participating in community meetings and clean lake activities;

- Boat operators gained awareness of their role in environmental stewardship of Lake Toba, as a result of meetings with this important stakeholder group;

- Local partners learned the benefits of involving people and working with the community in planning and implementation activities;

- If fully implemented, the project can be expected to have long-term social, economic and environmental impacts, given that improved sewage systems, invasive species reductions, trash reduction and improved local capacity will improve Lake Toba and community health, as well as facilitate poverty alleviation; and,

- The publication of information on the Lake Toba Online website and LakeNet's electronic forum of more than 900 members involved in lake activities around the world.

In terms of stakeholder participation in this project, almost 1,000 community members were involved in the clean lake and community meetings aimed at the formulation of community action plans. Participants included boat operators, farmers, fishermen, small traders, vendors, housewives, and hotel owners. The ten environmental cadres were chosen from grassroots participants and were central to all activities. Women were specifically targeted to be involved in the community meetings. The fact that 33% of the participants were women is a significant achievement in this regard, due to the very paternalistic local culture. The women proved to be very active and outspoken in the community discussion, making significant contributions to the local action plans. Many community members made in-kind contributions to the clean lake activities. Government officials from the local Police and sub-district (kecamatan) office were involved in the clean lake activities. The Mayor of the City of Malang and his staff provided all of the facilities needed during the study tour of the environmental cadres from Lake Toba. The Governor of North Sumatra gave his support to the environmental cadres before their departure on the study tour. Other NGOs at the national and provincial level also took part in the project. The Hanns Seidel Foundation (HSF), for example, provided the trainers and the environmental education training materials for schoolteachers. Three researchers involved in formulating an environmental education book for the elementary school children trained the teachers from the six districts of Lake Toba. Local universities surrounding Lake Toba sent their representatives to the three days teachers' workshop.

There is a big potential for community participation in the efforts to sustain Lake Toba and its drainage basin. The critical point lies in determining where and how to improve the awareness and understanding about different aspects of ecosystem sustainability, and to bridge the community awareness with real action toward sustaining the lake ecosystem, which at the same time renders benefits for improving the social economic condition of the community. This goal translates into an integrated program involving social economic improvement and sustainable environmental development. Where community members from varying backgrounds, including schoolboys and girls, hotel owners, fishermen, traders, farmers, etc., join together in various environmental activities such as re-greening, garbage collection and clearing water hyacinths, and environmentally sensitive farming practices are all positive examples of the potential to increase community awareness and involvement.

4.3 Enabling Environment

4.3.1 The Critical Policy and Institutional Framework for Management of the Lake

Before the establishment of the Coordinating Board, the Lake Toba region had been proposed by UNESCO to be designated as a Biosphere Reserve, focusing on three main activities: conservation of bio-diversity; economic and social development; and preservation of associated cultural values. With this biosphere reserves status, it was expected that Lake Toba would receive international attention and invite international participation in its development and preservation. According to the Act No. 24, 1992 regarding Spatial Planning, the Biosphere Reserve designation is identical to the designation of 'Special Region', a region with prioritized spatial planning. Designation of a region as a 'Special Region' requires a Presidential Decree, and up to the present time, this proposal has not been realized for lack of the Decree.

The general policy formulated by the Coordinating Board has resulted in the development of a comprehensive and environmentally sensitive Lake Toba drainage basin management master plan becoming a priority. The Coordinating Board must ensure that the master plan sufficiently accommodates the aspirations and concerns of all lake stakeholders. Since the enactment of regional autonomy, each kabupaten reserves the authority to manage its region, and each is trying its best to reach the highest possible genuine regional revenue target. For this purpose, all five kabupatens tend to grant permits to capital investment, with forest logging being the main resource, followed by fishery and estate crops. With the union of the five kabupatens into a coordinating board, it is hoped that a common vision and commitment can be reached and, for the sake of maintaining the sustainability of the Lake Toba basin ecosystem, that they would refrain from using the lake's natural resources in an abusive manner.

4.3.2 Stakeholder Involvement

The Lake Toba drainage basin is not only home for 590,861 local watershed inhabitants, but also a promising area that attracts outsiders, domestic as well as foreign, to invest in business undertaking. Thus, all interested parties related to Lake Toba comprise its stakeholders, including the government, the private/business sector, and grassroots level communities. The community, however, is the main lake stakeholder, since anything done in the drainage basin can have direct consequences on the lives and livelihoods of the people living in the Lake Toba watershed.

At the national level, there are at least eight institutions interested in this area, especially those with authority to give approval to foreign investment, namely the Departments of Forestry, Agriculture, Tourism and Culture, Finance, Marine and Fishery, State Ministry for Environmental Affairs, Asahan River Authority, and the Agency for Studies and Application of Technologies, which played a significant role in the initial decision on PT Indorayon.

At the provincial level, there are the Offices and Agencies of Forestry, Estate Crops, Agriculture, Marine and Fishery, Mining and Energy, Tourism and Culture, Planning Agency (BAPPEDA), provincial-level Environmental Impact Management Agency (BAPEDALDA), Meteorology and Geophysics, PDAM (Local Government Water Company) and the River and Lake Transportation Agency.

At the kabupaten level, the head of administration (Bupati) is directly involved, assisted by the related agencies in his realm of responsibility (BAPPEDA, BAPEDALDA, etc).

Although several agencies in each level of the government have been undertaking efforts related to sustaining the environmental conditions in Lake Toba, the Coordinating Board has acknowledged the weakness of coordination among the agencies within one single kabupaten as it is with one province, between the province and the kabupaten and between the government and the community. In fact, it is this sectoral approach that results in the program of one agency being alien to the mission and priorities of other agencies, which highlights the need for establishing the Coordinating Board.

In the meantime, compared to other Lake Toba stakeholders, the community participation at the grassroots level for environmental sustainability of the lake and its basin is generally better, although they must be accompanied and facilitated by NGO activities. As previously discussed in the section on the grassroots level programs, although they may seem small, they have produced tangible results in sustaining the Lake Toba basin ecosystem.

Thus, there is a big potential for community participation in the efforts to sustain Lake Toba and its drainage basin. The critical point lies in determining where and how we can improve awareness and understanding about the various aspects of ecosystem sustainability, and in bridging community attention with real action directed toward sustaining the lake ecosystem. This also will render benefits for improving the social economic condition of the community. Thus, an integrated program between social economic improvement and sustainable environmental development is necessary. A favorable indication regarding the potential for community attention is the fact that community members from varying backgrounds, schoolboys and girls, hotel owners, fishermen, traders, farmers, etc. have joined together in various environmentally-related preservation activities such as re-greening, garbage collection and water hyacinth clearing, and environmentally sensitive farming practices.

4.3.3 Monitoring and Research Capacity

Routine monitoring (e.g., rainfall) is performed by the Agency for Meteorology and Geophysics, which maintains 11 rainfall measuring stations throughout the basin. The water level fluctuations in the lake are monitored by the provincial office of the Department of Mining and Energy. In the meantime, rehabilitating and maintaining sustainability of the Lake Toba

ecosystem is a complicated, multi-dimensional problem. The root causes of the problem vary extensively, and the problems have been piling up for several decades. A number of research investigations have been conducted, including studies on water quality, analyses of the suitability of various plant species, identification of plant species diversity, and a field trial on the application of environmentally sensitive concepts in land use. But all these research efforts only partially address the problems, being focused only on some specific aspects. Further, the agencies conducting the research tend not to share their results with other agencies. There is yet no solid and comprehensive research project covering the major environmental and concerns regarding Lake Toba and its drainage basin. Some of the research/studies that have been conducted include the following:

- Study on lake water quality by the BAPEDAL, in collaboration with the Bogor Institute for Agriculture, 1993;
- Study on disturbances to the Lake Toba basin ecosystem by the BAPEDALDA, in collaboration with the Faculty of Geography, University of Gadjah Mada, 2000;
- Study on the suitability of several perennial trees to critical lands in the Lake Toba watershed, and nutrient depletion in soils under eucalyptus stands, by the Forestry Research Center Pematang Siantar;
- Study on land rehabilitation and soil conservation by North Sumatra Provincial BAPPEDA, in collaboration with Community Development Research Division, University of North Sumatra.

4.3.4 Past and On-going Financial Investments

Up to now, no specific records are available regarding the extent of capital investment for Lake Toba preservation efforts, since such programs are implemented singularly and in isolation. However, there are a few small investments that could be found in the available records, including:

- In 1996, UNESCO, in cooperation with the Government of Denmark through DANIDA, supported the publication of the newsletter 'Pesan Danau Toba' (Message from Lake Toba) (Parlagutan Siahaan 1999) as a vehicle for information exchange to accelerate the environmentally-friendly development of the region. LTHF administered the publication of 1,500 copies of the monthly bulletin;
- Lake Toba activities have received financial support from the U.S. government. Starting in 1996, the investment of U.S. federal funds over a six-year period totaled just over US$400,000, with matching funds from other sources in the U.S. totaling approximately US$220,000. These funds were used in a series of projects on Lake Toba under the sister lakes partnership between Lake Toba and Lake Champlain, including program implementation at the grassroots level.

Although there is not yet any specific commitment and confirmation regarding financing, there are at least two funding sources available for Lake Toba ecosystem preservation. For example, the North Sumatra government administration and DPRD (Provincial Parlilament) have tried to obtain clarification regarding the annual fee for Lake Toba conservation paid by PT Inalum to the government through the Ministry of Finance. Up to now, it is not clear how these funds are to be used. The accumulated fee paid from 1982 through 1999 has reached a total of US$59 million. Further, according to the North Sumatra BAPEDALDA, PT TPL has paid the local community development foundation (Toba Samosir Community Development Foundation) the funds initially agreed upon.

The Coordinating Board for Lake Toba Basin Conservation is unable to identify the level of funding available for maintaining the sustainability of the lake's drainage basin. Rather, it only indicates that the potential funding sources would be the Central Government Budget (APBN), Provincial Government Budget (APBD), Kabupaten Budget (APBD), national and international NGOs, and other non-binding sources.

4.3.5 Global Network

Lake Toba has greatly benefited from the Sister Lakes Partnership with Lake Champlain in the State of Vermont in the United States. In 1996, a delegation from Lake Toba consisting of government representatives, the business and industrial sector and the university visited Lake Champlain to observe and learn the concepts of integrated management implementation of a lake drainage basin in a systematic and economically-profitable manner. The delegation from Lake Champlain also visited Lake Toba in 1999 to observe the potential and the problems faced in the Lake Toba drainage basin. The "people to people" exchange has proven to be a very effective learning medium.

5. Lessons Learned

5.1 Stakeholder Involvement is Key to Program Design, Implementation and Effective Action

A new management paradigm for Lake Toba drainage basin conservation, particularly in the context of coordination among stakeholders, covering community groups, NGOs, the private sector and the government, must be created and strengthened. With an integrated and coordinated approach, it is anticipated that a synergetic effort could become reality. This will result in establishing common priorities, mutual understanding in the approaches to be applied, and prevention of duplication and overlapping of sometimes conflicting activities. Achievement of the above will help make a sustainable development process in the Lake Toba drainage basin become a reality.

The establishment of the Coordinating Board at least highlights the political will of the North Sumatra provincial government in its effort in managing Lake Toba. Most of its members are ex-officio, although several represent regional and national level NGOs. Being newly appointed, the effectiveness of the Board

has yet to be demonstrated, which may take a considerable period of time. In the long run, however, the Coordinating Board could become a very strategic institution if it can maintain a continuing community development effort and reconcile the different interests of the various stakeholders, thereby allowing them to work synergistically together, including filtering out any exploitative conduct in natural resource-based economic activity. The Coordinating Board must be able to maintain continuation in building synergism, coordination and sustainable development of Lake Toba drainage basin, including regular monitoring, in order to allow timely corrective measures if any deviations in the development implementation become necessary.

The involvement of environmental stakeholders at all levels is indispensable, one being the grassroots community. Management of the Lake Toba watershed is impossible without the involvement of the communities living in it. The adoption of participatory approaches into the development projects in Indonesia has been increasing over the past several years. During the past three decades, the government of Indonesia has used a centralized, top-down approach in many development sectors, which resulted in many abandoned infrastructures and facilities with large investments. The political changes in 1998, however, created a greater autonomy for the provincial and local governments, thereby facilitating a greater chance for direct community involvement in development activities.

Field observations have convinced many, including development practitioners, that the participation of the community in the decision-making process greatly influences the implementation and sustainability of projects. The participatory approach is an effort to solve common problems through the use and building of community knowledge regarding matters related to the problems. A dynamic, demand-based and change-oriented participatory approach can improve the concern and capability of communities by giving them skills to analyze and solve their own problems. The participatory data and information collection and inventory process by the community stimulates the sense of belonging and involvement in the implementation of the plan they themselves developed.

Community-based activities with a significant participatory approach will hopefully bring into the policy development process the voices of an often-excluded principal stakeholder group — the community. From the experiences of community-based project implementation in the Lake Toba region, policymakers can draw insight regarding what works and why, and use that knowledge to create strategies to bridge the gap between national or regional policy and local practice. Through the application of dialogical approaches combining bottom-up and top-down program formulation practices, it is expected that community commitment in Lake Toba basin conservation program implementation can be developed and improved.

5.2 Capacity Building on Community Participation

Community participation in lake management is essential, not optional. A community-based approach offers the most promising strategy for sustainable management of Lake Toba and its watershed. Whether planning a wastewater treatment facility, rehabilitating critical land through tree planting, introducing environmentally-sound farming, solving water supply problems, implementing measures to improve water quality, or trying to change the personal hygiene behavior of people in the community, the most effective programs are typically those which involve citizens and stakeholders from the very beginning. This is perhaps one of the more useful lessons to be learned from community-based pilot projects, especially when one considers the investments in wastewater infrastructure and other environmental projects on Lake Toba and elsewhere in Indonesia, whereby a facility is usually built, or a plan developed, without the input or involvement of the community. More often than not, lack of a community-based approach will result in facilities that do not operate properly and plans that are not effectively implemented.

Unfortunately, even when the provincial and district government staff is committed to a participatory approach, as stated in the General Policy for the Lake Toba Basin Ecosystem Conservation document, they may not have the capacity to implement it. Lack of incentives and skills among government staff to encourage them to adopt a participatory approach is the main reason for this problem. If government staffs are not provided with the necessary knowledge, skills and incentives to work in a participatory way with local communities, their willingness and ability will be severely hampered. Government staffs often are less qualified to work in a flexible, responsive manner in facilitating community action. Thus, they have less capacity to develop participatory forms of stakeholders working together; thus, their decisions tend to be made in a more top-down manner, involving only the village leader(s) or a small group of elite members of the community. Furthermore, the standard government system for planning, transferring and accounting for funds means those government personnel do not have the time, authority or resources to modify the program to suit the changing needs of the community. Workshops and training in the proper mechanism of community participation is necessary not only for the local community itself, but more importantly for government officials.

5.3 Planning Must be Supported by a Strong Research and Monitoring Program

To enable development of a workable, comprehensive, and widely-accepted Lake Toba basin management master plan, and to turn a common vision into reality, it is necessary to build a thorough research base covering a wide range of disciplines, as well as support for complete and accurate data obtained from a continuous and regular monitoring program. The availability of such data would allow the implementation of Lake Toba basin conservation activities be undertaken in a holistic approach covering every angle of the relevant

problems, thereby also facilitating the success level and its impact on all lake stakeholders.

As an example, in the general policy for Lake Toba basin ecosystem conservation, there is a specific mention of zoning of cage aquaculture as one component of the master plan. For this reason, there is a need for an extensive, in-depth study of this issue. Up to now, there has been no study conducted on the environmental impacts of the vast growing cage aquaculture on Lake Toba. The lack of accurate and reliable data is obviously a hindrance to formulating a realistic program to address this issue. At this time, virtually every attempt for rehabilitation or preservation works in Lake Toba has had to start from scratch (e.g., visiting various government agencies in order to collect the needed basic data). It often happens that data users do not know where to find the basic data they need and, if by luck the data were available, the users are not sure of their reliability or accuracy the data. There is no assurance about data reliability in statistical terms (i.e., data collection technique), as well as in terms of the non-technical aspects. Thus, the establishment of an information center to collect, arrange, update, verify, process and disseminate the necessary data to the parties in need of accurate data/information is urgent. The proposal for Lake Toba Science Center, which will function as an education and environmental research center in the Lake Toba area, is not only important for the future in assisting educational institution and developing community awareness in environmental aspect, but also could function as a data clearing house for Lake Toba.

5.4 Integrate Science and Policy throughout the Lake Management Institution

Research and monitoring are essential components, if the changes occurring in the lake are to be properly recognized and understood. Apart from the fact that very little has been done in terms of science and social research, the few works that do exist were not sufficiently published, let alone being used directly by policymakers or grassroots-level communities. The research community, especially science research, tends to be a closed community. Although the reports of scientific findings from many costly research projects may have found their way into libraries, they should have been better used as input for policymakers. On the other hand, policy- and decision-makers also seem to ignore scientific advice when they are formulating decisions. Thus, it is necessary to build a communication bridge between the scientist and the policy-makers, especially in the context of relevant scientific advice and the provision of feedback in the form of what could or should be done or not in solving a problem. Communication between researchers and the grassroots community also should be established because the community also needs scientific information in order to better understand the ecosystem in which they live. Accordingly, scientific terms and language level must be simplified, since scientific information is frequently too technical to be understood by policy-makers, let alone the grassroots-level people.

5.5 Environmental Awareness and Education

Community members are often the best influencers and communicators for change. People tend to be more easily convinced by their neighbors' experiences, tending to trust those they live with more than outsiders. When a new facility, such as the community-based wastewater treatment plant, is introduced, its pros and cons must be fully understood before it can get readily accepted. Explanations by outsiders may serve to inform people, but the community tends to better trust and accept such information as being true only when a relative, neighbor or a local leader confirms it. Many of the ten environmental cadres selected from the local respective community included in the pilot project have demonstrated their ability to help implement activities. However, their sustained willingness to be a community motivator after a project is complete cannot be guaranteed, since it often requires a highly-dedicated individual. A more thorough selection process for the environmental cadres as the indigenous potential change agents is needed. At least three months or more is typically necessary to devote to the exploration of dedicated, committed and trustworthy indigenous potential change agents. A scheme of small incentives is important to support the environmental cadres for the time and energy they devote to promoting environmental awareness and initiatives.

Behavior change does not happen until people realize or experience the benefits that can result from the change. Behavior can be said to have changed only when newer behavior patterns replace older ones consistently and are sustained over the long term. Although measuring behavioral change as a result of environmental education of schoolchildren can certainly take a very long time, the results can be far more effective and sustainable. Training elementary school teachers on practical environmental education has been expanded to cover more than a hundred teachers and community leaders in the Lake Toba region and should be continued.

The implementation of environmental education is a very appropriate means for raising awareness at the elementary school level, because the subject is filled with social, cultural and ethical norms. Environmental education is urgently needed in their early years to help students develop an attitude of caring for the environment and for avoiding behaviors that can hurt the environment. Environmental education also can help students begin to realize that they themselves are an inseparable part of the environment, and to feel a sense of stewardship and moral commitment to environmental conservation. Environmental education at the elementary school level is not an independent subject at the current time. Rather, it is generally taught as part of other subjects, such as social science, natural science and family welfare. As a result, environmental awareness tends to be low among school-age children. At later stages, mainstreaming the environmental education into the local curriculum of environmental education would be a positive effort in facilitating the health of Lake Toba.

5.6 Environmental Sustainability, Economy and Poverty Alleviation

The economy and environment are two inseparable aspects, especially natural resources-based economic activities. The economic aspect can be viewed from the local, regional, national and international perspective. The business sector in the basin, viewed from the regional/national context, is related to manpower and, from the international context, is the international capital share. The environmental aspect is related to how to sustain the Lake Toba drainage basin as an income-generating source for local population and attractiveness to the international community. Since the implementation of environmental regulations in Indonesia is still very weak, it is essential that the law enforcement apparatus be improved. Proper law enforcement would facilitate the possibility that everyone could work and invest capital safely, and that justice in the community could be established.

The links between environmental sustainability and poverty alleviation in the context of sustainable development also are important, particularly for natural resource management. This is because the very poor often contribute to environmental degradation when pushed to the margins in order to survive. More important, environmental degradation from various aspects of industrialization and growth have had very adverse effects on the poor; air and water pollution affect their health, soil erosion weakens their productive capacity, and land encroachment restricts their access to traditional productive assets. Because poverty is seen both as a consequence and cause of environmental degradation, improvements in environmental quality should help reduce poverty and vice versa. Poverty alleviation, however, requires a multidimensional approach. The root causes are complex—including for Lake Toba—and must be well understood in order to find the appropriate alternatives for integrated and structured solutions.

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