CHAPTER 2
DEVELOPMENT RISK AND THE TRAGEDY OF THE LAKE'S ENVIRONMENT

Human populations have an ongoing contact with and impact upon the land, climate, plant and animal species in their vicinities, and these elements of their environment have reciprocal impacts on them (Salzman and Attwood 1996:169).

The concept of environmental degradation refers to a situation of declining resources within the environment (Onuoha, 2008), which in general provides all the life supporting systems required by human societies. These life supporting systems are built and sustained by the natural resources found in air, land and water, and these resources include fresh/safe water, fish, arable land, plants, animals, mineral resources and air, among others. These resources often come in variable quantities and are of a variable quality, and humans exploit them for their survival and for sustenance. The misuse or over-use of these resources affects their quality and/or quantity in comparison with their pristine availability in the environment; therefore, the issue of environmental degradation comes into play when these resources diminish in quantity or quality, or both. According to Miller (cited in Jimoh 2006:276), environmental degradation refers to:

> *The downward trend in…environmental resources such that their level of use in the human societies equally decreases at an increasing rate.*

The problem of environmental degradation has generated both global and local attention, and while international environmental concerns are usually couched in broad terms like climate change and desertification, the environmental issues of concern in local settings and among vulnerable groups are generally localized in nature, and revolve around immediate issues that threaten their livelihoods and their survival. Examples of such types of issue include the deterioration of rangelands, deforestation, the degradation of topsoils, inappropriate disposal of waste, the depletion of fresh water supplies, air pollution and water systems, and animals facing

extinction. These problems directly or indirectly impact on human well-being; for example, declining soil fertility leads to poor crop yields while rangeland depletion reduces animal productivity, and any deterioration in water quality adversely affects the fish fauna. Thus, environmental degradation refers to the process or a situation of depreciation in quantity and/or quality of the resources in the environment, such as air, water resources, mineral resources, land, flora and fauna, as a result of harsh climatic factors, pollution and/or unsustainable exploitation by man. One notable implication of environmental degradation in terms of social existence is that it usually disrupts the socio-economic life of the human population which is immediately dependent on the local natural resources for its sustenance (Onuoha 2008a:1027). According to Leach (1999), environmental degradation is assumed to reflect a growing lack of synchrony between the community and its natural environment, and the implied solution is to constitute community based natural management (CBNRM) organizations so as to restore harmony to environment-society relations. As Sen (1984) has observed, an absolute lack of resources may be only one of a number of reasons for people not gaining access to the resources they need for sustaining their livelihoods.

Lakes are one type of environmental resource people can access and are highly productive ecosystems. Their values and functions support other ecosystems and are significant for economic development. Lakes once covered large areas of the world and are now among the rarest and most at-risk of ecosystems; however, they have significant value, providing recreational, educational, scientific, aesthetic, spiritual and cultural services, and these services form an important component of lake systems, as they play a critical role in influencing lake ecological functions.

Despite their important role in terms of sustaining ecology, supporting economic development and alleviating poverty, almost all lakes in the world are threatened by diverse anthropogenic factors. Today, lakes are facing a significant amount of environmental degradation through water contamination, eutrophication, water level decline and changes in water quality. Many different kinds of environmental degradation have a negative impact on the livelihoods of the local people residing in a given area, and like other lakes around the world, Inle Lake today

is environmentally threatened by a variety of factors, with sedimentation, water pollution, water level decline and a shrinking of the open water surface area being the most important among them.

2.1 Intensification of Agriculture and the Sedimentation of Inle Lake

In the Inle Lake area, local people use natural resource in a variety of ways to sustain their livelihoods. In the mountainous areas, people practice shifting cultivation and grow seasonal crops for a living, and these agricultural systems, as well as their other daily activities, contribute towards the sedimentation of Inle Lake, threatening the sustainability of its ecosystem.

A civil servant from the Irrigation Department in Nyang Shwe told me that the most severe threat to Inle Lake's environment is sedimentation. There are 29 creeks (see APPENDIX E) flowing into the lake, those which originate in the mountains around the lake. Every year, all the creeks and inlets flowing into the lake carry million of tons of sediment into the lake, and the situation is getting worse year on year. Even regular people in the area have noticed the situation in the lake:

> If sedimentation is not controlled properly in time, the lake will disappear within the next 550 years (Myint Maung Maung - Film Director, 1982).

In the Inle region, the lake plays a crucial role in the daily lives of local people in terms of transportation, fishing, the cultivation of floating gardens, rice cultivation and tourism. According to their livelihoods, people use the lake in different ways; however, unfortunately some of these activities have led to a deterioration in the Inle Lake environment, albeit unintentionally in most cases. However, though some people know they are hurting the lake, the locals have been carrying out the same activities for a long time, since they lack the option to do other things.

Whenever the environmental degradation of an area is being discussed, population increase cannot be neglected. In the Inle Lake area, there are 36 village tracts and 34,272 households, in which 173,099 people reside (The New Light of Myanmar, 27th June 2011). According to the statistics, the rate of population increase

is about 3%; with a population of 154,877 in 2005, and 173,099 in 2011 (Forest Department, 2012). This shows that the population dynamic in Inle Lake is one of the most significant pressures on the lake ecosystem.

In the upland areas around the lake, people practice shifting cultivation, which was once considered a sustainable agricultural practice. During the days of a low population, these farmers felled the trees, cleared the land and grew their seasonal crops, and after one or two years, they left that land fallow and moved to another location in time for the next growing season. After about ten years, they returned to the original land and started to grow crops again. This was a sound practice for their lives and for the environment as the fallow period left enough time for the nutrients to return and to get a good yield. As time has passed, so the population has increased, with more and more land needed to support more people. For this reason, the fallow periods have become shorter and shorter, and there is now little or no land to shift to. At the same time, there is less chance of the land having a good soil cover due to deforestation to make way for agriculture.

Kashio (2000, cited in Sidle et al., 2007) points out that land preparation through soil baking, coupled with plowing up and down the hillside, is one of the most unsustainable agricultural practices in the region, and contributes significantly to soil erosion. During this practice, the soil is first ploughed into a fine powder by cattle, then made into pieces, whereby a portion of the mound's top is scooped out and replaced with cow compost and unconsumed biomass, after which the organic material is burned, mixing with the soil. One Intha informant I spoke to, a government officer, said that potato farming in highland areas around the lake is a commercial concern. People start to grow potatoes in the winter season, after harvesting the wet season crops. After harvesting the potatoes, the soil is very loose, so the land is left over the summer and no crop is grown. When the wet season returns, the loose soil is likely to be eroded away by the rains.

Most Intha people blame those living in the highland because for them, the highlanders practice improper agricultural systems, those leading to sedimentation of the lake. Whenever one interviews the Intha about the environmental deterioration of Inle Lake, most point to the hills with their hands and blame the highland dwellers,

whom they believe are the main cause of Inle Lake's water level decline and sedimentation. They also mention that where there is no forest, there is no rain.

In term of deforestation, the western side of the lake is suffering more because more people live on that side, and also because there are more domestic snack-making factories there. The livelihoods of almost all the villagers on the eastern side of the lake rely on cane sugar plantations. Some inhabitants from the eastern side of the lake told me that their area creates less sedimentation rate than the western shore, because the mountains are still forested and are conserved as watershed forests, due to the presence of natural springs. Moreover, they claim that the roots of cane sugar plants slow down the flow of sediments into the lake.

One Intha respondent, a government officer, said that potato farming is widespread in the highland areas around the lake, as a commercial crop. The people there start to grow potatoes in the winter season, after harvesting their wet season crops. After harvesting the potatoes, the soil is very loose, after which the land is left over the summer with no crops grown. When the wet season returns, the loose soil is washed away easily with the rains.

Most Intha people blame those who live in the highlands because, to them, the highlanders practice improper agricultural systems, those that lead to sedimentation. Whenever the Intha are interviewed about Inle Lake's environmental deterioration, most of them point to the hills with their hands and blame the highlanders. They say that the highlanders clearing the forest for cultivation is a key cause of the lake's water level decline and high sedimentation rates. They also say that where there is no forest, there is no rain.

Mu Mu Than (2006) states that the former dimensions of Inle Lake were 60 km in length and thirteen kilometers in width, with a water surface area of 266 sq. km. Nowadays, the length and width of the lake are about eighteen and six kilometers respectively, with the water surface in the wet season at about 150 sq. km and in the dry season, 100 sq. km. The total catchment area of the basin is about 3682.94 sq. km and the average annual flows into the lake are about 1.13 cubic kilometers. The storage capacity of the lake is about 0.34 cubic kilometers and the remaining 0.79 cubic kilometers flow into Mobye reservoir. According to the study of Sidle et al.

(2007), the apparent open surface water area of Inle Lake has reduced from 69.1 sq. km in 1935 to 46.7 sq. km in 1999, a drop of 22.4 sq. km, based on a comparison between topographic maps from 1935 and 1937, and recent remote satellite imagery.

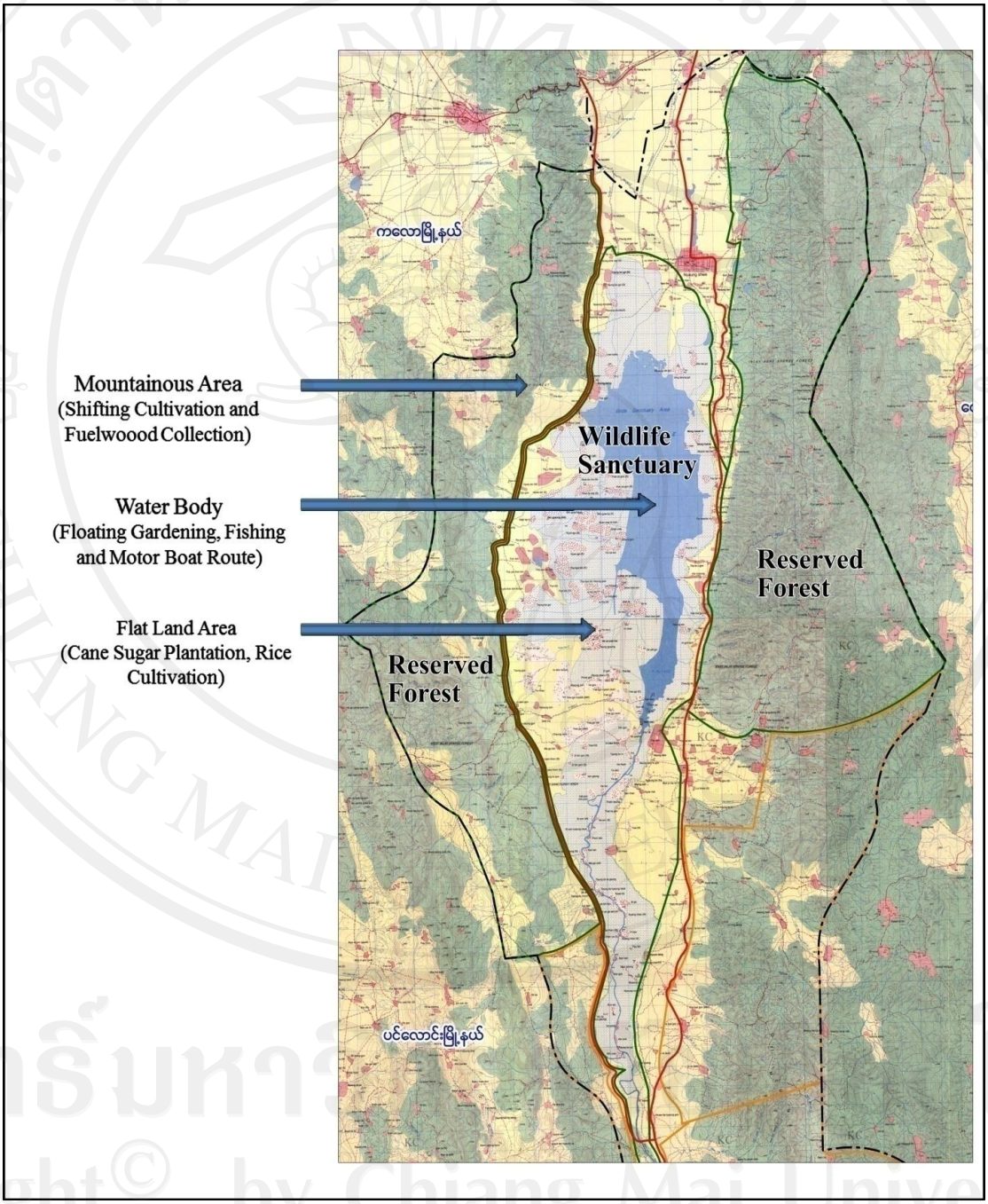

Figure 2.1: Resource Use Map of the Inle Lake Area

According to a 2007 data survey by the Settlement and Land Records Department of Nyaung Shwe Township, the open water area is 62 sq. kilometers, the natural floating bed area is thirteen square miles, the floating island area covers fifteen square miles, villages cover three square miles, and agriculture land uses up eight square miles, covering a total area of 163 sq. kilometers. In the summer season, the water level is low and this same area covers about 103 sq. kilometers. Nowadays, the longest the lake reaches is seventeen kilometers and the greatest width, about six kilometers.

A study in 1987 showed that sedimentation was 22 million cubic feet per year (Forest Department, 2012), while studies covering 2004 to 2006 show the annual sedimentation rates of some of the creeks that flow into Inle Lake, as follows:

Table 2.1 Sedimentation Rates of Inle Creeks - 2004 to 2006

No.	Name of Creek	Watershed Area(sq. miles)	Inflow Water Volume (million cubic meters per year)	Sedimentation (tons per year)
1.	Nant Kat	455.50	505.5	104,000
2.	Nal Char	101.22	92.5	19,000
3.	Kalaw(Than Taung)	292.41	275.6	56,000
4.	Balu (Indein)	277.36	459.6	89,293
	Total	**2166.80**	**1353.2**	**268,293**

Source: Forest Department (2012)

From this table, it is clear that Nal Char creek is the lowest sediment carrier, as it flows from the Heho plain and has the lowest watershed area. The creek that carries the most sediment into Inle Lake is the Than Taung creek, which has even created a

delta in the lake. This area is the most densely populated area of the lake also (Forest Department, 2012).

The total sediment load of Inle Lake is 2.6 million cubic meters per year, and approximately one quarter of this load may be deposited in the lake at a given time (Su and Jassby, 2000). The United Nations Development Program (UNDP, August 2011) has pointed out that the sedimentation rate is nearly 310,000 metric tons per annum.

Min Aung and Maung Maung Yi (2005) state that the amount of soil eroded under crop-covered land is 4.95 tons per hectare per year, and on non-cropped land is 8.95 tons per hectare. The equivalent monetary value of the soil conservation function by contour bund which can retard erosion in sloping area is thus US$100,314 per year, while the annual replacement cost of flood prevention functions in the paddy fields upstream account for US$0.11 per hectare.

In Ywa Ma Village, where Balu creek flows into Inle Lake, it is very clear that the sedimentation has become worse in recent years. This village is the largest village on Inle Lake, and was once famous for its floating market. Today, due to the shallow depth of the water, the floating market has become a land market, but the sellers and buyers still have to come to the market by boat. Once this market was unique and of fascination to visitors, both tourists and pilgrims from other areas of the country. According to the motor boat drivers I spoke to, the canals in the village need to be dredged every year, and the depth of the creek is becoming shallower and shallower year on year. In the summer, they have difficulty driving their motor boat to some areas of the village, and sometimes their motor boats cannot be moved anywhere, so they have to drop into the water and push their boats along.

In this way, shifting cultivation and firewood collection in the watershed area have caused soil erosion and this has led to sedimentation of the lake. The sedimentation of Inle Lake is an urgent issue, taking into account the stability of the lake and livelihood security of people who rely on it for their livelihoods. If the current rate of sedimentation cannot be reduced, the negative impacts will be severe for local residents and become very serious in the near future.

2.2 The Tragedy of Inle Lake and Development Risks

Development projects and agrochemicals from the mountainous areas, agrochemicals from the floating gardens, waste from households and from the tourist industry, as well as diesel residues from motor boats in the lake, all increase pollution levels in the lake and the problems associated with this.

Within the watershed area of the lake, people use pesticides, insecticides and chemical fertilizers to enhance crop production levels, and in the upland areas around the lake, the locals grow upland rice, maize, wheat, garlic, potatoes, ginger, taro, sweet potatoes, vegetables and other seasonal crops. On their farms, soil fertility levels have declined in recent years, so they use chemical fertilizers and pesticides to offset this trend.

In the lake, the number of floating gardens has been increasing year on year, though in some areas they are prohibited in order to protect the lake's ecology. According to the Forest Department (2012), the floating garden and open water areas are now as per the figures shown in Table 2.2, though it is not clear whether these figures are based on open water areas measured in the wet or dry seasons.

Table 2.2 Floating Garden and Open Water Areas in Inle Lake (2005 to 2010)

Year	Floating Garden Area (Acres)	Open Water Area (Acres)
2005	25,327	11,599
2010	28,739	11,076

Source: Forest Department (2012)

According Win (1996), there are three major pesticides used within tomato cultivation; the insecticides monocrotophos and cypermethrin, and the fungicide metalaxyl. According to his research, the loading capacity rate of the lake is 1.50 kg m^{-3} yr^{-1} for Cypermethrin and 195.0 kg m^{-3} yr^{-1} for Metalaxyl. However, Butkus and

Su (2001) point out in their work that Cypermethrin is applied at 1500% of the recommended rate, while Metalaxyl is applied at 5900% of the recommended rate, and the over-application of these pesticides is not only costly to the farmers, but also causes unnecessary pollution that may be harming the health of watershed residents. Min Aung and Maung Maung Yi (2005) state that nitrogen removal due to tomato cultivation in Inle Lake is about 30,545 tons per year, and the cost necessary to take out water weeds and sediment is US$ 419,074 per year.

One interviewee who lives in Kalar Village told me that they know about the adverse impacts of pesticides, but have no option but to use them. If they go fishing, they cannot even get enough for their household consumption activities, so the floating gardens are their key source of income, meaning they have to use pesticides to obtain a good crop yield. In the 1990s, they still used local varieties of crop and did not need to use pesticides; however, now they have to use pesticides as they grow hybrid varieties, most of which are imported from neighboring countries. According to their experiences, the more they use pesticide, the greater the yields; hence, in years when the crop prices are high, they use more pesticides, with the intention of maximizing their profits.

The worst point is that most of the gardeners do not understand the warnings given on the use of the pesticides, as most of these are written in English. Sometimes, they use pesticides imported from China, and on these, the warnings are written only in Chinese, so the gardeners cannot understand these warnings either. Most of them do not know which pesticide is suitable for which disease, so simply use what other people use; mixing the pesticides with water on their boats and one of them spraying while the other rows the boat.

There was one tragic case in which one villager was mixing pesticide with water on his boat, and accidentally dropped the pesticide in the water. As a result, he dived into the water himself to get the pesticide can, which was already open, and ended up dying of pesticide poisoning the following day, although he was hospitalized.

The Tigit coal mine project is another cause of water pollution in the lake. It is located thirteen miles southwest of the lake and is also Myanmar's biggest open-cast

coal mine, producing nearly 2,000 tons of coal every day. The main mine is an open-cast pit covering an area of over 500 acres, and continues to expand. Smaller amounts of coal are also extracted through an underground tunnel system four feet square which runs under farmland. As the coal mine has deepened, so it has reached the water table underneath the ground, so water emerges at the coal mine. This water is then pumped out and poured into Tigyit Creek, which flows through Balu Creek into Inle Lake. As a result, the water from Tigyit Creek is always polluted by waste water from the mine, or fly ash runoff. Villagers nearby the creek used to use it for washing and bathing, but can no longer do so (PYO, 2011). Water contamination, plus sedimentation, have had an adverse impact on Inle Lake, through Balu Creek.

In Balu creek, there is also a hydropower project under construction, and local inhabitants worry about the future effects of this development on the lake and their environment. Some parts of the reserved forest, under the control of the Ministry of Environmental Conservation and Forestry, have been de-classified with the agreement of the Cabinet.

As already mentioned, there are fifteen village tracts containing over 10,000 households and with a population of 55,000 around the lake (Than, 2007), and these households dispose of their household waste into the lake, without treating it first. Once they used to use the lake's water for drinking, washing, cooking and bathing purposes, but nowadays they cannot drink it, though they still use it for the other purposes. Every day, they dump their domestic waste water into the lake, plus they throw their garbage into the lake water every day, with no campaign in place to prevent this, and none planned. In some villages, the villagers leave their garbage outside the village, creating a garbage dump.

Most of the people wash their clothes on the decks of their houses, while others go to their floating gardens to wash their clothes. Like other people around the world, the Intha people use detergents, and after they have used them, leave the detergent bags around the floating gardens and their homes.

Another cause of water pollution is the households' latrine systems, as these lead to eutrophication of the lake, and the large amount of aquatic vegetation growing on the lake bed is evidence of this. Over recent decades, the households have used

direct latrine systems to discharge their waste into the open water, and this is considered one of the major contributors to the high level of water pollution. Recently, the villagers have been asked to build pit toilets, and one health staff member said that she believes the villagers do not pay much attention to the issue. She also said that it is not a minor issue, but that gradually people are building more pit toilets. However, most of the household are poor and so cannot afford to build these pit latrines, though they would like to.

The waste from domestic industries also causes water pollution in the lake. There are eight villages which host weaving factories, and these factories use both natural and chemical dyes, which affects the local water quality. The weaving industry also uses bleaching agents, and the waste from the use of these flows directly into the lake. A local resident - an artist from Ywa Ma - shared his experiences with me about the weaving industry. According to him, the water near the weaving factories is more polluted than in other areas. In addition, chemicals used by the gold- and silver-smiths are poured into the lake. He told me that most people think their waste will not destroy the lake, so continue to act in the same way.

As well as the local residents, tourism is another source of pollution around the lake. International tourists, as well as domestic pilgrims, have been visiting the lake in increasing numbers over the last few years. By 2010, there were 1,861 registered motor boats around the lake (Nyaung Shwe, General Administrative Department, 2011), and local residents said that there are also many not registered; hence, the number of motor boats may be as high as 2000 or more. Diesel residues from these boats are also poisoning the lake, as are the plastic bags used by tourists to carry bird food. Moreover, the garbage and sewage from hotels and restaurants around the lake are also thrown into the lake.

Table 2.3: Number of Hotels, Inns and Restaurants in the Inle Lake Area

No.	Type	Nyaung Shwe	On the Lake	Total
1.	Hotels	15	14	29
2.	Inns	13	-	13
3.	Restaurants	46	5	51
Total		**74**	**19**	**93**

Source: Forest Department (2012)

Some hotels in Nyaungshwe have expanded their number of rooms very recently, and in 2012, tourist arrivals at Heho Airport were up 50% on the previous year, so even if the hotels add rooms it would not be enough to cater for all the tourists. Even in 2011 they didn't really have enough rooms, so the Shan State government has given the green light to a 622-acre hotel zone near Ingyin village, on the eastern side of the lake, about sixteen miles from Nyaungshwe. A spokesperson from the Inle Lake Conservation Department (under the Shan State Ministry of Forestry) said that this site was chosen because it would have the least impact on the environment and that it was unlikely to create land ownership disputes (The Myanmar Times, September 10th to 16th 2012).

According to the Fisheries Department, the pH level in Myaung Wa Gyi at the north-end of the lake is around 8.9; 9.6 at Bo Te in the center of the lake, 9.1 at Shwe Kywun Myaw Hotel (Mine Thout) in the northeast and 9.0 at Phaung Daw Oo Pagoda in the south of the lake (Weekly Eleven, 29th February 2012). This clearly shows that the lake water is no longer drinkable, meaning local people have to fetch water from other villages, those located in the vicinity of the lake, and this takes time. In some villages located on the lake, they have constructed some facilities in order to bring water from the land.

Near Nant Pan Village in the southern part of the lake, there was a natural barrier that slowed water flows in the lake and maintained its water level. In early 2009, with the aim of allowing water to flow water directly to Moebye Dam, which

supplies water to the Lawpita Hydroelectric power station, this natural barrier was removed by backhoe dredgers. As a result, the water from the lake started flowing directly into Moebye Dam, leading to a reduction in the lake's water level. As a consequence of this, plus due to low rainfall levels in 2009 and significantly increased temperatures and a late monsoon in 2010, the water in Inle Lake reached its lowest level ever that year, leading to water scarcity and problems in terms of transportation problems and for the floating gardens. In August 2010, the Irrigation Department started rebuilding the barrier (100 feet wide and 5.5 feet high) by filling geo-tubes with sand, to slow the flow of water out of the lake and maintain its water level.

Inle Lake started to be used as a pollution sink involuntarily, when the local community introduced agrochemicals into their cultivation processes - this form of agricultural extension being common in the region. Instead of blaming local people; however, government organizations as well as civil society groups should take account of the issues involved and introduce effective and proper methods for using agrochemicals, as well as look at the introduction of organic agricultural practices. Waste water from both households and hotels should be treated before it is poured directly into the lake, and garbage should be taken away from the lake area.

The factors contributing to water pollution in the lake are anthropogenic ones such as the use of agrochemicals in upland areas and around the lake itself, plus also development projects being carried out in the watershed area, and also tourism. All the stakeholders in this region rely on these activities for their livelihoods, but at the same time are destroying the lake's ecosystem through the creation of unwanted byproducts, which in turn will impact adversely on their livelihoods over the medium to long term.

As identified above, pollution in the lake is threatening its fish population and has led to livelihood insecurity among the local fishers. At the same time, the water in the lake is no longer suitable for household use, which is proving a challenge for those who are live there. The unwanted by-products from the many different activities taking place around the lake can now be seen as creating a tragedy in the area.

2.3 Local Livelihood Insecurity and Emerging Opportunities

Generally, most people think that the environmental degradation of the lake is having only negative impacts on the well-being of local people; however, some new opportunities have arisen as a result of environmental deterioration in the area.

At the center of the lake's west bank is a delta area where Ka Law Creek flows into the lake, breaking into five smaller creeks. Ka Law creek is one of four main sub-watershed areas of the lake, and the delta area is the most crowded around the lake, with densely populated villages and the most severe sedimentation rates among all the other creeks around the lake. Once, the area was covered with paddy fields, but nowadays the former paddy fields have been turned onto cane sugar plantations, which are expanding year-on-year into the paddy areas.

One elderly woman told me about the local environment, as follows:

> About ten years ago we grew rice in our fields, but these have been transformed into cane sugar plantations, so now every year there is a lot of sedimentation in the fields, as can be seen. The local villagers now grow cane sugar on their land, and this is their source of main income (An elderly woman from Than Taung Village, 2011).

She added that now they can make more money, as they do not need to cultivate every year, as cane sugar is harvested every three years having been planted. This case shows that sedimentation is not a risk for these people, but is linked to opportunities to enhance their well being.

The sedimentation rate is getting worse each year, and in Linkin village, most of the former paddy fields have been turned into cane sugar plantations, because the sediment in the water has led to high soil fertility. However, some of the paddy fields are no longer suitable for growing rice or sugar cane, and so some farmers have even let sediment accumulate in their fields in order to grow seasonal crops, which they can now grow twice a year and so earn more.

The experience of people from Ye Oo village is also unique in relation to the decline in the lake's water level. U Than, the head of the village (about 55 years-old),

told me that when he was about twenty, they grew only rice around the, and at that time, the lake water reached the village. As time has passed, so the permanent water body has shrunk dramatically, by about one mile. Before, water reeds and grass grew in the area, so the villagers could get roof thatch from there, but as the water level has declined, so they have cleared this area in order to grow rice in the open seasons. As a result, they can now grow more rice than they did before and can make more money.

In Taung Po Gyi village, on the northern part of the lake, almost all the villagers have sold their motor boats due to water level decline, as the boat waterways are not as good as they were before. In fact, only two motor boats are left in the village - one of which is used as a floating shop selling at the five-day markets on the lake, and the other of which is owned by the village monastery. Until the last decade, there were some floating gardens in the, but now there are only two households who practice floating gardening. Most of the villagers now grow seasonal crops and flowers, when the water level is low in the open season, and also rice as the water level declines, harvesting in the early monsoon season.

In 1992, the village recorded its highest ever water level in the wet season – an abnormal years for them – and many lost their rice harvest. However, in the summer of 2010, the water level in the lake reached its lowest level ever, and many of the floating gardeners lost their capital.

> Our village is in the vicinity of the lake, but we do not have a good road and so use the water body as a transportation route. In 2010, when the lake in dried up in the area, it was difficult to transport things out of the village to town and back. If we wanted to send our crops to the town, we had to carry by hand, which was very tiring for each household and costly (Sam Myint from Lin Kin Village, 2012).

Again, in the summer of 2011, the water level was low and this did not favor the floating gardeners; however, in the wet season of 2011, the water level was nearly as high as the 1995 record, so was a bad year for the rice farmers. Just as the farmers were about to harvest their rice, the water level in the lake rose and there was immediately a flood.

The Myanmar Times, a local newspaper, reported about the floods around Inle Lake in 2011, and an official from the township planning department in Nyaungshwe told me about 150 people were displaced due to the high level of Nant Kat Creek and following several days of heavy rain that began on August 22nd. He told the paper that the water was waist-high in some areas of the quarter on August 24th, and that the road between Nyaungshwe and Shwe Nyaung was also flooded up to a depth of two feet.

An abbot from one village told me that in 2010, the lake was dry, and in 2011 the water level rose a lot, flooding all the paddy fields and leading a failure of the rice harvest and a large loss of capital. Even offering rice to the monks was difficult for the farmers at this time; for normally the farmers offer a lot of rice to the Buddhist monks every year. In 2011, the rice farmers' villages could not make Kahtain robes to donate, so they had to donate other things or reduce the amounts donated. For instance, if they had donated robes to 100 monasteries the previous year, they donated to only about 50 or 60 monasteries in 2011.

As mentioned above, the water level in the lake reached its lowest recorded level in summer 2010, a time when the floating gardeners usually start their cultivation process. In some gardens, they could not start as the depth of the lake was not enough to row boats, while some gardeners started the harvesting process, but with great difficultly. All floating garden processes are carried out by boat, so if the depth of the water does not allow boat to be rowed, one cannot cultivate floating gardens.

Inle Lake hoteliers and residents told me that they believe the rate of decline has accelerated in recent years, and in 2010 the problem was exacerbated by a severe drought. During recent years, some areas traditionally open to tourists have been difficult to reach because the water levels are so low. In one year, a village was cut-off entirely from boat traffic, leaving boatmen having to wade through the mud for the final hundred meters from the canal. Tin Aung Moe, a senior program officer at UNEP's Regional Resource Center for Asia and the Pacific in Thailand, said that if recent trends continue, the lake might be gone in one or two decades (Wall Street Journal, June 17th 2010).

In terms of the environmental impacts on floating gardening activities, the abbot also told me that during these the last three or four years the situation has been very severe for the Intha people in terms of generating an income, referring to the crises in the summers of 2010 and 2011. The Intha people used to make a lot of money from their floating gardens, but now even maintaining and repairing their houses is not so easy for them. On the lake, building a house is very costly; it costs three times as much as constructing on land. When building on water, people have to use more materials, so some extended family all live together in the same house, as they do not earn enough to build more housing.

Concerning transportation, the motor boat drivers told me that piloting their boats in the dry season is more difficult than it used to be, and in some cases, the motor boats break down due to the shallow water – as the boats sometimes touch the lake bed, and so need to be repaired frequently.

Water pollution is having a large impact on the livelihoods of the local residents, as local fish species are now facing extinction, especially the Nga Phein, a local fish species. Once, when talking about the Intha people, people always mentioned the Nga Phein as it is one of the symbols of Inle Lake. Until the last decade, Nga Phein could be easily caught when fishing and was the major fish species in the lake. The Intha people prefer Nga Phein to other fish species, but recently chemical fertilizers, pesticides and insecticides from the floating gardens plus other sources have left unwanted by-products in the lake's water, causing pollution and leading to the extinction of local fish species. As a result, the Fisheries Department has introduced Tilapia to the lake, and now this newly-introduced fish is the major fish species present. A member of staff from the Fisheries Department told me that the Tilapia can spawn three or four times per year. The Tilapia is cheaper than the other local fish species and almost all the fish caught nowadays are Tilapia. Two decades ago, the fishers could carry out ten trips during a normal day's fishing. A local elder told me that if he wanted to eat fried fish, he simply cleaned the frying pan and put it on the fire, then added some cooking oil, after which he took a harpoon and looked for some fish around his house. By the time the cooking oil in the frying pan

was hot, he would have already caught some fish and be ready to cook them. This reflects how easy fishing was in the area a few decades ago.

Nowadays, the fishers only make two or three trips and almost all the fish they catch are Tilapia. As a result, their incomes have declined, with most are having to spend more time fishing to catch a reasonable amount.

Before, when floating gardening was not popular on the lake, the lake water was clear and people could drink it. Nowadays, the water is no longer drinkable and fetching water takes up a lot of time for the Intha people. The Abbot of Inn-Oo Monastery told me about this, saying that they started drinking water from the land five years ago, when they built a well and sent the water via a pipeline to the village. His younger brother, who lives in Nyaung Shwe (the nearest town), covered the cost of the well, while a tank was donated by the UNDP. The pipe was paid for by villagers and some people from other areas, as well as the Abbot of Lin Kin monastery. Due to the low water levels, the environment in the area is drier than ever before, meaning the water in the lake is undrinkable. Every household has to pay 1500 Kyats (about US$1.80) per month to fuel the engine of the water pump, and they are planning to get a tank in the monastery. So, the local Intha people now need to spend money in order to access clean water for household use (not including washing and bathing), due to the environmental deterioration of Inle Lake. There are fifteen village tracts around the lake, and each village tract consists of one to five villages of between 100 and 1000 or so households. The amount of money spent on sourcing water around the lake is now huge, and in some villages, they have to use a motor boat to fetch water, which means they spend a lot on fuel.

According to U Hla Aung, a motor boat service provider, all the local residents will recognize and understand the environmental degradation taking place around the lake eventually. Even in 2012, a relatively normal year, the high water level did not reach the levels it did one decade ago, and for about five years now the water level has been declining at a faster pace. In December 2010, due to water level decline, villagers needed to walk some distance to get to the jetty, in order to use their motorboats, and the summer of 2010 was the worst in terms of water level decline. At that time, U Hla Aung took the old people by motorbike to the jetty.

U Hla Aung added that he thinks the cause of the environmental degradation around Inle Lake is sedimentation. He said that until a few years ago there was no land around his home, whereas now there is due to sedimentation, adding that the soil has been eroded by the water. Evidence of this is that since three years ago, it has not been easy to drive motorboats within Ywama viallge, the biggest village on the lake, due to the sediment brought by Indein creek. Although the water level in the summer of 2011 did not decline as much as in 2010, it was still drier than during other, normal summers. As of writing this paper, the summer of 2012 is expected to be dry, although there was some flooding in the wet season, as the water holding capacity of the lake is not as great as before.

When the water level is shallow in the canals and the open water, it is much more difficult to get from one place to another, because water hyacinths are now blocking the routes. Sometimes motor boats get stuck within the water hyacinths and cannot be moved easily.

To overcome this tragedy, a five-year sustainability action plan, based on workshops held by two national stakeholder groups in Nay Pyi Taw and Taunggyi, was produced in 2010, entitled the Inle Lake Sustainable Development and Environmental Conservation Plan (2010-2014), its aim being to implement an effective watershed management process in Myanmar, to manage the effects of global climate change and climate variability. Furthermore, it has focused on an all-inclusive multi-sectoral approach, which is of utmost important for the sustainability of Inle Lake.

Hence, in collaboration with line departments, UN agencies and IGOs, INGOs and NGOs, the Ministry of Environmental Conservation and Forestry (MOECAF) is trying to restore and rehabilitate Inle Lake ecosystems and the lake's watershed area. Currently, MOECAF is planning to hold a series of workshops jointly with UN-HABITAT, to review and identify the remaining gaps and requirements, and to formulate a comprehensive conservation action plan for Inle Lake, one which will be reinforce the existing plan (2010-2014) and ensure the sustainability of the lake and its ecosystems (Forestry in Myanmar,2012).

At the local level, the Forest Department has established a watershed forest plantation and has built check dams in the inlet creeks so as to stem the flow of sediment into the lake. Each year, the Forest Department is building ten more check dams with the same purpose.

The Irrigation Department has also constructed some check dams which are bigger than the Forest Department's; however each check dam lasts only one year, because the dams are full of sediment by the end of the wet season.

As the water level has declined, so transportation has become difficult, because local people cannot use their boats or other vehicles to get to public areas. When a member of Pyithu Hluttaw, the Lower House in Myanmar, asked about government measures concerning transportation around Inle lake, the Deputy Minister of the Ministry of Agriculture and Irrigation said that the Irrigation Department was removing sediment along the routes to important public places, such as hospitals, markets, schools and pagodas, using backhoe dredgers.

The UNDP has helped some villages construct sediment-retarding dams, by providing some funds for soil conservation. Moreover, it has given support to several communities by establishing forest plantations nearby, encouraging agro-forestry practices such as the growing of fruit trees, the planting of farm boundaries, planting trees, harvesting water and distributing energy efficient stoves.

The Norwegian government has provided US$2 million and the UNDP US$0.58 million in funds to implement the Inle Lake Conservation and Rehabilitation Project, its aim being to restore environmental stability and improve the quality of life of the local communities in and around the area of Inle Lake. This project will be carried out with the cooperation of the Forest Department and a local NGO - the Intha Literature and Culture Association.

U Min Htut Yin of UNDP in Myanmar told me the Intha Literature and Culture Association has EU support of US$3 million for the economic development of the Inle Lake area (Popular News Journal, September 6th 2012).

However, both government organizations and NGOs have focused on environmental issues without considering social phenomena also; however, in reality, environmental degradation is just the result of human actions, so to break the

environmental damage cycle, government organizations as well as NGOs should also focus on local communities. Moreover, most of the projects implemented around Inle Lake are taking a top-down approach, so before implementing any project, policymakers as well as decision-makers should investigate from the bottom-up, otherwise the actual needs of the local people and environment will not be served – leading to low effectiveness and a lack of sustainability.

To conserve, restore and/or rehabilitate the environment around Inle Lake, local people's participation is fundamental, for cooperation with local communities can serve the long term objectives of a project. So, the projects around Inle Lake should be community-based and bottom-up, instead of top-down in approach.

Due to environmental degradation, some people have gained new opportunities and some have lost their main livelihood sources at the same time. If the winners and losers are weighted together, the number of winners is lower than the number of losers. When few people have emerging opportunities, most lose their livelihoods, such as those people living on and around Inle Lake, those who cultivate floating gardens and go fishing.

2.4 Summary

Currently, shifting cultivation and the collection of firewood in the watershed area of Inlse Lake is leading to soil erosion, leading to sedimentation of the lake. The sedimentation of Inle Lake is a critical issue, as it impacts on the stability of the lake and the livelihoods' security of the local people who reside near and rely upon the lake for their livelihoods. If sedimentation cannot be controlled in time, the impact will worsen and will have a negative impact on the Intha in the very near future.

Being used as a pollution sink, Inle Lake is now suffering from water contamination and sedimentation overload. In fact, pollution in the main body of the lake is threatening the fish population, leading to livelihood insecurity among the fishers there. At the same time, water in the lake is no longer suitable for household use, providing a challenge for those who live nearby. These long term and unwanted by-products from the different economic activities taking place around the lake can now be seen as a tragedy for Inle.

However, as environmental degradation has worsened around the lake, so some people have been able to take advantage of new opportunities, while others have lost their main livelihood sources at the same time. When comparing the winners and losers, the number of winners has been lower than the number of losers; most people's livelihoods are failing, for most of them rely and live on the floating garden and fishing activities.

To restore and rehabilitate the ecosystems around Inle Lake, one should not ignore the roles and needs of local people like the Intha. It will be essential to heed their local knowledge when implementing the tasks needed to restore the lake's environment.