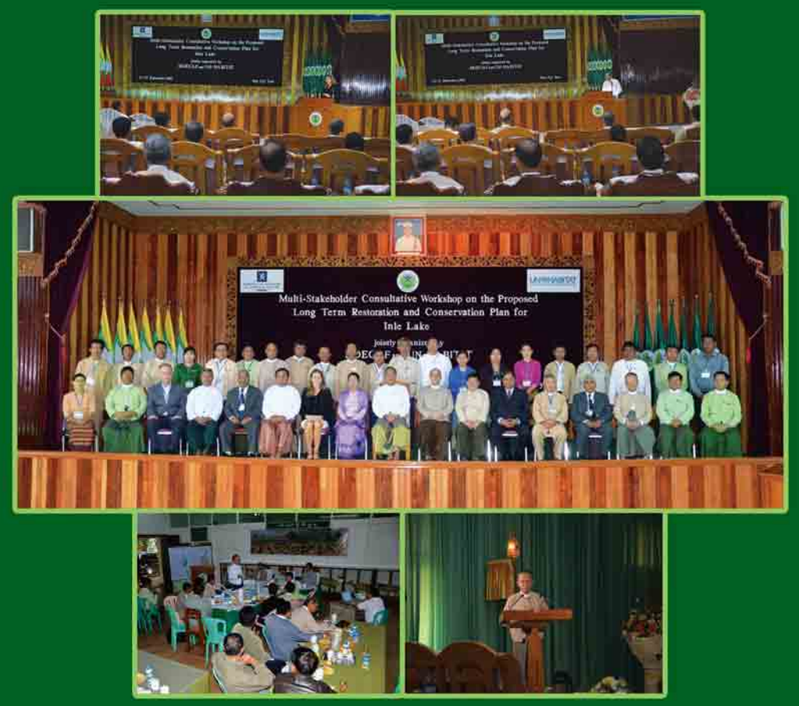

NORWEGIAN MINISTRY OF FOREIGN AFFAIRS

UN HABITAT
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Inle Lake Long Term Restoration & Conservation Plan

Government of the Republic of the Union of Myanmar

Ministry of Environmental Conservation and Forestry

Inle Lake

Long Term Restoration & Conservation Plan

Foreword

Inle Lake is one of the priority conservation areas in Myanmar due to its unique ecology, historical, religious, cultural, traditional background and natural beauty. It is one of the most popular tourist destinations in Myanmar and tourism is expected to rise significantly with the opening up of the country.

Realization that widespread soil erosion on the mountain ranges flanking Inle Lake could eventually cause problems that would threaten the future existence of the Lake prevailed since late 19th century. Measures were introduced, but were ineffective as they were not developed progressively enough. Several droughts occurred since 1989, but the severe drought that occurred in 2010 was the wakeup call, which brought about serious concerns and recognition that urgent planning and mitigation measures in a comprehensive and integrated manner was imperative, if the Lake was to be saved.

Ministry of Environmental Conservation and Forestry (MOECAF) organized a National Workshop in 2011 at Nay Pyi Taw; basic elements required to draw up a Long Term Action Plan were identified and a resolution to formulate a Long Term Restoration and Conservation Plan for Inle Lake was adopted. MOECAF requested UN-Habitat to assist in formulation of the Long Term Restoration and Conservation Plan for Inle Lake and the Royal Norwegian Government kindly provided necessary financial assistance.

The Team of experts engaged by UN-Habitat identified the main causes, both natural and human induced, that have impacted adversely on the Lake and its environment. Fall out of climatic variations, irresponsible clearing of soil cover, various forms of change in land use patterns in the Watershed areas caused widespread soil erosion, resulting in heavy loads of sediment entering the main feeder streams and ultimately into the Lake, causing it to become very much smaller in size and shallower in depth. Dumping of chemical fertilizer and pesticides, all forms of wastes into the Lake water has caused hazardous pollution impacting on the health and livelihoods of local communities.

The team rightly pointed out that the task of restoring Inle Lake and its Watershed areas is immense and complex, as it involves not only solving environmental issues, but also uplifting the Socio-economic status and capacity of local communities. Also, that only a multi-sectoral, multi-disciplinary, holistic approach with the committed participation of the people, could achieve any tangible results. This is a clear indication that the task of saving Inle Lake cannot be achieved by this Ministry acting alone, but will need the full cooperation of all related Ministries, Ministerial Departments, CSOs, CBOs, local communities and stakeholders.

I would like to commend the Shan State Government, UN-Habitat, all Governmental Departments at the Union and Shan State level, and local stakeholders for their whole hearted cooperation. In particular, the team of experts, for their unstinting effort to formulate this Long Term Plan in a comprehensive and holistic manner through painstaking collection and collation of baseline data, on-ground validation and incorporation of feedback from series of Workshops and dissemination sessions at the local community level. As such, I am pleased to confirm official adoption of the Long Term Restoration and Conservation Plan for Inle Lake by MOECAF.

On behalf of the Ministry of Environmental Conservation and Forestry, I hereby convey our heartfelt gratitude to the Royal Norwegian Government and UN-Habitat for having made formulation of this comprehensive Long Term Restoration and Conservation Plan for Inle Lake possible.

July 2014
Nay Pyi Taw

U Win Tun
Union Minister
Ministry of Environmental Conservation and Forestry

Long Term Restoration and Conservation Plan For Inle Lake

Executive Summary

Inle Lake is situated in Nyaung Shwe Township, Taunggyi District, Southern Shan State. It is the second largest fresh water lake of Myanmar. Scientists have estimated that Inle Lake was transformed from a Tectonic Lake to a Solution Lake over a period of 1.6 to 65 million years, placing it among the world's oldest surviving lakes.

Possessing several ancient Pagodas, Temples and Shrines held in high esteem by Buddhist believers, many domestic pilgrims travel to the Lake every year to pay homage to these revered religious sites. The Lake is world renowned for its breath taking scenic beauty, its history, richness in biodiversity; unique religious, culture and traditions. Inn-thars (Lake Dwellers) while standing on one leg at the rear end of the boat, curl their other leg around a long oar to propel the boat with their leg (leg rowers) and the practice of growing vegetables on floating vegetation strips are novelties unique to Inle. The genuinely warm hospitality and good cheer of the local ethnic communities is also an attraction. Inle has thus become a **"national icon"**; a must see destination that attracts large numbers of international tourists each year.

Due to Inle Lake's diverse Wetland ecosystem, richness in biodiversity and species endemism including rare and threatened species, it was classified as a "Ramsar Site" by the Ramsar Convention and also recognized as an "Important Bird Area" as it is a popular stop over site for migratory water birds along the East Asian Flyway. The Government of Myanmar designated it as the Inle Lake Wildlife Sanctuary in 1985, incorporating Saga Lake and the Mobye` Reservoir to the south. It was later declared an ASEAN Heritage Site by the Association of Southeast Asian Nations. The Government of Myanmar (GOM) is cooperating with UNESCO to have Inle Lake recognized as a World Heritage Site.

Through several surveys conducted on the topography and soil structure of its Watershed areas since the late 19th century, it had been realized that sedimentation from the upland ranges could cause dire consequences for the future survivability of the Lake. Many interventions were introduced, but **implementation was mostly nominal and therefore ineffective.** A concerted effort was coordinated in 1992-1993 with the main focus being to address problems in the Watershed areas. Majority of interventions lacked coordination; related UN agencies, CSOs, CBOs, NGOs and INGOs **worked according to their own agendas,** independent of Government Ministerial Departments. Inter Ministerial coordination was also weak. Besides, all their **focus was principally on peripheral issues, leaving the most critical need to effectively restore the Lake unaddressed.** As such, deterioration of Inle Lake continued unabated.

Maintenance clearing and dredging of rivers, streams, lakes, reservoirs need to be undertaken at regular intervals to ensure a sustained supply of water to maintain their storage capacity. But as these operations are costly, labour and equipment intensive, most countries had not been able to undertake them. Irresponsible utilization of water from the rivers and streams that feed water bodies such as lakes, and excessive use of the underground water resource, has resulted in the **loss or severe degradation of large inland lakes and seas around the world.** For example, the Aral Sea between Kazakstan and Uzbekistan, Lake Barnaby in Canada and most recently Lake Oroumieh in Iran.

According to a survey of Inle Lake conducted in the early twentieth century, the total open water surface area was known to be around 100.4 square miles; length from North to South 36 miles; width from West to East 8 miles; deepest part of the Lake 20 feet in the rainy season and 12 feet in the dry season. A survey conducted by the Forest Department and the Land Records Department in 2007 revealed that the total area of open water surface was only 63 square miles; length from North to South 11 miles; width from West to East 4 miles; deepest part of the Lake 12 feet in the rainy season and around 6 feet in the dry season. **The Lake had therefore lost 37+ square miles of open surface water area, 25 miles in length, 4 miles in width and 6 to 8 feet in depth.**

Dr. Takahisa Furuichi, then a scholar at the Centre for Resource and Environmental Studies, The Australian National University, conducted a study of Inle Lake over a period of 3 years. He submitted his final report to the Forest Department in March 2008, in which he stated that according to his measurements, the north to south axis is about 18km (11.2 miles) and east to west axis about 5 km (3.11 miles). The deepest part of the Lake was 2.8 m (9.2 feet). The open water surface in the Lake based on Landsat TM 2000, was 43.5 sq. km (16.791 sq. miles), which is even less than the 2007 measurements mentioned in the preceding paragraph. He calculated that the **Peat Marshes would be infilled within 120 years and the Lake would disappear in approximately 2200 years (higher Mass Accumulation Rate – MAR suggests this would be 700 years)**, if the sedimentation rates estimated in this study were uniformly applied to the entire lake and marsh areas **and dredging did not occur.**

These are extremely alarming indicators that **Lake Inle is indeed in peril;** and that drastic measures need to be taken immediately, to restore it and its watershed areas. This **will require massive inputs and a holistic, multi-sector, multi-disciplinary, peoples' participatory approach;** for addressing the severe degradation of the Lake is complex, as it involves not only the environmental issues, but also the socio-economic aspect of the Lake Dwellers and communities living within the confines of its watershed areas.

UN-Habitat undertook drafting of this Long Term Restoration and Conservation Plan at the behest of the Ministry of Environmental Conservation and Forestry (MoECAF) in 2011, to assist in formulating a Long Term Restoration and Conservation Plan for Inle Lake. A team of international experts was mobilized and entrusted to conduct a comprehensive study to identify the root causes of deterioration of the Lake and formulate a draft Long Term Restoration and Conservation Plan. The expert team was assisted by personnel from the Forest Department and UN-Habitat who accorded them access to the Union Minister, related Ministers of the Shan State Government, Heads of Departments at the Union, Shan State, District and Township levels, all related stakeholders including local communities.

The Plan is **based on adoption of a "Community Based Approach"** to resource management, with the realization that no Plan or Project involving communities can succeed if the communities are not empowered to take charge as "owners", given a lead role in decision making and provisions made for their wholehearted participation in its implementation. This approach has been adopted taking into consideration the following actions:

- **Adopting a Watershed Approach** for conservation and sustainable development of the Lake and its Watershed areas.
- Integrating Biodiversity conservation as a priority consideration into Developmental Planning to minimize impacts on the ecosystems and species endemism.

- Peoples' Participatory Approach to mobilize **local communities within the Lake and its Watershed areas, to take ownership** of this Long Term Restoration and Conservation Plan and its realization. To actively assume a keen interest and lead role in all activities concerning implementation of the Plan.
- Adopting proactive measures to **address problems at the source while they are manageable**; rather than assume a reactive attitude of addressing crisis situations arising as a result of neglect, as curative measures.
- Revive and incorporate Indigenous Knowledge and Traditional Practices relating to Watershed Management and Biodiversity conservation that are practical, applicable and cost effective.
- Apply Knowledge Based Techniques through Research and Development.
- Conduct effective Monitoring and Evaluation on a regular basis.
- Develop a strong and capable Institutional Framework that will be instilled with professional dedication and motivation.

Comprehensive hydrological, ecological and socio-economic assessments involving all Stakeholders and local communities were conducted. Information gathered was analyzed and verified onsite and in consultation with experts and related Government Departments to identify "key issues". The main emphasis of the Plan is on the Restoration of the Lake and its total Watershed area; to prescribe management methodologies and practical approaches to conserve them sustainably.

The **Watershed Approach** incorporates the upland ranges starting **from the source of streams**, along the streams to the plains, and eventually their entrance into the Lake. It also includes the whole of the Inle Lake area. To identify all "key issues" impacting the Lake and Watershed areas, the upland areas and the plains will be subdivided into "Sub-Watersheds" according to the catchment areas of individual streams. Sub-Watersheds of each stream will be further divided into "Micro-Watersheds" based on the catchment areas of their feeder streams. The Lake will also be partitioned likewise. Markers to indicate each Sub-Watershed and Micro-Watershed will be put in place. This is in conformity with the prescription in Paragraph 12, sub-paragraph (a), sub-paragraph (4) of "A Brief presentation on the basic data relating to Inle Lake and measures undertaken to conserve it" by the FD, February 2012, in which is stated – To produce a Land Use Map of all the Watershed areas of Inle Lake. It is envisaged that two to three years would be required to accomplish the above activities.

This partitioning and demarcation must in no way infringe upon the ownership rights of individuals; they are to be established merely to enable methodical identification and documentation/marking on maps, problems existing within each Micro-Watershed. In this way, all problems existing within the total Watershed areas will have been identified and documented, enabling setting of priorities and addressing issues holistically **with the involvement of local communities and all stakeholders.**

Due to time constraint and complexity of establishing a "Lake Development Authority - ILDA" and "Inle Lake Trust Fund - ILTF", the team of experts **focused principally on implementation measures to restore the Lake and its Watershed areas.** The Long Term Restoration and Conservation Plan merely states that – establishment of a Lake Development Authority should be thought out very carefully; that it will need to merge with the existing management network set up by the Government of Myanmar – GOM; that the ultimate decision to establish the ILDA and Trust Fund and their Terms of Reference –TORs would have to be the GOM's decision.

Given the large expanse of the Lake and its watershed area, undertaking to restore them to a degree that can ensure their sustainability will be a massive undertaking; only a Multi-sector, Multi-disciplinary effort would be capable of achieving a degree of success. **Currently, the Forest Department is held responsible for the needs of all departments and agencies working to conserve the Lake.** This has been found to be ineffective, as the Forest Department itself has an extremely difficult task in addressing Watershed issues; besides, it alone cannot coordinate or influence the tasks and address the needs of other related sectors.

As such, **implementation of the Plan is based on a Multi-sector, Multi-disciplinary approach. Four "Special Task Working Groups - STWGs"** similar to the "Special Task Force Units" concept are to be set up. Lead Governmental Departments, supporting Ministerial Departments and related agencies / organizations, their role and functions will need to be defined so that all departments /agencies will coordinate and cooperate closely as a cohesive team. Each STWG will be required to formulate "Sub Plans", to clearly define their roles, functions and needs within the framework of their Sector Plans and this Long Term Restoration and Conservation Plan. Most importantly, **all departments to be involved in the STWGs need to be adequately strengthened** in staffing, capacity building, funding, equipment and support facilities etc. to enable them to achieve their set objectives at a high level required of them.

STWG - 1: To be responsible for the restoration of the upland Watershed areas **(Remote Zone)**. **The Forest Department will be the lead Department** and the following departments will support its efforts as part of a team. The Agriculture Department, Mechanized Agriculture Department (Upland agriculture land development mobile teams), Rivers and Streams Maintenance Department for training of streams (Ministry of Transport), Irrigation Department (Necessary dredging of streams), Rural Development Department (Ministry of Livestock, Fisheries and Rural Development), Cooperatives Department, General Administration Department, the Legal Department, and Law Enforcement Departments.

Other Ministerial Departments, Banks, Health, Education, Cottage Industries etc: will be called upon as and when necessary. **A vital component will be the local communities** (Owners of the Lake), CBOs and CSOs.

NGOS, INGOs, domestic and international professionals (individuals / organizations) will be invited according to their expertise and capabilities as and when required.

STWG - 2: To be responsible to develop proper agricultural practices, protect stream banks and the Lake shoreline, establish sedimentation control measures **(Buffer Zone). The Agriculture Department will be the lead Department.** Related support departments have been listed as in STWG (1).

STWG - 3: To be responsible for the restoration of the Lake, constructing silt traps at the mouths of the streams, clearing of undesired vegetation **(Core Zone). The Irrigation Department will be the lead Department.** Inle Lake being a Wildlife Sanctuary, it will need to work closely with the Wildlife Sanctuary Warden and staff, so that clearing and dredging operations will cause least damage / disturbance to the Wetland ecosystem, biodiversity, Bird Sanctuary etc. Support departments have also been listed.

STWG – 4: To be responsible for the uplifting of the social-economic status of all Lake dwellers and communities living within the confines of the total Watershed areas (All Zones). The **Rural Development Department (Ministry of Livestock, Fisheries and Rural Development) will be the lead Department.** Its related support departments have also been specified.
An **Implementation Command component** will need to be set up at Nyaung Shwe to undertake the following role and responsibilities:

- Overall policy directions and overseeing performance at the field level.
- Approve the sub-sector plans for implementation within policy guidelines of MoECAF, the Shan State Government and the ILDA; and in accordance with this Long Term Restoration and Conservation Plan.
- Assure fullest Inter agency / Departmental coordination and cooperation for overall achievement of the Plan's objectives.
- Integrate and monitor the Plan's components, while safeguarding the interests of the communities.

The Long Term Restoration and Conservation Plan was translated to the Myanmar language and distributed to the local communities ahead of the Multi-stakeholder Consultative Workshop held at the Forest Department, Nay Pyi Taw in September 2013. The National coordinator of UN-Habitat travelled to Taunggyi ahead of the Workshop to disseminate the actual status of the Lake, and the concept of the Long Term Restoration and Conservation Plan to the related Ministers of the Shan State Government, Heads of Departments at the State, District and Township levels and concerned Stakeholders. The State Ministers at the above meeting and Stakeholders at the Consultative Workshop requested that such dissemination sessions should be held at Nyaung Shwe, Pin Laung, Kalaw Townships and within the Lake.

The National Coordinator with the concurrence of MoECAF and the Shan State Government, travelled to the Inle Region in January 2014 and conducted five dissemination sessions at Taunggyi, Nyaung Shwe, Pin Laung, Kalaw Townships and Hei`Yar Ywama village tract within Inle Lake. The Director of the Shan State Forest Department and the Assistant Director, responsible for the Greening of Inle Lake coordinated the itinerary with the State and Township General Administration Departments ensuring a good attendance and keen interest at all venues.

The **principal message relayed to the communities** was – no undertaking concerning the people has ever succeeded without the whole hearted participation of the people; the need for people to understand that they are the rightful owners of Inle Lake; that they are "Inn-thars" because of Inle and Inn-thars would no longer need to be referred to as Inn-thars if Inle ceased to exist; that people living in the Watershed areas were also enjoying benefits accrued from Inle; this would all end if present attractions no longer appealed to domestic and international tourists; more so if it died away.

Inle Lake is in a serious state of deterioration and will certainly disappear if the people continued to regard restoring and conserving it as not being their concern. It is time for the total population of the Inle Region to awaken to the seriousness of the situation; take ownership of restoring and conserving the Lake and its Watershed, by working in tandem with responsible Ministerial Departments and other related organizations. **The people need to be involved in every aspect of restoration and conservation; from the planning right down to every aspect of implementation. All decision making must be processed involving the people; the final**

decision must be that concurred to by the people. Just as the people need to participate wholeheartedly, **they must be prepared to make sacrifices** where it will be necessary to prioritize the needs of the Lake, to give back to the Lake what rightfully once belonged to the Lake.

This Long Term Restoration and Conservation Plan being of a comprehensive nature, it must be understood that it would not be possible to include all practical aspects at the implementation level. Individual Sector plans and sub-plans of each Special Task Working Group would have to be drawn up based on this comprehensive Plan, in relation to their objectives, roles and functions.

Photo 1: National Workshop on Formulation of a Holistic Management Approach for the Long Term Conservation of Inle Lake, between MOECAF and UN-Habitat. (24-8-2011 to 25-8-2011)

Photo 2: Multi-Stakeholder Consultative Workshop on the Proposed Long Term Restoration and Conservation Plan for Inle Lake, sponsored by MOECAF, Norwegian Embassy and UN-Habitat. (12-9-2013 to 13-9-2013)

Conversion Factors

Table 1: Weight Conversion

	Viss	Lb	Kilogram	Long ton	Short ton	Metric ton
1 Viss	1	3.6	1.6329	0.001607143	0.0018	-
1 Lb	0.2778	1	0.4536	-	-	-
1 Kilogram	0.6124	2.204622	1	-	-	-
1 Long ton	622.2222	2240	1016.047	1	1.12	1.016047
1 Short ton	555.5555	2000	907.18	0.89286	1	o.90718
1 Metric ton (tonne)	612.3952	2204.62	1000	0.9842065	1.102311	1

Table 2: Length Conversion

	Cm	Feet	Meter	Mile	Kilometer
1 inch	2.53995	1/ 12	0.0253995	1/ 63360	-
1 foot	30.48	1	0.304801	1/ 5280	-
1 meter	100	3.28085	1	0.0006213	1/ 1000
1 mile	-	5280	1609.34	1	1.60934
1 kilometer	100000	-	1000	0.621371	1
1 Nautical mile (UK)	-	6080	1853.2	1.151515	1.8532
1 Nautical mile (Intl)	-	6076.11549	1852	1.150779	1.852

Table 3: Area Conversion

	Acre	Ha	Sq. mile	Sq. km.
1 acre	1	0.404686	1/ 640	0.004047
1 hectometer (ha)	2.473	1	0.003861	1/ 100
1 square mile	640	258.9981	1	2.589981
1 square kilometer	247.1054	100	0.386102	1

Table 4: Volume Conversion

	True cubic feet	Hoppus cu.ft.	Cu.meter	True cu.meter	Hoppus cu.ton
1 true cu.feet	1	0.7853982	0.028317	1/ 50	0.02546479
1 Hoppus cu.ft.	1.2732395	1	0.036054	0.015707964	1/ 50
1 cu. Meter	35.3147	27.7401	1	0.7064	0.5548
1 true cu. Ton	50	3926991	1.41585	1	0.7853982
1 Hoppus cu.ton	63.661975	50	1.8024	1.2732395	1
1 cu. Meter/ha	14.29/ac	11.226/ac	0.404686/ac	0.28587/ac	0.22452/ac
1 true cu.ton/ac	123.5529/ha	97.038/ha	3.4986/ha	2.471054/ha	1.9407/ha
1 Hoppus cu.ton/ac	157.3124158/ha	123.5529/ha	4.453834/ha	3.146248/ha	2.471054/ha

Acronyms

GOM	Government of Myanmar
MoECAF	Ministry of Environmental Conservation and Forestry
CSCOIL	Central Steering Committee for Environmental Conservation of Inle Lake
SSSC	Shan State Supervisory Committee
FD	Forest Department
UN Agencies	United Nations Agencies
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN-HABITAT	United Nations Human Settlements Programme
FAO	Food and Agriculture Organization
WHO	World Health Organization
IMF	International Monetary Fund
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
LTRCP	Long Term Restoration and Conservation Plan for Inle Lake
ILDA	Inle Lake Development Authority
ILTF	Inle Lake Trust Fund
TORs	Terms of Reference
NGO	Non Governmental Organization
INGO	International Non Governmental Organization
STWGs	Special Task Working Groups
CSOs	Civil Society Organizations
CBOs	Civil Based Organizations
IKONOs	Earth Observation Satellite
GPS	Global Positioning System
GIS	Global Information System
WBSJ	Wildlife Bird Society of Japan
IWRM	Integrated Water Resource Management
IDWSO	Inle Drinking Water Supply Organization
TPA	Terra People Association of Japan
JKK	Jissen Kankyo Kenkyusho Company of Japan
MFI	Micro Finance Institution
ROI	Return on Investment
STP	Sewage Treatment Plant
MSL	Mean Sea Level
SMS	Sediment Monitoring Station
HMS	Hydro-Metrological Station
PRSPS	Poverty Reduction Strategy Papers (By IMF and World Bank)
FGD	Focused Group Discussions
BOD	Biological Oxygen Demand
DO	Dissolved Oxygen
SLA	Sustainable Livelihood Approach
CDM	Clean Development Mechanism
EIA	Environmental Impact Assessment
POA	Program of Activity

TABLE OF CONTENTS

Annexures

Chapter 1
General Information

1. Background Data

Scientists have estimated that Inle Lake is a natural lake that was transformed from its Tectonic state to become a Solution Lake during the Tertiary Period between 1.6 to 65 million years ago. Geologists however have calculated from rock and soil formations, artifacts and inscriptions discovered in many lime stone caves within the region, that it had been formed during the past two million years. Remains of domesticated and wild animals excavated and etchings in the Htat Inn Cave and surrounding limestone caves indicate that humans had inhabited the region since the Neolithic Age (the New Stone Age).

In 1927, Mr. H.L.Chibber published Geographical Data of Myanmar, in which he stated that many lakes had existed in the Shan Plateau; however, due to geological erosion processes, these large water bodies were infilled creating huge plains, such as the Heho valley. Inle being the only Lake of sizeable dimensions remaining in that region. (Heho valley is 800 feet higher than Inle Lake).

Originally, the Bilu stream flowed out of Inle Lake to join the Pun stream to the south, which then continued to flow into the Thanlwin (Salween) River. With the construction of Mobye` Dam to build the Law Pi Ta hydroelectric power station, Saga Lake and the Mobye` Reservoir became permanent water bodies.

Elderly folk assured the team that portions to the south of **"Nam Pan village"** right down to the Saga Lake were small lakes (water bodies); but with accumulation of silt through centuries they had been infilled and currently are **submerged during the rainy season, and transformed to "Paddy Land" as the water recedes** in the dry season.

The Let Moung Gway Range to the West (around 3000 feet) and the Hsin Taung Range to the East (around 5000 feet) flank Inle Lake, running parallel to it from north to south. Realization that soil erosion on these upland ridges due to their loose composition, could cause major sedimentation problems to the Lake in the long term had been prevalent since the mid 19th century. But effective measures to control the sediments were not introduced.

In 1915, the Agriculture Department introduced Cropping Designs within Taunggyi and Nyaung Shwe Townships; but it was not widely propagated. In 1937, the Forest Department – FD established a Soil Conservation Unit to monitor and study soil erosion and undertake necessary measures to contain sediments from entering the Lake. However, this unit was disbanded in 1962 due to lack of funding and qualified technical staff.

From 1947 to 1949, measures to develop awareness among local communities were introduced, but were not progressively developed. The Shan State Soil Protection Act No: 1 was promulgated in 1951, but this also was not effectively enforced. Earnest efforts to address the problems on a holistic multi-sector, multi-disciplinary scale were introduced in 1992 – 1993 and carried through till 1999 – 2000; but lack of funding, inadequate support of man power and material; weak coordination and cooperation among sectors, UN agencies, NGOs and INGOs resulted in very little tangible impacts. Besides, all efforts were focused on rehabilitating the Watershed, with little or no designs to restore the Lake.

Map 1: Inle Lake flanked by two Mountain Ranges

The FD was designated the task of being responsible for every aspect of implementation in the field and to address the needs of all sectors involved. The FD was already over taxed with its own commitment to rehabilitate and conserve the whole Watershed area, it could in no way cope with the added task, especially without adequate financial, manpower, technical and equipment support. There was also no provision for a command and control body, making coordination and cooperation between sectors ineffective; and siltation of Inle Lake went on unabated.

The first awakening occured in 1989, when a relatively severe drought caused the water level within the Lake to decrease alarmingly. This was followed by another drought in 2000, which caused serious concern that it would cause reduction of water supply to the Law Pi Ta Hydroelectric Power Plant. The then Head of State toured the Inle region and prescribed guidelines relating to conservation of the Lake and its surroundings within a radius of 20 miles.

MoECAF formulated the first Five Year Rolling Plan (2000-2001 to 2004-2005). This was followed by the Second Five Year Plan (2005-2006 to 2009-2010).

The issue came up at centre stage during the dry season of 2010, when there was a sudden fall in the volume and level of the Lake water, due to low rainfall caused by severe drought; the Irrigation Department had to take on the task of frantically clearing / dredging channels for boat traffic. Serious concerns were expressed by the GOM. The first workshop to address these issues was held at the FD, Nay Pyi Taw on the 1st and 2nd of July 2010. The deteriorating situation of the Lake, the need for sustainable utilization of water resources, status of land use, environmental impact and socio-economic conditions of local communities were reviewed. Workshop resolutions included – urgent planning and mitigation measures to restore the Inle Lake eco-system and rehabilitation of degraded forest areas falling within the catchment.

This was followed by a Regional Workshop held at Taunggyi from the 12th to the 14th of July 2010. The Minister of Forestry - MOF, members of the Shan State Peace and Development Council, various Ministerial Departments, NGOs, INGOs, Heads of Departments from Taunggyi University and related Stakeholders were in attendance. Pertinent Resolutions adopted were as follows:

- Stakeholders make a coordinated effort towards restoration of the Lake.
- A two stage approach with primary focus on planning and mitigation measures to be adopted.
- Issues and problems confronting Inle Lake to be reviewed, as well as gaps and needs identified during the planning phase.
- The main component of the mitigation phase to include assessment of critical areas such as land use changes, eco-system services and socio-economic status of the Lake Dwellers.
- A ten year Action Plan to mitigate the environmental factors affecting the Lake eco-system was also to be prepared.

The GOM / MoECAF prepared a comprehensive Action Plan (2010 – 2015) for Environmental Conservation and Sustainable Management of Inle Lake. The Action Plan provided for almost every aspect and identified critical inputs required to propel concerted action for saving Inle Lake. While the Plan identified the major areas requiring initiatives, **it fell short in detailing the underlying inputs and innovations**. Besides, there was no institutional mechanism to monitor and generate important data that could serve as useful tools for effective implementation. As a consequence, even though a large number of UN agencies, NGOs and INGOs had been operating on several internationally funded programs, little was achieved to arrest the rate of degradation of the Lake, because of the fragmented approach.

The Central Steering Committee for Environmental Conservation and Sustainability of Inle Lake, chaired by the Minister of Forestry, was established in September 2010. This was reorganized in June 2011, as the Central Committee for the Sustainability of Inle Lake and Conservation of its Favourable Environmental Status.

The Shan State Implementation Supervisory Committee for the Sustainability of Inle Lake and Conservation of its Favourable Environmental Status chaired by the State Prime Minister of the Shan State Government was established in July 2010; it was reorganized in September 2011.

Current implementation is being undertaken in accordance with the Third Five Year Rolling Plan 2010-2011 to 2014-2015. In MoECAF's "Action Plan for Environmental Conservation and Sustainable Management of Inlay Lake (2010 – 11 to 2014 – 2015)" under the heading - Detailed activities of Action Plan, page 9, sub-paragraph B. "Protection from erosion and sedimentation", sub-sub paragraph (1), Systematic removal of deposits of silt from the Lake, it clearly states that – "It is needed to **find places outside the Lake where deposition removal from the Lake is to be kept**"; but it was not to be, as the Irrigation Department lacking necessary resources had to continue heaping the dredged material on either side of the dredged channels.

Photos 3and 4: Mounds of dredged silt

As per MoECAF's request to assist in formulating a comprehensive Long Term Restoration and Conservation Plan for the Restoration and Conservation of Inle Lake, UN-Habitat with financial support from the Norwegian Government, assisted the Ministry in organizing a National Workshop from the 24th to the 25th of August 2011, at the Forest Department, Nay Pyi Taw, on the formulation of a Long Term Restoration and Conservation Plan for a period from 10 to 15 years.

In accordance with a resolution passed at the above National Workshop, and in consultative agreement with MoECAF, UN-Habitat commissioned a team of international experts to assist in formulating the Long Term Restoration and Conservation Plan. The team of experts spent two months in the field, collecting and collating information and basic data from all available sources. They were assisted by the Director and personnel from the Shan State Forest Department and UN-Habitat's National Coordinator. The team was accorded access to related Ministers of the Shan State Government, Heads of Departments at MoECAF, the Shan States, District and Township levels; all related stakeholders, NGOs, INGOs, UN agencies, CSOs, CBOs and local communities. Thus, they were able to accumulate a wealth of basic data and related information. Gaps were filled by physical verification.

The (Proposed) Long Term Restoration and Conservation Plan was submitted to MoECAF in March 2013, for necessary guidance. A meeting between MoECAF and UN-Habitat was held at the FD, Nay Pyi Taw on the 13th of May 2013. MoECAF was represented by the two Deputy Ministers, Directors General, related Directors and staff. UN-Habitat presented the actual situation of Inle Lake and the concept of the Long Term Restoration and Conservation Plan. The (Proposed) Plan was well received by their Excellencies.

The (Proposed) Long Term Restoration and Conservation Plan was translated to the Myanmar language and distributed to the community level stakeholders ahead of the Multi-stakeholders' Consultative Workshop scheduled to be held in early September 2013. The UN-Habitat National Coordinator travelled to Taunggyi in July 2013 to meet with related Ministers of the Shan State Government, Heads of Departments at the Shan State, District and Township levels; related Heads of Departments of Taunggyi University, related stakeholders, CSOs and CBOs to present the factual state of degradation Inle Lake was in and explain the concept of the Long Term Restoration and Conservation Plan. The Ministers requested that likewise dissemination sessions should be held at Nyaung Shwe, Pin Laung, Kalaw Townships and within Inle Lake.

The Multi-stakeholders' Consultative Workshop was held at the FD, Nay Pyi Taw on 12th and 13th of September 2013. The (Proposed) Long Term Restoration and Conservation Plan was fully supported by the Stakeholders who repeated the request to hold dissemination sessions as stated above.

With the permission of MoECAF, the UN-Habitat National Coordinator travelled to Taunggyi in early January 2014 and held five dissemination sessions at Taunggyi, Nyaung Shwe, Pin Laung and Kalaw Townships and Hei` Yar Ywa ma village tract within Inle Lake.

The (Proposed) Long Term Restoration and Conservation Plan has been revised incorporating all relevant feedback from the Multi-stakeholder Consultative Workshop and the dissemination tour. Thus, the process of gathering and collating information to complete the formulation of the Long Term Restoration and Conservation Plan for the Restoration and Conservation of Inle Lake was fulfilled.

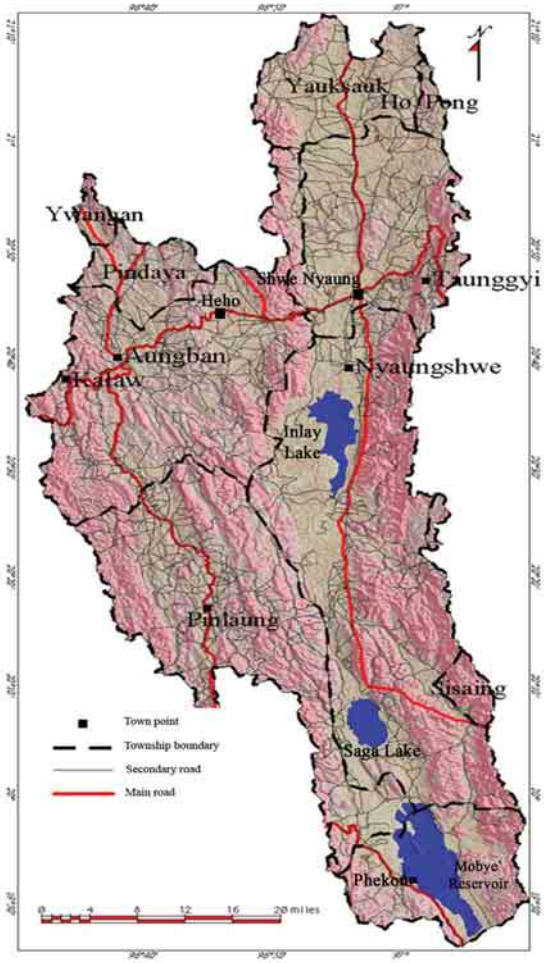
1.1. Location, Area and Status

Inle Lake is situated in Nyaung Shwe township, Taunggyi District, Southern Shan State. It extends from approximately 19° 28' to 20° 38' N Latitude and 96° 47' to 97° 6' E Longitude. The Lake is located at an elevation of 2890 feet above mean sea level. The lake is elliptical in shape. The north south axis is approximately 11.18 miles and the east west axis is approximately 4 miles. The distance of Inle Lake from Taunggyi (Capital of Shan State) is 32 miles; from Kalaw 52 miles; from Heho (the nearest airport) 44 miles and 13 miles from Shwe Nyaung.

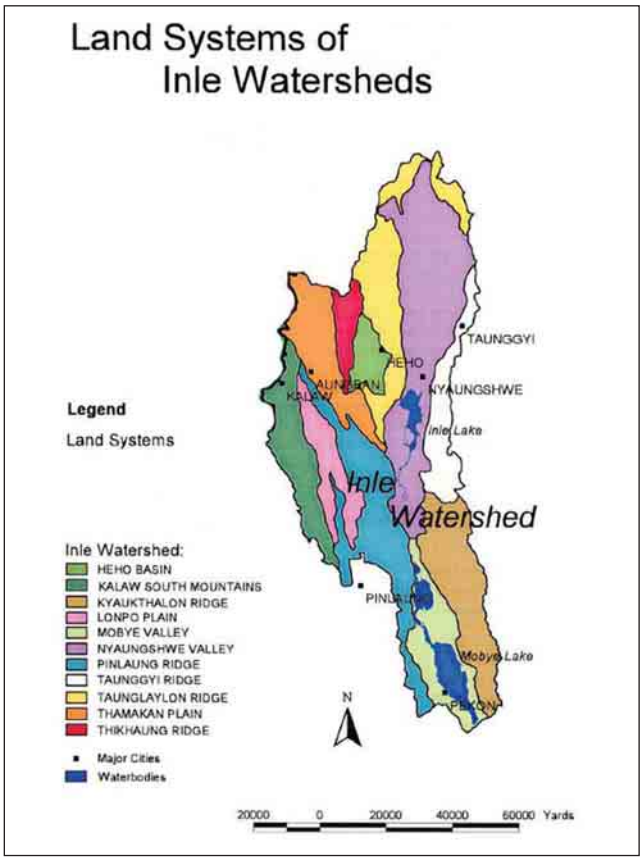
The catchment area has been assessed by different parties at different times. The last assessment made indicates the catchment area to be 1405 sq. miles. The water surface area of Inle Lake was known to be around 100.4 sq. miles; its length from north to south was 36 miles and its width from west to east was 8 miles. **A survey of the Lake dimensions conducted by the Land Records Department in 2007 revealed that the Lake area had decreased alarmingly.** The total Lake area was reduced to 63 sq. miles, of which only 24 sq. miles remained as open water surface area. Of the remainder, 15 sq. miles was floating agriculture gardens, 13 sq. miles wild floating vegetation and peat marshes, 3 sq. miles human habitation and 8 sq. miles of land based agriculture on land that had encroached into the Lake. The length from north to south measured only 11 miles and its width from west to east a mere 4 miles. This indicated the **loss of the total Lake area was 37+ sq. miles; the decrease in length was 25 miles and width 4 miles.** The deepest part of the Lake, which was once known to have been 20 feet in the rainy season and 12 feet in the dry season, measured merely 12 feet in the rainy season and around 6 to 8 feet in the dry season.

Dr. Furuichi in his final Report stated the measurements of the Lake to be – **north to South axis 18km (11.2 miles); West to East axis 5 km (3.11 miles); expanse of Open Water Surface area 43.5 Sq. km (16.79 sq. miles); deepest part of the Lake 2.8 meters (9.2 feet).** The reasons for shrinkage of the Lake and its becoming shallower are mainly attributed to the upstream soil erosion and general watershed issues, coupled with the impact of floating gardens.

Inle Lake is interconnected with Saga Lake and Mobye` Reservoir to the south by Bilu Stream. This stream originates from Pinlaung Township and flows into Inle Lake at its south western part. It then flows south to Saga Lake, Mobye` Reservoir and ultimately into the Than Lwin River.



Map 2. Location and Watersheds of Inle, Saga Lakes and Mobye` Reservoir



Map 3: Inle Watershed. Source FAO - 1995

Inle Lake was designated as an ASEAN Cultural Heritage Site. In 1998, Inle Lake was named as one of the representatives of the Earth's 200 most valuable eco-regions. The Lake is home to the revered Phaung Daw Oo, Alo Daw Pauk, Inn Dein Pagodas that attract large numbers of domestic pilgrims each year.

Photos 5 and 6: The Revered Hpaung Daw Oo Pagoda and Buddha Images

The Inn-thar people, are famous for their unique tradition of rowing boats while standing on one leg at the back edge of the boat, curling the other leg around a long oar and propelling the boat by rowing with the leg curled around the oar.

Photos 7 and 8: Leg rowers, unique to Inle

Floating agriculture practice is also a novelty; and the genuinely warm and cheerful hospitality of local communities attract large numbers of international tourists each year. As such, Inle has become one of the most popular sites; "a must visit destination"; a **globally renowned national "icon"**.

Photo 9: A mature floating tomato strip

Photo 10: Harvesting tomatoes by boat

Despite implementation of a wide variety of improvement and rehabilitation projects since 1992, the Lake has been shrinking and becoming shallower every year. Furthermore, in 2010 the water level of the Lake dropped to its lowest in 50 years. Low lake water levels and shrinkage of the open water surface area of the Lake, has impacted directly on the lake ecological systems and the ability of local people to carry out lake based livelihoods.

The FD in its Report published in 2012, states that in severe dry periods, the area of the Lake recedes to around 40 sq. miles.

1.2. Geology and Soils

Basic rocks of the Shan plateau are Lime stone. Granite and Shale can be found in some areas. Soil found in the catchments are mountainous brown and yellow brown, classified as Cambisol and Ferrasols as per FAO classification.

1.3. Climate

Climate is a broad summation of temperature, humidity, rain fall and wind velocity. The ambient temperature and rain fall are main factors which influence the lake environment. The Inle Lake has a warm, humid and temperate climate. The minimum temperature that occurs within Nyaung Shwe Township in December is around 7.6ºC, while the maximum temperature occurs during April to May, to around 37.7ºC. The area experiences severe cold nights during the Cold Season with temperatures in Kalaw and Pinlaung Townships going down as low as 1º C to -1º C. The humidity ranges from less than 40% in March to 90% in August. In summer the prevailing winds are south-westerly warm tropical winds, originating from the Bay of Bengal. In the Cold Season (December to February) the winds are north-easterly cold winds, originating from Central Asia. The Rainy Season occurs during the period from April to November, with maximum rainfall occurring from August to September. The annual precipitation for several rain-gauge stations around the lake are as shown in the table below:

Table 1: Annual rainfall at several stations around Inle Lake (inches)

Station Name	Year												
	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	Aver-age
Nyaung Shwe	34.44	47.17	34.09	30.15	46.37	41.8	45.04	29.3	43.41	32.1	35.13	54.05	39.42
Taung-gyi	51.13	73.04	56.3	65.73	65.24	60.75	60.24	56.33	55.6	50.41	45.63	79.98	60.03
Kalaw	37.11	45.72	42.07	34.08	46.44	46.28	36.67	36.67	35.22	47.66	32.53	42.4	40.24
Pinlaung	72.87	87.84	95.4	78.24	94.76	97.03	88.86	95.27	103	86.2	70.74	93.2	88.61
Pindaya	42.89	58	53.03	38.08	54.3	43.63	49.8	42.05	47.24	23.49	38.93	60.54	46.00
Yatsauk	32.5	44.59	34.49	41.65	52.2	63.71	70.79	53.49	39.1	30.31	44.76	72.34	48.33
Pekhon	45.04	47.67	43.55	37.2	63.09	41.83	32.68	35.28	33.99	26.37	37.86	44.36	40.74
Catch-ment RF	45.14	57.72	51.28	46.45	60.34	56.43	54.87	49.77	51.07	42.36	43.65	63.84	51.91

There are 29 major streams flowing into the Lake, of which the following four are perennial and the remaining seasonal:

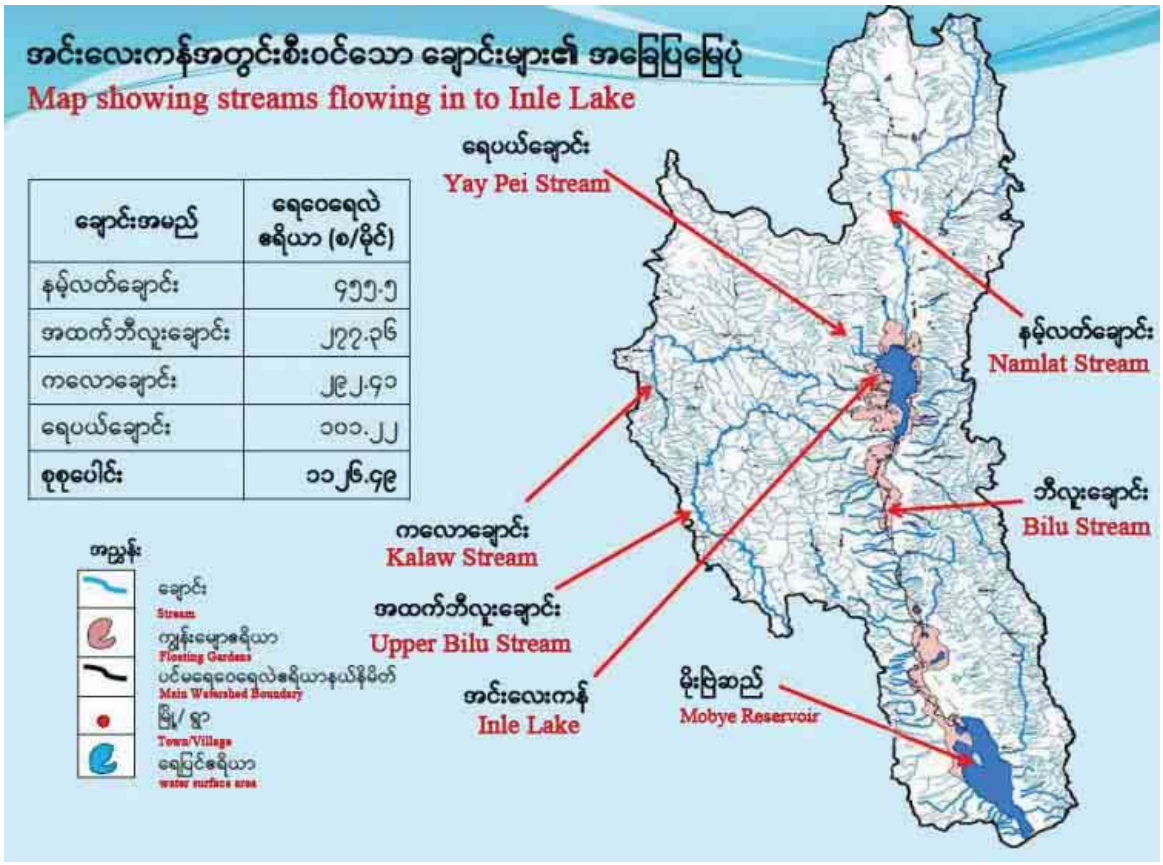
1. Nam Lat
2. Nei Gyar (Yay Pei)
3. Kalaw (Thann Daung)
4. Bilu (Indein)

Table 2: Sub-watersheds of the 29 streams (Source: Shan State Irrigation Department)

Sr. No.	Stream Name	Catchment Area (m2)	Percentage
1	Nam Lat	1367.38	37.13
2	Shwe Lin Ban	20.72	0.56
3	Chaung Chauk	6.47	0.18
4	Namzi	33.67	0.91
5	Loitan	12.95	0.35
6	Wadaw	3.88	0.11
7	Thapyaepin	5.18	0.14
8	Chaung Sauk	23.31	0.63
9	Thale Oo	33.67	0.91
10	Nyaung Gyi	16.83	0.46
11	Kho Pan	5.18	0.14
12	Nyaung Pin Kan	6.47	0.18
13	Yay Pu	41.44	1.13
14	Maezali	28.49	0.77
15	Yay Pok	72.51	1.97
16	Dali	12.95	0.35
17	Kan Per	5.18	0.14

Sr. No.	Stream Name	Catchment Area (m2)	Percentage
18	Nam Me Sin	49.2	1.34
19	Thanakha	6.47	0.18
20	Yay Pei	352.20	9.56
21	Thekone	11.65	0.32
22	Magyipin	7.77	0.21
23	Yay U	3.88	0.11
24	Kalaw (Thann Daung)	662.97	18.00
25	Bilu (Indein)	808.00	21.94
26	Seinka Myauk	45.32	1.23
27	Magyi Seik	20.72	0.56
28	Hti Khan	10.36	0.28
29	Pauktaw	7.77	0.21
	Total	**3682.00***	**100**

*Note- The area of Catchment is 1405 in Sq. miles; difference in figures is <2% and is negligible for Hydrological Assessments besides variation in individual catchment area.



Map 4: Streams flowing into Inle Lake

The Lake is mainly fed by four perennial streams located on the north and the west; streams on the east side are all seasonal. The eastern part of the basin accounts for only 10%, while the western part comprises 53% and the northern part constitutes 37% of the catchment area.

The Watershed area of Inle cannot be defined as being confined within the two flanking mountain ranges, as the source of all four perennial streams originate in far off townships. The northern Nam Lat stream originates in Lawk Sawk Township; of the western streams, Yay Pei` stream originates in Heho Township; the Kalaw stream originates in Kalaw Township near its border with Thazi Township, and the Bilu stream originates in Pin Laung Township. Thus, the total Watershed area incorporates the whole of Nyaung Shwe township and portions of seven other townships as indicated in Table 1, necessitating the inclusion of those townships in all planning, coordination and implementation endeavours concerning restoration and conservation of the watershed areas.

1.4. Population

Some researchers have stated that human habitation within Inle Lake could have started earlier than ten thousand years ago. Legend has it that initially there were four villages and thus the Lake was named – "Inn" meaning lake and "Lay" meaning four (villages).

There are 35 village tracts within Nyaung Shwe Township, comprising 444 villages, 32,139 households and approximately 1,68,130 people within Inle Lake and its surroundings. Of these, 17 village tracts lie within the lake and 5 village tracts lie partially within the Lake and partially on dry land. The remainder 13 village tracts lie on land in the vicinity of the Lake. The total number of people living in the seven townships within the whole watershed area of Inle Lake (Nyaung Shwe – 168,130; Kalaw – 133,804; Pin Laung – 146,321; Lawk Sauk – 19,700; Pindaya – 13,693; Taunggyi – 99,521) according to the last census was 5,81,169 individuals.

Population estimates are highly variable. Due to the absence of demarcation of the Lake boundaries, the exact number of villages located in the submergence area is not clear. As a result, the number of villages / households 'in the water' and 'on land' has been reflected differently in reports and documents published so far. However, the impact of villages on the shoreline and those in the water, on the Inle Lake ecosystem are the same.

Photo 11: Villages on land that was once the Lake

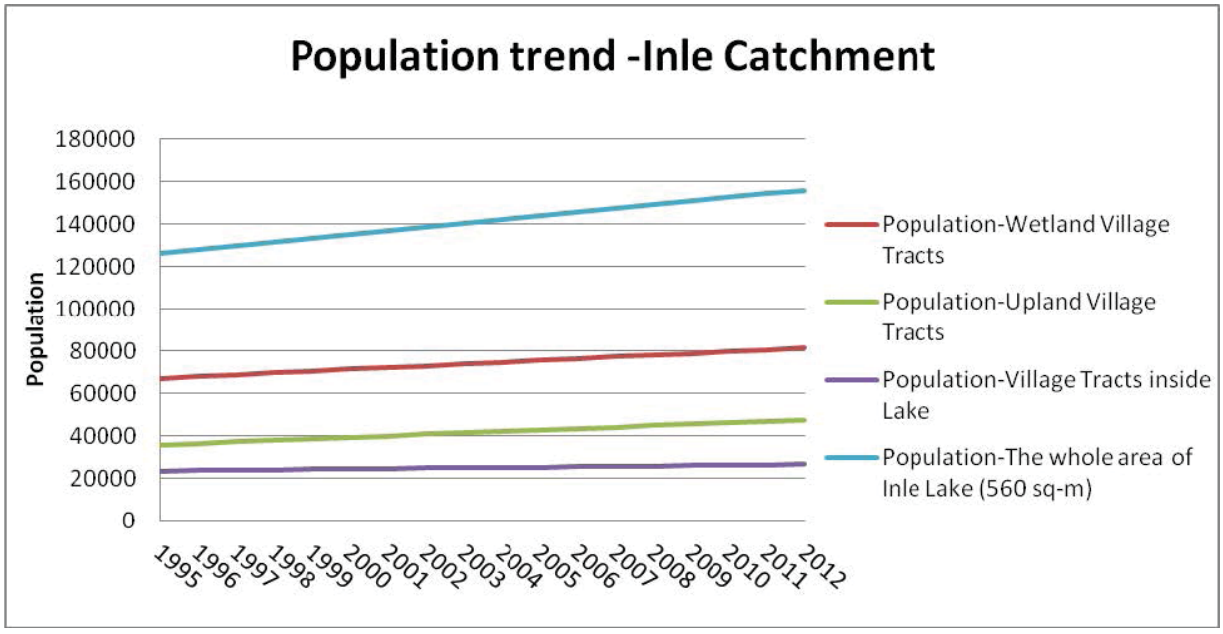
Table 3: Population and Population Density in Inle Lake

Year	Wetland Village Tracts (265 sq-m)		Upland Village Tracts (272 sq-m)		Village Tracts Inside Lake (23 sq-m)		The whole area of Inle Lake 560 sq-m)	
	Population	Density	Population	Density	Population	Density	Population	Density
1983	56,916	215	27,448	101	21,169	937	105,533	188
1990	62,871	237	32,427	119	22,541	998	117,839	210
1995	67,101	253	35,866	132	23,516	1041	126,483	226
1996	67,943	256	36,565	134	23,711	1050	128,219	229
1997	68,785	259	37,264	137	23,906	1058	129,955	232
1998	69,627	263	37,963	139	24,100	1067	131,690	235
1999	70,469	266	38,662	142	24,294	1076	133,425	238
2000	71,311	269	39,359	145	24,487	1084	135,157	241
2001	72,152	272	40,056	147	24,680	1093	136,888	244
2002	72,992	275	40,752	150	24,873	1101	138,617	248
2003	73,831	279	41,448	152	25,066	1110	140,345	251
2004	74,670	282	42,139	155	25,259	1118	142,068	254
2005	75,504	285	42,837	157	25,452	1127	143,793	257

Source: Immigration and National Registration Department, (2005)

Given the absence of credible information with respect to the population, estimates have been attempted through trend analysis depicted in the graph below:

Graph 1: Population trend



The population numbers in the Inle catchment are projected based on the population trends observed in the 1990's. In order to generate numbers up till year 2012, linear projections were carried out by estimating the growth rates for each category of catchment population.

From the projections it can be inferred, that the population in the catchment has been growing consistently at 11.5% per annum during the last two decades; the population growth rate for the upland tracts is highest at 14% per annum and slowest for the village tracts in the lake at less than one percent per annum. Over the years, the pressure on the lake has increased considerably; in 1995, there was an average of 226 people residing on each sq. mile of the lake catchment; in 2012 this number shot up to 278, which is a 23% increase in just 17 years. Villages within the lake make up for 17% of the catchment population, whereas thrice of this population resides in the Wetland village tracts (contributing 52% of the catchment population), the remaining 30% of the population resides in villages that are situated on Upland tracts.

According to official records, village tracts with population density of 1000 per sq. mile and above are Nam Pan, Min Chaung, Kyun Gyi, Tha Bye Pin, Inn Chan / Kay Lar, Hei Yar Ywa Ma, Thar Lay, Inn Paw Khone. These eight village tracts situated within the Lake comprise a mere total area of 5 sq. miles, makes it a very densely populated area. Likewise, Ywar Thar, Nan The`, Naung Taw, Inn Hlyar, Nga Hpe` Chaung and Inn Dein village tracts have a density of between 500 to 1000 per sq. mile (Source: Department of Immigration and Manpower). In the past three decades the population in the Lake area has grown by nearly 40%. Besides the Inn-thar ethnic population, the Shan, Pa O, Danu, Taung Yoe and Burman communities also dwell within the area.

Livelihoods in the region include land based and floating agriculture, commercial fishing within the Lake, textile cottage industries, tourism, fish farms (ponds on land and cages within the Lake), metal smiths and motor driven boat transportation.

Of these, Min Chaung, Kyun Gyi, Tha Byay Pin, Inn Chan / Kay Lar, indulge in cultivating tomatoes on floating gardens within the Lake and its fringe areas. Nam Pan, Ywar Ma, Inn Paw Khone, Thar Lay village tracts indulge in cotton and silk fabric weaving and dyeing cottage industries, goldsmiths and carpentry (furniture making), domestic and international tourism. The Pa-O ethnic race, dwell mainly on the Eastern Mountain Range and indulge in raising Cheroot leaf tree plantations. People who live near water sources grow garlic in the cold season and maize during the rains. They have recently started mango orchards and are also growing tamarind trees, avocado, dragon fruit and jack fruit. The Taung–Yoe is an ethnic race whose livelihood is based mainly on slash and burn (Taung-Yar) cultivation, where they grow paddy, wheat, maize, sesame and lentils. The Western Mountain Range has a much higher incidence of shifting cultivation. This mountain range is the prime drainage area for Inle Lake, as all four perennial streams run down through it, carrying heavy loads of silt. Villagers produce their own line of products funded by moneylenders / traders, who subsequently buy the produce at a price predetermined by them; after their commitments to the traders have been fulfilled, villagers market their produce within and outside of the Shan State at a higher profit margin.

Due to the high population density within the Lake area, **waste discharged from households, agriculture and cottage industries are largely responsible for the pollution of the Lake and degradation of the environment**.

1.5. Land Use

Nyaung Shwe Township forms the main drainage of Inle Lake. It covers an area of 557.06 sq. miles. 33.37% comprising the lake area and its surroundings have been designated as a Wild Life Sanctuary (DOF, Shan State). As per data from the Satellite imageries (2010), the current Land Use pattern is as follows:

Table 4: Land Use Pattern of Nyaung Shwe Township

a.	Land under Agriculture	887.61 sq. miles	42 %
b.	Forests with sparse canopies	343.66 sq. miles	16 %
c.	Forests with dense canopies	139.37 sq. miles	7 %
d.	Other forms of Land use	626.31 sq. miles	30 %
e.	Water Surface area	99.51 sq. miles	5 %
	Total:	2096.47 sq. miles	100 %

The area of Forests with dense canopies and sparse canopies are nominal when compared with Land under Agriculture and other forms of land use.

On comparing the Land Use pattern in 2005 with that in 2010, changes can be observed as follows:

Table 5: Comparative Land Use Patterns for 2005 and 2010

	Land Use Type	2005	2010	Difference
a.	Area under Forest cover	434.43 sq. miles	410.13 sq. miles	- 5.6 %
b.	Land under agriculture/ Other land uses	1562.80 sq. miles	1593.74 sq. miles	+ 2.0 %
c.	Open water surface area	99.24 sq. miles	92.60 sq. miles	- 6.7 %
	Total:	2096.47 sq. miles	2096.47 sq. miles	-10.3 %

Decrease in the Forest Cover and the Open Water Surface area within a short period of five years **indicate the severity of the situation**, **endangering the lake and the tectological stability of the area**.

1.6. Biodiversity

Inle Lake with its associated wetlands supports a wealth of biodiversity and provides important habitats for migratory water birds within the East Asian Flyway. The Lake also provides one of the large fishery resources within the Shan State, supporting livelihoods of a large human population living in the Lake and along its fringes. Recognizing the importance of the Wetland for its biodiversity richness and socioeconomic values, the lake was not only designated as the 190th World's Eco-region but also declared as one of the Fresh Water Biodiversity hotspots by the World Conservation Monitoring Centre.

Inle Lake is home to nine indigenous fish species including the locally prized *Inle Cypris* (the Inle Carp, locally known as "nga-phein") and the *Sawbwa Genera* that are endemic to Inle Lake and are not known to be found in any other part of the world. There are 16 sub-species that thrive in the inflows of streams that discharge into the Lake.

Photos 12 and 13: Endemic fish species

The Lake is regarded as one having the highest water plant diversity in Myanmar. Its connection to the Saga Lake and Mobye Reservoir makes it into a Wetland spreading over a length of 62 miles and area of 248 sq. miles. The floating leaved water plants and those submerged in the Lake provide different temperature zones and micro environments to the fish and plankton. It has been regarded as one of the most threatened lake systems in Myanmar (2004 survey). A four sq. mile area on the northern fringe of the Sanctuary area has been demarcated as a Bird Preservation Area, where around 25,000 – 30,000 birds consisting of about 270 species, both native and migratory species, congregate during the Cold season months.

Forests in the area are classified as below:

Hill areas around 4000 feet. The eastern portion of Kalaw Township and the northern portion of Pinlaung Township are mostly covered with Pine Forests. The southern part of Lawk-Sawk is covered with Dry Indaing forests. In some places, Pine Forests are mixed with Hill Decidous forests. In areas around 4000 feet and above, Hill Forests, Pine Forests, and Grass Lands can be found. Slash and burn cultivation (Taung-yar) is practiced mostly in these areas and where Taung-yars had been abandoned, Elephant Grass has taken over.

Hill areas around 3000 feet. These Hill areas are covered mostly with Moist Upper Mixed Decidous Forests, Dry Upper Mixed Decidous Forests and Indaing Forests.

The Botany Department of the Yangon University conducted a survey from 1957 to 1959 to identify the botanical species that are found in and around Inle Lake. The following species were identified and recorded:

Table 6: Botanical species found in and around Inle Lake

Sr. No.	Kinds of Flora	No. of Families	No. of Genera	No. of Species
1	Fern and Fern Allies	10	31	64
2	Gymnosperms	3	7	12
3	Angiosperms (Monocot)	26	149	292
4	Angiosperms (Dicot)	130	682	1320
	Total	169	869	1688

The survey also revealed 527 species of medicinal trees, plants, climbers etc. In 2002, the Wildlife Department undertook to identify Orchard species endemic to the Inle Lake region. So far 217 species have been identified and catalogued.

1.6.1. Flora. The native flora of the Lake comprises:

a. **Amphibious:** *Marsilea*, *Colocasia*, *Polygonum sp.*, *Alternanthera sp.*, (and possibly the introduced *A. philoxeroides*).
b. **Creeping:** *Ludwigia adscendens*, *Ipomea aquatica*, grasses *cf. Echinochloa*
c. **Emergent:** *Phragmites sp., Typha sp., Nelumbo nucifera, Saggitaria sp., Saccharumsp*
d. **Free-floating:** *Eichhornia crassipes, Salvinia sp., Pistia stratiotes.*
e. **Floating-leaved:** Two species of *Potamogeton, Nymphoides sp.*, two colour variants of *Nymphaea sp*
f. **Submerged rooted:** *Najas sp., Chara, Nitella,* (often encrusted with calcium).
g. **Submerged, non-rooted:** *Elodea sp., Hydrilla verticillata,* two spcs of *Utricularia*.
h. **Plankton Phytoplankton:** Dominated by *Ceratium*, with a mixture of *Microcystis*, *Dinobryon* and *Botryococcus.*
i. **Zooplankton:** Dominated by *Heliodiaptomus cinctus* (62%), with *Moina micrura* subdominant (34%); *Daphnia lumholtzi, Moina micrura* and *Bosminopsis deitersi*, growing sparsely. Rotifers dominated by *Polyarthra* (61%). In a second sample taken, *Macrophytes, Ascomorpha* were dominant (80%). Overall, twenty-one species were found.

Photos 14 and 15: Pictures of Submerged plants

1.6.2. Fauna: Native fauna found within the Inle region are as stated below:

a. Birds: 241 species of birds have been identified and documented to date. Of these seven species are listed as being threatened with extinction (Vulnerable Spp; According to Criteria of IUCN). The Eastern Sarus Crane is endemic to the Inle region. The remaining six species are migratory birds that inhabit the region in the cold (winter) months.

Waterbirds: Great Cormorant, Little Cormorant, Purple Heron, Great Egret, Intermediate Egret, Cattle Egret, Indian Pond-Heron, Black-crowned Night Heron, Lesser Whistling Duck, Ruddy Shelduck, Common Shelduck, Eurasian Pigeon, Spot-billed Duck, Northern Pintail, Garganey, Common Teal, Femrginous Pochard, Purple Swamphen, Common Moorhen, Common Coot, Pheasant-tailed Jacana, Common Sandpiper, Herring Gull, Black-headed Gull, Brown-headed Gull.

Other birds: Eastern Marsh Harrier, Black-winged Kite, Black Kite, Steppe Eagle, Common Kingfisher, White-throated Kingfisher, Black-capped Kingfisher, House Crow, Magpie Robin, Brown Shrike, Long-tailed Shrike, Stonechat, Baya Weaver, White-vented Myna, Black-collared Starling, Vinous-breasted Starling, Asian Pied Starling, Collared Myna, Yellow-bellied Prinia, Lesser Coucal, Greater Coucal, Little Green Bee-eater, Black Drongo, Red-rumped Swallow, Arctic Warbler, White Wagtail, Citrine Wagtail, Long-billed Vulture.

Photo 16: Eastern Sarus Cranes

Photo 17: Migratory birds

b. Fishes: Estimates of the fish diversity range from 23 to 42 species. Latest research indicates that there are around 36 species; fish species which occur only in the inflows and outflows may be included in this figure. These include two endemic *Cyprinid Genera*, the *Inle Cypris* and the *Sawbwa*. There are 16 endemic sub species, 12 of which are *Cyprinidae*. Thus, there is a 50% specific endemism in Inle Lake, making it one of the most important lakes in Southeast Asia for fish endemism. There are around seven introduced species. *Ctenopharyngodon idellus* and *Labeo rohita* are regularly stocked by the Fisheries Department for control of water plants. African catfish (*Clarias garipinus*), had also been introduced into the lake and its surroundings, through on land ponds and in Lake cage culture (though this practise had been prohibited since over a decade ago, villagers have continued to indulge in it, due to the high profit gains.)

c. Mammals: Locals have reported the presence of otters *Aonyx/ Lutra sp.*, Large Indian Civet *Viverra zibetha*, Masked Palm Civet *Viverra tangalunga*, Mongoose *Herpestes sp.*, Barking Deer *Muntiacus muntjak*, Myanmar Hare *Lepus peguensis* and Jackal *Canis aureus*.

d. Amphibians: 25 species within Inle Lake, 17 species within the "Wet Phyu Reserved Forest" area and 15 species within Taunggyi Township have been identified and documented by National scientists and scientists from California Academy of Science, from July to August 2002. These constituted snakes, frogs, lizards etc. It was striking that a water lizard species (*Tylototriton Verrucosus*) inhabited a small lake within the precincts of Taunggyi University. Two frog species - the Inle Hpar Sunn (*Megophry Sp*) and the Inle Hpar Pyan or Flying Frog (*Chirixalus Sp*) were identified as newly discovered species.

Photo 18: Frog endemic to Inle

Photo 19: Endemic Turtle

e. Turtles and Snails: Three species of Turtles and 26 species of Snails were Identified within the Wildlife Sanctuary.

f. Butterflies: 52 species of Butterflies were identified and listed within the Wildlife Sanctuary.

Source: Wild Life Department, Nyaung Shwe.

1.7. GOM's Initiatives

Inle Lake, Saga Lake and Mobye` Reservoir together, covering an area of 248 sq. miles of Nyaung Shwe, Pin Laung and Phe Khon Townships, were designated as a Wildlife Sanctuary in 1985 by order of the Central Government for fuller legal protection in restoring and conserving the eco-systems, biodiversity (particularly the Lake's endemic Flora and Fauna species) native and migratory birds. The Wild Life Sanctuary Warden's Office was established at Nyaung Shwe in 1990.

In 1986 the UNDP / FAO Pilot Watershed Management Project for Kinda Dam (BUR/81/003) was implemented. This project introduced a new concept of watershed management including community participation and new techniques for producing land capability and maps from aerial photographs. The Kinda Watershed Pilot Project was later transformed in 1995 as the "Watershed Management for Three Critical Areas Project" of Kinda, Inle and Phugyi watersheds. Inle was

included as part of this project due to massive soil erosion in the catchment, causing a long term threat to the water supply to the Law Pita Hydroelectric Power Station. The Project introduced modern techniques such as Land Use Planning; utilizing Remote Sensing and GIS technology; training and actual implementation of Land use surveys down to the level of Treatment Oriented Land Capability Surveys. It recognized and identified the severity of soil erosion, large scale gully formations and adversities of shifting cultivation. Thamakan and Heho basins being considered as most fragile and susceptible to erosion, the decision to treat them on a priority basis was adopted. Control of shifting cultivation, promotion of Agro-forestry systems in mountainous regions were recognized as needing urgent interventions.

With the objectives of preventing the Eutrophication process of the lake and conserving the Inle watershed for greater environmental stability, the GOM initiated several actions as stated below:

In 1992, the following policies were laid down to reinforce the conservation efforts:

a. Law enforcement prohibiting expansion of human settlements and floating gardens within the Lake; controlling of slash and burn cultivation and cutting of trees in the upland watershed areas.
b. Institutional strengthening of key agencies (FD and Irrigation Department) for closer supervision.
c. Extensive implementation in reforestation and forest protection by the FD and removal of sediments and aquatic weed with drainage improvement in the lake by the Irrigation Department.

In 2000, a Preliminary Survey on potentiality of **Reforestation under the Clean Development Mechanism - C.D.M model was carried out by "Karamosia International"** in collaboration with Ecodev and Ngwe Sint. In 2001, a joint study on Water Quality of Inle Lake, particularly the Ph., Dissolved Oxygen and Conductivity was conducted by a **joint team from the Ministry of Forestry – MOF and Ministry of Environment – MOE of Japan**. They deduced that though the level of Eutrophication was high, evidenced by the expansion of wild vegetation, it had not reached a level that would threaten the survivability of existing fauna.

For effective monitoring and enhancing coordination among all Governmental Departments, and other agencies, the Central Steering Committee for Environmental Conservation and Sustainability of Inle Lake (CSCOIL) was set up in 2010 and reorganized in 2011.The FD drew up periodic plans for implementation of integrated conservation activities. More than 750,000 acres of Reserved Forests were established and about 75000 acres of natural forests were managed scientifically within the period, from 1992 to 2005.

In a scientific publication in the year 2000, an attempt was made to highlight problems faced by the Lake and **gather related information on the Lake by conservationists from around the world**. (Myint Su and A.D. Jassby). The **problems of the Lake and its watershed were seen together for the first time**. The floating gardens, pollution of lake water, over extraction of the watershed forests for fuel and timber, severe soil erosion in the mountainous regions, causing rapid siltation of the lake, reduction in water surface area thereby threatening the fish population and loss of local fish fauna etc. were recognized as major threats to the eco system.

In year 2010, the Chairman of the State Peace and Development Council during his tour of Inle Lake, made the following **comments regarding the future management of the lake**:

a. Further expansion of villages, houses and floating gardens should be prohibited.
b. Floating wild vegetation and other types of vegetation, together with silt need to be removed.
c. Water ways of the 4 major streams need to be cleared to ensure a regular inflow of water into the Lake.
d. Clearing of forest land, cutting of trees and indulgence in shifting cultivation should be prohibited within a 20 mile radius from Inle Lake.
e. The Ministry of Forestry should establish a special team within the Lake area, to take care of the watershed areas. It should be given the task of protecting existing natural forests, and rehabilitating denuded areas through the establishment of forest plantations.
f. The Ministry for Agriculture and Irrigation should also establish a special team within the lake area, to cooperate with the above Forest conservation team.
g. A department to oversee and coordinate the above teams should be established and its office should be located in Nyaung Shwe.

This broadly triggered various Government Departments working in the Shan State to focus their activities in and around Inle Lake area. The FD also stepped up its plantation program in the watershed areas. The Mechanized Agriculture Department established special mobile teams to address the Taungyar problem. In the valley also, attempts were made by the Governmental Departments, UN agencies and NGOs to promote sustainable agriculture practices, livelihood programs, credit flow to farmers, provision of safe drinking water, silt removal etc.

The issue came up at centre stage during 2010, when there was a sudden fall in the volume of the Lake water due a severe drought causing low rainfall. Serious concerns were expressed by the GOM. As a result, the first workshop on this issue was held on the 1st and 2nd of July 2010 by the FD, Ministry of Forestry, in Nay Pyi Taw. It was attended by representatives from various line ministries, NGOs, International NGOs, Universities and other stakeholders. The workshop reviewed the deteriorating situation of the Lake, the need for sustainable utilization of water resources, status of land use, environmental impact and the socio-economic conditions of communities living in and around the Lake. The workshop recommendations included urgent planning and mitigation measures to restore the Inle Lake eco-system and rehabilitation of degraded forest areas falling inside the Catchment.

This workshop was followed by another regional workshop held in Taunggyi from the 12th to the 14th of July, 2010. This was attended by the Minister of Forestry, members of the Shan State Peace and Development Council, various Ministerial Departments, NGOs, INGOs, related heads of departments from Taunggyi University and stakeholders.

During this workshop it was decided that stakeholders make a coordinated effort towards the restoration of the Lake. It was further decided that a two stage approach with primary focus on planning and mitigation measures should be adopted. In the planning phase, issues and problems confronting Inle Lake were to be reviewed, as well as gaps and needs were to be identified. The main component of the mitigation phase included assessment of critical areas, such as land use changes, eco-system services and socio-economic status of the people living within and around the Lake. A ten year Action Plan in order to mitigate the environmental factors affecting the Lake eco-system was also to be prepared.

Accordingly, the GOM prepared a comprehensive Action Plan (2010-2015) for Environmental Conservation and Sustainable Management of the Lake. **The Action Plan provided for almost every aspect and identified critical inputs required** to propel concerted action for saving Inle Lake. While the plan identified the major areas requiring initiatives, it **fell short in detailing the underlying inputs and innovations**. Besides, there was no institutional mechanism to monitor and generate important data that could serve as useful tools for effective implementation. As a consequence, even though a large number of NGOs and INGOs had been operating on several internationally funded programs, **little was achieved to arrest the rate of degradation of the Lake**, because of the fragmented approach.

A Workshop was organized by MoECAF and UN-Habitat on 24.08.2011 at Nay Pyi Taw, to further thrash out and focus on issues and challenges facing Inle Lake. It was decided that the GOM in partnership with UN-Habitat would prepare a Long term Restoration and Conservation Plan of the Lake.

1.8. Formation of the National and State Level Committees

The Central Steering Committee, or the Central Committee for Environmental Conservation and Sustainability of Inle Lake - CSCOIL was established in September 2010, on completion of the then Chairman of the State Peace and Development Council's tour of Inle Lake. It was chaired by the Minister of Forestry – MOF and incorporated Deputy Ministers, Directors-General, Managing-Directors of all related Ministries, the Deputy Commander of the Eastern Army Command (Taunggyi) and the Secretary of the Shan State Peace and Development Council. The Director-General and Deputy Director-General of the FD were appointed as Secretary and Joint-Secretary.

The Central Steering Committee was reorganized in 2011. It is chaired by the Minister of MoECAF and incorporates Deputy Ministers, Managing-Directors, Directors-General from related Ministries and related Ministers of the Shan State Government. The Director-General and Deputy Director-General of the FD were appointed as Secretary and Joint-Secretary.

The Shan State Implementation Supervisory Committee for the Sustainability and Conservation of Inle Lake – SSSC was established in 2011. It is chaired by the Prime Minister of the Shan State Government and includes related Shan State Ministers, Directors (Heads) of Shan State Governmental Departments, District and Township level officials, a wide range of Stakeholders and entrepreneurs operating within and around Inle Lake. The Shan State Minister for Forests and Mines was appointed as the Secretary, with the Director of the FD and the Director of the Irrigation Department functioning as Joint Secretaries (1) and (2).

A **Working Sub-Committee** was also established to provide close supervision of implementation being conducted by Departments in the field.

A **Township level Committee** was recently formed, to address issues concerning the welfare of the Inn-thars (Lake dwellers), but it also coordinates with related departments to address issues concerning the Lake at the micro level.

1.9. Expectation of the people

According to the scope of work, surveys were conducted and investigations undertaken to assess the existing status of the Lake and its problems, to enable identification of appropriate remedial measures. For this purpose, the Project team also conducted two rounds of Stakeholder's meetings at the State Forest Director's office in Taunggyi. The first Stakeholder's meeting was conducted on the 13th of August, 2012, in which the plan of work and activity schedule was discussed with Heads of Departments and related officials and concerned individuals. The second Stakeholder's meeting was conducted on 26 September 2012, to highlight proposed interventions and to seek their suggestions if any at this stage.

1.10. Meeting with Governmental Departments, Donor Agencies, NGO's and related Stakeholders

As a first step, a meeting of the team with officials, NGOs and other Stakeholders was arranged to elicit their views, opinions and suggestions. Meetings were held in Yangon and in Nay Pyi Taw to understand the concerns shown by His Excellency U Win Tun, the Union Minister of MoECAF, UN-Habitat and other concerned organizations / agencies, about the need for the drawing up of a "Long Term Restoration and Conservation Plan for the Restoration and Conservation of Inle Lake".

Thereafter, several rounds of discussions were held with all related Government Ministerial Departments at the Shan State level, the District level and Township level; all major NGOs/ INGOs, Multilateral Agencies operating within the Inle Lake area, all relevant Stakeholders and local communities.

Some of the issues pointed out during the meetings are stated below, **indicating that the Lake system is indeed being subjected to heavy anthropogenic pressures**:

a. Water Quality deterioration due to anthropogenic activities.
b. Encroachment in Catchment areas and Fringe areas of the Lake.
c. Disposal of Solid Wastes in and around the Lake.
d. Sewage overflowing into the Lake.
e. Lack of infrastructure for disposal of sewage, storm water and solid waste.
f. Blockage and diversion of spring water and stream channels within the catchment areas.
g. Heavy silt deposition in feeder channels due to agricultural practices steep slopes.
h. Lack of public awareness towards environmental and pollution abatement.
i. Location of hotels within the Lake, fringe areas and catchment areas.

Chapter 2
Approach and Methodology
Preparation of theLong Term Restoration and Conservation Plan

2. Adoption of Watershed Approach

Changes in land use patterns within the catchment effecting hydrological processes has a profound impact on the biodiversity and the socio-economic environment as well as aquatic ecosystems. Therefore, **management of the Lake cannot be addressed by a fragmented approach without recognizing the importance of the interconnected streams and their sub catchments.**

The challenge therefore is to conserve Wetland Ecosystems along with their rich biodiversity, while providing sustained economic benefits to the communities dependent on these resources for their sustenance.

A Watershed approach has been adopted, to address the management problems of Inle Lake, taking into account the external, natural and induced factors and their influence on the ecosystems. Inle Lake and its resources are essentially adapted to the hydrological regimes, vulnerable to changes due to anthropogenic pressures and Climate Change. The emphasis for successful management of the Lake, therefore, is on maintenance of ecosystem characteristics, prudent utilization of its resources to sustain the environment and for the benefits of stakeholders, particularly local communities. **Integrated Watershed Management Planning** therefore aims at bringing together stakeholders at all levels and to consider their needs and aspirations, while ensuring sustainability of the Wetland Ecosystem within the Inle Watershed. The Long Term Restoration and Conservation Plan on the Restoration and Conservation of Inle Lake will **need to take into consideration** the following issues:

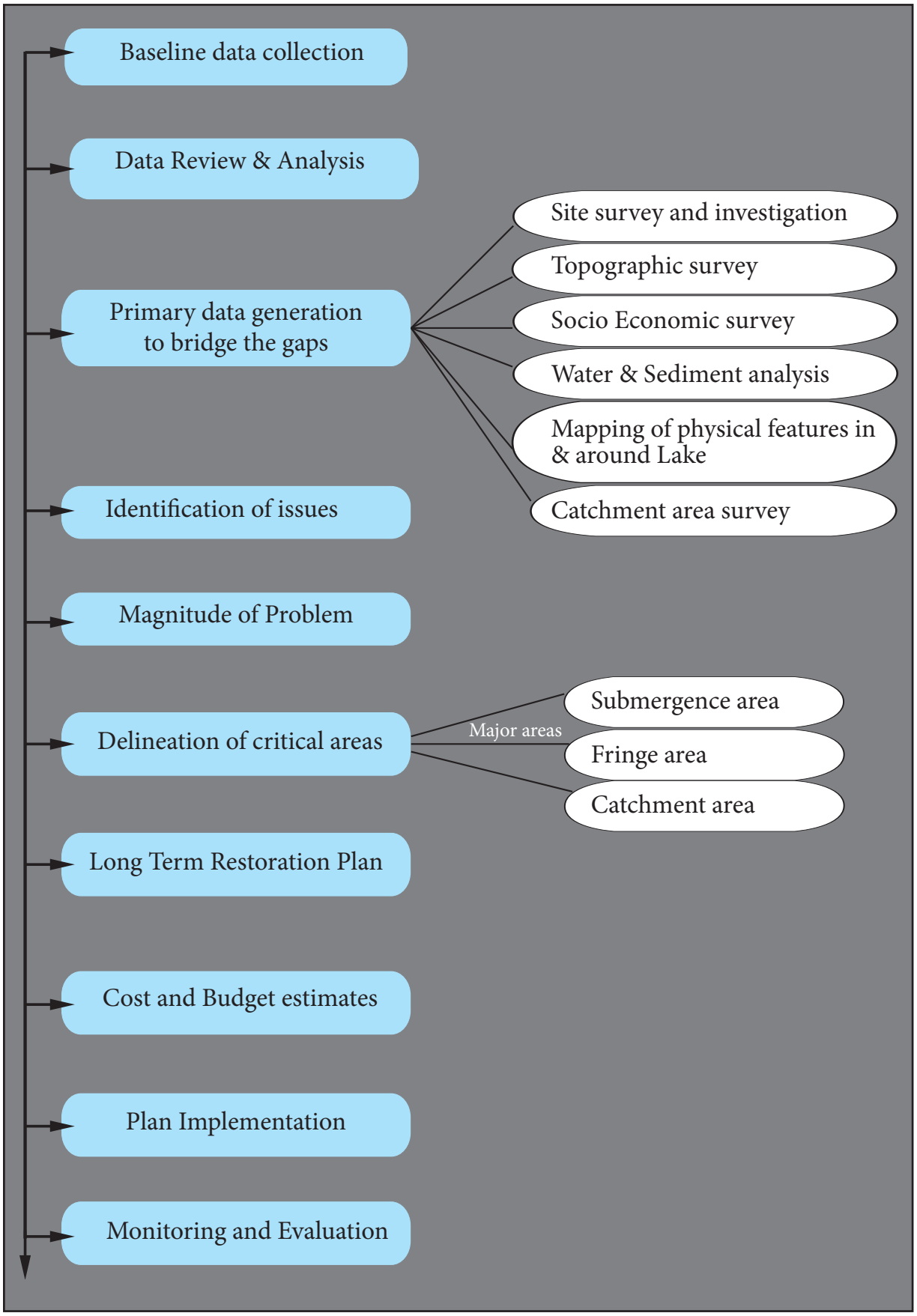
a. Adopting of a Watershed approach for conservation and sustainable development of the Lake.
b. Integration of biodiversity conservation into developmental planning to minimize impacts of developmental activities.
c. Participatory approach involving local communities, scientists, NGOs and Governmental organizations to ensure sustainability of activities.
d. Adopting preventive measures in **addressing problems at source**, rather than addressing crisis situations as ad-hoc curative measures.
e. Revival of indigenous knowledge and traditional practices which are cost effective for Watershed management and biodiversity conservation.
f. Application of knowledge based techniques for restoration through research and developmental activities.
g. Periodic monitoring and evaluation with a focus on **achieving the goals and objectives**, rather than merely dutifully carrying out of prescribed activities.

In view of the above considerations, rapid assessments and extensive socio-economic surveys were undertaken in selected villages within the Lake as well as its surroundings, which include the Wetland areas, to identify the critical ecological issues, socio-economic needs and constraints on the communities, resource linkages and the carrying capacity of such resources in the areas assessed and surveyed. The evaluation of the assessment and the survey report led to the identification of the management objectives which are based on problems confronting the Lake.

Accordingly, the Long Term Restoration and Conservation Plan broadly focuses on biodiversity conservation and maintaining of the ecological processes, through land and water management. Sustainable resource development for livelihood improvement is proposed to be achieved mainly through sustainable agriculture, fish culture, forest conservation and micro enterprise development compatible with the Lake eco-system, biodiversity conservation and Wetland management. Tourism has been incorporated as a tool for awareness on lake values and functions recognizing its potential for providing economic benefits to the local communities. Institutional development; and last but not the least, community participation are envisaged as cross cutting components to achieve sustainable development of the Lake.

A synoptic presentation of the Approach and Methodology is given in the Schematic presentation in Figure 1, on page 37:

Figure 1: APPROACH AND METHODOLOGY



2.1. Data Collection and Review

2.1.1. Secondary Data Collection

Secondary data relates to environmental baseline data and reports relating to Climate, Hydrology, Demographics, Land use, Water utilization, Water quality, Social and Economic conditions, Flora and Fauna, Point and Non point sources of pollution, Revenue details etc. The secondary data basically is the data supplied by various agencies including Government Departments. This data is important as it gives the present status / baseline, so that future predictions / assessments etc. can be made by considering it as a datum or present scenario. Accordingly, the economic, social and cultural data was collected from different Government Agencies. Reports of previous studies conducted by the Irrigation Department, Forest Department, Non-Governmental Organizations, Academic Institutions etc. were also collected.

2.1.2. Review of Secondary Data

All collected baseline information was reviewed and analyzed by the project team to assess the actual site conditions and the problems faced by the Wild Life Sanctuary. The following is a list of areas, which were reviewed and analyzed in depth:

a. General Topography and Land use pattern of the Inle Valley.
b. Hydro-geological data of Inle Lake and its catchment.
c. Secondary data pertaining to water inflow from four major streams feeding the Lake.
d. Climatological data in and around the Lake, from related Government Departments.
e. Data pertaining to Land use, floating garden agriculture, crop selection, shifting cultivation, forests, tourism etc.
f. Data regarding utilization of water for designated uses, storage, and water covered surface area of the lake.
g. Available secondary water quality data.
h. Collection of reports of earlier studies carried out by Ministerial Departments and consultants etc.
i. Demographic and socio-economic data of selected villages in the Core, Buffer and Remote Zones.
j. GIS layers and photo imagery maps of the lake, available from concerned authorities.
k. Water Supply, Sewage and Storm water status data concerning the valley.
l. Flora and Fauna in the Wetland and Catchment areas.
m. Policy, Regulatory and Institutional Aspects, including various stakeholders, their present roles and responsibilities for conservation and management of Inle Lake.

2.2. Lake Edge Facilities

a. Total area of Lake.
b. Catchment area of Lake.
c. Water surface spread area in different months and encroached areas.
d. Land use in the Catchments, sediment yield of areas.
e. Details of storm water / sewers outfall into the Lake.
f. Discharge analysis of all inflows and outflows from the Lake.
g. Peak flood flow in to the Lake.
h. Characterization of the discharge flowing into the Lake.
i. Human interventions in the Wetland and Catchment areas.
j. Agricultural practices.

The gaps noticed in the available secondary data are as stated below:

i. No generalized thematic maps indicating surface features like land use, villages, agricultural areas, crops, floating gardens, marshes etc. exist.
ii. The storage capacity of the Lake, including Lake bed topography (hydrographic survey on a regular basis) have not been carried out till date.
iii. Monitoring of quality and quantity of lake water (inflow also) on a regular basis, have not been undertaken.
iv. Quantity of sediment / silt entering the streams, their deposition and status of Lake bed sediment material, have not been measured / analyzed.
v. Quantity and quality of Sediment deposition in the mouths of streams entering the lake and also the balance of deposition within the Lake are not known.
vi. Evaporation loss is an unknown factor.
vii. Ground water extraction and recharge have not been monitored.
viii. In depth study for understanding the bio-diversity of the Lake and its Catchment areas have not been conducted.

2.3 Primary Data Generated

To bridge the identified gaps of secondary data, **detailed site surveys and on the spot investigations were conducted** to generate the primary data as follows:

a. Topographic Survey.
b. Bathymetry Survey and Depth Measurement.
c. Mapping of the physical features in and around the Lake.
d. Physico-chemical characterization of water and sediment.
e. Biological assessments.
f. Ecological Characteristics of Lake.
g. Socio–economic survey.
h. Potential for Eco-Tourism.
i. Environmental / Social Impact Assessment.

The areas of concerns were identified through data analysis and its interpretation.

Chapter 3.
Issues and Concerns

3. Issues and Problems

As can be seen from the above data, several studies have been undertaken in the past, regarding issues and problems confronting Inle Lake and the root causes of degradation of the Lake Environment. But **little or no substantive follow up actions or support ensued**. The broad issues and problems identified in the studies are as follows:

a. Decreased water storage capacity of the Lake.
b. Deforestation and change of land use patterns.
c. Siltation in main perennial streams.
d. Sedimentation.
e. Floating gardens and non-removal of defunct floating gardens.
f. Excessive use of pesticides and fertilizers.
g. High bloom of water hyacinth.
h. Prevalence of unsuitable agricultural practices.
i. Cultivation of paddy on banks (north and south sides) of the Lake and areas encroached by users.
j. Disposal of untreated solid wastes and waste water into the streams and Lake by villagers, hotels etc.
k. Heavy inflow of tourists and plying of motor boats resulting in fuel oil / lubricant spillage.
l. Inadequate institutional frame work, policy and regulatory measures.
m. Lack of inter-departmental co-ordination.
n. Lack of public awareness towards protecting the Lake and streams.

3.1. Catchment Conservation and Watershed Management

In the context of Restoring and Conserving Inle Lake, **Watershed Management and Catchment Protection are crucial components**. It is evident that unless there is an effective Watershed Management Plan, Inle Lake will continue to be impacted and silted. At present, **Watershed Management Planning is lacking**. Deforestation in the catchment areas is rampant, especially by harvesting of fuel wood by the communities. Because of deforestation of hills in the catchment, the erosion gets accelerated by loose and dug up soil making their way into the Lake. In some parts, large gullies have been formed due to erosion and these have become an ever increasing source of silt, which gets deposited in the marsh and mouth of streams entering the Lake. Siltation is thus mainly due to soil erosion in the upper Catchments.

The **reforestation program in the Catchment areas is far too inadequate** to cope with the rate of deforestation taking place. Lack of manpower, funds and equipment has limited the FD's efforts to carry out effective measures.

Forests account for about 483 sq. miles of the Catchment area. The forest cover has been altered drastically due to increasing population pressure (both human and animal), agriculture expansion, over grazing and fuel wood / timber extraction activities, resulting in loss of forest cover. These are the most prominent threats to the upland forest estates. Changes in tree density and canopy cover are evident. The slopes surrounding the Lake area are covered with grassland

and tree species which are susceptible to fire. They are often burnt by villagers to extend land for agricultural purposes. Trees are cut to meet the fuel demand; sold in the form of wood or coal to buyers who have limited access to wood based fuels. Cutting trees, and digging up of roots, accelerates soil erosion and results in rapid loss of top soil.

Out of the 29 Sub Watersheds, four major Sub Watersheds namely, Namlet, Yay Pei, Kalaw and Bilu streams are large sized that cover an area of about 1126 sq. miles of the total Catchment. These four streams are the major source of supplying water as well as sediment to the Lake. There are no strategies in place to treat them as priority watersheds from 'valley to ridge' and neither any treatment planning for each of the Sub Watersheds.

Denudation of hills as a consequence of deforestation has lead to various environmental problems as stated below:

a. Accelerated soil erosion.
b. Loss of fertile soil cover.
c. Choking of water channels.
d. Decreasing water storage capacity of the Lake.
e. Increase of nutrient loads in the Lake.

Specific problems encountered in the Lake Catchment, have been classified as below:

i) Submergence area (Core Zone)

a. Recharging of lake.
b. Human settlement and Solid waste disposal.
c. Siltation and Sedimentation.
d. Floating gardens.
e. Ingress of fertilizer and pesticide.
f. Threats to the aquatic life of Lake.

ii) Fringe area (Buffer Zone)

a. Illicit cutting of trees.
b. Fringe area settlements and activities.
c. Influx of tourists.
d. Inflow of waste water and sewage.

iii) Catchment area (Remote Zone)

a. Cutting / Pruning of trees and loosening of soil.
b. Excessive silt flow in running water.
c. Enlargement of agricultural areas.
d. Human settlements and other activities.
e. Soil erosion due to shifting cultivation.

iv) Public Awareness

a. Lack of public awareness.
b. Ignorance and Illiteracy.
c. Lack of Community involvement.

v) Administrative and Legal Back up

a. Involvement of several Governmental agencies.
b. Lack of Co-ordination.
c. Weak legal back-up.
d. Delayed in the prosecution process.
e. Inadequate monitoring mechanisms.

3.2 Water Assessment

Catchment degradation has resulted in reducing the inflow of water into the Lake. Surface water availability and storage capacity governs the recharging capacity of the Lake. Surface water availability / runoff are generally confined to four monsoon months when precipitation is heavy. But rainfall alone is not sufficient for recharging the lake water, as the surface runoff generated has limitations due to soil strata and its texture.

The accumulation and deposition of silt in the marshes and the streams at their mouths (point of entry into the Lake) also limits the recharging capacity of the Lake by rain water, due to formation of shoals. During lean periods, withdrawal of surface and ground water by local farmers to irrigate their agriculture land also lowers the water storage capacity of the Lake.

3.2.1. Water Availability

Inle Lake receives water from its Catchment area of approximately 9428 sq. miles which is mainly hilly and undulating. Rain water is the only source of water which maintains the water level of both surface and ground water in the region. To assess water availability it was essential to assess the rainfall patterns of the entire catchment and of each sub catchment to **determine the total rainfall and the total inflow into the Lake**.

Eight rain gauge stations exist in and around the Lake, where annual and monthly rainfall data (some periods only) from 2000 to 2011 are available.

Since there are four perennial streams which discharge into Inle Lake, the Catchment rainfall of each Sub Catchment has been determined as below:

Table 7: Catchment Rainfall

Sr. No.	Stream Name	Catchment Area (Km2)	Annual Rainfall (mm)	Remarks
1	Bilu (Indein)	813	1636.41	Average of Pinlaung & Kalaw RG Station
2	Kalaw(Thann Daung)	742	1022.03	Observed Rainfall
3	Nei Gyar	250	1089.37	Average of Kalaw & He Ho RG Station
4	Nam Lat	1149	1376.16	Average of Yatsauk & Taung-gyi RG Station
5	Balance Area	686	1281.00	Average of all Stations
	Total	3640	1281.00	---do----

Based on above data, the total rainfall / precipitation falling in the entire Catchment area would yield a runoff of 4949.12 Mm3 considering no losses; i.e. total amount of water which should be received by the whole Inle Lake Catchment.

3.2.2. Run Off

Information on the Run Off factor does not exist and as such, **discharge measurements of the four major streams** was carried out using the float method (Current meter observations could not be carried out due to non availability of related equipment). The flow observations that were carried out for a few days during August, 2012, in the four streams, are indicated in the table below. The mean average rainfall of the region is 1281 mm. The discharge from the remaining streams comprising 686 sq.km of the total Catchment area, has been assumed in the same proportion as that of the Nei Gyar Sub-Catchment. The observed discharges are as follows:

Table 8: Observed Discharges (* Assessed yield)

Sr. No.	Sub Catchment name	Catchment area (Sq. Km)	Discharge (Cumec)	Specific Yield (Cumec/ Km2)
1	Nam Lat	1149	2.41	0.00209
2	Nei Gyar	250	4.796	0.0192
3	Kalaw	742	3.969	0.00534
4	Bilu	813	28.93	0.0355
5	Balance	686	28.93*	0.0429

Observed discharges during August 2012(Details are given in annexes 2 and 3)

The observed flow data (primary data) indicates at the most, the average flow during the month of August and as such cannot be utilized uniformly for all months of the year. As the rain fall usually occurs during the monsoon months between June and October, negligible precipitation occurs during the remaining months (lean period); as such, there is minimal flow data available for those months. Therefore an approximation has been made by considering the mean monthly runoff as a percentage of mean monthly rainfall of the region, utilizing all available data from

rain gauge stations around the Inle Catchment. Accordingly, the mean annual inflow into the Lake is now assessed as 954.78 Mm3 from the entire Catchment. Since direct precipitation is also available to the lake water surface area, the same is assessed as 128.1 Mm3. Thus the total annual water available is 1082.88 Mm3 (878248.34 Ac. ft) as compared to rainfall of 4949.16 Mm3 during the year thereby suggesting a Runoff factor of approximately 21.8 %.

The mean annual evaporation loss was estimated as123.10 Mm3 (99840 Ac. ft) assuming a mean annual evaporation loss rate of 1224mm.

While It has been estimated that the lake receives enough rainfall to generate a mean annual runoff of 4949.12 Mm3 (considering no infiltration or losses), however due to topography, soil and climatic conditions only 1082.88 Mm3 reaches the Lake and the rest is lost (based on the present study). Even this water reaching the Lake is further put to various uses including use for paddy cultivation, water supply to Hydro-Electric Power stations, domestic and industrial use etc. This is causing over harvesting of the Lake water and consequently, the reduction of the Lake water levels especially during the lean season.

From the above data, it is clear that the runoff water received in the Lake is approximately 22% of the total precipitation; this does not augur well for the maintenance of desired water levels in the Lake.

3.3 Sedimentation in the Lake

The Watershed area in close proximity of the Lake is mostly rugged with minimal flat land. The soil is composed of easily erodible types namely, red earth, loose sandy soil covering porous lime stone rocks, shale and clay. Slash and burn shifting cultivation and encroachment for agriculture and other human related activities have led to excessive deforestation, resulting in Sheet Erosion, followed by Rill Erosion and Gully Erosion.

Dr. Takahisa Furuichi in his Final Report, March 2008, has quoted several well established sources relating to soil erosion and sedimentation. To state a few:

- Soil erosion is Asia's most serious natural resource problem and is equally severe in Southeast Asia, South Asia and the People's Republic of China. This statement was made in the **Environmental Policy of the ADB in 2002**, in the context of mainstreaming of "Poverty Reduction" in **the international development community**. This is driven by the well-known initiative **"Poverty Reduction Strategy Papers (PRSPs)" by the IMF and World Bank**.

- ADB further wrote in 2002, that "Asia's rural poor are almost wholly dependent on agriculture land, and the degradation or loss of cropland places their livelihoods at serious risk.

With regard to soil erosion and sedimentation, it states that - Soil erosion and sedimentation in the Inle catchment have been singled out for attention in several documents. **In 1944 Mr. Thompson, a Deputy Conservator of Forests** wrote a report on soil erosion **based on a ground survey during the monsoon season of 1940 that serious accelerated soil erosion extended back to the 19th century**. He found field evidence of serious sheet erosion resulting in considerable loss of surface soil and disappearance of all but the hardiest vegetation, as well as gullies actively advancing uphill. **Mr. Miller a FAO consultant reported in 1999**, that extreme gully erosion with large gullies extending and expanding sideways into branch gullies.

Dr. Furuichi in his study found abundant evidence of sediment runoff in small rivulets on agriculture land and bare land during the rainy season, and gullies developed on many hill slopes as well as on the edge of flatlands. Sheet erosion was evident on arable land. Although topsoil and subsoil contributions appeared to vary through the year, topsoil was the dominant source in the rainy season (69% to 88%). Based on studies conducted for the Bilu Chaung (stream) catchment, he estimated that total inputs for the whole Inle Lake were approximately 2,77,000 t/yr; output at the outlet was about 14,000 t/yr, indicating that 95% of sediment was stored in the sinks. Specific storage was highest in river mouths.

He further states that soil erosion control needed to be understood and planned as a measure for sedimentation control that forms an essential part of land and water management **at the catchment scale**.

A report of the Forest Department (2010) states that - based on a survey conducted during a three year period from 2004 to 2006, soil erosion within main perennial streams was found to be as below:

Table 9: Erosion within individual main streams

	Streams	Area of watershed (square kms)	Volume of water released (million cubic metres / year)	Volume of siltation (tons / year)
(a)	Nam Lat	1179.74	505.50	1,04,000
(b)	Yay Pei	262.16	92.50	19,000
(c)	Kalaw	757.34	275.60	56,000
(d)	Bilu	718.36	479.60	89,293
	Total	2917.60	1353.20	2,68,293

From the above table it can be seen that water released and soil erosion within the Bilu stream watershed is the highest; even though its watershed area comprises about half the watershed area of Nam Lat stream, the volume of siltation is almost as much as that of Nam Lat. The extent of land encroached into the Lake in the form of birds' claws at the mouths of Yay Pei (Nei`Gyar), Kalaw (Thann Daung) and Bilu (Inn Dein) streams, indicate the volume of silt being transported into the Lake by them. Map 5: on page 46.

In the context of the above report on Siltation, it may be pertinent to mention that, rivers originating in the Himalayan Region, normally have an annual average silt load varying between 1.0 to 1.5 Acre feet / Sq. mile / year. It appears that during year 2008, no silt observations were made; thus, silt assessments of each stream has been made, based on empirical formula utilizing corresponding discharge data. As such it is felt that the study does not indicate realistic silt rates.

Studies undertaken indicate that a silt rate of at least 1.2 Acre feet / sq.mile / year, needs to be adopted for assessing the silt being deposited in the marsh and mouth areas of Bilu, Kalaw, Nam Lat and Nei Gyar streams.

The paragraph above indicates that silt is entering the Lake through major streams and their tributaries. Silt gets deposited en route, also in stream mouths and marsh areas of the Lake, thereby reducing its storage capacity.

Measures of silt trapping such as silt traps, check dams, gulley traps had been proposed earlier and constructed by Governmental agencies, yet the silt continues to enter into the streams and is being deposited into the Lake. Although, dredging is being done, the dredged material is heaped on the lake shore and dredged channel banks and not disposed of in sites far away from the Lake, causing it to eventually wash back into the Lake. **The annual deposition of silt into the Lake is approximately 410 Acre feet, which is equivalent to 708000 tons t/yr**. The lower reaches of the catchment and the valley have large areas under rice cultivation on shore, with very little cultivated areas having field bunds, vegetative barriers or agro forestry systems. The cultivated fields without vegetative barriers on contours are a major source of soil, fertilizer and pesticides being washed into the lake with the rains.

Map 5: Intrusion of Land in the form of Birds' claws

The need for **Micro Watershed Planning** had been ignored. The Micro Watershed Planning involves integration of engineering and vegetative measures to prevent soil erosion. As a result of this negligence, soil erosion has accelerated. A composite treatment of the area involving Agro forestry, Tree plantations and Drainage line treatment has not been adopted on a scale to address the soil erosion control measures holistically.

The Irrigation Department as per its 2011 Report had been undertaking to dredge the silt and undesired vegetation from the Lake, utilizing the following machines –

1. 3 nos. old Dredgers
2. 1 no. Amphibious Excavator
3. 4 nos. Excavators (B/H)
4. 3 nos. 9-unit Pontoons
5. 2 nos. old Weed Cutters
6. 1 no. Transport Barge

It can be seen that the Irrigation Department is totally ill-equipped and therefore has been able to dredge the water ways for boat traffic only. Three old dredging machines which can dredge about 21600 cubic feet of silt per day in a six hour shift (about 1200 cubic feet per hour). This is far from adequate.

Photo 20: An old Dredger

Photo 21: Excavator digging silt and dumping it on the near shore

3.4. Water Quality and Related Issues

The water quality continues to deteriorate due to discharge of fertilizer and pesticides from agricultural activities, disposal of wastes, siltation etc. The lake is also impacted by urban pollution loads due to discharge of untreated human wastes / sewage and industrial pollutants. The situation is compounded due to erratic precipitation, evaporation and movements of motor boats, oil spillage and waste disposal of tourists residing in hotels within the Lake. All activities which are essential for maintenance of the Lake and its surroundings do not adequately amalgamate the developmental, management and conservation measures that would minimize negative impacts of one on the other. Lake water is no longer safe for drinking and ecologies dependent upon the Lake, are struggling to adjust to high chemical and nutrient levels. Twenty years of exposure to the neurotoxins in chemical pesticides and fertilizers, and a lack of knowledge on how to use these safely, **are directly affecting the health of local communities**.

No temporal data was available on the quality assessment of the Lake water for comparison, apart from data sets for 2010. Therefore primary data was collected for water quality assessment from 21 locations inside the Lake, all four major streams feeding the lake and channels from villages located within the Lake. Water samples collected were sent to reputed laboratories of Government / Private Organizations located at Yangon for analysis of water quality parameters, including physical aspects, content of chemical, biological, pesticides and heavy metals.

The parameters were analyzed as per standard manuals and procedures published / indicated by the American Public Health Association and the American Water Works Association. Since Myanmar does not have water quality standards, the parameters have been assessed based on established standards which are being adopted presently in Myanmar. Details of the methods used and parameters specifically analyzed are as follows:

a. Colour
b. Odour
c. pH
d. Dissolved Oxygen (DO)
e. BOD
f. Coliform
g. Electrical Conductivity
h. Sodium
i. Potassium
j. Temperature
k. Carbonate
l. Bicarbonate
m. Chloride
n. Sulphate
o. Total Dissolved Solid
p. Sodium Absorption Ratio
q. Residual Sodium Carbonate
r. Turbidity
s. Salinity
t. Ammonical Nitrogen

3.4.1 Sampling Results

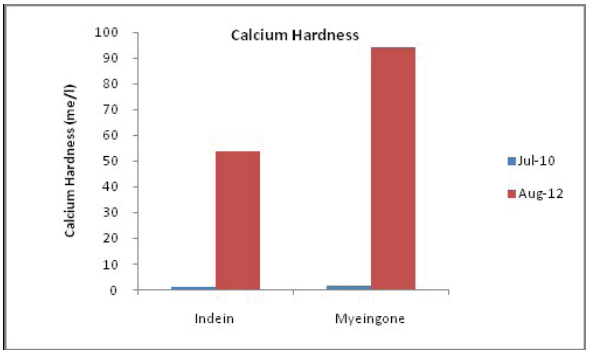
While water samples were taken from 21 locations, the results indicated below relate to location of samples from location numbers 10 to 21 and **present the water quality profile of the Lake during year 2010 and August, 2012**. The results are shown in the table below and graphically presented in Annex 3, indicating the important parameters:

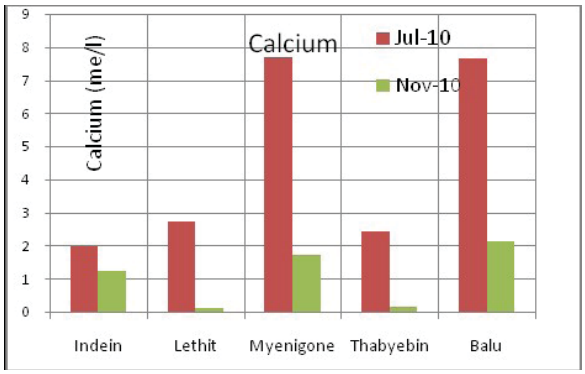
Table 10: Water sampling results

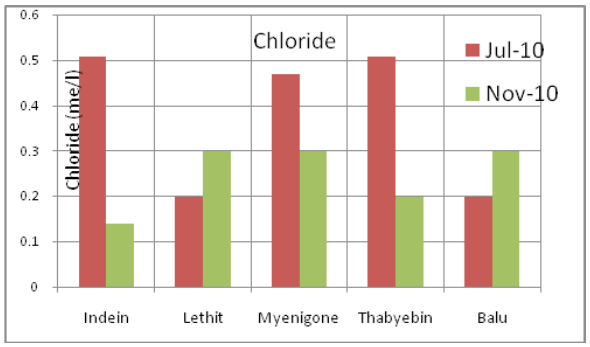
Sr. No.	Particulars	Symbol	Unit	Results				
				Mid Lake	Nam Lat	Bi-Lu	Yay Pei	Kalaw
1	Calcium	Ca++	mg/l	2.4	2.52	2.88	3.44	1.84
2	Copper	Cu	p.p.m	0.01	0.02	0.02	0.02	0.02
3	Magnesium	Mg++	mg/l	2.2	1.8	1.36	1.24	3.4
4	Sodium	Na+	mg/l	N.D	N.D	N.D	N.D	N.D
5	Carbonate	CO3-	mg/l	0.2	N.D	N.D	N.D	0.2
6	Bicarbonate	HCO3-	mg/l	1	1.2	1.2	1.6	1
7	Sulphate	SO4	mg/l	2.92	2.84	2.6	2.66	2.86
8	Chloride	Cl-	mg/l	0.26	0.21	0.16	0.16	0.16
9	Iron	Fe++	mg/l	N.D.	0.15	0.15	N.D.	N.D.
10	Lead	Pb	p.p.m	0.02	0.05	0.01	0.02	N.D.
11	Arsenic	As	p.p.m	N.D	N.D	N.D	N.D	N.D
12	Total Alkalinity	-	mg/l	100	120.02	120.02	160.03	100
13	Phenolphthalein alkalinity	-	mg/l	6	0	0	0	6
14	Total Hardness	-	mg/l	230	216	212	234	262
15	Calcium Hardness	-	mg/l	120	126	144	172	92
16	Magnesium Hardness	-	mg/l	110	90	68	62	170
17	Total Dissolved Solids	TDS	mg/l	224	256	212.48	256	259.84
18	Soluble Adsorption Percentage	SSP	%	0	0	0	0	0
19	Sodium Adsorption Ratio	SAR	-	0	0	0	0	0

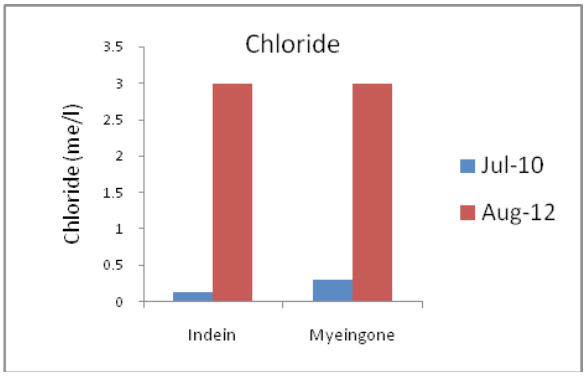
Sr. No.	Particulars	Symbol	Unit	Results				
				Mid Lake	Nam Lat	Bi-Lu	Yay Pei	Kalaw
20	Residual Sodium Carbonate	RSC	mg/l	-3.4	-3.12	-3.04	-3.08	-4.04
21	Dissolved Oxygen	DO	mg/l	4.85	4.85	4.85	4.8	4.85
22	Salinity	SAL	%	0.01	0.01	0.01	0.01	0.01
23	Turbidity	TURB	NTU	0	2	0	0	0
24	Temperature	TEMP	°C	32.7	32.8	33.2	33.1	32.7
25	pH	pH	-	7.12	6.94	6.86	6.78	7.29
26	Electricity Conductivity	ECw	Mmhos/cm	350	400	332	400	406
27	Classification	-	-	C2S1	C2S1	C2S1	C2S1	C2S1

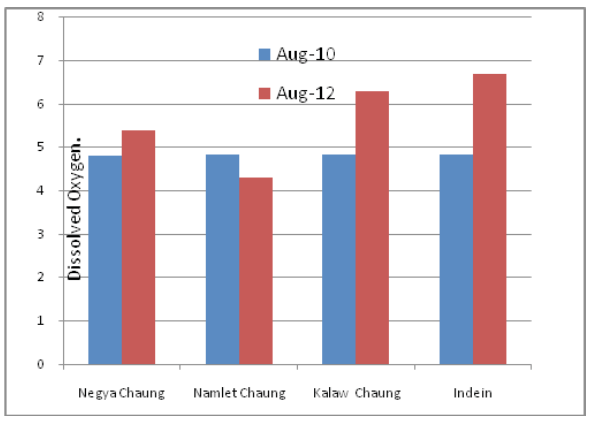
Graph 2: Data on Water Quality

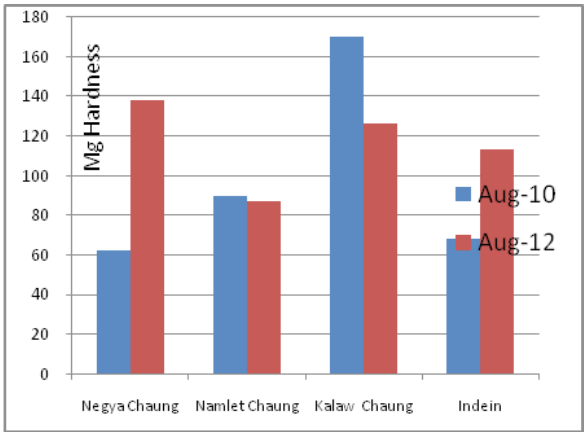












The examination of historical data on water quality as of August 2012, indicated that Calcium (Ca++) and Chloride (Cl-) during the month of July 2010, was higher when compared to November 2010 at In Dein, Tha Bye Bin, Lei Thit and Mye Ni Gone sites. There was a decline in magnesium hardness during August 2012, as compared to August 2010, in all the four major streams. Since the sampling locations during the year 2010 and 2012 are not identical, the present interpretation is merely indicative. Further samples, comparison of various water quality parameters and their plots, indicated that water quality has deteriorated in comparison to quality that existed during July and August 2010. The month of August generally has high precipitation, along with good sunshine, coupled with good assimilative capacity of water; therefore the impact of contamination is not appreciable. It does not reflect the true picture of water quality decline when compared with the lean season water flow situation.

The quality of water within streams and the Lake are within tolerance limits, and a few physical parameters meet WHO standards:

a. Dissolved Oxygen is high near Yay Pei village (Yay Pei stream), Tar Yaw bridge (Nam Lat stream near Shwe Nyaung Town), Thann Daung village (Kalaw stream) and Indein village (Bi Lu stream) respectively.
b. The water at Ywa Ma village on Bi Lu stream and near Zayat Gyi village in the Inle Lake have high turbidity.
c. The water at Mye Ni Gone and Inn Oo villages on the west bank of the Lake, have high concentrations of Total Alkalinity as CaCo3.

It was observed that waste water entering the major streams / Lake is not being intercepted, diverted or properly treated before disposal. **Monthly sampling of the Lake water at various critical locations, need to be taken all the year round**, to acquire site specific pollution load data.

In the context of the above information, it needs to be further stated that the assessment was based on results of water samples collected from the surface only. It is not known what impact it will have with depth and during lean periods when inflow from the streams is diminished. Besides, samples were collected once only and as such, they may not represent a realistic status of the water quality.

It needs to be noted that samples collected were tested for physical and bacteriological parameters only. Water samples were collected from such locations only after mixing of effluents. The volume of effluents is small as compared to Lake Storage capacity and as such, impact of dilution has not been accounted for. Samples collected from stream / effluent sites were not tested. Furthermore, no tests were carried out by the testing organization to assess the presence of pesticides, heavy metals, ammonical nitrogen etc.

3.4.2. Safe Drinking Water

As the influx of international tourists increases, clean water for drinking and domestic purposes will become a critical issue. Hotels and restaurants within the Lake and its fringes are using purified bottled water for cooking and washing purposes to cater to tourists.

The Shan State Municipal Department has been undertaking to provide clean water to villages within the Lake, by sourcing water from natural springs and underground aquafiers below the Lake bed. The target for 2010/2011, was to set up clean water supply systems in 53 villages, which it fulfilled. The target for 2011/2012, was set at 44 villages; the Municipal Department completed setting up water supply systems in 7 villages; UNICEF in 6 villages and UNDP in 1 village.

As most of the Lake dwellers who travelled to Taunggyi for medical treatment, were found to have been infected with water related illnesses, the Venerable Chief Monk of the "Naga Bwet Monastery" in Taunggyi and Chief Monks from monasteries within the Lake, took the initiative and established the **"Inle Drinking Water Supply Organization – IDWSO"** in 2009. Funding solely relies on donations from well wishers; and the Organization was able to accumulate Kyats 65.58 million at the end of 2012. In June 2012, UNDP offered to donate part of the contribution it had received from the Norwegian Ministry of Foreign Affairs. With the recommendation of the Shan State Government, IDWSO has been authorized to undertake clean water supply projects in 27 Lake Villages.

The **"Terra People Association – TPA"** of Japan, has confirmed their commitment to undertake Clean Water Supply Projects in 69 Lake villages at a cost of Kyats 410 million. TPA will employ their own experts to implement the above projects, but will cooperate closely with the Municipal Department and IDWSO.

There are **139 natural springs occurring within the Watershed area** which act as additional sources of water flowing into the Lake. Local authorities **declared "Law No. 144 - Curfew" prohibiting entry into the precincts of all the natural springs**. However, it appears that most of the water supply projects that were implemented or are being implemented, are mostly in villages in close proximity to "natural springs", as they are clean and easy to access. Villages far from these springs have resorted to deep underground wells in the Lake bed. Some private individuals have been distributing water to fellow villagers at a cost. But the appearance of the underground water is turbid; no testing of its quality has been done. People drink it only after boiling and use it mostly for domestic purposes.

The GOM will need to **lay down definite Policy Guidelines** as to how this very important issue should be addressed at all levels; and should include adequate funding and support prescriptions. All agencies and organizations participating in this endeavour should be consolidated and designated specific tasks in specific areas. **Prohibitions and Restrictions imposed in the past will need to be reviewed and amended** as necessary.

As the natural spring waters are increasingly sourced, there is a very real possibility that these "Springs" will recede and ultimately dry up. Therefore, all communities living at all levels of the Watershed, must be made to understand that preservation and development of **forests in the upland ridges and slopes, particularly in the Head waters of streams, will be crucial in recharging the streams, "springs" and the underground water resource**.

3.4.3. Lake Burials

Lake burials had been a long standing tradition of the Inn-thars; whereby corpses inserted in to coffins, or wrapped in mats were dropped in to the Lake bottom and pegged down with bamboo poles. With the expansion of "floating agriculture" areas, corpses were "buried" under the floating garden strips.

Governmental agencies have been trying to dissuade the Lake Communities away from this practice. Two crematoriums, one at Nam Pan and one at Ywa Ma were constructed; but Lake burials still continue for the following reasons:

a. Lake burials are less cumbersome and less costly than cremations; thus, a poorer class of people continue their indulgence.

b. Lake villages traditionally disallow passage of funeral parties (corpses) crossing their villages or areas demarcated as village land. Thus, villages situated in the inner parts of the Lake cannot access the Crematoriums and therefore have to resort to Lake burials.

At the meeting with H.E. U Win Myint, Minister for Inn-thar Affairs at Nyaung Shwe, he informed the team that efforts were being undertaken to solve the problem of not granting passage of funeral parties, through the Venerable Chief Monks and influential elders, to designate routes from all villages to the crematoriums. He also proposed **constructing additional crematoriums** at Maing Thauk, Khaung Daing and Lin Kin villages; and one between the last two villages. This issue also **needs to be addressed as a priority concern.**

3.5. Eutrophication of the Lake

Villages in the submergence area (core area) have constructed semi permanent houses made of wood and bamboo on stilts. The areas are either fully or partially inundated during the rainy season, and the Lake water receives everything that is dropped in the form of solid or liquid waste from the houses, ranging from plastic bottles, human waste, kitchen waste etc. The increase in population of the Lake villages has not been matched with any improvement in living conditions, particularly civic amenities that could facilitate disposal of generated human waste. It has simply increased the per capita intensity of waste / sewage going in to the Lake, which also receives enormous waste from other commercial activities. The waste generated by the township and agriculture waste management facilities fall far below prescribed standards. Waste is left in the open to decompose and is eventually washed into the Lake by the streams during the rainy season.

Pollution of Lake water is exacerbated by two growing semi-urban clusters located upstream, i.e. Nyaung Shwe Township, and Shwe Nyaung Industrial area above it. These are located directly in the drainage system of the Lake. Solid waste, Hospital Waste, non biodegradable waste and waste containing heavy metals are gradually **destroying the fragile ecosystem of the Lake** that could bring about dire consequences in the not too distant future. The effects of pollution are becoming more and more evident, as its load increases from year to year; the increase in area under Wild Vegetation and Water Hyacinth and consequent shrinkage of the Lake water surface area are distinct indicators.

Clusters of undesired vegetation could be seen floating in the Lake during the monsoon months; but when the water recedes, the vegetation anchors itself in the Lake bed and proliferates on accumulated nutrition generated from the waste / sewage. The thick growth in the form of a mat on the surface, does not allow sunlight to pass through, thus cutting off photosynthesis to submerged native plants. The weed cover also accelerates water loss through evapo-transpiration, with net loss of water without it being utilized. The evapo-transpiration loss is 13 to 22 times more as compared to simple evaporation. Besides, growth of fishes is severely affected due to the water surface being covered by weeds. In addition, the biomass that accumulates after the death and decay of weeds, form a land mass, reducing the Lake's water storage capacity. It will be pertinent to mention here that there are several lakes in the world that have been dried up, due to the neglect in addressing the weeds and water hyacinth problem. The eutrophic effects are visible with the change in chemistry and physiology of the lakes, as indicated below:

a. The excessive growth of macrophytes and weeds.
b. Decrease in biodiversity.
c. Increase in the Evapo-transpiration loss.
d. Formation of the land mass increases and Lake water storage capacity decreases.

3.6. Biodiversity and Activities Impacting the Lake

Even though Inle Lake which covers an area of 247.5 sq. km, including the water body and peripheral swamps, was declared as a Wildlife Sanctuary in 1985, **not much has changed resulting in unabated biodiversity destruction**.

There are a number of channels in and around villages within the lake that are used to transport people and goods from one village to another. **Many activities prohibited under the Wildlife Sanctuary Regulations that adversely affect the habitat that sustains the flora and fauna of the lake ecosystem, are still continuing**. The ongoing activities such as felling of trees for fuel wood, disposal of waste, free fishing in the lake, plying of motor boats etc. are regarded as traditional and allowed as rights of the communities living in and around the Lake. **The staffing of the Wild Life Department to effectively enforce the Wild Life Regulations is far from adequate**. The department suffers from a structural handicap due to lack of adequate resources.

Lake flora and fauna have been continuously destroyed due to habitat degradation and if this continues it may lead to extinction of some of the species unique to Myanmar and the Inle region. The same applies to terrestrial fauna, comprising birds and mammals that can also face extinction over a short period of time.

The Lake area is being used as a resource by the floating garden farmers as well as commercial fishing groups. This has also resulted in invasion by exotic fishes like the Talapia species that are fast breeders; and infestation of unwanted weeds which are rapidly establishing a foothold in the Lake system.

Important aquatic species found in the Lake include Coontail (*Ceratophyllum demersum*), Musk grass(*Chara aspera*), and Pondweed(*Potomageton crispus*). They provide a self sustaining habitat to the micro-invertebrates, insects, snails and fish that are part of the prey base to the higher order fauna. The important plant species that are available in the Lake for use as resource in constructing floating gardens include Stonewort (*Nitella flexilis*) and Musk grass. Over exploitation of these for use as mulch is causing their decline. The absence of any study on their growth and distribution in the Lake is a major constraint and inhibits future strategy for their conservation. Snapping of this fragile ecological pyramid would lead to irreversible damage to the Lake ecology.

Therefore **maintaining appropriate density of vegetation within the lake is critical to provide ecosystem services**. Enhanced growth of aquatic vegetation or phytoplankton and algae blooms, disrupt normal functioning of the ecosystem, causing a variety of problems such as a lack of oxygen needed for fish and shellfish to survive.

3.7. Floating Garden Agriculture

Floating islands are formed in the Lake from coarse grasses, reeds, sedges, and other aquatic vegetation, some of which grow submerged while others have floating runners with aerial parts well above the water surface. Inn-thars are prudent in using floating gardens for hydroponics agriculture. They are cut into blocks 6.5 feet wide and up to 590 feet long. Black silt from the bottom of the Lake is carried by flat boats and spread over it to the extent the bed does not sink, but remains afloat. Farmers cut off portions of these floating gardens and tow them to

preselected sites; after which they are anchored with bamboo poles. The floating islands thus become a growing medium for planting fruits, flowers, vegetables, and other cash crops, from which a lot of income is derived. Silt and clay alluvium from the bottom of the lake and weeds such as water hyacinth, are used to augment the structure and fertility of these floating strips.

Photo 22: Towing strips of floating vegetation

Photo 23: Over laying floating strip with mud from the bottom of the Lake

By trimming these islands annually, Inn-thars continue floating agriculture year round, growing assorted vegetables. The floating islands can be used up to about 15 years or as long as the floating mattress can hold its buoyancy. The sunken mass of decayed material has to be taken out of the lake bottom and deposited on the land. However, the practice of farming on floating islands also encroaches into the diminishing area of the Lake. Villagers had been disposing of their abandoned floating gardens along the Lake shores in order to extend their arable land, thus causing further encroachment into the Lake. An interesting observation worth mentioning is that the Supreme Bio Organic Fertilizer Production Company, while digging on their land at Taung-bo-gyi village, discovered that the peat and wild vegetation (grass) layer below the land surface, went down to a depth of 12 feet throughout the whole of the12 acres. This indicates the depth of sedimentation that had accumulated over a long period of time and transformed into dry land.

Earlier records indicate limited practice of floating agriculture before 1960. Records further indicate that data regarding this practice were not available at that time. In recent times, floating agriculture has expanded and is the main source of tomato cultivation. Farmers are using hybrid seeds imported from Thailand, China and other countries, in order to grow bigger sized tomato so that they can fare better in the market. It is a proven fact that crops grown with hybrid seeds are high fertilizer demanders and also need pesticides to protect the crops from native insects. The ever increasing load of pesticide and fertilizers has grown into a vicious cycle; "more fertilizer means higher yields, but need more chemical pesticide to protect the crop", thus triggering higher doses of fertilizers and pesticides being applied to crops. The trend has not been contained and therefore the externality of eutrophication of the Lake continues. Expenditure incurred by farmers in buying chemicals can be taken as a proxy to measure the quantity of chemicals added to the Lake by each farmer. From the surveys undertaken, it was concluded that the average expenditure by a farmer to buy chemicals (including pesticide, fungicide) is Kyats 0.375 million (calculations based on 50 observations).

Farmers also conveyed that the average cost of a 200 ml. bottle of chemical pesticide costs between Kyats 8000 to 20000. Assuming an average 200 ml. bottle costs Kyats 15000, an average farmer uses about 25 litres of chemicals in a tomato farm, within a period of six months.


Photos 24 and 25: Large expanses of Mature Floating Garden strips

A study on the carrying capacity of the Lake and the chemicals used by tomato farmers was carried out in July 2001, by the **Living Earth Institute (Washington USA)**, which concluded that chemicals harmful to humans and birdlife are in use in the Lake and of quantities exceeding the Lake's carrying capacity. The study also documented that the **chemicals** which had been **banned elsewhere, were still being used** in the Inle region. The negative impacts of excessive use of fertilizer include:

a. Soil degradation including change in composition.
b. Decrease in soil binding capacity.
c. Increase in soil erosion.
d. Pollution of surface and ground water.
e. Reduction in moisture holding capacity.
f. Damage to crops.

Based on the study by the Inn-thar Literature, Culture and Regional Development Association, it was concluded that the Lake's water holding capacity is severely affected by the floating agriculture farms. Also, data available at the Association, reflects that **tomato farmers dump about 0.46 million tons of agriculture waste into the Lake every tomato season**.

3.8. Shifting Cultivation

Photo 26: Extensive Taungyar cultivation on the eastern aspect of Let Moung Gway Range

A significant loss of forest area is caused by Shifting Cultivation in the upland forested areas. This needs to be addressed immediately. Shifting Cultivation or Taungyar in the upper and middle reaches of the Inle Catchment is being practiced by the Taung-Yoe ethinic race, causing large amounts of soil erosion. The Forest and Agriculture Departments and some NGOs have been attempting to dissuade them, but the practice continues. As a result, the soil has been exposed to erosion on the steep slopes due to removal of soil cover, and is being washed down year after year, with the onset of the rains. Such areas are mostly found on the "Let Moung Gway" Range. The view of the plateau from the air exposed unbelievable increase of agriculture land. The team witnessed **totally "red" sheets of rain water** flowing down from the hills while conducting their tour during the months of August and September.

Table 11: Area of Inle Watershed by slope classes

Area (acres)

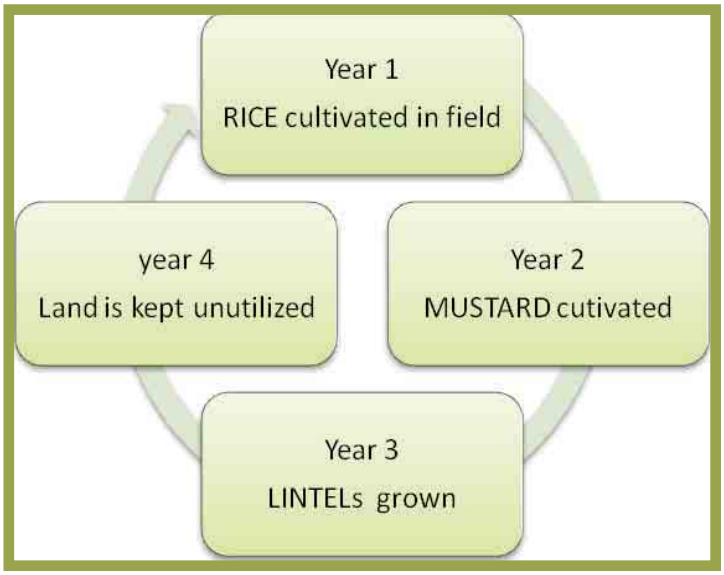
Sr. No.	Township	< 5" (< 8%)	5 - 15" (8 - 27%)	15 - 20" (27 - 37%)	20 - 25" (37 - 47%)	25" - 30" (47 - 58%)	> 30" (> 58%)	Grand Total
1	Kalaw	22955	82178	35045	28575	22703	86336	277791
2	Sisaing	210	1140	717	775	798	10096	13735
3	Nyaungshwe	63506	103640	28472	22967	19983	132538	371105
4	Taunggyi	36937	74265	17596	10588	6724	19390	165501
5	Pinlaung	20990	63110	29133	25775	21690	92085	252782
6	Pindaya	4048	16664	6903	4970	3226	5355	41167
7	Pekhon	21357	28826	8935	7093	5936	24916	97063
8	Yauksauk	19300	41716	8557	4726	2903	9577	86779
9	Ywangan	855	3188	1257	928	692	2470	9390
10	Ho pong	1072	4212	1472	835	486	1012	9089
	Grand Total	191230	418940	138086	107231	85141	383774	1324403
	Percent	14%	32%	10%	8%	6%	29%	100%

Prescriptions regarding slope categories on which vegetative cover is not to be removed, have been promulgated since many years ago; these prescriptions must be revived, awareness developed within related communities, their consent and participation sought to rehabilitate those areas that fall into the above slope classes.

More evenly leveled areas around the Lake periphery are used for rice, vegetable, sugar-cane and flower cultivation. Bamboo also grows profusely in these areas.

Typical shifting cultivation cycle followed in Inle Lake catchments: The crop rotation varies across the region, and cultivation cycles vary between four to five years. The crop cycle followed in Shwe Taung O village is of four years, barring the first year when paddy is grown (for sustenance); cash crops are grown during the second and third years. Land is left unutilized for the fourth year. In other villages, five year cycles were also witnessed.

Figure 2: Cultivation Cycle



Mixed cropping methods are followed in shifting cultivation areas; farmers have identified suitable combinations that work, which enables them to feed the family and also ensure regular cash flows.

Horticulture species are grown by farmers in kitchen gardens as well as farmland; growing of woody species are also common.

Adverse impact of Shifting cultivation. Shifting cultivation causes loss of flora and fauna which includes precious species of tree plants, shrubs, medicinal plants and minor forest products. The long term harmful impacts of shifting cultivation include (but are not limited to):

a. Large scale deforestation.
b. Loss of habitat and shelter for wild animals.
c. Drying up of water bodies and springs.
d. Soil erosion. (The problem of soil erosion due to shifting cultivation is very serious in the Inle catchment. The intensity of erosion depends on slope, soil characteristics, crop coverage, depth of soil and rainfall patterns etc.)

This is difficult to control as it is an old and established practice. It would be a prudent decision to encourage farmers, through counseling, funding and technical support, to establish sedentary agriculture in their current Taungyar plots. The practice has to be improved and made sustainable by developing the sloping lands into bench terraces as is done in most Himalayan areas under cultivation. This prevents soil erosion and also retains soil fertility. Cash crops such as potato, millet, maize etc. can be grown from year to year. Coffee, tea and grape plantations have already been well established within the region. Establishment of Fruit Orchards, such as mango, avocado, nuts, spices and high value cash crops such as Saffron, Cocoa plantations should be undertaken as a test case. Marketability of their produce will need to be assured, so that it would act as an incentive that would encourage a broader participation.

3.9. Fisheries

The lake has a unique diversity as regards its fish population. About 41 species are found in the Lake, of which 16 are endemic. Though the water body of the lake falls within the Wild Life Sanctuary, commercial fishing had been permitted through a method of annual auctions by the Fisheries Department. Elsewhere in the world, most protected areas allow only limited subsistence fishing, keeping in view the bio-diversity values of the species. However, an important factor with regard to fishing in Inle Lake is the settlements of the Inn-thar people who are traditional fishermen and have been fishing in the lake since centuries ago. **The team's revelation** of this practice and its adverse effects on the eco-system and biodiversity, **resulted in it being discontinued** since the 2013 fishing season, and currently, only subsistence fishing is being permitted.

In many parts of the world it is now being recognized that fish farming in the Wetlands by **constructing fish ponds within the Wetland area itself**, has led to draining away the water from the natural water bodies, thereby reducing their water levels and **consequently impacting on Lake Bio Diversity**. Fish ponds have been constructed on the north and western shores, where fish are bred in captivity. Species like Tilapia (originally from Africa but of good food value is bred world over in fish ponds) have found their way in to the Lake and are ruling it in large numbers, displacing some of the native species. The proportion of Tilapia is increasing to alarming levels, as about two thirds of the catch by fishermen has been observed to consist of Tilapia in the last few years. **Tilapia was introduced by the Fisheries Department about ten years ago but later discontinued.** However, it is still being bred in private ponds set up in close proximity of the Lake. When floods occur, these ponds often overflow and Tilapia enters the Lake through flood waters. It is a prolific breeder and uncontrolled growth of its population in the Lake has led to reduction of endemic fish species. Talapia is a rival to most of the native species, and in time could overwhelm them to the point of extinction. This also **needs to be addressed as a serious issue.** Although **Orders prohibiting this practice** had been put in place over a decade ago, it **had not been enforced**; these prohibitions need to be reviewed and those that are no longer compatible need to be scrapped, while those that are still relevant must be reviewed, updated, propagated widely and enforced effectively.

The team also exposed the **cage breeding of African Catfish within the Lake.** Although it had been banned since over a decade ago, **90 villagers in 13 villages** were continuing this illegal practice. The Fisheries Department, the Wildlife Sanctuary Warden's staff and the Shan State Central Fisheries Board (NGO) need to be alert to these types of practices, in order to be able to take timely action to stop them. The Village Administration Departments, related CBOs / CSOs / NGOs and the security forces need to cooperate closely to assist the Wildlife Sanctuary Warden's

Office to eradicate such detrimental practices. Perpetrators must be punished in a sufficiently severe and swift manner; so as to set an example that would dissuade potential offenders.

In the absence of any survey carried out in the last 5 years, there is a possibility that some of the endemic species have either become extinct or have been driven out of Inle to southern water bodies of Saga Lake and Mobye Reservoir. Development of fish farms or cage culture within the precincts of the lake is a practice that **would ultimately lead to a change in the profile of the aquatic flora and fauna** within a short period of time. This would mean an end to the uniqueness of the Lake. Commercial fishing of any kind should never be promoted in fresh water inland water bodies that are fed mainly by monsoon precipitation. They have very fragile ecosystems that are rich and unique in terms of Biodiversity. Inle is one such lake where fish endemism is high.

3.10. Problems of the Communities

The economic conditions of the communities residing within the Lake and its catchment, has a high bearing on the ecological stability of the Lake ecosystem. This aspect of **uplifting the economic standards of the households has not received the priority that it deserves**. There are insufficient financial instruments to improve their livelihood (saving and credit based services) and help families survive economic downturns and other vulnerabilities.

During the primary survey conducted among the households in the lake and the catchment, it became clear that households have **limited access to financial instruments.** The three basic instruments which are key to uplifting of household's economic status are: **Savings, Loans and Insurance**. These are not easily accessible to the households who depend on costly credit services, offered by private moneylenders, to meet their consumption and working capital requirements.

The primary survey carried out in the Lake villages and those in its catchment, captured the credit services availed by the households, source of credit and its cost.

Majority of the households in the catchment reportedly had taken loans from the local Micro Finance Institution - MFI (UNDP supported PACT program); whereas about 12% had taken it from Government Banks. About 33% of the households reported that they had taken loans from the local moneylenders. None of the households from on lake villages had access to a formal banking system.

There are huge variations in the interest on loans, the government sources are the cheapest, whereas private money lenders charge rates which are extremely exploitative. The interest rates charged by the MFI (PACT) ranges from between 24 to 30 percent per annum. The Cooperatives Department is known to charge similar interest rates. As the focus is to be on alleviating poverty, **a more favourable loan scheme should be considered** for the poorer class of people.

Recent news have indicated that the Cooperatives Department has been dispersing loans to affiliated Cooperative Associations at a much lower rate of interest. Similar arrangements need to be introduced within the Inle region.

Table 12: Range of Interest Rates

Source of credit	House-holds	% of sampled households	Reported interest rate (mode)
Microfinance institution	199	56%	30% p.a.
Banks	0	0%	NA
Government bank	45	13%	8% p.a.
Private money lenders	125	35%	Min 48% and max 120% p.a.

Most of the households on the Lake (Core Zone) indulge in agriculture, so also, households living in the (Buffer Zone and Remote Zone). These households require periodic loans to support their activities; this is particularly true for tomato farmers, as this requires high amounts of working capital. The households take a large number of small loans from the tomato traders. Plus most of the fertilizer and other chemicals are also acquired from traders on prearranged payback agreements. The repayment is either in the form of buy back arrangements (value of the produce being agreed upon between farmers and traders) or in cash when money is available. Farmers do not pay any interest for such deals.

Upland households that indulge in shifting cultivation are far from the markets, and given the remoteness of the villages, the households have almost zero access to any type of financial institutions. The households use their cattle as a fallback option. When in need of money, they sell their cattle, since cattle are critical for agriculture activities, they are repurchased when surplus money is available [1].

The lack of financial instruments restricts the economic performance of the households. The data collected from the sampled households reflected that the rate of interest paid by the households varied from 1.5% to 10 % per month. Putting in perspective, an 8% interest rate per month, essentially means that at the end of the year, the **borrower has to repay 2.5 times the amount** of the borrowed money as principal and interest.

Since the majority of the households active in similar income generation activities, operate in similar environmental conditions, hence their financial needs (consumption needs or working capital loans to support income generation activities) match a lot. Here it is possible that in times of financial depression, local money markets will be flushed with gold (gold is the major saving instrument for farmers) making it essentially a buyer's market. This results in a very low value to the local farmers, rendering their long term savings being grossly undervalued. There is an **urgent need for a financial support program** to enhance income generating opportunities of the inhabitants of Inle Lake.

A **Revolving Fund Scheme** was successfully implemented during the FAO / UNDP (MYA/81/003) Pilot Watershed Management for Kinda Dam Project. The Fund was **designed to build the capacity of the communities** by training them in management and accountancy, and **empowering them to manage their own funds**, by identifying the poorest of the poor, the landless peasants, widows, the needy; making collective decisions to issue loans. As the initial recipients **repaid their loans to the Village Management Committee,** new deserving recipients were identified and loans disbursed. Interest rates were nominal, so that it would not be a burden on the poor.

1 Interaction with villagers from Shawe Taung O and village Kyaung Shae Ywa (Let Mong Kwe village tract)

Some villages are known to have kept this Revolving Fund alive till date; but villages within Inle Lake had stopped the practice with the termination of the Project; some of these villages informed the team that they have substantial sums of remnant funds in the Taunggyi Bank and did not know what to do with it. The Shan State Government **needs to look into the matter** and if feasible, help them to restart their Revolving Funds on the model of those villages that are currently continuing running theirs'.

3.11. Rural Energy

Inle Lake watershed being primarily rural, biomass based cooking is dominant. This is more pronounced among the households on the lake fringe areas (the households have access to village forests and privately owned trees).The wood and coal that is burnt to meet the energy demand has two direct impacts on the lake ecosystem:

a. **Reduced tree cover:** Trees are cut to meet the fuel demand, sold in the form of fuel wood or coal. Farmers cut off trees to meet the household energy demand and also supply it to buyers with little / limited access to fuel wood. The cutting of trees, digging up of roots in the lake catchment, accelerates erosion resulting in loss of topsoil.
b. **Biomass flow into the Lake:** The wood and coal burnt by the villages on Lake, results in ash being flushed into the Lake. This activity is carried out by most households daily, adding small quantities of biomass into the Lake all the year round.

Limitations in promotion of energy efficient Cook-Stoves: The primary surveys carried out in the villages in Inle Lake revealed that a number of households use energy efficient Cook-Stoves; but these have associated limitations:

i) **Limitation 1:** A focused group discussion carried out in three villages revealed that energy efficient stoves are available in limited models (three variations based on stove size were identified) which do not necessarily meet the users' requirement. There are no local fabricators available who can make stoves that would meet households' needs.
ii) **Limitation 2:** The stoves promoted by the Forest Department and UNDP supported NGOs, and the variant Cook-Stoves sold by the local vendors are visibly better than the rudimentary stoves in use in the Catchment (see picture). However, the energy efficiency achieved by these stoves is not known. Besides, households had not received any training on proper operational measures to ensure the intended energy efficiency by using these stoves.

Photo 27: Rudimentary Cook-Stove

Photo 28: Energy efficient cook stove promoted in the catchment

Limitation 3: There are no MRV (Monitoring, Review and Verification) procedures in place to determine the energy usage behaviour of the households and the energy efficiency achieved by using Cook-Stoves promoted by the FD and UNDP.

Chapter 4
The Long Term Restoration and Conservation Plan (LTRCP)

4. A Multi-Sector / Multi-Disciplinary Approach

Based on the issues stated above, this "Long Term Restoration and Conservation Plan" has been **designed to address all pertinent issues in a holistic manner**. The Plan provides for activities in the Short term, Medium term and Long term **over a period of ten years, initially**. The implementation of the Plan involves a multisectoral / multidisciplinary approach for the rehabilitation and conservation of the Lake and encompasses all the issues and sub-issues with respect to the following zones / areas:

Zone 1(Core area)

i) Submergence area

Zone 2 (Buffer area)

ii) Fringe area

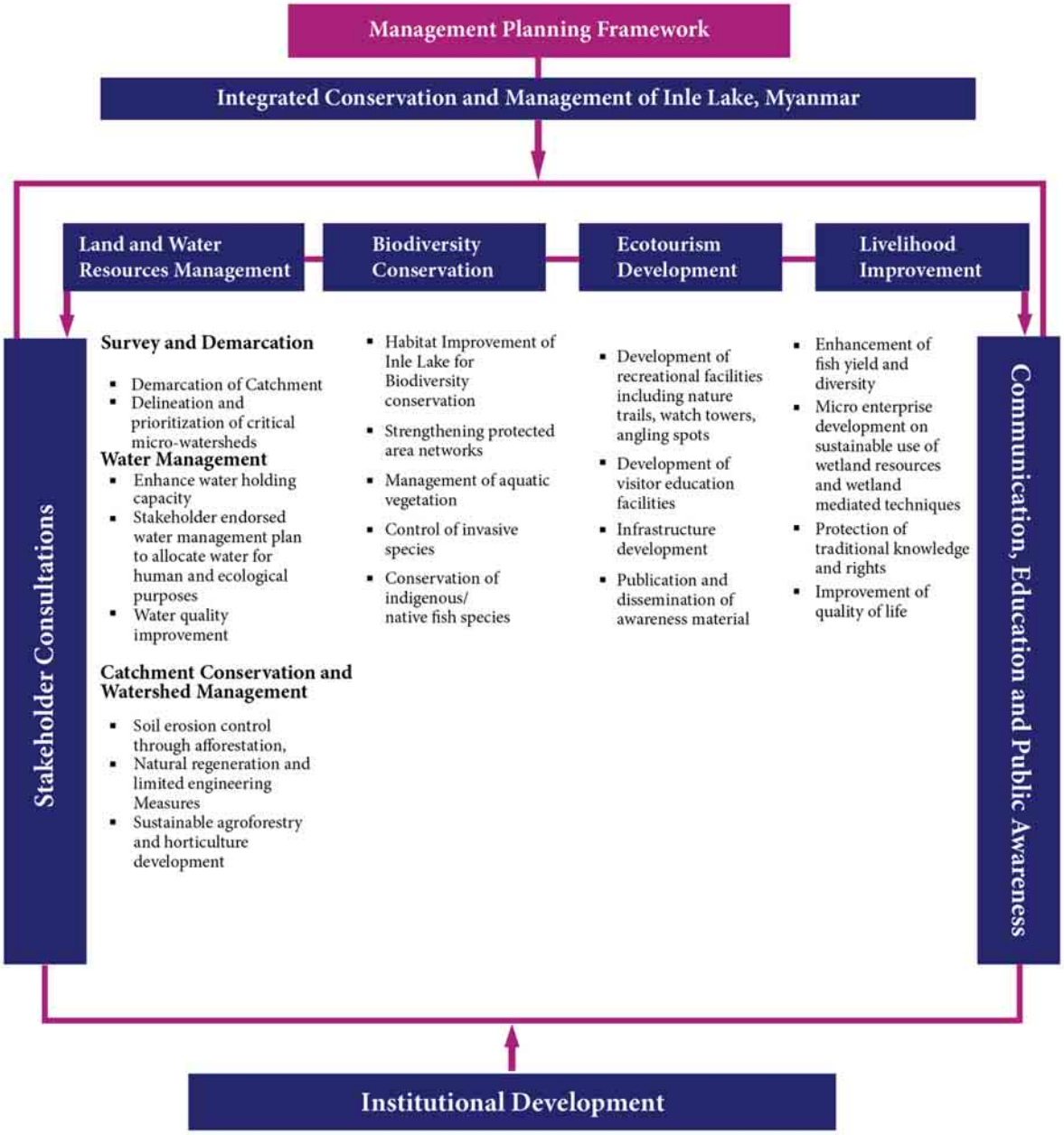
Zone 3 (Remote Area)

iii) Catchment area
iv) Public awareness
v) Administrative and legal issues

4.1. Management Planning Framework

A Management Planning Framework has been developed to **provide a balance between ecosystem rehabilitation and conservation for ensuring ecological integrity of Inle Lake and ensuring sustainable livelihoods for the communities**. It also seeks to ensure an effective institutional mechanism that harmonizes planning at various levels, with participation of all concerned stakeholders, to achieve the objectives of the Plan. A Management Planning Framework has been organized along five subcomponents; **land and water resources management, biodiversity conservation, ecotourism development, livelihood improvement and institutional development.** A schematic presentation of the planning framework is presented in Figure 3, on page 64.

Figure 3: Policy and regulatory mechanisms, Database Management, Capacity Building



The **Management Planning Framework** indicates specific activities for each of the five components that together constitute the 'Long Term Restoration and Conservation Plan'. Implementation mechanisms have been provided to achieve the management objectives identified. The Plan has been designed to **ensure the effectiveness of the interventions and sustainability of the activities**. A time schedule for all the activities has been provided. A strict regime for timely implementation by the designated Institutional bodies will need to be set.

4.2. Land and Water Resources Management

4.2.1. Land Resources

In order that the Long Term Restoration and Conservation Plan (LTRCP) can be effectively implemented, it is essential that accurate and complete information of the total Catchment area (including the Wetlands) is collected to delineate precisely the aforementioned zones.

Adopting a Watershed Approach, includes addressing the needs / problems of all the three Zones; i.e, the Remote area, the Buffer area and the Core area holistically. The whole Watershed area; initially the Remote and Buffer areas will be segregated and demarcated into **"Sub-watersheds"** according to the Catchment areas of individual streams. The Sub-watersheds will be further subdivided into **"Micro-watersheds"** based on the feeder streams within each Sub-watershed. Boundaries of these Sub-watersheds and Micro-watersheds must be clearly demarcated with easily identifiable markers, such as boundary pillars. Demarcating of these two areas can be done with the use of maps, GIS/Remote Sensing technology and Satellite Imagery which can be achieved with technology available in-country.

In the case of the Wetland areas, **demarcation can only be undertaken based on the hydrological regimes, using an integrated Wetland Inventory and Assessment approach**. The Core area (the Wetlands including the marshes) must also be sectionalized and demarcated with pillars / posts / floats or buoys. In order to **undertake dredging within the Lake, it is essential to know the status of the Lake bed**; it is the only way that planners can know areas where siltation is heaviest and requires priority consideration; which areas can be dealt with later. This can only be achieved through conducting **a comprehensive Hydrological Survey** of the total Lake area. This will **possibly require technological support from international sources.**

Local communities must be convinced that **this demarcation has nothing to do with their ownership rights;** that it is merely undertaken to sectionalize the Watershed areas and the Lake, so as to enable identification of existing problems within the whole area of the Lake and its Watershed; needs, problems, land use, forest cover etc. in every Micro-watershed will be documented and marked on maps. Priorities can then be set; Sub and Micro Action Plans can be drawn up to address all issues of the Lake and the Watershed areas on a holistic multi-sector, multi-disciplinary manner. This is in line with **FD's prescription in its Report Summary, published in February 2012, page 34, Section 12, sub-paragraph (a) (4) that states – A "land use map" of the total Inle Lake Watershed must be prepared.** Local communities will need to be advised and involved in these activities.

It is apparent that **a certain period of time will be required to complete demarcation of the whole Watershed and Lake**; thus the tasks will have to be phased and implemented according to priorities set. **The four main perennial streams will have to be demarcated as top priority**, as the supply of water they provide to the Lake must not decrease, but increase; besides, the sediments they transport must be contained.

Once the delineation / demarcation of the Wetlands and Catchment areas have been completed, boundary demarcation indicators (such as pillars etc.) must be established **in consultation with the local communities**. To achieve the above goals there would be a need for the adoption of a multi scaled / multi tiered inventory and assessment system. **Intensive stakeholder**

consultations will be essential, as this would enable the people to understand the objectives and advantages of demarcation during implementation of the Long Term Restoration Plan. This consultation is also important to **facilitate conflict resolutions** vis. a vis. **traditional rights of the Communities and the Lake Management**. The delineation of the zones will be a prerequisite for regulating developmental activities in various parts of the Catchment areas (including Wetlands) to maintain its ecological character.

Ground truthing must be carried out using suitable markers at a spacing of about 820 feet. Areas under Floating Agriculture, Swamp and Peat areas within the lake can be demarcated using floating markers. This should be completed within a period of 3 years and thereby has been categorized as a short term activity. Delineation of the micro watersheds in the catchment areas need to be undertaken in a phased manner. The process can be expedited by involving local communities, schools, military personnel etc.

The Action Plan for the above activity should be prepared by the concerned departments. Due consultations with stakeholders should be done and suitable modifications made. It should be approved by the Implementation Command Centre (Nyaung Shwe). It in turn will need to submit it for approval of the Shan State Government and ultimately approval of the GOM / MoECAF.

1: 10000 scale Land Use mapping of the project area using a sequence of high resolution images from available satellite data should be used for mapping the Wetlands, including its hydrological regimes during various seasons (see fig. 4). The boundaries of sub-watersheds of all 29 streams should be delineated, along with marking of permanent land features like major roads and other structures to serve as fixed reference points. The map so obtained should be updated by ground truth verification and community consultations. These maps would form the basis for identification of critical areas as well as villages and help in monitoring changes in the Lake Ecosystem. **Activities to be carried out** include:

a. Procurement of satellite imageries.
b. GIS processing of the imageries and preparation of a base layer series for various seasons.
c. Ground truthing and map validation.
d. Community consultation.

The survey and demarcation of the Catchment areas **must be undertaken on a priority basis**. As this will provide all field data, that implementation will have to be based on. An outline of the multi scaled / multi tiered approach is presented in figure 4:

Figure 4: Multi scaled / Multi tiered approach to inventory and assessment of Inle Lake

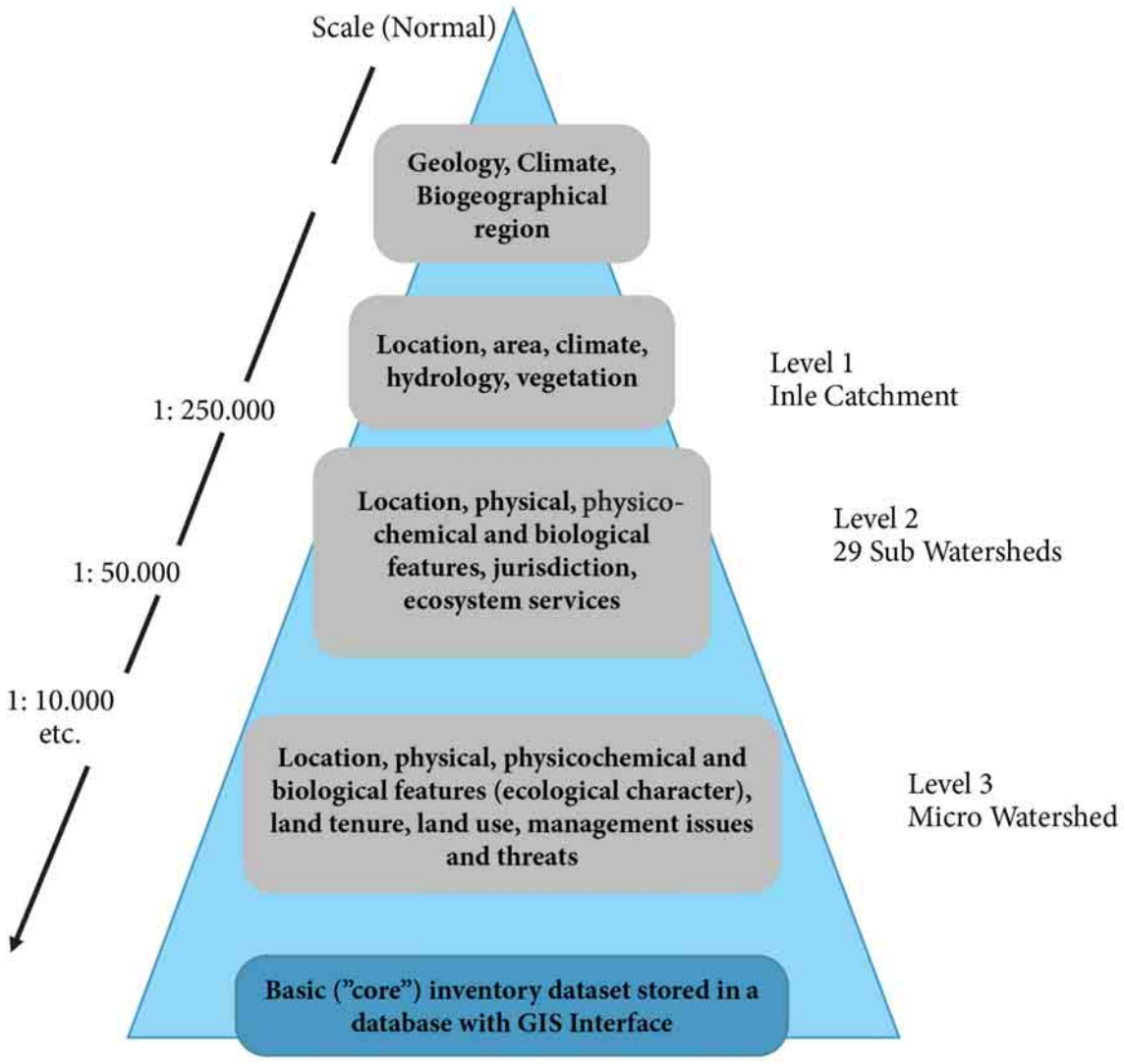


Table 13: Financial Implications

Item Description	Works	Budget USD
Survey, Mapping of the Catchment and Delineation of micro watershed	Area 1274sq km	1.27 Million
Demarcation of Lake area	**Area 250 sq km**	**0.3 Million**

4.2.2. Water Resources

4.2.2.1. Water holding capacity

In order to determine the water holding capacity of the Lake and its enhancement, the secondary data from various departments in the form of reports, action plans, published papers etc. were used. The historical / primary data thus collected indicated the baseline status. Based on the data collected, a detailed study was undertaken to address the following issues:

a. General topography and land use pattern of lake.
b. Water inflow from streams.
c. Population inside and outside the Lake, including their social / economic character.
d. Water supply and waste management system in Lake Villages.
e. Flora and fauna in the catchment and Lake Area.
f. Agricultural practices and their impact on the Lake.
g. Catchment area and water spread area of Lake.
h. Area under marshes, floating gardens.
i. Sediment yields and areas needing to be dredged.
j. Inflow / outflow discharge.

While the above issues will need to be addressed together, there is also the need to collect primary data for addressing the following issues. Gaps that need to be filled in currently available data are as follows:

i) Generalized thematic maps must be prepared to indicate surface features like land use, villages, agricultural areas, crops, floating gardens, marshes etc.

ii) The storage capacity of the Lake, including bed topography based on hydrographic survey undertaken on a regular basis. Regular assessment of quantity of Lake water inflow.

iii) Quantity of sediment / silt entering the streams, their deposition and status of lake bed sediment material.

iv) Evaporation loss.

v) Ground water extraction and recharge.

The **data listed above, needs to be collected on a regular basis; so that implementation of the Plan can be adjusted** in accordance with the data generated. **The Plan has been formulated on a rolling format and allows for such adjustments**; so as to make implementation flexible and cost efficient.

Lake water depth measurement along the east / west axis alignment was conducted, and an estimate of the Lake bed profile along the cross section was determined, as shown **in Annexure 4**. The health of the Lake and its recharging capacity to maintain favourable water levels depends on the availability of water flowing into the Lake. **Water budgeting is therefore proposed for ensuring adequate water levels** in the lake and alternative measures identified with the following objectives:

a. To ensure water inflow into the lake and recharging of ground water in and around the Lake.
b. To ensure safe navigational depths throughout the year.
c. To ensure suitable water availability to villagers residing in villages inside the Lake.
d. To ensure reduction of water losses and increasing water quantity in the Lake.
e. To reduce soil erosion and enhancing surface water runoff.
f. To ensure protection to flora and fauna in the region.
g. To ensure lake water quality and reduction of water pollution.

Since monthly demands and evaporation depths are not available, simulation was carried out (tentatively) on an annual basis. The simulation takes into consideration existing floating gardens, sedimentation etc. including salient features of the Lake, as shown below:

i)	Zero of gauge / MDDL	883.27m	(2897.5 ft)(Mean Sea Level).
ii)	Desired lake level	885.14m	(2904.0 ft).
iii)	Average annual utilization	792.19Mm3	(642493 Ac. ft).
iv)	Evaporation loss rate		1.224m (4 ft).
v)	Lake water spread area at MDDL		99.84sqkm (39 mile2).
vi)	Lake storage Capacity at MDDL		240.43Mm3 (195000 Ac. ft).The results of the simulation study revealed the following:

Table 14: Lake water storage capacity

Sr. No.	Water Level	Capacity	Inflow	Evap	Withdrawl	Total loss	Balance	Level	Remarks
	(m)	(Mm3)	(Mm3)	(Mm3)	(Mm3)	(Mm3)	(Mm3)	(m)	
1	883.27992	240.435	1047.02	123.1027	792.193869	915.2966	372.1589	884.71	With Minimum water Level
2	883.27992	301.40192	1047.02	123.1027	792.193869	915.2966	433.1258	885.20	Advantage of removal of defunct floating gardens
3	883.27992	301.45247	1047.02	123.1027	792.193869	915.2966	433.1763	885.215	Defunct floating gardens plus dredging
4	883.22	305.15147	1047.02	123.1027	792.193869	915.2966	436.8753	885.32	Removal of partial paddy fields
5	883.27992	308.56935	1047.02	123.1027	792.193869	915.2966	440.2932	885.47	Removal of additional 5% floating gardens

From the above table, it is clear that if the desired level of Lake water is to be maintained throughout the year, implementation of the activities listed below are **not only necessary but imperative**:

a. **Removal of all defunct floating gardens.**
b. **Dredging of silt from marsh and mouth areas of Bilu, Kalaw, Nei Gyar and Nam Lat streams.**
c. **Removal of partial paddy fields** west of Nyaung Shwe and downstream of Nam Pan to retrieve an area of 500 acres or more of the Water Surface area.
d. As a long term measure, **removal of an additional 5% of existing floating garden area.**

4.2.3. Facts and Requisites. The following facts and requisites are vital for a better understanding about the Lake and for long term sustainability of its ecosystem, including its water holding capacity:

a. Rainfall in the region is sufficient to replenish the Lake annually and meet the designated demands, besides maintaining sufficient depth for navigation.
b. The land mass and soil conditions are favourable to generate enough runoff.
c. The mean annual utilisations / demands need to be reviewed, considering the inflow into the Lake, and if possible alternative water sources need to be identified in the region to meet such requirements.
d. Efforts must be made for conjunctive use of surface and ground water for paddy cultivation instead of surface water utilisation only.
e. Dependence of the Law Pita Hydro-Power station on Inle Lake for its water supply on a daily / 10daily basis will need to be reviewed.
f. Shallow wells where ever feasible can provide enough good quality water for irrigation; as such wells get recharged during the monsoon season.
g. **Water harvesting structures** should be planned in the upper reaches, **to arrest flood waters for subsequent use during lean periods**.
h. Small / mini dams including check dams with impervious clay bed to arrest seepage can be constructed near the villages situated in upstream areas of major streams. **Lowle Tan dam near Kan Taw village is a good example**. Local available material is used in it's construction, as such cost is not prohibitive.
i. Limited de-silting at vulnerable locations would assist in increasing the Lake capacity.

Activities stated below are required for perspective planning:

i) Data collection with respect to silt content based on site specific conditions, need to be initiated immediately. The tentative assessment made, needs verification and validation.
ii) Hydro-Meteorological observations including discharge measurements, water quality observations on a regular basis, need to be initiated immediately on all four major streams.
iii) Setting up of Hydro-Meteorological and Sediment Monitoring Stations in the four perennial streams (HMS).
iv) Hydrographic survey of the Lake must be carried out immediately to determine the exact Lake capacity and water spread area.
v) The annual and monthly proposed utilizations, M&I demands and other uses of Lake water, need to be assessed properly.

The foregoing activities are vital for ensuring maximum water level of the Lake. There is an **urgent need to build up manpower capacity, as well as allocate adequate resources** in order to enable effective implementation of these activities.

4.2.4. Short Term Measures

Considering the minimum level of the Lake at the beginning as 2898 feet (883.27m); this is termed as the Minimum Draw Down Level (MDDL) of the Lake. In the absence of no de-silting or dredging during the year and only net water received is the runoff from the catchment with minus losses, the corresponding level reached at the end of the annual cycle would rise and thus be 2902.65 feet (884.725m).

Senario 1: If de-silting of the waterways and dredging at the mouths of streams and marsh areas of the four perennial streams, up to a depth varying from 0.82 feet to 3.3 feet and for a length upstream between 0.62 miles (1 km) to 1.2 miles (2 km) is undertaken, the resulting increase in capacity would push the level up to 2904.26 feet (885.215 m).

4.2.5. Medium and Long Term Measures

Senario 2: If all defunct floating gardens occupying the Lake, at present over an area of 12.9 sq. miles (33.41 sq. km) are removed over a period of time (say 10 years), the resulting increase in Lake holding capacity would be pushed up to 2904.26 feet (885.215m).

Senario 3: Simulation carried out with respect to removal of partial paddy fields downstream, south of Nam Pan on the east bank, reveals that removal of such paddy fields would provide additional storage of the lake. An area of 202.5 Ha (500 Acres*) is proposed to be retrieved from encroachment, thus ensuring availability of 3.7 Mm3 (3000 Ac. ft) of additional storage, the Lake level would rise to 2904.60 feet (885.32 m).

Senario 4: Further simulations carried out to retrieve additional lake area by disbanding / removing at least 5% of existing floating gardens on a pilot basis annually; i.e. only 1.86 sq. km (462 acres) from existing cultivated floating garden area being 3746.25 Ha (9250 acres), additional storage available would be 3.417Mm3 (2772 Ac. ft). The Lake level would further rise to 2905.10 feet (885.47m).

(*Source –Department of Irrigation, Nyaung Shwe)

4.3. De-silting / Dredging

Above data clearly indicates that **dredging of the Lake and streams is imperative** if Inle Lake is to be saved. The land use pattern within the Catchment area plays a major regulatory role in maintaining water quality and storage capacity of the Lake. The land use pattern indicates that a major part of the Catchment is under agriculture; the second largest part being covered by forests. The area under forest cover amounting to 483 sq. miles out of the total catchment area of 2096 sq. miles had not been maintained effectively in the past, due to anthropogenic pressure. The Catchment area adjoining the Lake (Buffer Zone) is the most important, as far as land use control is concerned.

Over a period of time, the vegetative cover has been lost, exposing the land to erosion. The eroded silt is transported with rain water and deposits in the water ways, with the rest accumulating within the Lake. The inflow of eroded fertile top soil has encroached as land masses, accumulating at the confluence points of streams, causing a net loss of water holding capacity of the Lake. Details concerning sedimentation have been described fully in section 3.3.

From the volume of silt deposition taking place in the lake (approximately 708000 t/yr), it is evident that **de-silting operations need to be assigned the top most priority.** The volume of silt discharge being only an estimate, it is therefore imperative that the **silt estimates along with concurrent discharge observations are carried out at suitable frequencies**, to estimate a realistic silt rate and corresponding amount of silt deposition in stream mouths and the Lake.

Likewise, **surveys of streams had never been considered in the past**; also maintenance measures to consolidate their head waters, secure their banks, their expanse, their depth and storage capacity had never been undertaken, resulting in their severe degradation that could eventually lead to drastic decrease of water supply to the Lake. Surveying of streams, plans to enhance and sustain their storage capacity and **inflow of water into Inle Lake must also be undertaken as a Priority measure** and carried out concurrently with activities to demarcate the Watershed areas. Streams must be sectionalized and communities living along them given charge to check them regularly, address minor issues that occur and report infringements to the relevant authorities.

De-silting and dredging are essential to restore the water storage capacity of streams and the Lake. Dredging is proposed in the deeper parts of the lake and the mouths of the perennial streams. The minimum water depth for operating with dredgers is 6.5 feet (2 meters). Dredging is a wet process of removing silt and sediments, operated by cutting and suctioning of slurry. De-silting utilizing heavy digging equipment is only feasible in shallow parts of the lake where land is exposed after receding of water in the dry season. Priority should be assigned to de-silting of the mouths and marsh areas of Bilu, Kalaw, Nei Gyar and Nam Lat streams, and **should be carried out regularly on an annual basis**. Removal and de-silting of defunct floating gardens should be undertaken concurrently. This should be followed by de-silting of seasonal paddy fields in the north, west and south areas of the Lake which together with the marshes comprise 13 sq. miles. These were once water bodies which through centuries had silted up and will certainly become solid land mass shortly, if not dealt with. In which case, **a further 13 sq. miles of the current remaining 63 sq. miles will be lost**, leaving a mere 50 sq. miles of total Lake area.

The team of experts have provided four alternatives as **simulation models** below. They have prescribed that - based on hydro-graphic surveys, partial de-silting of Inle Lake to maintain an average depth of at least 11 feet is proposed near the mouths of major streams. De-silting of the Lake should be carried out continuously in phases.

Given the magnitude of the de-silting and dredging activities, the estimated requirement of heavy equipment and dump trucks have been included:

Alternative I
Dredging silt from mouths and marsh areas of Bilu, Nam Lat, Kalaw and Nei Gyar Streams

Total quantity to be dredged / excavated: 0.05 M cu.m.
Completion Time: 6 months (150 days).
Number of excavators required: 1.
Mucking:
Selecting 12 cu , 20 MT capacity Dumper.
Quantity to be handled per hour: 55.55 / 0.83 66.92.
Number of dumpers required: 2.
Piping Cutter Section / Dredger / Slurry.
Adoption of Glory dredging / slurry piping machine with dredging capacity.
Of 100-3500 cu m / hour from 6 to 27m depth.
Number of machines required to dredge 55.5 cu m / hr: 1.

Alternative II
Removal of Partial Paddy
Total quantity to be dredged / excavated: 3.7 M cu.m.
Completion Time: 12 months.
Excavation / dredging from Hydraulic Excavator.
0.9 cu. M Hydraulic excavator adopted.
Number of excavators required: 21.
Mucking:
Selecting 12 cu, 20 MT capacity Dumper.
Number of dumpers required: 50.
Piping Cutter Section / Dredger / Slurry,
Adoption of Glory dredging / slurry piping machine with dredging capacity,
Of 100-3500 cu. m / hour from 6 to 27m depth,
Number of machines required to dredge: 4.

Alternative III
Removal of Defunct Floating Gardens
Total quantity to be dredged / excavated: 60.9 M.cu.m.
Completion time: 60 months.
Excavation / dredging from Hydraulic Excavator,
0.9 cu. M Hydraulic excavator adopted,
Number of excavators required: 68.
Mucking:
Selecting 12 cu , 20 MT capacity Dumper,
Number of dumpers required: 120.
Piping Cutter Section / Dredger / Slurry,
Adoption of Glory dredging / slurry piping machine with dredging capacity,
of 100-3500 cu m / hour,
Number of machines required: 13.

Alternative IV
Removal of additional 5% of floating gardens
Total quantity to be dredged / excavated: 3.4 M cu.m.
Completion Time: 12 months.
Excavation / dredging from Hydraulic Excavator,
0.9 cu. M Hydraulic excavator adopted,
No. of excavators required: 21.
Mucking:
Selecting 12 cu , 20 MT capacity Dumper,
Number of dumpers required: 50.
Piping Cutter Section / Dredger / Slurry,
Adoption of Glory dredging / slurry piping machine with dredging capacity,
of 100-3500 cu m / hour from 6 to 27m depth,
Number of machines required: 4.

The dredged material should be temporarily stored in dykes constructed nearby to retain solid mass and allow water to back flow into the Lake. **Dredging of Inle Lake should be undertaken selectively**.

De-silting with the help of heavy earth moving equipment is the better option to remove sediments accumulated in the fringe areas and shallow parts of the Lake where the soil is reasonably hard. The de-silted matter rich in nutrients may be used in horticulture, agriculture and may also be used as landfill. The silt in any case should be disposed of out of the catchment area or used with precaution, so that it should not be washed back into the Lake. In the eventuality that dump trucks are not available to transport the dredged material away from the Lake, local people will have to be consulted as to where and how it should be disposed. **It should not be disposed of in parts of the Lake as had previously been done**, as it will diminish the water surface area. Preferably, it should be **heaped on either side of stream banks and on the Lake shore to form protective bunds**. Local communities will need to be involved and dumping sites should be decided upon as **agreed to by the people.**

Considering the large submergence area of the Lake, de-silting the entire lake will be a difficult task. It would also be **nigh on impossible to restore the Lake to its original state**; it would be more practical and realistic to aim to restore what remains of the Lake; once that has been achieved, restoration measures can be expanded as feasible. Most importantly, areas that have been restored must be conserved sustainably. Therefore **selected areas should be identified and priorities set**. The **main objectives of this undertaking** is, to sustain the storage capacity of the Lake and streams; to ensure a sustained (if possible increased) supply of water to the Lake and reduce and contain sedimentation occurring in the Watershed areas and in major streams that transport it into the Lake.

The costs for undertaking the augmentation of the Lake capacity have been given in the table below. The activity of **de-silting and dredging has to be decided based on the findings of the hydrographic survey of the Lake**. The priority areas should then be finalized and a calendar of operations prepared. **The de-silting operation should be closely monitored as it is highly cost intensive**.

Major Streams are also in dire need of dredging. The Bilu stream suffers the severest effects of sedimentation due to increasing upland agriculture and other forms of human intervention.

When the team undertook to measure the depths of the streams, Bilu stream near its mouth adjacent to "Hei` Yar Ywa Ma" was a mere 3 feet deep. It had to be dredged later as it had become difficult for boat traffic to transport tourists. Not having means to transport the dredged material out of the Lake, the Irrigation Department was requested to dump it **in an area that was once "a floating market"**. The stream has become very shallow again. This process will be recurrent due to the heavy inputs of sediments from the Watershed area and development projects undertaking heavy earth moving operations. Similar projects **should no longer be allowed within the Watershed areas**. If inevitable, they must ensure that dug up earth will be handled in such a way that the loose earth will not find its way into the streams and ultimately into the Lake.

Photo 29: Severe sedimentation in Bilu Stream

Photo 30: Loose soil pushed over the hill side bordering Bilu stream

Bank erosion within Bilu stream due to heavy motorized boat traffic transporting tourists, is one of the contributory factors to the stream becoming shallow. Retaining walls were constructed in the past, with wooden stakes and woven bamboo sheets, but these were not adequate to with stand for long the effect of waves caused by the boat traffic. The team observed that only a few sections of the above retaining walls remained and bank erosion was occurring again. **Local communities were of the mind that only permanent structures would be able to solve the stream bank erosion problem in Bilu Stream.**

Photo 31: Bank erosion in Bilu Stream

Photo 32: Bilu stream only knee deep

Kalaw Town a hill station had been suffering from floods since several years ago, due to the Kalaw stream silting up, becoming narrower and shallower. To make matters worse, people had extended their agriculture land, encroaching into the stream, causing it to narrow. Downstream agriculture farms had constructed weirs to divert water to their fields. The Army 55th Light Infantry Division Commander, Deputy Commander, officers and soldiers joined hands with the town's folk; but they could only clear the stream of debris, and were **not able to address the root causes**.

Preservation of protective vegetative belts to prevent bank erosion in the form of trees, bushes, grass etc., had been prescribed since many years back. Expanse of these belts will depend on the size of the river / stream. Any form of **felling trees, clearing of bushes and grass, tilling of land for agriculture purposes are not to be permitted**. But these prescriptions had not been enforced; it would be difficult to enforce them at this juncture, as local people have earned rightful ownership to lands that should have been left untouched. However, a way must be found in concurrence with local communities.

Table 15: Financial Implications

Sr. No.	Item Description	Works	Budget USD
1	1. Removal of defunct floating gardens 2. Dredging of marsh, mouth & inlet of Bilu, Namlet & Nei gyar streams 3. Removal of paddy fields 4. Clearance of additional 1.8 Km2 of floating gardens	Desilting and dredging has to be done selectively based on the calendar of scheduled activities.	15 Million for ten years @1.5 Million / year
2	1. Establishment of four Hydro-meteorological station and establishment of Silt observation post, water quality (physical parameters) testing laboratory. 2. Hydrographic survey of lake at least once in 10 years	1. Installing a Hydro-met station to monitor climatological parameters including rainfall on daily basis. 2. Monitoring major stream discharges using current-meter on regular basis 3. Monitor quantum of silt entering lake from streams on regular basis	1 station @0.48 M$X 4= 1.92 M$ Recurring Cost for 7 years--0.10M$ for 4 stations Annually as operational cost Total =17.62 Million

4.4. Water Quality Improvement and Management Measures

Implementation of the measures for sustenance of the water quality of Inle Lake to cover Lake villages, peripheral villages and townships situated within the Catchment, includes **prioritized primary activities** that need to be carried out as follows:

4.4.1. Control on the use of Chemical Fertilisers and Pesticides in the Watershed and within the Lake

The following actions should be implemented on a short, medium and long term basis, to reduce the flow of pollutants into the Lake:

a. Pest control using biotechnology, bio fertiliser (Blue green algae) for rice etc. Farmers should be educated through Awareness Campaigns to reduce the use of chemicals and switch to Bio Fertilisers and Bio Pesticides. Establish research cum demonstration plots on farmers' fields, for training of farmers by the Extension Division of the Agriculture Department.
b. The role of the Agriculture Department should be stepped up significantly in the area by establishing agriculture education and training centres, coordinated by an Agriculture University system. The main focus should be on agronomy.
c. Vermiculture has been successively introduced by the Township Agriculture Extension Department by breeding of earth worms that produce good fertilized soil from bio-waste. Apparently many villagers have taken this up as they are now confident that this is a better option to chemical fertilizers. The species currently being bred are - the **Red E and Tiger from Europe; the Night Crawler from Africa and the Indian Blue from India**. It is still very much in the introduction stage, and should be propagated extensively.
d. A technical package should be developed for hydroponic crop raising methods as an alternative to the current inefficient floating agriculture.
e. The practice has to be streamlined by the Agriculture Department by establishing its own field farm (research cum demonstration) floating station on the periphery of the lake for developing efficient and eco friendly cropping methods.
f. The Agriculture Department in Nyaung Shwe is only an Extension Section. The Agriculture Department should upgrade its capability by establishing an office headed by at least an Assistant Director to address the agriculture needs.
g. Regulatory guidelines need to be developed to ensure safe disposal of abandoned floating agriculture strips and related waste.
h. An incentive system needs to be established to motivate and assist a desired percentage of households within the Lake to **diversify their livelihood activities and in return reduce area under tomato cultivation**.
i. Identify set of activities that can be taken up in the Inle Lake or the Catchment area, which is not associated with negative externalities. An extensive study of the local industries should be carried out, and this should become the basis for identifying activities, that have the potential of engaging the individuals that are affected by reduction of the tomato farms.

4.4.2. Promotion of Organic Farming in the Catchment

The farmers' preference towards chemical fertilizer has developed because of:

a. Introduction of imported hybrid seeds.
b. Easy availability in the market.
c. Easy in handling and application.
d. Faster results.
e. Higher yields.

The study and experience earned regarding the ill effects and negative impacts of chemical fertilizers on natural resources are summarized below:

a. Change in chemical composition of soil.
b. Decrease of edaphic content in soil.
c. Increase of soil erosion.
d. Reduction of moisture retaining capacity of soil.
e. Polluting the ground water due to percolation.
f. Polluting surface water resources due to inflow of fertilizer residue.

Farmers are fully aware of the benefits of traditionally using organic manure since many years ago. However, modernization and advancement in the field of agriculture practices, has enticed farmers to depend more on chemical fertilizers instead. Manufacturers and distributers have promoted the benefits of chemical fertilizers for major crops such as rice so effectively, that farmers have accepted it as the most reliable means to increased crop yields. **Research and development should be accelerated** to provide simple and low cost substitutes, which can equally benefit the farmers **and promoted vigorously in the Inle region**.

4.4.3. Organic Manure

Total Quantity of Waste contained in one heap is 2 tons, and should include the following;

a. Decomposable matter in the form of solid waste, 68%.
b. Plant Biomass, 10%.
c. Dung and animal waste, 20%.
d. Green leaves, if available, 2%.

Wastewater and raw sewage should be used to water the garbage heap for decomposition. The heap prepared for decomposition should be completely covered with soil and dung mortar. The thickness of mortar will need to be maintained for the purpose of retaining gases generated due to decomposition of waste. Guidelines to maximize benefits are stated below:

i) The heap should remain covered throughout the period of decomposition.
ii) Decomposing matter needs to be added in the form of soiled and decomposed dung and biomass.
iii) The prepared manure needs to be kept in a cool place.
iv) The best results will be obtained by using of the decomposed manure within a 6 to 8 month period.
v) Avoid insertion of plastic, polythene, wood, stone and metals or other non- biodegradable matter in any heap.

A minimum period of 21 days shall be required for decomposition. This may vary with climatic conditions, as during the dry season it can extend from 21 days to 40 days; while in the cold season, it can decompose within 30 days.

Application

The first spray of manure requires a bit higher quantity, which will gradually reduce in subsequent years and become stabilized after a period of three years to 100 kg /acre.

a. First Year: 400 kg / acre.
b. Second Year: 300 kg / acre.
c. Third Year: 200 kg / acre.
d. Fourth Year onwards: 100 kg / acre.

Organic manure has the following merits:

i. Least capital and recurring expenditure involved.
ii. Simple method of preparation and easily available material can be used.
iii. No side effects.
iv. Improves soil texture and increases humus in soil.
v. Improves of soil quality and fertility.
vi. Retains moisture content in the soil.
vii. Supports plant growth by providing nutrients.
viii. Provides both macro and micro nutrients.
ix. One dose of manure provides nutrients to plants for at least three years.
x. Reduces the water demand of crops.
xi. Increases soil binding, thus reducing soil erosion.
xii. Very low nutrient flushing from the manure to pollute water resources.

Table 16: Comparison between Chemical and Organic fertilizers

Sr. No.	Chemical Fertilizers	Organic Manure
1	Involves higher cost	No cost is involved
2	Provides only NPK	Provides all the required Macro and Micro nutrients
3	Higher water demand for irrigation	Less water demand for irrigation
4	Only 2% is used by plants and rest of the fertilizer either flushed out and pollutes surface water or leached to contaminate ground water	Fully remains in the soil and used by plants in long run. There is no side effect of the organic manure or any pollution problem caused by it
5	Changing the soil texture and making soil loose	Improving soil texture and binding the soil
6	No addition in humus content of soil	Humus content increases
7	Water retention capacity and moisture content of soil decreases	Water retention and moisture content of soil increases

Sr. No.	Chemical Fertilizers	Organic Manure
8	Short term effective with limited half life period	Long term effective with slow and steady nutrient release
9	Decreasing soil flora and fauna including bacteria	Provide sustainability to the flora and fauna of the soil
10	Dependency on the market for the availability of fertilizers	Own preparation and availability of manure is ensured

Considering the advantages of organic manure and the need to reduce chemical fertilizer polluting loads being inserted in to the Lake, the Catchment areas should be declared as **"Chemical Free, Organic Farming Zones"**. Farmers and stakeholders should be convinced of benefits gained by not using chemical fertilizers in the Catchment areas and within the Lake.

These activities will need to be carried out on a continuing basis. The annual program with site specific details should be prepared by the concerned STWGs / Departments and approved by the Shan State Government. Course correction if any, should be done after one year of implementation and suitable modifications made together with stakeholder participation.

Table 17: Financial Implications

Item Description	Works	Budget USD
1. Reduction of chemical pollution. 2. Promotion of Organic Farming	1. Organising Awareness Camps/ Farmers training to propagate the harmful effects of excessive use of Chemicals. 2. Adaptive trial on farmer's fields for new techniques on farming, crop rotation, agro-forestry etc. 3. Demonstration on the use of Bio-fertilizer/Vermiculture instead of chemical fertilizer and the benefit thereof in production & productivity. 4. Demonstration on Production of farm manure from farm waste.	20000$(recurring) 10000$(recurring) 10000$(recurring

4.5. Ozonisation of water

Tropical lakes subjected to pollution are highly productive in nature. These lakes exhibit phenomena of diurnal thermal stratification, instead of forming metalimnion (Middle layer). The day and night ambient temperatures have remarkable differences; hence, clear demarcation at the trophic level is not significant as such. The temporary formation of metalimnion does not differentiate the epilimnion (Uppermost layer) to metalimnion. However the transparency and turbidity restricts the euphotic zone to the upper layer of water only. This condition changes the dissolved oxygen concentration in the hypolimnion (Bottom layer) and forms anaerobic conditions. The eutrophic lakes have higher concentration of dissolved oxygen in the epilimnion, while the D.O concentration in the hypolimnion differs. The atmospheric and algal oxygen does not change the hypolimnion, thus bottom dweller plants and animal species start shifting towards epilimnion.

With Ozonisation of water, the anaerobic conditions of the lake shall be changed to the aerobic state, which will help in forming a healthy ecological status. The chemical, biological and bacteriological pollution will be reduced due to oxygenation of pollutants. The MPN count will be reduced, to make water uncontaminated. The heavy metallic contamination will be controlled by oxidizing the metallic ions. The simple oxygenation method of spraying water upwards (fountaining of water) is generally used to oxygenate water. The atmospheric oxygen mixed with water reaches to deeper layers and improves the oxygen level.

It has been established that **ozone is 150 times more reactive than chlorine and 1300 times more than oxygen**. It has good disinfectant values and increases the D.O level. O3 also oxidizes chemical pollutants and controls microbial infection.

A detailed study on Ozonisation of Inle Lake must first be undertaken, but in the interim period, 4 ozoniser-cum-floating fountains should be installed within the Lake. The Units should be free floating and temporarily anchored at the place of aeration, so as to enable it to be shifted to other parts as and when required. The Lake area being rather large, fixed units may not serve to cover the entire lake. The running cost of the aeration unit is one tenth of the fountains using 30-40 HP pumps. The installation of two should be done in the 1st year and the remaining two installed in the 2nd and 3rd years respectively. The benefits accrued by passing ozone into the Lake shall lead to:

a. Improvement in lake water Dissolved Oxygen level.
b. Control of micro-biological action / infection.
c. Oxidation of heavy metals and inorganic ions into oxides of elements.
d. Better water quality for aquatic life.

Table 18: Financial Implications

Sr. No.	Item Description	Works	Budget USD
1.	Installation of Ozonizers and aeration systems	4 no. of Floating Fountain-cum-ozonisers	0.2 million
2.	Operational cost and Maintenance	5000/year	35000

4.6. Community based solid waste management systems

The management of solid waste is practically non-existent in areas in and around Inle Lake. Average generation of solid waste is about 0.35 kg per capita per day, with density of about 500 kg / m3, which is based on the production of domestic and commercial waste, animal waste and construction waste etc. Since major industrial areas do not exist, industrial waste has not been considered.

The total domestic and commercial waste generated in a year based on a population of 80,000 individuals living in village settlements in and around the Lake, is estimated to be about 28 tons. It is therefore proposed to **develop Community based Solid Waste Management Systems** for systematic collection and disposal of solid waste. This would involve construction of waste collection centers at common locations, with segregated compartments for recyclable and non-recyclable wastes. Specially designed carriages should be operated through non-governmental organizations / community based organizations for waste Collection.

4.6.1 Low cost sanitation in peripheral villages / habitations

Presently, households residing in villages situated in the Catchment outside the Lake, do not have access to adequate sanitation facilities. It is therefore proposed that sewage generated from the rest of the villages without sanitation facilities, scattered in the Catchment area shall be intercepted using **low cost sanitation units** as per WHO design or construction of septic tanks.

4.6.2 Township Wastewater / Sewage Treatment Plant

A total of about 5.60 MLD of wastewater is generated from the two major townships located in the North of the Lake. These liquid wastes carry inorganic nitrate and phosphorus, which not only enriches the lake sediments but also increases the fertility of the water, resulting in accelerated growth of aquatic vegetation and proliferation of algal growth.

Therefore, sewage interception and treatment is one of the most important activities that should be undertaken to mitigate water pollution. This will stabilize the wastewater and reduce its organic content to a great extent. Nyaung Shwe town, the largest urban peripheral town in the North, habitations on the eastern and western sides of the Lake, are proposed to be targeted for sewage management, to reduce direct / indirect discharge of wastewater. Sewage generated from these areas shall be intercepted and treated by **construction of two / three sewage treatment plants using the Activated Sludge process**.

The treated waste water may be used for the following purposes:

a. **Sewage fed fisheries:** Treated sewage may be stored in separate tanks of required size and used for aquaculture. Suitable varieties of fish seed may be introduced and allowed to grow in the sewage fed water.
b. **In horticulture:** Treated sewage after disinfection may be used to irrigate horticulture crops.
c. **In agriculture:** Treated sewage after disinfection, can also be used to irrigate major agriculture crops. The effluent provides sufficient nutrients to crops for growth.

The work implemented in a pilot village, should be completed in one or two years time and then replicated in other critical villages; it is **to be implemented continuously** on a regular basis. It would require a long period of time before the issue of pollution in the Lake can be adequately addressed. The financial break up of required components is given in the table below:

4.6.3 Interception and treatment of sewage within the Lake

Most of the houses within the Lake, discharge their domestic effluents directly into the Lake. Assuming per capita per day at 40 liters as the norm, with 80% of the total water used converted into wastewater, these villages generate a total of about 1.0 MLD (approximated in the absence of actual surveyed data) of domestic sewage directly into the Lake. Domestic waste generated contains nitrate nitrogen, ammonical nitrogen and total phosphorus as nutrients which add to the Lake fertility leading to Eutrophication.

The wastewater generated from inhabited areas should be treated by applying appropriate technology. A pilot village situated inside the Lake should be identified for launching of the **community based toilets**. It is of most importance, that local communities should be made to participate willfully, starting from the initial planning and throughout the implementation

stages. This will not only create ownership but will also help design a system that meets local requirements. Further, such an approach will reduce friction between various stakeholders and management.

Table 19: Financial Implications

Item Description	Works	Budget USD
1. Pilot Project: Supply of Septic tank on community basis. 2. Collection, disposal of wastes 3. A cluster approach of sewage treatment in one village as demonstration project	1. Village identification and detailed household survey 2. Awareness generation among community for investing into a toilet system that is compatible with the sewage treatment tank to be developed for the village 3. Identification of appropriate technology for septic treatment 4. Establishing financial system to support manufacturing of toilets (loan products for households) 5. Development of infrastructure 6. Expansion of cluster based sewage management approach to other villages on the lake	1. Survey cost 2000$ 2. Awareness program cost 2500$ 3. Technology research 5000$ 4. Provisioning of revolving fund to microfinance institution to extend loans for toilet making 25,000 $(100 concrete toilets) 5. 10,000$ for building of septic tank and laying of pipelines

4.7. Catchment conservation and watershed management

The lake catchment that covers most parts of Zone 3 is the receiving area of the annual rainfall. The deteriorating condition of the forests in these areas has made it susceptible to soil erosion and is thus a major source of silt flowing in to the lake. About 80% of the 3640 sq. km of the Catchment area falls within Zone 3.

4.7.1. Watershed Management

The goal of Watershed Planning is to provide a framework **to protect, restore and maintain a healthy natural Watershed ecosystem**. Watersheds can be of different sizes depending upon the order of the streams. The emphasis in the Long Term Restoration and Conservation Plan is clearly around optimum utilization and conservation of land and water resources. As Watersheds increase in size, they become more complex with regard to slope, topography, soil and vegetative cover. Most watershed development works have been proposed essentially to cater to the domestic needs of the local population (human and live stock), and provide some irrigation for otherwise rain fed land owners. Such watersheds should be developed in the upper reaches of the streams where soils are shallow and less retentive and people are unsure of getting even one crop. Watershed development will guarantee their survival needs, because it **harnesses rainwater where it falls and / or facilitates and increases seepage into the underground aquifers**. This means that the cultivated areas in the valleys, may enjoy increased irrigation by between 20 to 30

per cent, as they could gain access to water through recharged wells. In certain areas this could even mean a 100 per cent increase in production / productivity; and it also minimizes lake water utilization for agriculture.

It is also **important to realize that through Watershed Planning, the community is embarking on a major learning curve**. They learn about the issues and potential solutions to local environmental problems, that the entire Lake ecosystem is facing; and at the same time, they also learn about the difficulties many of them experience, when trying to make a living from activities such as agriculture, fishing, tourism, forestry, etc. and the different challenges they face. It is thus imperative to identify issues of importance to the local communities that would persuade them to participate in the Watershed Planning process. **Appropriate training programs** will also need to be adopted to develop awareness. The following activities will need to be undertaken:

a. Identify organizations and individuals who can influence communities to accept and comply to Watershed decisions.
b. Determine how best to bring diverse stakeholders together.
c. Begin the process of learning about and understanding individual interests in the Watershed.
d. Assist the technical team in addressing issues that concern all stakeholders.

Watershed Planning involves collection of data at the Watershed level. This should be followed by delineating areas into smaller annually workable units called Micro Watersheds (200-500 Ha), and preparation of a Micro Plan for Forest, Agriculture and the Drainage area of streams flowing through the Sub Watersheds. The treatment strategy should then be finalized **in consultation with the community** living in the Sub Watershed. The activities to be implemented as per the Micro Plan include the following measures:

a. **Ground cover Restoration Measures:** Planting of trees, bushes and grass along steep hill slopes, waste lands, field boundaries etc. to prevent soil erosion and meet the fuel wood needs of the people.
b. **Soil Conservation Measures:** Contour dykes / bunding, Bench Terracing, land leveling, contour farming etc. to prevent and arrest sheet erosion of topsoil.
c. **Water Conservation Measures:** Engineering structures such as check dams, gabion structures, silt detention dams and spill ways should be constructed to prevent free and unchecked flow of rainwater by conserving it wherever possible, so that it permeates into the substrata and recharges the ground water in the entire watershed area.

Execution of the above works may be undertaken by different agencies, but the planning and site identification should be done jointly at the micro level, by Watershed teams for each Sub / Micro-Watershed, to integrate various components on a single map. **All 29 Sub Watersheds within Inle Lake Catchment need to be delineated after a survey, and the fragile areas susceptible to erosion within each of them, identified**. This survey would define the area requiring priority treatment. The technical measures to protect such areas should be finalized in consultation with the communities within each Sub Watershed. Locations should be clearly indicated on the map, so that it will be a part of the Micro Plan prepared for the Sub Watersheds. **This would result in a holistic planning for treatment of the identified critical areas**.

4.7.2. Ground Cover Restoration

In the context of environmental conservation and sustainable development, the FD has adopted three approaches such as **the natural system, the modified natural system and the plantation**

system. Under the natural system, protected areas have been established so as to safeguard the Lake ecosystems, species etc.; also to support the life supporting systems of the people. But these efforts have not yielded tangible results. There is therefore an urgent need to intensity the efforts for restoring the forest cover and conserving it. Areas to be considered under reforestation and natural regeneration need to be protected by erecting fences to inhibit human and animal interference. This will ensure that the root stock available slowly grows and develops into a natural forest once again. There are areas that are completely devoid of trees that require planting. Certain areas which have rootstock available would require dressing of left over stumps so that they can regenerate. These areas should be supplemented by gap planting.

Treatment of degraded forests will have to be carried out through the following mix of biological and small scale engineering measures:

a. Reforestation

The satellite imageries would facilitate to identify critical areas falling within the 29 Micro Watersheds for reforestation. The activities should include:

i. Selection of native soil binding and economically important species in consultation with local communities through the PRA exercise. Walker (2002) stated that "it is commonly assumed that there is no erosion under the forest, this is not the case; **ground cover, rather than canopy, is the chief determinant of erosion**". This is noteworthy.
ii. Nursery raising through community organizations.
iii. Preparatory works, including weeding and constructing pits / trenches for planting of saplings.
iv. Protective measures (including watch and ward) from illegal cutting, fire, cattle grazing etc.

b. Species selection

Selection of tree species in reforestation or establishing forest plantations is crucial in acquiring maximum benefits. One of the most important functions of trees and forests is the **recharge of the underground water resource**, which is mostly overlooked. Selection of species should be made according to the role, function and desired benefits from the trees / forests. In the head water areas (source) of streams, species that enhance the recharge of the ground water resource should be selected. If the object is to alleviate a community's firewood supply, fast growing species should be selected. It should also be noted that FD had issued Policy Guidelines that **species such as Teak, Eucalyptus must not be planted in Watershed areas**. It would be more beneficial to plant only species that grow naturally in the area.

c. Planting Pattern

The topography and terrain must be considered when deciding the planting pattern and selection of suitable plant species. Planted areas need to be protected, to minimize human interventions. The planting of trees would need to be supplemented with sowing of shrubs and grass species, in order to protect the soil cover in the initial years, while the trees establish themselves and grow to a suitable height. Plantations should be maintained for at least three years after establishment. The best strategy to ensure protection of the plantations would be through **Joint Forest Management** Models, involving local communities and field functionaries of the Forest Department.

d. Planting Technique

The pit size for plantations in rocky areas should be of a large size. The proposed size of a pit could be; L - 45 x B - 45 x D - 60 cm. **Chemical fertilizers should be avoided**; natural soil mixed with organic manure to a 3:1 ratio would be appropriate.

Special attention must be given to the size of saplings for planting. They will need to be developed for one year in the nursery before transferring to the plantations.

e. Natural Regeneration

Degraded forest areas within the 29 Sub Watersheds that could be re-established through Natural Regeneration should be identified and measures taken to treat them. Activities should include:

i. Pruning of trees.
ii. Cutback operations and dressing of stumps.
iii. Planting in gaps.
iv. Weeding and hoeing of planted trees.
v. Protective measures (including watch and ward).

Naturally Regenerated areas shall be maintained for at least three years after creation.

f. Soil Moisture Conservation Measures

Cultural operations along with supplemental planting of appropriate species, intensive soil and moisture conservation measures such as constructing contour dykes, box trenches, small check dams etc. should be the main activities. As a result of these activities, the velocity of water coming down from the hills and other sloping areas, during the rainy season, will be checked; resulting in decrease of soil erosion.

Small-scale engineering measures as mentioned above must be **taken up on a priority basis to arrest flow of silt from critical Micro Watersheds**. The work shall start from the valleys and move up gradually to the ridges.

Table 20: Financial Implications

Sr. No.	Item Description	Works	Budget USD
1.S	1. Delineation of micro watersheds(10/year). 2. Natural regeneration and plantation to create vegetal cover in micro-watersheds. 3. Soil conservation measures to be carried out in drainage lines in the micro watersheds.	1. Average 1000 Ha Plantation/year on forest land, community land. 2. Soil Conservation measures 3. Up-keep and their maintenance. 4. Watch and ward to control illegal cutting/burning	0.75M/ year for 10 years=7.5 Million

4.8. Shifting Cultivation - Possible Alternatives

Various soil conservation measures must be adopted in areas under Shifting Cultivation, depending on the slope and the soil type, in order to maintain soil fertility. Most of these techniques consist of building contour structures which are engineering, agronomic and biological. This would include specific activities like contour trenches, V ditches, bunds, bench terracing, mulching, small check dams etc. Under a mean average of annual rainfall (1281 mm) in the Catchments, about 850 cum to 1150 cum. of water can be retained in one acre, which will be sufficient for growing of two crops. Additional storage facilities such as farm ponds, catch pits, trenches and bunding should also be considered.

4.8.1. Permanent Structuring of the Land

It mainly consists in establishing two lines of trees at a distance of about 3 to 4 feet apart, along the contour lines. The distance between such rows of trees will vary depending upon the degree of slope. The greater the slope, the less will be the distance between the rows of trees and vice versa. Stones are to be piled up in the space between the rows of trees. In the course of time these two rows of trees with the stones etc. piled up in the middle, will form a contour wall or bund supporting the soil on the upper side of it. Once the slope is divided by these rows of trees, the different plots will be transformed into terraces, as the land will become leveled in due course. Thereafter, perennial and seasonal crops can be cultivated on them.

The boundary of the land should be planted with trees for timber and fruit, depending on the needs of farmers. Regular pruning and trimming of these trees will prevent harmful shading of the cultivated crops.

4.8.2. Establishment of Perennial Crops

Seasonal food crops are being cultivated in the Shifting cultivation areas as a subsistence measure. In order that the practice should be transformed to become a sustainable livelihood, it would be necessary to select perennial and seasonal crops that would be compatible with the environment and soil conditions, and plant them in an appropriate manner to optimize utilization and productivity of the land.

4.8.3. Multiple cropping

Intercropping, relay cropping, sequential cropping, double cropping, triple cropping, etc. should be practiced wherever possible. Intercropping is a system of cropping, in which two or more crops are grown simultaneously in rows in a definite pattern. Relay cropping is the practice of planting successive crops on the same soil in the same season. Sequential cropping refers to the growing of two or more crops in sequence on the same field within the same year. Multiple cropping should therefore be promoted, as it is an integrated system of land use in which a variety of crops are cultivated using the horizontal and vertical space to the maximum. Seasonal crop rotations between the cereal and pulse crops should be practiced so that soil fertility is maintained. In general a soil exhaustive crop should be followed by a soil enriching crop.

4.8.4. Mulching and Organic Matter Recycling

As far as possible, all the biomass generated in the farm must be recycled in one form or another. This should be done through mulching of weeds and crop residues. Mulching will also help in the control of weeds and maintenance of moisture in the soil.

4.8.5. Cropping Systems

Cropping systems as an alternative to shifting cultivation, vary with each farm and each person, according to his preferences and needs. Often, the market situation and accessibility plays an important part in their selection. The following are some of the possible cropping systems that can be established as alternatives:

a. Rice based cropping system.
   Rice is taken as the main crop and all other crops are subsidiary to it.
b. Maize based cropping system.
   Maize is cultivated as the main crop and all other crops are subsidiary to it.
c. Pulses based cropping system.
   Anyone of the pulses is selected as the main crop; and depending on the situation and need, other crops are selected in addition as secondary crops.
d. Seasonal spices based cropping system.
   Anyone of the seasonal spices is cultivated as the main crop and other crops are selected as secondary crops.
e. Vegetable crop based cropping system.
   Where marketing facilities for vegetables are available, a vegetable based cropping system will prove profitable. With this cropping system also, several varieties of vegetables can be selected.
f. Perennial crops based cropping system.
   Just as any seasonal crops are selected as the main crop of a cropping system, the perennial crops are also selected as the base of the cropping system. Such perennial crops are planted in well planned permanent land use designs and all other crops are subsidiary to it.
g. Fruit tree based cropping system.

Any specie / species of fruit trees, depending on soil and climatic factors, individual needs and marketing facilities, can be chosen and cultivated on a permanent basis. Using the vertical and horizontal spacing properly, one can have a variety of cropping designs with perennial fruit crops. Thus several short term crops can be accommodated in between the long term crops. For example, wide spaced (about 30 to 36 feet) trees, such as mango; medium spaced (15 to 18 feet) trees, such as lime, guava, custard apple, etc. can be planted either in a one line direction or in two way directions. In both types of spacing, crops such as pineapple, banana, papaya etc. can be cultivated to optimize land utilization and income.

Awareness generation through education of farmers practicing shifting cultivation, **is the key to success**. They need to understand the limitations of productivity of land if the choice of crop cycles, do not supplement nutrient uploading of the soil; also, the importance of applying appropriate amounts of organic manure frequently to compensate for the depletion of nutrients from the soil. Thus, the common steps for rehabilitating shifting cultivation areas are as follows:

Step 1: Agriculture extension activities: Create an extensive agriculture extension plan for the upland villages. Anchored by the Agriculture Department, the extension activities should focus on crop diversification, mixed crop promotion and horticulture extension.

Step 2: Consensus on development plans: The Government Departments will have to work with the relevant stakeholders (villagers, village administrative bodies, local monasteries etc.) to prepare a development plan for the village, that includes land leveling and forestry activities. An incentive package will have to be designed to offer assistance in developing terrace farming in exchange for village commitment for developing Community Forests in the village lands.

Step 3: Demarcation of areas for step farming: It is necessary that the villagers develop some percentage of the hilly areas for permanent farming. The Agriculture Department can help villagers through technical inputs in identifying patches where land leveling can be taken up. The Mechanized Agriculture Department has organized Highland Agriculture Planning mobile teams that are equipped with heavy machines to construct bench terraces on slopes. Their close coordination with the Forest Department is essential for construction work in difficult areas.

Step 4: Identification of areas for forestry activities: To increase land productivity and reduce soil erosion, priority should be assigned to **Community forestry activities in areas abandoned by shifting cultivators**. Such plantations will also help households meet their timber and fuel wood demands.

Step 5: Strengthening of Forestry / Agriculture: Infrastructure development and capacity building of field staff.

4.9. Rural Energy

4.9.1. Promotion of Energy Efficient Cook-Stoves

In the past few years Energy Efficient Cook-Stoves have been distributed to households for free by the Forest Department and UNDP. A market for lower-income groups could be created through partnerships to raise awareness of 'energy-efficient Cook-Stoves', health benefits and improved designs by incorporating users' preferences.

It is proposed to increase access to clean biomass based Cook-Stoves for the majority of households and micro-enterprises on the Lake through the following measures:

a. Identify agencies and partnerships to create an enabling environment for designing, testing and promoting of clean energy efficient Cook-Stoves.
b. Technical and financial assistance services for sustainable deployment of these technologies.
c. Provide subsidies for use of energy efficient Cook-Stoves.

4.9.2. Waste to Energy Projects for Households Living On the Periphery of Lake

The electricity option though cheapest, is not being suggested for application for all households, as **there is a huge potential for converting waste to energy in the Inle catchment. The household waste and sewage alone can generate power that will be sufficient** for the households living in the immediate periphery of the Lake.

The household waste of communities within the Lake can be taken to the Lake shore for treatment and safe disposal. The anaerobic digestion of the waste will generate methane gas and will also convert the waste into bio-fertilizer that can be used in the agriculture farms. This program when promoted at the Catchment level can also be promoted as a Program of Activity (POA) for getting CDM benefits.

4.9.3. Qualitative Upgrading of Cook Stoves

The existing Cook Stove program in the Inle Catchment is implemented by two agencies, UNDP supported NGOs and the Forest Department. The experience of these NGOs should be utilized in promoting the better versions of the Cook Stoves.

a. **Technical service provider for Cook Stove development:** The Forest Department or other project proponents (UNDP supported NGOs) should associate technology service providers to develop Cook-Stoves based on the local cooking requirements.
b. **Testing of Cook Stoves:** The energy efficient Cook Stoves when designed should be tested for the achieved energy efficiency and operating conditions to maximize efficiency, if required further product modifications should be carried out.
c. **Product publicity:** The energy efficiency cook stove thus developed should be launched using the village institutions and Microfinance Institutions as sales platforms.
d. **MRV mechanism for developing carbon project:** The project proponent should develop a robust Monitoring, Review and Verification (MRV) system to develop a case for carbon revenue.
e. **Bio fuel Options:** "**The Supreme Bio-Tech Company**", of the "Supreme Group of Companies" has engaged in the production of bio-fuel "Pellets" from Floating Vegetation, Peat and Grass from within and around the Lake since about a decade ago. They have made progress in refining their product and are currently exporting to China and South Korea. They are seeking inroads to Indian and European Companies that are producing specially designed stoves that utilize the same pellets as fuel and have been claimed to be extremely energy saving and non polluting; even cleaner than natural gas; and that the residue ash provides good non polluting bio-fertilizer. The Company had started their enterprise in Pantanaw Township in the Ayeyarwaddy Division, but the "Nickel" content being high at over 40%, was not compatible with the buyers' preference. The Nickel content in the raw material from the Inle Lake being a mere 1%, has proven to be favourable to the buyers. They are exporting a bag of the Bio-pellets at Kyats 6000 to China; and are prepared to sell to the Lake communities at a lesser price. This should be considered as a good option and the **Supreme Bio-Tech Company's cooperation should be sought**; and if proven viable, ways and means to involve the communities to produce these pellets at a lower cost, or **other forms of producing Bio-fuels utilizing alternative raw materials** such as Water Hyacinth need to be identified. This program, if successful and can be developed on a large scale; it would to some degree contribute towards the de-silting process while at the same time enhance the socio-economic status of the communities.

4.9.4. Additional sources of Energy in the Catchment- Mini hydro project

A mini run-off river hydro plant is under construction to utilize the hydro potential of Bilu stream near Pattupauk village in Pin Laung Township. The power generated could be partly utilized to augment the energy needs of the Inle Lake residents. Micro hydro projects can be feasible in series along fast flowing streams.

The costs involved in the above mentioned components of Catchment Conservation for a period of 10 years have been given below. The silt flow into the Lake would be reduced considerably after the successful implementation of this activity. Plans should be prepared after intensive consultations with stakeholders; it would need to be approved by the SSSC and the CSCOIL.

Table 21: Financial Implications

Sr. No.	Item Description	Works	Budget USD
1.	1. Sustainable Agriculture in Shifting Cultivation areas.	1. Demonstration on Pilot basis of sustainable agriculture practices in Shifting Cultivation areas.	20000
2.	1. Promotion of clean energy-cook-stoves		50000

4.10. Biodiversity Conservation

The major components for Biodiversity Conservation in the Inle Catchment that should be addressed on a priority basis are as follows:

4.10.1. Rehabilitation of Threatened / Rare Species

Adaptive management should be applied based on available knowledge of the marsh vegetation, water depths and new information gained during the implementation of MOECAF's Action Plan. A standard sampling point grid should be established in the Lake. Through experimentation within sample plots, different vegetation management regimes should be tested. Continuous monitoring of:

a. Water bird diversity, abundance and habitat use.
b. Floral species diversity, abundance and cover.
c. Aquatic faunal diversity and abundance.

Actions to manage the aquatic vegetation (species, quality and abundance / densities) should be undertaken with a complete understanding of their importance for water birds, fish and other aquatic fauna.

4.10.2. Management of Aquatic Vegetation

A study needs to be undertaken on the growth and distribution of the aquatic vegetation in the Lake to come up with strategies for their conservation. Also a regular formal scientific framework must be established to monitor on a regular basis, not only the over exploitation of some plant species found in the Lake, but also over growth of other species caused by the rapid eutrophication of the water.

Implementation of the following measures should be undertaken immediately:

a. Monitor and establish the extent of Lake vegetation by undertaking a comprehensive survey.

b. The current resource management system is untenable and therefore calls for institutional reorganization with active participation of user groups.
c. Involvement of the Taunggyi University in undertaking related studies.

4.10.3. Weed Infestation

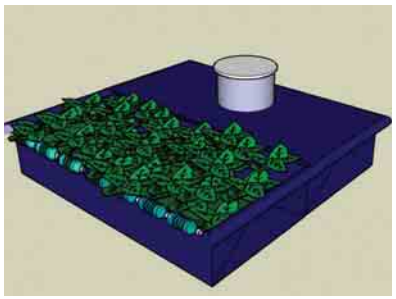
Large patches of Water Hyacinth were observed during the course of study, at several places around the shores of the Lake. Therefore, water hyacinth eradication is essential to maintain a balance of the ecosystem.

The removal of Water Hyacinth from the Lake should be undertaken on a continuous basis so as to expose the water surface to atmospheric of oxygen and to reduce evapo-transpiration losses. Two weed harvesters are proposed for weeding periodically. It is essential to select the appropriate frequency of the weeding operation so that the biodiversity and lake ecosystem stability is not compromised. **Weeding of the Lake is not a one time job**, because weeds grow at regular intervals and continuously. Thus, controlled de-weeding is a better option which should be done periodically and seasonally.

The Hyacinth biomass removed from the Lake should be stored in areas accessible to the local communities as after it dries it can be used as manure and its stem used for making handicrafts which have become quite popular in the Assam State (India), as well as in some countries within the Southeast Asia region. Local communities have **requested technical inputs** whereby water hyacinth could be chopped into small pieces and processed into organic fertilizer that could be packaged and transported to other regions for sale.

The Forest Research Institute had collaborated with the University of Sustainable Development EBERSWALDE, GERMANY and German Academic Exchange Service – DAAD in the project – Utilization of Invasive Species as a Feedstock for production of "Biochar" by Hydrothermal Carbonization Using the Example of Water Hyacinth, *Eichhornia crassipes*. **A time frame has been set for 2014 – 2015**. This should be followed up as it could benefit local communities greatly; they could use it as fertilizer for their crops or market it extensively in other regions that need such inputs.

Scientists from the Zoology Department of Taunggyi University are against total removal of Water Hyacinth as in their view the floating plants provide shelter for certain fish species.



Photos 33, 34 and 35: Designs of Pods

At a workshop organized by the IID at the Forest Department in Nay Pyi Taw, a presentation was made of the **successful use of "Pods" filled with Water Hyacinth to clean human faeces** from toilets by a scientist working on the Ton Le Sap Lake project in Cambodia. The plants are placed in shallow troughs holding water, into which the human waste drops by way of a pipe; bacteria thrive on the roots of the plants; the bacteria devour the solid faeces, leaving only residual liquid. This application must be tested extensively; and if proven successful, must be propagated widely within Lake Communities.

De-weeding must also be **encouraged through Water User Groups**.

While introduction of a Weevil bug has been found to be successful in Uganda and Mexico; it will need to be researched in depth, by simulating the Lake ecosystem to determine its impact on the aquatic flora and fauna of the Lake. Until research results are available and proven to be compatible, it would **not be advisable to introduce an alien bug in to the Inle Lake eco-system**.

4.10.4. Conservation of indigenous / Native Fish Species

The lake is famous for fish endemism. More than 25% of endemic fishes of Myanmar are found in Inle Lake. Activities that should be taken up for securing the fish endemism in the Lake on a long term basis are as follows:

a. The Fisheries Department and the Shan State Central Fisheries Board (NGO) release around 3,00,000 fingerlings of native fish species into the Lake every year. **Prior approval of the Wild Life Department should be made mandatory** whenever fingerlings are to be released. The Wildlife Department must check to ensure that undesired species of fingerlings are not included among those that are to released into the Lake.
b. Cage culture within the Lake should be gradually phased out. If it has to be continued, only endemic fish species must be permitted to be bred and measures taken to secure the cages, so that fish from within the cages will not escape into the Lake.
c. Individual commercial fish farming ponds constructed in the submergence areas and streams that feed the lake, must be stopped and discontinued as soon as possible.
d. Achieve self sustaining native and endemic fish populations through targeted restocking.
e. **Fingerlings of the Nga Hpein and other endemic species should be released in to the lake only when they have reached a size of two inches or more**. Because smaller fingerlings are predated upon by the Glass Fish (*Chanda raninga*). Attempts should be made to clear out the Glass fish, Tilapia (*Tilapia mossabica*) and most importantly, the African catfish from the Lake. The Fish Breeding Station at Nyaung Shwe must be provided with **an appropriate increase of funds**, to cover the extra cost of holding the endemic fingerlings longer in the Breeder ponds as indicated above.
f. Ex-situ breeding and rearing of rare endemic fishes and those of ornamental value should be initiated on priority basis by the Fisheries Department.
g. Develop a suitable patrolling network with wireless communication facilities and adequate boats etc., by the Wild Life Department, for timely control and reduction in poaching or illegal fishing; such as utilization of the battery shock method to stun the fish, or the use of poison to make an easy catch.
h. Improved management practices and codes of good practice for the aquaculture sector need to be introduced.
i. The turtle breeding places need to be identified, protected and their population monitored.
j. Habitat studies and monitoring of the various fish found in the lake have to be mainstreamed with the Taunggyi University Science Faculty.

k. Studies should be undertaken to determine the appropriate size of the catch from the Lake. It should be made mandatory that, undersized catch must be released back in to the Lake.

4.11. Infrastructural Strengthening

Despite several changes, such as expansion of floating gardens, construction of permanent houses, shops and hotels etc. inside the Sanctuary in the last twenty years, there has been **no focused strategy** to reconcile the Sanctuary Regulations vis-à-vis ground situation. There is a change in the needs of the community and it has been accepted as fait accompli that certain activities cannot be rolled back. It will therefore be necessary to undertake a comprehensive study to reassess the situation on the ground and have extensive consultations with the stakeholders to achieve the following actions on a priority basis:

a. Redefine and modify developmental objectives of the Sanctuary area.
b. Maintain the ecological seral stage of this ecosystem, by arresting the process of plant succession at the stage suited for fish life in particular and others in general.
c. Protect and maintain ideal habitat conditions for a diverse spectrum of fishes and birds inhabiting the Lake.
d. Document and Research primary issues threatening the integrity of the ecosystem as well as social issues.
e. Wild Life training for conservation of threatened species has now evolved into a specialised skill. **Training to upgrade skills of staff should be a priority area**.
f. Man power development and Capacity Building of all concerned departments.
g. Adequate equipment for communication, and patrolling gear with mobility. There should be round the clock patrolling, equipped with necessary equipment.

The above activities should be completed in five years for optimum results. Concurrent reviews of the implementation progress would be useful in making desirable alterations to meet any changes that may develop. Detailed work plan and technical estimates should be prepared by the implementing departments and approved by the SSSC. It is extremely important to involve subject matter experts, the University Science Faculties and NGOs at relevant stages of implementation.

Table 22: Financial Implications

Sr. No.	Item Description	Works	Budget (In USD)
1	Habitat Improvement of Catchment and Inle Lake for Conservation of avifauna	a. Develop monitoring mechanisms for assessment of migratory and residential waterbird populations. b. Development of Breeding areas	100000
2	A. Management of aquatic vegetation B. Control of invasive species	a. Vegetation status census b. Capacity building and training to staff c. Field research through University system d. Removal of water Hyacinth	500000
3	Conservation of indigenous /native fish species	Publicity and awareness generation- Stakeholders meeting	50000

Sr. No.	Item Description	Works	Budget (In USD)
4	Strengthening of Infra-structure	a. Infrastructure development b. Training and capacity building c. Awareness program for school children	350000
5	Operational cost and maintenance	@20000/year	100000

4.12. Eco Tourism

The Inle Lake area is visited by approximately seventy thousand foreign tourists annually. However, very few basic infrastructure facilities are available to enhance the visitors' experience, such as good roads, accommodation, safe drinking water, hygienic eating joints, nature guides, resting places, opportunities for angling, bird watching platforms, museums, information centers etc. With the growing popularity of the Lake system and its likely declaration as a World Heritage Site, the tourist inflow is sure to increase in the near future. Therefore, it is a big challenge to establish a balance between the increased numbers of tourists and the conservation issues of the eco system. It is imperative that a **non-intrusive form of tourism** generally referred to as **Ecotourism** should be promoted. Figure 3 indicates the niche where ecotourism can be positioned within the process of developing more sustainable forms of tourism. This figure also demonstrates that ecotourism is a sustainable version of nature tourism including rural, religious and cultural elements.

Figure 5: Adopted and modified after UNEP, 2002

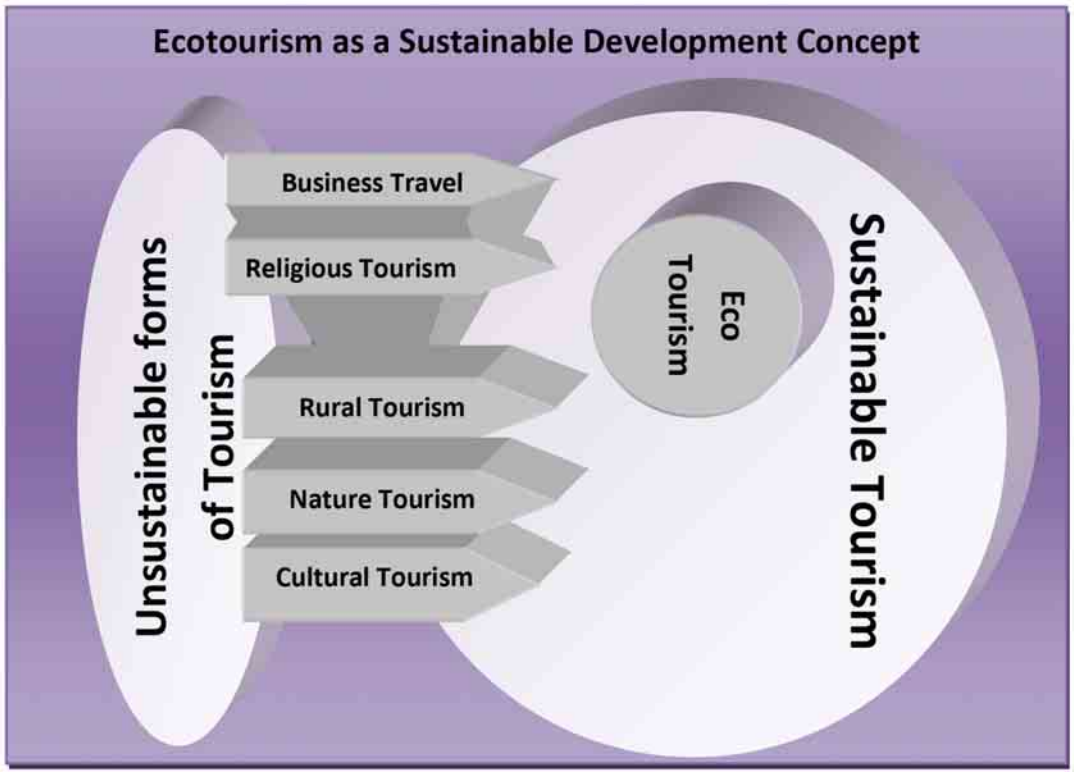


Figure 6: Adopted and Modified after UNEP,2002. It provides a reflection of how ecotourism fits to enhance the tourism potential within the local economy.

The main contributions of Ecotourism Planning should be focused to achieve the following objectives:

a. Contribute to conservation of biodiversity.
b. **Sustain the well being of local communities** by establishing equitable sharing of benefits arrangements. Communities voiced their feeling of being excluded. This will be a positive step in enhancing the socio-economic status of communities.
c. Include interpretation facilities, in order to provide tourists with a learning experience.
d. Involve responsible action on the part of tourists and the tourism industry.
e. Cater primarily to small groups by small-scale businesses.
f. Require lowest possible consumption of non-renewable resources.
g. Stress local participation, ownership and business opportunities, particularly for rural people.

Hence, for ecotourism development in the Inle Lake area, the prime motivation should be the observation and appreciation of natural features and related cultural assets, coupled with adventure tourism which involves the physical exercise and challenging situations in natural environments.

4.13. Inle Lake Wild Life Sanctuary

The fact that **Inle Lake, Saga Lake and Mobye` Reservoir combined, is a legally designated Wildlife Sanctuary has been overlooked** and the need for all developmental activities to conform to **the Wildlife Law and prescriptions laid down, to be adhered to in the Sanctuary had been ignored**. Related Sectors undertook developmental projects disregarding that they were operating within a Sanctuary and therefore needed to abide to certain Rules and Regulations.

The status of the Sanctuary Warden's office and the Warden will need to be upgraded, so as to be able to deal with related departments, to impress upon them the need to comply to prescribed Rules and Regulations and to ensure their compliance. The Warden's Office is currently grossly understaffed and ill equipped; the Warden is a Staff Officer. The Warden's Office

is equipped with one local boat which has been in use since many years ago and is mostly in disrepair. Staffing needs to be strengthened and better equipped to be able to conduct a more pro-active, assertive role and also be able to cover Saga Lake and Mobye` Reservoirs. Educationally qualified **youth from local communities** must be recruited, trained and employed to assure full staffing, continuation of service in the Inle Sanctuary, and creating job opportunities.

Strategies need to be designed to maximize conservation of the Sanctuary and the Wetlands as a whole, while ensuring Socio-economic gains for local communities; also involving other stakeholders in promoting such strategies which must focus on the following issues:

a. Strengthening the involvement of local communities through improving access to markets, credit and training. This could be for groups or individuals within the community.
b. Promoting income generating opportunities for those who are not directly involved in tourism, through backward and forward linkages. Training, credit and market facilitation, regulation and promotion of local goods and services that could be the tools for promoting such linkages.
c. Linking environmental and community developmental activities with community based tourism.
d. **Dispersing the tourism areas to spread the gains from tourism to new destinations**. This will also help in avoiding many of the negative impacts that begin to appear when the scale of tourism becomes too large and too narrowly focused.
e. Promoting and creating local facilities and programs for recreational activities that could attract tourists. Establishment of an Interpretation Centre would benefit both local communities and enhance nature conservation activities.
f. Identify ways of promoting meaningful approaches in which local communities have a stake in resorts / hotels that are coming up in their area and also their involvement in decisions on planning for the construction of the resorts, their maintenance, and development of recreational activities.
g. Frame regulations to ensure that the promoters of resorts / hotels contribute to the development of the local communities and the environment. This should go beyond token charities and should specifically include human resource development activities, which should be able to meet future manpower needs for the industry locally, and build up forward and backward linkages. It needs to be done in a way that encourages their commitment to successful local initiatives, rather than scare them off by bureaucratic procedures.
h. Find ways of promoting domestic tourism and ensuring that tourism planners recognise its value.
i. Promote market access and business support for the informal sector, and ensure that tourism planners and local authorities recognise its importance as an avenue for participation in tourism by the poor.
j. Adapt the pace and scale of tourism development and implementation in the Inle Lake Ecotourism Plan. Potential conflicts between multiple objectives – such as fast growth of revenue versus maintenance of local entrepreneurial involvement – need to be recognised and reconciled.

In order that the Wetlands of Myanmar can be managed and their issues addressed holistically, GOM / MoECAF need to seriously consider **promulgating a "National Wetland Law",** to be followed by formulation of Rules and Regulations. This will enhance the status of the Wetlands to a National level and provide a stronger mandate to deal with related international organizations.

4.14. Guidelines for preparation of an Ecotourism Plan

a. Ecotourism Planning for the development of tourism in the Inle Lake, should specify green zones, trails, walking paths, public access areas, and clear rules on the density of development to be permitted in residential and commercial areas.
b. Areas for tourism use should be clearly designated, as also areas inappropriate for tourism use.
c. Visitor management and its procedures should incorporate opinion of local communities during the design and implementation phases; with monitoring programs that allow for regular discussion on tourism use and addressing problems identified.
d. Full stakeholder consultation should take place on the type of tourism development (if any) desired by local communities, utilizing local neutral intermediaries who understand the community's viewpoints and will not advocate a particular approach.
e. Integrated natural resource planning should offer residents a variety of sustainable economic development alternatives beyond ecotourism.

The above planning guidelines should also include issues relating to Eco destinations listed below:

i. Provide adequate budgets to conserve popular tourist areas, and earmark tourism fees for conservation.
ii. Tourism businesses should pay impact fees that fund the infrastructure for solid waste treatment, sewage treatment, electrification and water purification, because their guests will require these services.
iii. Environmental Impact Assessment (EIA) programs should be followed by impact monitoring programs. These programs should be tied to business licensing and certification systems.
iv. Well-managed trails and camping areas should provide clearly marked rules for low-impact use.
v. Published and recognized rules or regulations for public lands should detail the type of vehicles permitted in specific zones, speed limits, fines for dumping or polluting; clear rules for limiting off-road driving, oversight on the number of visitors allowed in zoned areas, and instructions on how and when to observe Wildlife Guidelines, should also state what is inappropriate.
vi. Training programs are necessary to provide local inhabitants with the opportunity to run their own businesses.
vii. Affordable housing programs should ensure that local residents are not excluded from their own communities, due to increased pressure on land resources for development of tourism infrastructure.

The approach should be highly participatory. An Inter-sectoral collaboration will help to catalyze the change needed to keep tourism destinations healthy.

In order to implement the above guidelines and to promote ecotourism around Inle Lake, it is imperative to have a comprehensive Ecotourism Plan, with detailed zoning as stated below:

- Recreation Zone.
- Education and Awareness Zone.
- Service Zone.

Due to the exclusive destination value of Inle Lake, Ecotourism planning will need to be undertaken with care. **It should be a planning for restoration of the heritage, conservation of natural resources and their sustainability, rather than a hurried plan of change to modernity**.

4.14.1. Recreation Zone

The following Key Features should be included:

a. Attract more visitors to the Inle Lake for bird watching, angling and leisure.
b. Develop a circuit for site seeing of several Pagodas, Temples and prominent landmarks.
c. Develop Lake front, fishing, boating / sailing areas at existing and newly selected points.
d. Introduce horse safari from Inle Lake to various high points, cycle tracks etc,
e. The natural sites of attraction in and around Inle Lake to be equipped with adequate facilities for the visitors to stay for longer durations.
f. Innovative entrepreneurs should be encouraged to design specialized low-impact lodges that allow tourists to stay in relative comfort within the natural surroundings. Eco lodges specializing in innovative approaches that minimally impact the natural environment, should be built and where possible powered by alternative energy, designed in harmony with the local environment, and using local materials and indigenous designs.
g. Local people should be shareholders and where situations permit owners of eco lodges or nature inns. Mini hotels / motels run by villagers in their households, are also viable substitutes and income generation activities that should be encouraged.
h. Picnic areas and trekking routes to be improved and strengthened.
i. Communities to be involved in organizing field trips and providing clean, safe and low cost accommodation.
j. Communities to be involved in ecotourism related activities for livelihood support from these activities.
k. Trained field guides should be made available to interact with tourists for awareness generation.
l. Signages erected at key spots for generating awareness about biodiversity and ecological significance of the Lake.
m. To ensure that the Environment and Biodiversity of the Inle Lake are not negatively impacted by the ecotourism activities.

4.14.2. Education and Awareness Zone

A large number of local and tourists from neighbouring Asian countries visit the Inle Lake for religious purposes. The rush is mainly in the month of October at the Hpaung Daw Oo Pagoda festival time. The Lake faces problems on account of a heavy rush of visitors in a short period of time only, to partake in several religious performances and other related activities in and around the Lake.

The awareness, sensitization and motivation of people towards the conservation of the Lake may be helpful to shift waste generation activities to places outside of the Lake. This should be done sensibly after convincing people without hurting their sentiments. The following measures should be undertaken:

a. Organize meetings / seminars with the concerned target groups.
b. Develop awareness towards Lake Conservation and Management.
c. Involve administrative departments, senior citizens, schools and influential people for the very purpose of conservation of the Lake and its environs.

d. Arrange meetings with religious monks / Social groups so that they can help to influence the communities.
e. Distribution of pamphlets (hand bills) and erection of sign boards for mass awareness.

4.14.3. Establishment of an Awareness Development Center

An Awareness Development (Education) Center should be established for tourists. The historical literature regarding the Lake environment and its development will need to be displayed. Education and interpretation of services provided by the natural ecosystems should form a fundamental component of a visitor's experience at the Center. It should be designed keeping in mind different target groups such as tourists, school children, local youth, communities, decision makers and policy planners.

The following facilities are proposed to be developed in the Education complex:

a. Exhibits with posters, comprising models of ecosystems, local and migratory birds; interactive panels and exhibits explaining the ecosystem / food chain of the Lake.
b. Viewing Gallery, comprising panels highlighting the ecological, socio-economic and cultural aspects.
c. Features on economic activities within the Inle Catchment and their impact on the Lake.
d. A small Library.
e. Hydrological model of Inle Lake and its associated Wetlands indicating the various hydrological influences on Wetland conservation.
f. Children's play area consisting of open dioramas, water paintings should be developed as a special section to cater to the young visitors. The area should have several innovative environment oriented interactive games.
g. Auditorium having audiovisual facilities for screening documentaries and for organising talks / workshops / meetings.
h. Souvenir Shop for visitors, consisting of Wetland products, Wetland biodiversity replicas, reading materials, photographs, maps for the visitors to take away on payment basis as memorabilia.

4.14.4. Service Zone

The following works should be included under the beatification plan;

a. Providing of proper illumination.
b. Greenery in available spaces between lake and road.
c. Places for rest, drinking water, pathways, cafeteria and parking.
d. Pictorial Signages.
e. Cleaning and painting of structures.
f. Construction of shades and shelters at appropriate sites.
g. Improvement of existing parks and gardens.
h. Improvement of Roads and pavements.
i. Facilities and photo projections for identifying various destinations.

4.14.5. Precautions and Regulations

While constructing new structures or providing facilities for public use, the historical structures and land marks should not be affected or suppressed. Wherever possible the common places

have to be identified for public use, instead of selecting private and isolated areas. The places or facilities need to be developed keeping in mind the need of common people and their easy access to the places concerned.

The use of local materials such as stones and boulders shall be utilized to save cost as well as to merge with existing structures. The pavement area should also match the existing structures, so as to maintain symmetry. Similarly, the use of color should also be sequenced as per the matching tone of color of the surrounding areas. This will not segregate the new and old structures, and will maintain conformity. It is essential to take precautions so that the Lake view and other facilities are not obstructed.

Constructions of Hotels and Resorts on the Lake front should be permitted only after all Environmental Safeguards regarding pollution of the Lake, are in place and prevalent guidelines are followed. No further construction particularly of concrete should be allowed in the Wetland without clearance from the Shan State Supervisory Committee and the Central Steering Committee. Strict norms need to be put in place for all such construction in the future, **within a distance of 5 km from the boundary of the Wetland, on all sides of the Lake**. There should be specific guidelines to allow only one floor construction in the Lake vicinity with restrictions on floor area ratio. This area should be designated as an "**Eco-Sensitive Zone**". Establishment of industries, factories etc., should be prohibited and allowed only in exceptional circumstances by the competent authorities, after ensuring adequate environmental safety measures. Cottage industries should be promoted with minimum intrusion in the Watershed areas. Tree felling should be controlled.

A **Development Plan for Eco Tourism** would have to be first prepared, with site surveys and detailing of activities phased over a period of five years (Mid Term). It should be implemented by engaging experts / NGOs in the related fields. Component wise budgeting for five years is given in the table below:

Table 23: Financial Implications

Sr. No.	Item Description	Works	Budget USD
1	Development of recreational facilities including tourists walkways, nature trails, watch towers, angling spots	a. Construction of tourist facilities. b. Lake front spots to be developed. c. Training and capacity building of Communities involved in eco tourism	250000
2	Development of visitor education facilities	a. Control over unsustainable activities during festivities. b. Establishment of Interpretation center	200000

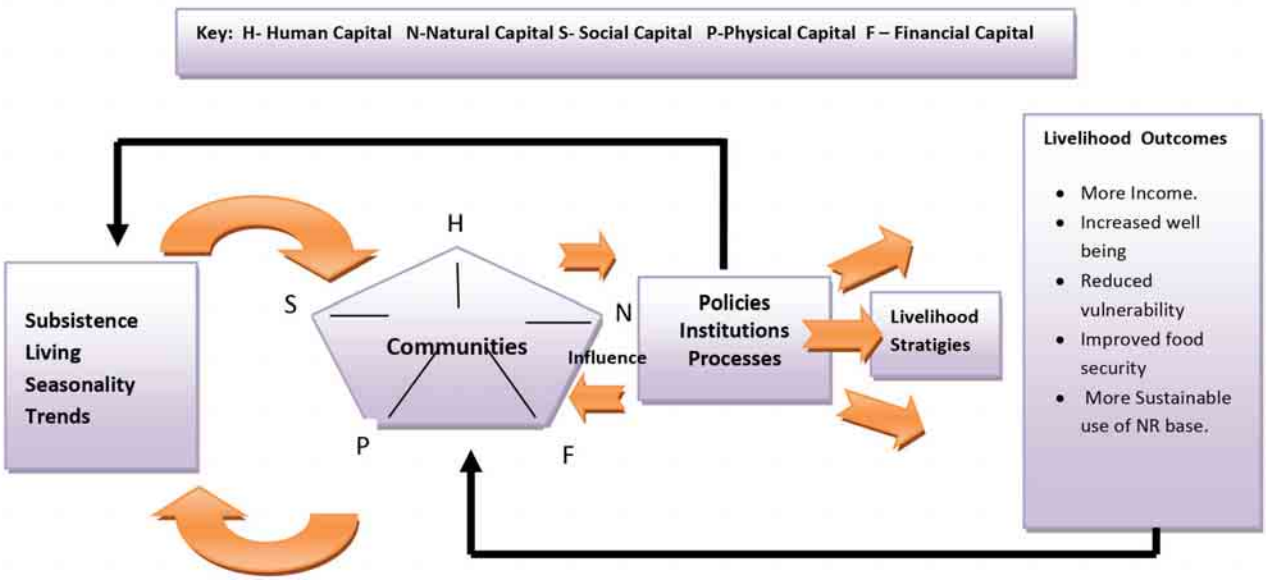
Sr. No.	Item Description	Works	Budget USD
3	Infrastructure development	a. Beautification and face lifting of the lake fronts b. Illumination, cleaning and providing facilities for visitors neat the lake shores and places of public interest c. Improvement of roads and pavements in the fringe area of the lake	400000
4	Publication and dissemination of awareness material	a. Training and capacity building b. Awareness program for school children	50000
5	Maintenance	@20000/year	100000

4.15. Sustainable Livelihoods

There has been a drastic decline in resources both within the Lake and its catchments, leading to decline in incomes and continued poverty within the communities. Accordingly, a **'Sustainable Livelihood Approach'** (SLA) has been proposed. The sustainable livelihoods approach (SLA) is a way to improve understanding of the livelihoods of the communities / rural poor. It draws on the main factors that affect people's livelihoods and the typical relationships between these factors. It can be used in planning new developmental activities and in assessing the contribution that existing activities have made to sustaining livelihoods:

Sustainable Livelihood Approach

Figure 7: DFIDs Sustainable livelihoods framework, adopted and modified from www.ceciasia.org/utthan/sla.htm



The SLA framework indicated above, **places people, particularly the rural poor, at the heart of a web of inter related influences** that affect the manner in which these people create a livelihood for themselves and their households. At the centre of the framework, are the resources and livelihood assets that people have access to and utilize. These can include natural resources, technologies, their skills, knowledge and capacity, their health, access to education, sources of credit, or their networks of social support. The extent of their access to these assets is strongly influenced by external influences and trends (for example, economic, political, technology, as well as seasonal; for example: prices, production, employment opportunities etc.). Access is also influenced by the prevailing social, institutional and political environment, which affects the ways in which people combine and use their assets to achieve their goals. These are their livelihood strategies.

It is important to note that elements of the framework, if successfully employed, will ensure a greater possibility of long-term social and institutional sustainability such as:

a. **People's empowerment**: Confidence, negotiating capacity, capacity to discern useful projects based on values, education programs etc.
b. **Institutional change**: Representation in government bodies, enhanced service provision that goes beyond an ephemeral change.
c. **Enabling policies**: Access to resources, water and nature conservation etc.
d. **Partnerships and multi-level macro / micro linkages**: Cohesive, multi-disciplinary teams with a strong sense of ownership and the ability to reach an expanded geographical area and multiple sectors, linkages from the community, to district and state levels, so that successful strategies are translated into policy.

4.15.1. Constraints

As evident from the primary survey carried out in September 2012, in 26 villages within the Lake and its Catchment, the constraints observed are as follows:

a. The livelihood options such as handloom weaving, silversmith, ironsmith, woodcraft are taken up by limited households due to lack of information about market demands, required skills and product designs. More than 80 % of the households in the Lake were found to be involved in the semi-skilled option of floating agriculture.
b. There is limited emphasis on value addition and post harvest management of various natural products from the Inle Catchment area, which restricts opportunities for enhancement of economic returns.
c. Absence of access to economic infrastructure such as banking and credit facilities. This has rendered the communities vulnerable to moneylenders, thereby pushing the communities into a debt trap.
d. Lack of financial linkages has had high socio-economic impact on local communities, restricting the economic performance of the households.
e. There is a prevalence of chronic mismatches between skills acquired and actual skills required in the work place.
f. No framework for information dissemination about resources accessible to the communities.
g. Inadequate access to basic services.
h. The economic condition of communities residing in the Lake and its Catchment, has resulted in a "fight for survival" approach and this in turn affects the quality of stock and flow of ecological services within the Inle Lake ecosystem.

In the context of the above framework, the following strategies have been proposed for implementation:

4.15.2. Building Assets

a. Human assets: Development should take the form of technical, vocational and organizational capacity-building provided to individuals / communities and disadvantaged groups (poor, landless, women / widows, elderly etc.), producer groups, Community Development Associations, local and national NGO's and Governmental Institutions.
b. Social assets: These should be built through the formation, training, cohesion and capacity-building of community social groups, committees, farmer groups, and local leaders. To ensure social inclusivity, community / farmer groups and associations are essential.
c. Financial assets: Should be enhanced through income generation and savings as well as access to community development funds, Agriculture Development Bank, Cooperative Bank or other credit facilities / schemes.
d. Physical assets: Should be built through infrastructural support, related to soil conservation works, afforestation activities, sanitation, water supply, roads and shelter, and / or the provision of farming tools and related equipment.
e. Natural assets: Or stocks should be addressed in a variety of ways to include:

    i. The incorporation of productive resources, such as the planting of fruit trees - mango, dragon fruit, pineapple etc.
    ii. Addressing upstream / downstream relationships through integrated Watershed Management.
    iii. Managing lands to make them akin to natural ecosystems.
    iv. Promoting improved farming and land use practices; success stories of this approach implemented in Myanmar are well documented.

4.15.3. Good Governance

Governance should ensure the strength of the governing systems - structure, power, effectiveness, efficiency, rights and representation. It should address honesty, accountability, accessibility, property rights and decentralization.

The principles of governance and / or multi-level linkages should be articulated through approaches such as:

a. Strengthening existing Village Institutions or creating new Village-level Institutions.
b. Building community representation in local government.
c. Building the capacity for participatory, multidisciplinary or collaborative approaches.

4.15.4. Implementation of the above Strategies should focus on the following:

a. Top most priority should be assigned to the rural population within Inle Lake, engaged in floating agriculture, by moving them towards the non-farm sector. A host of measures should be implemented, including creation of productive employment opportunities, based on utilization of local raw materials and skills, as well as undertaking interventions

aimed at: improving the supply chain, enhancing skills, upgrading technology, expanding and ensuring sustained market accessibility and capacity building of the entrepreneurs / artisans and their groups / collectives.

b. Village home industries should be promoted along with incentives to help households switch over to other livelihood options (partially or fully). It should be supported by robust financial instruments (saving and credit based products), to ensure sustainability of efforts and also to help families survive economic downturns and other vulnerabilities. The potential for growth of alternate employment should be identified to include the unique products of lacquer, wood, silver, handmade cheroots, hand woven cloth and Lotus Silk.
c. Establish model villages away from wetlands to rehabilitate villagers practising floating cultivation through land based activities, as well as non farm employment.
d. Provide infrstructural support for weekly markets organised in the villages, coupled with promotion of these weekly markets among tourists.
e. External support should focus on what matters to people, understand the differences between groups of people and work with them in a way that is congruent with their current livelihood strategies, social environment and ability to adapt.
f. Assisting individuals in choosing and preparing for new livelihood activities. Detailed financial modelling should be carried out for the selected livelihood activities (that have the potential of engaging individuals); this will help individuals select the activity depending on their interests and capabilities. Need assessment for Capacity Building to enable them to take up the alternative livelihoods will have to be carried out; manuals and other tools will also need to be developed, so that individuals can take up activities of their choice.
g. Technical and vocational training systems that foster an innovative approach, which enhances the employability of workers as well as the sustainability of their livelihoods, should be adopted.
h. Diversified approaches towards workforce development and partnerships, with the private sector to improve the quality and relevance of skills development.
i. To appraise inhibiting and enabling factors, and approaches supporting diversification of livelihoods, and enterprise development.

In addition to the above, a well structured and exclusive **Program of Micro and Small Enterprises** should be developed with a focused approach and assigned priority in its implementation as follows:


Photos 36 and 37: Cottage Industries

4.16. Micro and Small Enterprises Cluster Development Program

a. Soft Interventions

A Micro and Small Enterprises Cluster Development Program is proposed for implementation for holistic and integrated development of micro and small enterprises, in clusters through Soft Interventions such as diagnostic study, capacity building, market development, export promotion, skills development, upgrading technology, organizing workshops, seminars, training sessions, study visits, exposure visits, etc. Pilot villages where general acceptance among stakeholders is found for taking up such micro enterprises should be initially targeted.

b. Hard Interventions

This should be taken up later as **Phase II** after soft interventions described above have been well received and understood. Normally a period of two years lapse is regarded as appropriate. This would include setting up of Common Facility Centers and Infrastructure upgrading of the new / existing industrial areas / clusters. This is regarded as a Long Term activity under the LTPRC of Inle Lake. Such facilities would be a provider of the following:

i. **Provide feedback to the Government** for policy formulation on the promotion and development of the Micro and Small Enterprise Sector.
ii. Provide techno-economic and managerial consultancy, common facilities and extension services to the MSE units.
iii. Provide facilities for upgrading technology, modernisation, quality improvement and infrastructure.
iv. Develop Human Resources through training and upgrading of skills within communities.
v. Provide economic information services.
vi. Maintain a close liaison with the Central Ministries, State Government, Financial Institutions and other organisations concerned with the development of MSEs.
vii. Evolve and coordinate policies and programs for development of MSEs as ancillaries to the large and medium scale industries.

Some of the activities that should be promoted for alternative livelihoods are as follows:

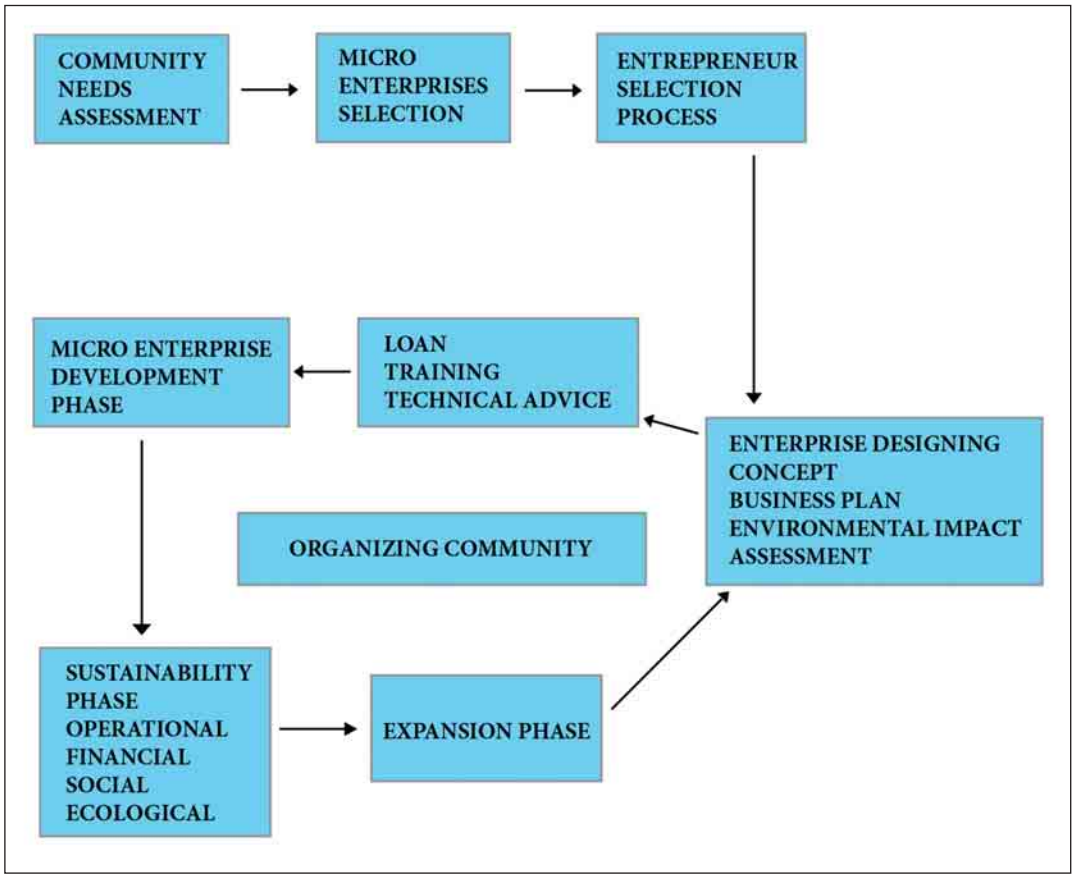
4.16.1. Micro enterprises for communities

a. Mushroom cultivation: There is a vast scope for commercial cultivation of mushrooms in the hill villages, which offer ideal weather conditions for their cultivation. Morchella is a highly valued mushroom variety cultivated in the hill areas. It is proposed to introduce mushroom farming in 10 villages through self-help groups.
b. Medicinal Plants: Cultivation of Alovera, Lemon grass, Saffron and other species should be undertaken on a demonstration scale in some hill villages. Scope exists for upscaling cultivation of medicinal plants with technical support of the Agriculture University. The medicinal plants could be grown in homesteads, which could be subsequently networked for a sizeable and commercially viable harvest. It is proposed to establish medicinal plants based enterprise in 5 hill villages through self help groups.
c. Sericulture: Mulberry based silk worm rearing could be introduced in lower altitudes. There is already a highly recognized craftsmanship of silk weaving within Lake dwelling communities, which could support sericulture. It is proposed to take up sericulture in 10 hill villages through organized networks.

d. Apiculture: The flower bearing trees in the homesteads as well as within the forests can support apiculture, which can be used to augment incomes of the hill households. It is proposed to support 100 apiculture units in 5 hill villages to reduce dependence on forests.
e. Minor Forest Produce: The hill communities traditionally collect several minor forest produce for their livelihood. Enterprises based on sustainable use of the MFP should be setup for their grading, storage and marketing on a Pilot basis.
f. Coffee and Tea and Grape cultivation: These crops have already become well established in the Lake Watershed region. Large volumes of production, quality control market accessibility are important factors to attain economic viability; as such, concerted efforts to achieve these requisites should be undertaken.
g. High market value crops: Trials to plant high market value crops such as Cocoa, in the uplands of the hills should be considered on a trial basis.
h. Economic utilization of Aquatic and Terrestrial vegetation: Several species of water plants such as Lotus are currently being utilized within the Lake. Similarly use of Bamboo and Cane in making a large number of products, including furniture should be up scaled in quality. Several other plant species are being utilized for mat and basket weaving etc. Vegetables, organic farming, and floriculture have active interest groups and growth potential, but they do not have access to funding instruments. Techno economic feasibility studies should be undertaken to identify ways and means to promote these activities on an economically viable scale.

The process for establishment of MSEs and their sustenance, is depicted by the diagram in Figure 8, below:

Figure 8: Establishing process for a micro enterprise



4.16.2. Microfinance model suggested for Inle Lake Catchment

A critical requirement associated with micro enterprise development is, the availability of working capital to small entrepreneurs. During the primary survey conducted among the households in the Lake and the Catchment, it became clear that households have very limited access to financial instruments. None of the households from on-Lake villages had access to any formal banking system.

Financial inclusion is necessary to promote socio-economic welfare in the Catchment areas. The MFIs are already running a microfinance program in the region, but there is an urgent need to further develop Community Based Microfinance Institutions to ensure availability of cheap credit services.

a. Short Term

Phase 1: The experience of the PACT / local NGOs should be utilized in formulating saving credit groups. The characteristics of the groups have to be defined based on the local socio-economic context. It is suggested that the women's self-help group model and farmers' group model should be replicated. The women's group will help develop an easy accessible saving / credit mechanism for the households to meet consumption requirements; whereas the farmer groups can be engaged in more complex tasks of accessing bank financing and graduating to collective marketing units.

b. Long Term

Phase 2: Integrating the Group Based Institutions with the financial institutions will require a policy change in the banking norms; and saving / credit groups will have to be allowed to operate bank accounts to ensure that they have access to the financial products offered by such institutions. Acceptance of the saving-credit groups has to be ensured by giving these entities legal status (many countries have formulated laws that gives legal status to the community saving / credit groups) thus empowering them economically.

4.16.3. Goal of the financial inclusion model

The Inle microfinance approach should be developed with a strategy to establish a community owned financial platform that increases the access of financial services to the poor in a cost effective manner. It is proposed that the relevant authorities develop and pursue financial inclusion outcomes that are in line with the socio-economic and ecological goals prescribed for the Inle Lake and it's Catchment. The defined outcomes for the suggested microfinance program are:

Table 24: Defined Outcomes

Attributes	
Policy recognizing microfinance programs and institutions	A regulatory guideline to recognize the community based institutions to operate financial services centric program. Government recognition is necessary to create formal linkage with the national banks and other institutions. The policies need to be flexible enough to accommodate variations among community based financial institutions
Promotion of community owned financial institutions	Promotion of community based financial institutions (i.e. self help groups, village banks, cooperatives etc) through capacity building of local NGOs and voluntary agencies

Attributes	
Bank supported microfinance products	Innovative financial products that are offered by banks to the Community Based Microfinance Institutions
Sustainability of community based models	Capacity building of communities in financial management awareness and simplified saving and credit products, so that clients understand and utilise financial services effectively

The major components for stepping up the Livelihood program with corresponding budget requirements, have been presented below:

Table 25: Financial Implication

Sr. No.	Item Description	Works	Budget USD
1	Public Awareness and provision for drinking water in lake villages	1. Identify target group of people among villagers, and Women group etc. 2. Organise Meetings in nearby area to be covered under it. 3. To undertake on pilot basis water supply network in one village	15000 (Recurring)
2	Step 1: i. Promote group based savings. ii. Skill upgradation of individuals.	1. Mobilization of households in the Inle Lake in Saving credit groups. The group can be activity based (i.e. farmers group) or purely women groups (in line with women self help group concept) 2. Formation of institution to support saving-credit groups 3. Capacity building of groups 4. Institutional support for training to upgrade skills of willing persons for development of micro enterprise or self employment in cottage industry the sector	25000 (recurring)

Sr. No.	Item Description	Works	Budget USD
3	Step 2: Policy to recognize microfinance programs and institutions	1. Supporting and creating the development of legal and regulatory frameworks conducive to the growth of financial services for the poor 2. Encourage policies ensuring that clients are not exposed to exploitation and unfair lending practices by private moneylenders 3. Work with private and national banks to implement strategies to expand poor people's access to financial services 4. Work with developmental agencies to develop financial products (credit, saving and insurance) that can be extended to the microfinance institutions. 5. Develop technical expertise of regulatory authorities responsible for the oversight of the financial services sector	10000 (recurring)
4	Step 3: Promotion of community owned financial institutions	1. Capacity building of the saving credit groups and federating them in to the large institutions	20000 (recurring)
5	Step 4: Bank supported microfinance products Stakeholders Participation & Awareness Campaign for giving up floating Agriculture/Shifting Cultivation for Sustainable Livelihood Activities.	1. Work with microfinance institutions and NGOs to develop financial products that can be promoted through group based financing instruments. 2. Educate the stake holders and make them understand the programme. 3. Periodic dissemination of programme objectives, progress and discussion on the issues and problems being faced implementation of programme. 4. Monasteries should also be involved in it.	10000 (recurring)

Sr. No.	Item Description	Works	Budget USD
6	Capacity Building of Implementing Agencies	1. Orientation & Training of staff. 2. Skill up-gradation, understanding of project, effective implementation, understanding of methodology and risk management.	20000 (recurring)
Total			0.1 Million (recurring)

Chapter 5
Institutional Development

5. Present Structure

The Government of Myanmar has established a "three tier" structure for the overall management of Inle Lake, at the National (Policy) level; the Shan State (Supervisory) level and the Township level.

5.1. The **Central Steering Committee for the Sustenance of Inle Lake and Conservation of its Environment** (CSCOIL) was established in September, 2010. It was reorganized in June, 2011, to conform to the newly adopted form of Government and the national Constitution. The members of the CSCOIL are as follows:

Sr. No.	Designation of Office held	Position held in the CSCOIL
1.	Union Minister, Ministry of Environmental Conservation and Forestry.	Chairman
2.	Deputy Minister, Ministry of Sports and Physical Education.	Member
3.	Deputy Minister, Ministry of Hotel and Tourism.	Member
4.	Deputy Minister, Ministry of Agriculture and Irrigation.	Member
5.	Shan State Minister for Forestry and Mines.	Member
6.	Shan State Minister for Electric Power Supply.	Member
7.	Shan State Minister for Inn-thar Affairs.	Member
8.	Director-General, General Administration Department.	Member
9.	Managing-Director, Myanma Agriculture Department.	Member
10.	Director-General, Irrigation Department.	Member
11.	Director-General, Land Records Department.	Member
12.	Director-General, Fisheries Department.	Member
13.	Secretary, Shan State Government.	Member
14.	Director-General, Forest Department.	Secretary
15.	Deputy Director-General, Forest Department.	Joint Secretary

The CSCOIL is responsible to the GOM. The objectives set for it are as follows:

a. To draw up a substantive plan for the sustenance of Inle Lake and to oversee and monitor its implementation.
b. To direct and supervise all implementation endeavours for timely completion.
c. To adopt and coordinate a combined multi-disciplinary, multi-sectoral approach to mitigate the degradation of Inle Lake and ensure its sustainability.
d. To protect the watershed areas of Inle Lake and **take measures to ensure the sustained flow of water in all streams** feeding the Lake.
e. To oversee and coordinate efforts of all Ministries in resolving Land Use issues.
f. To submit monthly progress reports on work accomplished, future plans to be implemented, to the higher authorities, and to undertake implementation in accordance with directives received.

5.2. The **Shan State Supervisory Committee for the Sustenance of Inle Lake and Conservation of its Environment** (SSSC) was established in July, 2011. Its composition is as stated below:

Sr. No.	Current Designation	Position held in the SGECC
1.	Prime Minister, Shan State Government.	Chair Person
2.	Minister, Security and Border Areas Administration.	Member
3.	Minister, Finance and Revenue.	Member
4.	Minister, Planning and Economy.	Member
5.	Minister, Social Affairs.	Member
6.	Minister, Road Transport and Communications.	Member
7.	Minister, Agriculture and Animal Husbandry.	Member
8.	Minister, Community Development (Municipal).	Member
9.	Minister, Electric Power Supply and Industries.	Member
10.	Minister, Inn Thar Affairs.	Member
11.	Shan State Chief Justice.	Member
12.	Secretary of the Shan State Government.	Member
13.	Chief of Shan State Police Force.	Member
14.	Taunggyi District, General Administration Department.	Member
15.	Director, Shan State Planning Department.	Member
16.	Director, Shan State Municipal Department.	Member
17.	Director, Shan State Immigration and National Registration Department.	Member
18.	Deputy Director, Land Records Department.	Member
19.	Deputy Director, Mechanized Agriculture Department.	Member
20.	Deputy Director, Department for Development of Border Areas and Ethnic Races.	Member
21.	Deputy Director, Information and Public Relations Department.	Member
22.	Shan State Chief Engineer for Electrification and Electric Power Supply.	Member
23.	Manager, Shan State Myanma Agriculture Department.	Member
24.	Deputy General Manager, Myanmar Timber Enterprise.	Member
25.	Director, Shan State Health Department.	Member
26.	Director, Shan State Education Department.	Member
27.	Professor, Zoology Department, Taunggyi University.	Member
28.	Professor, Botany Department, Taunggyi University.	Member
29.	Professor, Geology Department, Taunggyi University.	Member
30.	Professor, Geography Department, Taunggyi University.	Member
31.	Professor, History Department, Taunggyi University.	Member
32.	Rector, Taunggyi Education College.	Member
33.	Principal, Taunggyi School of Agriculture.	Member
34.	Assistant Director, Hotel and Tourism Department.	Member
35.	Assistant Director, Meteorological and Hydrology Department.	Member
36.	Assistant Director, Forest Department In-charge of Inle Greening Task).	Member
37.	Assistant Director, Watershed Management Department, Forest Department.	Member

Sr. No.	Current Designation	Position held in the SGECC
38.	Assistant Director, Irrigation Department (In-charge of Inle Restoration, stationed at Nyaung Shwe).	Member
39.	Officer-in-charge, No: 4, Highland Agriculture Land Development Project.	Member
40.	Warden, Inle Lake Wild Life Sanctuary, Forest Department.	Member
41.	Minister, Forests and Mines.	Secretary
42.	Director, Shan State Forest Department.	Joint Secretary-1
43.	Director, Shan State Irrigation Department.	Joint Secretary-2

The SSSC is truly representative of all stakeholders concerned with Inle Lake, as it has also incorporated as it's members, a wide spectrum of representatives from local entrepreneurial organizations as stated below:

a. Chair Person of the Hotel operators' Association.
b. Representative of the "Arr-man" Agricultural Company.
c. Representative of the Inle Lake Silver Smiths' Association (Hei` Yar village).
d. Representative of the Inle Tomato Growers' Association (Kay Lar village).
e. Representative of the Inle Lake Tomato Traders' Association. (Kan thar yar Ward).
f. Representative of the Inle Weavers' Association (Inn Paw Khon village).
g. Representative of the Sugar Cane Growers' Association (Maing Thauk village).

However, the principal focus appears to be on the Lake only. It is of vital importance to include representation of communities living within the Watershed areas, as their contribution regarding containment of sediments from entering into the streams and the Lake is crucial. Particularly, the **Chairmen of the Pa O Self Administered Region and the Danu Self Administered Region must be incorporated in to the SSSC**. Similar consideration needs to be made regarding the **inclusion of representatives of the smaller Ethnic Races such as the "Taung Yoe ethnic group" residing on the "Let Moung Gway" Range and other related ethnic groups**.

The SSSC was established to deal with all Environmental issues concerning Inle Lake. The SSSC is currently the main driving force behind efforts being undertaken. It directs and supervises all relevant Shan State level Government Ministerial line departments to conform to the objectives and directives laid down by the CSCOIL. It also supervises implementation of tasks at the field level. **There is a need to incorporate the Watershed areas and their related issues into the SSSC's Plans. Provision must also be made for implementation of the Watershed issues and problems** such as, clearing and dredging of streams (for example Kalaw stream); landscaping of "Taung Yars" established on steep slopes etc.

5.2.1. The **Implementation Sub-Committee for the Sustenance of Inle Lake and its Environment** was also established that same year, to oversee implementation activities to restore the original environmental status of Inle Lake. It consists of the following Shan State Ministers and officials of related Shan State Ministerial Departments:

Sr. No.	Current Designation	Position held in SSSC
1.	Minister for Forests and Mines	Chairman
2.	Minister for Inn-thar Affairs	Member
3.	Manager, Myanma Agriculture Services	Member
4.	Director, Municipal Department	Member
5.	Deputy Director, Land Records Department	Member
6.	Assistant Director, Hotel and Tourism Department	Member
7.	Director, Education Department	Member
8.	Director, Health Department	Member
9.	Assistant Director, Meteorology and Hydrology Department	Member
10.	Rector, Taunggyi University	Member
11.	Deputy Director, Animal Husbandry and Veterinarian Department	Member
12.	Administrator, Taunggyi District, General Administration Department	Member
13.	Assistant Director, Fisheries Department	Member
14.	Administrator, Nyaung Shwe Township, General Administration Department	Member
15.	Director, Forest Department	Secretary
16.	Director, Irrigation Department	Joint Secretary

Designated Responsibilities are as follows:

(a) To improve the environmental status around Inle Lake:
  (1) Protecting and managing the Watershed areas.
  (2) Re-greening of Inle Lake and its surroundings.
  (3) Sustainable land use management.

(b) To enhance the socio-economic status of the local communities:
  (1) Develop sustainable agriculture practices more extensively.
  (2) Create and upgrade livelihood opportunities for broader selection.
  (3) To create an environment conducive to health standards.

(c) To improve the status of the ecosystems:
  (1) Ecosystem management.
  (2) Biodiversity conservation.
  (3) Management of water resource utilization.

The Sub-Committee is to submit a "Working Plan", and monthly reports on progress of work relating to its task to **restore the original environmental status of Inle Lake. Here also, representatives of the Pa O, Danu, Taung Yoe and other related ethnic races need to be included.** And the Watershed areas be included in the implementation planning process and apportioning of financial resources.

Setting the task to restore the original environmental status of the Lake; is like setting a standard too high. The object of Implementation must start with a reachable goal; i.e. to initially work to halt further degradation of the Lake and its Watershed areas; after which, the focus should be to improve the status of both components as far as will be acceptable by the local communities.

5.3. The Nyaung Shwe Township Inle Region Development Implementation Committee was established recently, mainly to address the Human Resource Development aspect of the Inn-thars. But it also coordinates with related Ministerial Departments on certain day to day issues concerning Lake Conservation.

It has as its Patrons, the Minister for Inn-thar Affairs and three Pyi-thu-hlut-taw (Union Parliament) members. The Township Administrator of the Nyaung Shwe Township General Administration Department chairs the committee and it comprises all the heads of Township level Ministerial Departments. The Vice-Chairman is elected from among the Town elders. Representatives of all related private entrepreneurial and stakeholder groups are incorporated as members.

5.3.1. Related Governmental Departments have drawn up Action Plans, and carried out multi-faceted tasks for the conservation and sustenance of Inle Lake; but these actions have in no way turned back or halted the continued degradation of the Lake. This is partly due to lack of coordination and cooperation between Ministries and their subordinate departments. But the failing lies more in the inadequate staffing, funding and equipping of the departments undertaking actual implementation at the operational level. The departments are hardly in a position to fulfill their basic tasks, due to these constraints. It has therefore become clear that the Long Term Restoration and Conservation Plan of Inle Lake cannot be achieved with the present organizational set up, but will require the organization of **"Special Task Force" type of set up** that will ensure a multi-sector, multi-disciplinary effort concurrently in all parts of the Lake and the Watershed areas. **It is the only way by which tangible results can be achieved**.

In 2000, the Chairman of the State Peace and Development Council, on a visit to Inle Lake, directed that the Forest Department and Agriculture Department should establish special task organizations at Nyaung Shwe and that a hierarchical body to oversee, direct and coordinate the tasks of those organizations should also be established at Nyaung Shwe. This concept is very much in line with the "Special Task Working Groups - STWG" organizational set up presented in this Long Term Restoration and Conservation Plan.

A "Command and Control" component will need to based at Nyaung Shwe, to oversee, direct, coordinate all activities, address issues of the STWGs in accordance with prescriptions of the Long Term Restoration and Conservation Plan, directives of the CSCOIL, SSSC, Sector and sub-Sector Working Plans.

The lead nodal Ministerial departments will need to establish strong, specialized, well staffed, adequately funded and equipped teams to be part of the STWGs at the operational level to specifically deal with issues relating to their fields of expertise. These specialized teams should be led by competent officials with relevant experience relating to dealing with lakes. Their leaders should be someone who has held or is currently holding a position no less than that of an Assistant-Director in their related departments, as these specialized teams will need to be able to act independently and cooperatively, in addressing issues relating to their professional capabilities.

5.3.2. Organizational set up of the "Special Task Working Groups - STWGs" is shown in Annex 6.

a. STWG – 1, (Remote area): Restoration and Conservation of the Upland Watershed Areas. Protecting remnant natural forests; addressing land use issues particularly encroachment into Forest estates, problems of "Taung Yar" cultivation in Forest lands and steep slopes; rehabilitating degraded forest areas; establishing forest plantations for environmental protection; establishing Community Fuel wood Plantations; establishing and propagating "agro-forestry" designs; protecting forests in the head waters of the four main streams; training of streams and protecting encroachment into them; identify and demarcate expanse of land on either side of the streams on which protective vegetative belts are to be established and maintained.

FD will be responsible as the Lead Department.

The Supporting Departments are to be incorporated as follows: They will function as a combined team and work in Tandem to employ their expertise and experience to assist FD to achieve the above tasks:

1. Agriculture Department: To propagate proper agricultural practices; advise in land use planning; address the Taung Yar issue; advise proper landscaping and soil preservation measures in slope agriculture; propagate systematic agro-forestry practices; advise proper crop selection and cropping technique etc.
2. Highland Agriculture Planning Office (Mechanized Agricultural Department): To assist with its mobile teams organized to shape land systematically in the highland slopes for agricultural purposes. Currently there is only one mobile team in the whole of Southern Shan State
3. River and stream management Department, Ministry of Transport: To assist in clearing, dredging and training of the four main streams.
4. Irrigation Department: To assist in dredging activities as and when necessary.
5. Rural Areas Development Department, Ministry of Livestock Breeding, Fisheries and Rural Development: To undertake uplifting of the Socio-economic status of communities residing within the Remote Areas.
6. Cooperatives Department: To advise and assist with uplifting of the Socio-economic status of communities, through helping in development of micro-credit / micro-enterprise activities, cottage industries in tandem with the above Rural Areas Development Department.
7. Electricity Supply Department: To advise and assist in addressing electricity issues. Particularly, regarding the "Upper Bilu stream Hydro-electric power project, being undertaken by the "Oasis Development Co." in collaboration with the "Kansai Electric Power Co., Ltd. from Japan; and the "Superheated Steam System" Electricity Power plant to be constructed by the "Jissen Kankyo Kenkyushan Co., also from Japan at Zee Yar village for the upland communities.
8. People residing in communities within the upland Watershed areas: This did not occur in the past, resulting in local communities regarding restoration and conservation of the Lake and its environs not their responsibility. Thus, exclusion of the people can be regarded as the "missing link". **No plan/ project can succeed without the people's committed involvement.**
9. CSOs and CBOs.
10. Other ministries will be operating within all the Zones in accordance with their set agendas. They will be incorporated as and when the need arises.
11. NGOs, INGOs, national / international and individual experts will be requested to assist as and when the need arises.

b. STWG – 2, (Buffer Area): Responsible for the propagation of proper agriculture practices; introducing measures to protect stream banks and Lake shore, through establishment of vegetative cover as prescribed; propagate and establish extensive sedimentation control measures.

The Agriculture Department will be the Lead Department.
Supporting Departments will be incorporated as follows:

1. FD.
2. Mechanized Agriculture Department.
3. Rivers and Streams Management Department.
4. Irrigation Department.
5. Rural Development Department.
6. Cooperatives Department.

Departments, Organizations (CBOs and CSOs inclusive), Agencies etc. will be as per serial numbers (7) to (11) of STWG – 1.

c. STWG – 3, (Core Area): Responsible for the dredging / desilting and removal of sediments, marshes from within the Lake; removal of floating wilod vegetation, Water Hyacinth, undesired weeds, defunct floating agriculture strips that had been abandoned on the Lake shores; removal of sediments previously dug and heaped on either side of dredged channels.

The Irrigation Department will be the Lead Department.
Supporting Departments are to be as follows:

1. Wildlife Sanctuary Warden's Office (FD).
2. Agricultural Department.
3. River and Stream Management Department.
4. The Municipal Department.
5. Rural Development Department.
6. The Cooperatives Department.
7. (7) to (11) will be as per STWG – 1.

d. **STWG – 4, (Socio-economic Development of communities)**: Responsible for the uplifting the socio-economic status of communities living within Inle Lake and its Watershed areas.

The Rural Development Department (Ministry of Livestock Breeding, Fisheries and Rural Development) will be the Lead Department.
Supporting Departments are to be incorporated as follows:

1. Wildlife Sanctuary Warden's Office.
2. The Planning Department.
3. The General Administration Department.
4. The Cooperatives Department.
5. Agricultural Department.
6. FD.
7. (7) to (11) will also be as per STWG – 1.

5.4. Establishment of the Inle Lake Development Authority – ILDA. The Team of experts held the view that establishment of the Inle Lake Development Authority – ILDA will need to be thought out and set up very carefully. The ILDA will have to merge with the existing management network established by the GOM. It will have to work within the Policy Framework of the superior Committees; but at the same time, it will need a strong mandate to oversee, direct, monitor and supervise the actual implementation of all related departments, NGOs, UN and other donor Agencies, CBOs undertaking to implement chosen tasks relating to Inle Lake and the Watershed areas.

When contemplating to establish the ILDA, concerns of local communities must be taken into consideration. Communities expressed their concern of being excluded from the planning, decision making and implementation processes. They are aware of their role and responsibility and desire to play a proactive part in restoring the Lake and its Watershed. **Inclusion of local communities in all phases of establishing the ILDA is vital**, if they are to **take ownership** of Inle Lake and implementation of the LTRCP in order that Inle may be saved.

As establishment of the ILDA is rather complex and diverse views prevail, it should be dealt with as a separate entity, as it will require in depth discussions and deliberations with knowledgeable experts. The ultimate decision to establish the ILDA; define its mandate, role and functions will have to be made by the GOM.

5.5. Establishment of the Inle Lake Trust Fund – ILTF. The President of the Republic of the Union of Myanmar, on a visit to Inle Lake in 2012, Committed Kyats 15 million as the GOM's contribution and instructed that a "Trust Fund" be set up for restoration and sustainable conservation of the Lake.

The Shan State Government had been accumulating funds in the past years, in the form of "Zone Fees" from international tourists at 5 USD per person. Actual collection was done by auctioning the right to collect fees to the private sector on a yearly basis. Total funds generated from the auction (in Kyats), is divided in two equal portions; one portion is allocated to developmental tasks undertaken throughout the whole of the Shan State. The other portion is remitted into the ILTF. The Trust Fund is **managed by a high level Committee** lead by related State Ministers; check and balance mechanisms have been put into place to ensure that funds are utilized only for Inle Lake. The Zone Fee rate was increased to 10 USD per person as of October 2013; as such the ILTF is now in possession of a substantial amount of funds. **The ILTF has been functional** since its inception and has been providing financial support to departments that need financial inputs to conduct related implementation activities.

As the ILTF is already functional at the State level, it would be **politically sensitive** to take that right away from the Shan State Government and the Stakeholders. On the other hand, there is the need to **conform to international norms**, so as to build confidence among International Donors. The team therefore considered the feasibility of establishing the ILTF at two levels; one at MoECAF / CSCOIL level to deal with donations from National Governments, Bi-lateral, Unilateral and private organizations; and one at the Shan State Government / SSSC level to deal with funds they are able to generate locally to implement activities in the field. This will expedite disbursing of required funds to related departments, which in turn will enable the departments' speedy accomplishment of their tasks.

Here again, communities expressed their concern of the possibility of being excluded from the decision making process regarding management of the ILTF. They voiced their desire that funds presently being acquired at the State level be allowed to be managed by the State Government / SSSC and relevant Stakeholders.

It can be seen that organizing the ILTF is even more complex than setting up of the ILDA, as there is no set piece formula for setting up a Trust Fund that will fit all situations. There are so many Trust Fund designs afloat, because **Trust Funds need to be designed to apply to "a specific situation"**. Besides, in the case of Inle, it is a politically sensitive issue. As with the ILDA, inclusion of local communities / ethnic races / stakeholders must be considered as **a vital component** in all phases of establishing the ILTF. It must also **include funding the needs of communities in the Watershed areas**, as those communities voiced their concern that the **ILTF presently, is focused on the needs of Lake Communities only**.

Just as with the ILDA, establishment of the ILTF must be thought out and set up very carefully and decided upon only when a proper understanding is achieved and accepted by all stakeholders. The ultimate decision to define the ILTF's mandate, its role and functions will also have to be made by the GOM.

Table 26: Component wise Plan Cost

Sr.No.	Activity	Amount in USD	% of Total Plan Cost
1.	Survey & Demarcation	0.65 Million	2.01
2.	Water Resources Conservation	15 Million	46.47
3.	Water Quality Improvement	3.075 Million	9.53
4.	Catchment Conservation	7.8 Million	24.17
5.	Biodiversity Conservation	1.1 Million	3.41
6.	Ecotourism Development	1.6 Million	4.96
7.	Sustainable Livelihoods	1.55 Million	4.80
8.	Administrative Cost	1.50 Million	4.65
	Total	**32.275 Million**	**100**

Annexure 1: Discharge Computations of Streams

Discharge Computations near Yay Pei village on Yay Pei /Nei Gyar Stream

						Units	FPS		
Location		20 42 3.72			96 53 16.61				
River Length		150			Date	21-8-2012			
Time for									
Three									
Readigs									
S.No	Top Width (ft)	Water depth (ft)	Time (sec)	Avg Time (sec)	Cross-section	Velocity (ft/s)	Mean Vel. (ft/s)	Discharge (cfs)	
1	5	2.3	29.28		5.75			23.83	
2	5	2.3	28.44	30.04	11.5	4.99	4.14	47.66	
3	5	2.3	32.4		11.5			47.66	
4	5	1.1			8.5			35.23	
5	5	0.1			3			12.43	
6	5	0.25			0.625			2.59	
Total	30				40.875			169.41	
							Or	4.80	cumec

Annexure 1 contd

Discharge Computations near Shwe Nyaung Town on Nam Lat stream

						Units	FPS		
Location		20 45 14.23			96 55 20.12				
RiverLength		200			Date	21-8-2012			
Time for									
Three									
Readigs									
S.No	**Top Width (ft)**	**Water depth (ft)**	**Time (sec)**	**Avg Time (sec)**	**Cross-section**	**Velocity (ft/s)**	**Mean Vel. (ft/s)**	**Discharge (cfs)**	
1	20	4.45	619		44.5			12.33	
2	10	6.55	548.34	598.9133	55	0.33	0.28	15.24	
3	10	7.3	629.4		69.25			19.19	
4	10	7.3			73			20.23	
5	10	3.8			55.5			15.38	
6	10	3			15			4.16	
Total	70				312.25			86.55	
							Or	2.45	Cumec

Annexure 1 contd

Discharge Computations near Than Daung village on Kalaw stream

						Units	FPS		
Location		20 32 37.38			96 50 25.16				
RiverLength		200			Date	21-8-2012			
Time for									
Three									
Readigs									
S.No	**Top Width (ft)**	**Water depth (ft)**	**Time (sec)**	**Avg Time (sec)**	**Cross-section**	**Velocity (ft/s)**	**Mean Vel. (ft/s)**	**Discharge (cfs)**	
1	10	1	66.24		5			12.98	
2	10	1.5	62.28	63.94	12.5	3.13	2.60	32.45	
3	10	2.4	63.3		19.5			50.63	
4	10	0.3			13.5			35.05	
5	10	0.4			3.5			9.09	
Total	50				54			140.19	
							or	3.97	Cumec

Annexure 1 contd

Discharge Computations near Indein village on Bi Lu stream

	(one Tributary)					Units	FPS		
Location		20 27 35.92			96 50 31.44				
RiverLength		200			Date	22-8-2012			
Time for									
Three									
Readigs									
S.No	Top Width (ft)	Water depth (ft)	Time (sec)	Avg Time (sec)	Cross-section	Velocity (ft/s)	Mean Vel. (ft/s)	Discharge (cfs)	
1	0.5	5.4	68.94		1.35			3.27	
2	15	5.5	70.92	68.46	81.75	2.92	2.42	198.23	
3	11	5.1	65.52		58.30			141.36	
4	15	5.9			82.50			200.04	
5	14	6.3			85.40			207.08	
6	15	5.5			88.50			214.59	
7	11	4.3			23.65			57.35	
Total	81.5				421.45			1021.92	
							or	28.93	Cumec
			Total flow=		44.51				

Annexure 2: Mean Annual Rainfall

Station	Mean Annual Rainfall (inches)													
	Year													
	2000.00	2001.00	2002.00	2003.00	2004.00	2005.00	2006.00	2007.00	2008.00	2009.00	2010.00	2011.00	Mean	Avg(mm)
Nyaung Shwe	34.44	47.17	34.09	30.15	46.37	41.80	45.04	29.30	43.41	32.10	35.13	54.05	39.42	**1001.29**
Taunggyi	51.13	73.04	56.30	65.73	65.24	60.75	60.24	56.33	55.60	50.41	45.63	79.98	60.03	**1524.80**
Kalaw	37.11	45.72	42.07	34.08	46.44	46.28	36.67	36.67	35.22	47.66	32.53	42.40	40.24	**1022.03**
Pinlaung	72.87	87.84	95.40	78.24	94.76	97.03	88.86	95.27	102.95	86.20	70.74	93.20	88.61	**2250.78**
Pindaya	42.89	58.00	53.03	38.08	54.30	43.63	49.80	42.05	47.24	23.49	38.93	60.54	46.00	**1168.36**
Yatsauk	32.50	44.59	34.49	41.65	52.20	63.71	70.79	53.49	39.10	30.31	44.76	72.34	48.33	**1227.52**
Hpe` khon	45.04	47.67	43.55	37.20	63.09	41.83	32.68	35.28	33.99	26.37	37.86	44.36	40.74	**1034.88**
Average	45.14	57.72	51.28	46.45	60.34	56.43	54.87	49.77	51.07	42.36	43.65	63.84	51.91	
Average (mm)	**1146.56**	**1466.05**	**1302.40**	**1179.76**	**1532.71**	**1433.39**	**1393.66**	**1264.16**	**1297.25**	**1076.02**	**1108.82**	**1621.50**	**1318.52**	

Annex 2 contd

COMPUTATION OF MEAN ANNUAL INFLOW IN INLE LAKE

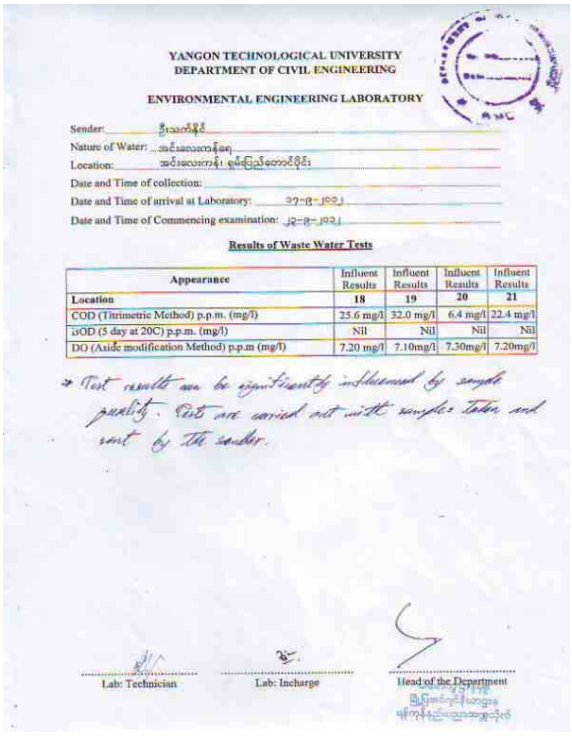
Stream Name	Catchment Area (Km^2)	Discharge (cumec)	Volume in MCM	Month	% of Rainfall	Ratio wrt August Rainfall	Volume in MCM		
Nan lit	1149.00	2.41	6.45	Jan	0.69	0.04	6.34		
Negya	250.00	4.80	12.85	Feb	0.93	0.05	8.55		
Kalaw	742.00	3.97	10.63	Mar	3.42	0.18	31.44		
Bilu	813.00	28.93	77.49	Apr	3.42	0.18	31.44		
Remaining	686.00	13.17	35.27	May	10.00	0.52	91.93		
Lake	100.00	13.17	35.27	Jun	14.44	0.75	132.75		
	3740.00			Jul	19.00	0.98	174.66		
Rainfall of			177.97	Aug	19.36	1.00	177.97		
Lake	1.28	M		Sep	15.24	0.79	140.10		
			1712.11	Oct	10.60	0.55	97.44		
				Nov	0.27	0.01	2.48		
				Dec	2.59	0.13	23.81		
				Sub Total	99.96		918.92		
				Volume of Annual Precipitation			128.10		
				Total Volume			1047.02	849165.00	Acre-ft

Annexure 3: Sampling Locations

Sr. No.	Date	Sample Code	Location	Water Depth (ft)	Description of Sampling Location
1	16-08-2012	ILWS-1	20° 39.27′ N 96° 55.29′ E	7.9	Sampling point at the corner of Nyaung Shwe Jetty
2	16-08-2012	ILWS-2	20° 36.32′ N 96° 55.12′ E	5	At the mouth of Inlay Lake on Northern side
3	16-08-2012	ILWS-3	20° 34.41′ N 96° 55.03′ E	7.4	Inside the Lake near Rest House
4	16-08-2012	ILWS-4	20° 27.07′ N 96° 54.24′ E	6.6	Inside the Lake near Nam Pan Village
5	16-08-2012	ILWS-5	20° 37.52′ N 96° 55.16′ E	5.6	On Nam Lat stream which is one of the major streams feeding the Lake from the North. The sample was collected from the mouth of the stream before its confluence with the Lake
6	16-08-2012	ILWS-6	20° 27.43′ N 96° 52.42′ E	3.5	In Ywa Ma village on one limb of Bi Lu stream near monastery. Besides, collection of water samples stream cross-section and discharge quantity was assessed. The flow was assessed as 28.93 cumec
7	16-08-2012	ILWS-7	20° 32.16′ N 96° 53.56′ E	2.6	In Mye Ni Gon village on Kalaw Stream which also is a major stream of Inlay lake. The sample was collected at the mouth of stream before its confluence with the lake
8	16-08-2012	ILWS-8	20° 29.40′ N 96° 52.42′ E	5	At the entrance of Lei Thit village on Kalaw Stream at its mouth entering the Lake
9	16-08-2012	ILWS-9	20° 30.16′ N 96° 54.30′ E	8	In Kay Lar village which is located between two major streams Bi Lu and Kalaw Streams. The samples collected is from the effluent drain / Nallah which discharges the untreated water into the Lake

Sr. No.	Date	Sample Code	Location	Water Depth (ft)	Description of Sampling Location
10	21-08-2012	ILWS-10	20° 42′ 3.72″ N 96° 53′ 16.61″ E	2.3	On Yay Pei Stream near Yay Pei village. Discharge assessment was also carried out using floats. The flow measurement was 4.796 cumec
11	21-08-2012	ILWS-11	20° 45′ 14.23″ N 96° 55′ 20.12″ E	7.3	Near Tar Yaw bridge adjacent to Shwe Nyaung town under Taunggyi Township on Nam Lat Stream. This stream is a major feeder of the Lake. Discharge measurement using float was carried out. The flow measured was 2.45 cumec
12	21-08-2013	ILWS-12	20° 32′ 37.38″ N 96° 50′ 25.16″ E	2.4	On Kalaw Stream near Thann Daung village. Discharge measurement was carried out using float. The assessed flow was 3.96 cumec. This is a perennial stream.
13	22-08-2012	ILWS-13	20° 27′ 35.92″ N 96° 50′ 31.44″ E	6.3	Near Indein village near bridge on Bi Lu Stream. This stream contributes maximum amount of Water to the Lake. The discharge measurement using the float method revealed a discharge of 28.93 cumec
14	22-08-2012	ILWS-14	20° 29′ 36.49″ N96° 52′ 56.47″ E	3	At Ywa Ma village near mouth of Bi Lu Stream. The sample was collected to assess the quantity of effluent water as usually no flow was observed as it is near to the point of entry to the lake
15	22-08-2012	ILWS-15	20° 29′ 14.95″ N 96° 54′ 26.99″ E	6.8	Effluent sample from Zayat Gyi village located on west side of Inle Lake.
16	22-08-2012	ILWS-16	20° 32′ 5.42″ N 96° 53′ 46.52″ E	5.4	At Mye Ni Gon village located on the West bank of the Lake for effluent quality assessment
17	22-08-2012	ILWS-17	20° 36′ 38.10″ N 96° 53′ 38.49″ E	6	Effluent water sample was collected from Inn Oo village located on the West bank of the Lake. In fact it is a link channel to Lake. It is also called as Nan The`– Khaung Taing link channel

Sr. No.	Date	Sample Code	Location	Water Depth (ft)	Description of Sampling Location
18	27-08-2012	ILWS-18	20° 16′ 6.64″ N 96° 54′ 16.68″ E	11	Near Ton Hom bridge. This is the extreme south end of the lake (end point). The water of the lake flows down to feed Law Pita Hydro-Electric power station downstream
19	27-08-2012	ILWS-19	20° 21′ 48.48″ N 96° 53′ 42.32″ E	11	At Kyaing Kham village. The Lake has the least width near to this village of approx. 0.5 mile only.
20	27-08-2012	ILWS-20	20° 24′ 51.27″ N 96° 51′ 48.50″ E	3	On the West bank of Inlay Lake near Si Zon village discharges water to the Lake.
21	27-08-2012	ILWS-21	20° 26′ 28.87″ N 96° 54′ 13.44″ E	5.6	Water samples were collected from Naung Dam village near Nam Pan before confluence with Inlay Lake



YANGON TECHNOLOGICAL UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING

ENVIRONMENTAL ENGINEERING LABORATORY

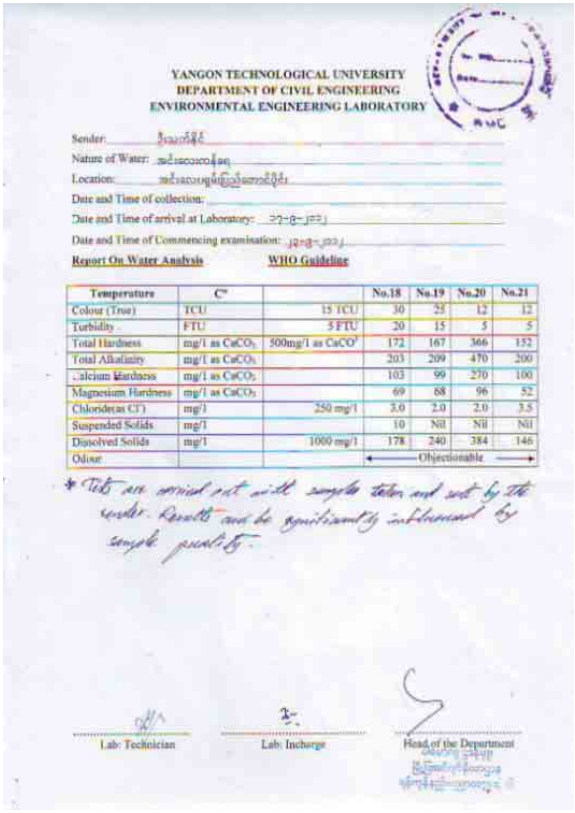
Sender:
Nature of Water:
Location:
Date and Time of collection:
Date and Time of arrival at Laboratory:
Date and Time of Commencing examination:

Results of Waste Water Tests

Appearance	Influent Results	Influent Results	Influent Results	Influent Results
Location	18	19	20	21
COD (Titrimetric Method) p.p.m. (mg/l)	25.6 mg/l	32.0 mg/l	6.4 mg/l	22.4 mg/l
BOD (5 day at 20C) p.p.m. (mg/l)	Nil	Nil	Nil	Nil
DO (Aside modification Method) p.p.m (mg/l)	7.20 mg/l	7.10mg/l	7.30mg/l	7.20mg/l

* Test results can be significantly influenced by sample quality. Test are carried out with samples taken and sent by the sender.

Lab: Technician | Lab: Incharge | Head of the Department



YANGON TECHNOLOGICAL UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING
ENVIRONMENTAL ENGINEERING LABORATORY

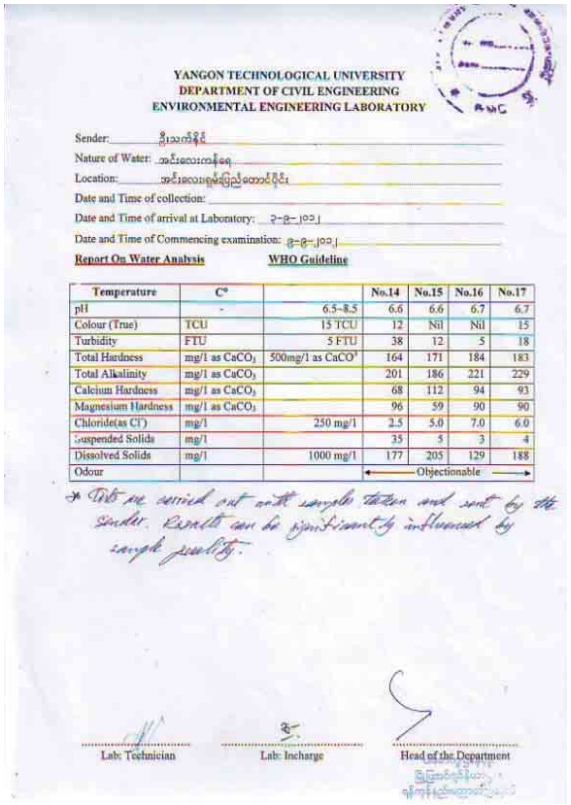
Sender:
Nature of Water:
Location:
Date and Time of collection:
Date and Time of arrival at Laboratory:
Date and Time of Commencing examination:

Report On Water Analysis **WHO Guideline**

Temperature	C°		No.18	No.19	No.20	No.21
Colour (True)	TCU	15 TCU	30	25	12	12
Turbidity	FTU	5 FTU	20	15	5	5
Total Hardness	mg/l as $CaCO_3$	500mg/l as $CaCO^3$	172	167	366	152
Total Alkalinity	mg/l as $CaCO_3$		203	209	470	200
Calcium Hardness	mg/l as $CaCO_3$		103	99	270	100
Magnesium Hardness	mg/l as $CaCO_3$		69	68	96	52
Chloride(as Cl)	mg/l	250 mg/l	3.0	2.0	2.0	3.5
Suspended Solids	mg/l		10	Nil	Nil	Nil
Dissolved Solids	mg/l	1000 mg/l	178	240	384	146
Odour			← Objectionable →			

* Tests are carried out with samples taken and sent by the sender. Results can be significantly influenced by sample quality.

Lab: Technician | Lab: Incharge | Head of the Department



YANGON TECHNOLOGICAL UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING
ENVIRONMENTAL ENGINEERING LABORATORY

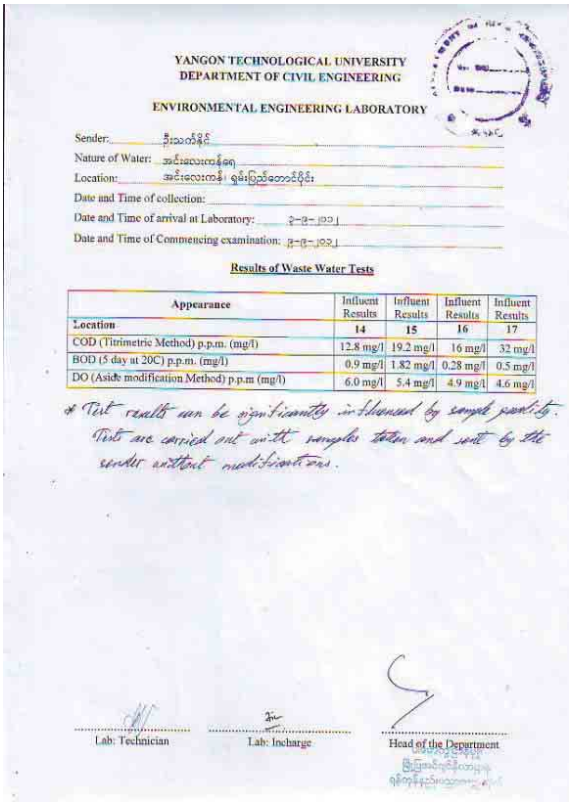
Sender:
Nature of Water:
Location:
Date and Time of collection:
Date and Time of arrival at Laboratory:
Date and Time of Commencing examination:

Report On Water Analysis **WHO Guideline**

Temperature	C°		No.14	No.15	No.16	No.17
pH	-	6.5~8.5	6.6	6.6	6.7	6.7
Colour (True)	TCU	15 TCU	12	Nil	Nil	15
Turbidity	FTU	5 FTU	38	12	5	18
Total Hardness	mg/l as $CaCO_3$	500mg/l as $CaCO^3$	164	171	184	183
Total Alkalinity	mg/l as $CaCO_3$		201	186	221	229
Calcium Hardness	mg/l as $CaCO_3$		68	112	94	93
Magnesium Hardness	mg/l as $CaCO_3$		96	59	90	90
Chloride(as Cl)	mg/l	250 mg/l	2.5	5.0	7.0	6.0
Suspended Solids	mg/l		35	5	3	4
Dissolved Solids	mg/l	1000 mg/l	177	205	129	188
Odour			← Objectionable →			

* Tests are carried out with samples taken and sent by the sender. Results can be significantly influenced by sample quality.

Lab: Technician | Lab: Incharge | Head of the Department



YANGON TECHNOLOGICAL UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING

ENVIRONMENTAL ENGINEERING LABORATORY

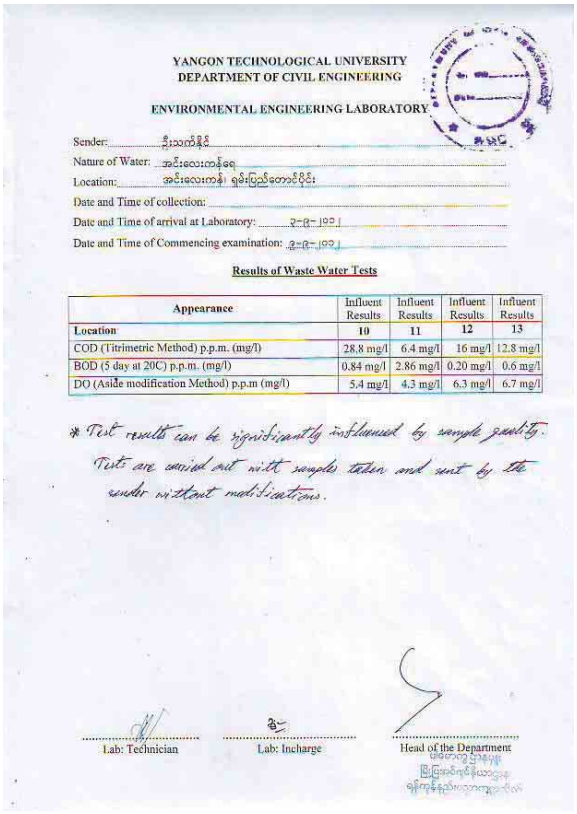
Sender:
Nature of Water:
Location:
Date and Time of collection:
Date and Time of arrival at Laboratory:
Date and Time of Commencing examination:

Results of Waste Water Tests

Appearance	Influent Results	Influent Results	Influent Results	Influent Results
Location	14	15	16	17
COD (Titrimetric Method) p.p.m. (mg/l)	12.8 mg/l	19.2 mg/l	16 mg/l	32 mg/l
BOD (5 day at 20C) p.p.m. (mg/l)	0.9 mg/l	1.82 mg/l	0.28 mg/l	0.5 mg/l
DO (Aside modification Method) p.p.m (mg/l)	6.0 mg/l	5.4 mg/l	4.9 mg/l	4.6 mg/l

* Test results can be significantly influenced by sample quality. Tests are carried out with samples taken and sent by the sender without modifications.

Lab: Technician | Lab: Incharge | Head of the Department



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ENVIRONMENTAL ENGINEERING LABORATORY

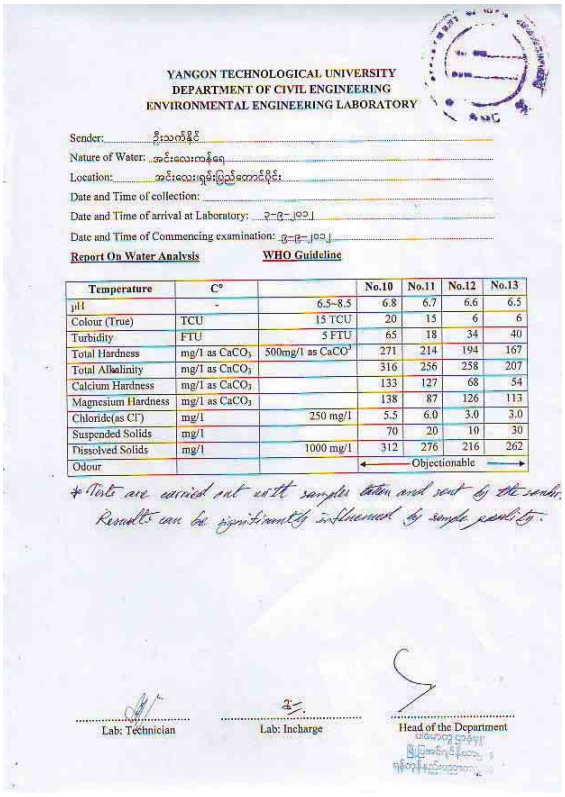
Sender: ဦးသက်နိုင်
Nature of Water: အင်းလေးတန်ရေ
Location: အင်းလေးကန်၊ ရွာမံကြည်တောင်ဝိုင်း
Date and Time of collection:
Date and Time of arrival at Laboratory: ၃-၉-၂၀၁၂
Date and Time of Commencing examination: ၃-၉-၂၀၁၂

Results of Waste Water Tests

Appearance	Influent Results	Influent Results	Influent Results	Influent Results
Location	**10**	**11**	**12**	**13**
COD (Titrimetric Method) p.p.m. (mg/l)	28.8 mg/l	6.4 mg/l	16 mg/l	12.8 mg/l
BOD (5 day at 20C) p.p.m. (mg/l)	0.84 mg/l	2.86 mg/l	0.20 mg/l	0.6 mg/l
DO (Aside modification Method) p.p.m (mg/l)	5.4 mg/l	4.3 mg/l	6.3 mg/l	6.7 mg/l

* Test results can be significantly influenced by sample quality. Tests are carried out with samples taken and sent by the sender without modifications.

Lab: Technician Lab: Incharge Head of the Department



YANGON TECHNOLOGICAL UNIVERSITY
DEPARTMENT OF CIVIL ENGINEERING
ENVIRONMENTAL ENGINEERING LABORATORY

Sender: ဦးသက်နိုင်
Nature of Water: အင်းလေးတန်ရေ
Location: အင်းလေးရွာမံကြည်တောင်ဝိုင်း
Date and Time of collection:
Date and Time of arrival at Laboratory: ၃-၉-၂၀၁၂
Date and Time of Commencing examination: ၃-၉-၂၀၁၂

Report On Water Analysis **WHO Guideline**

Temperature	C°		No.10	No.11	No.12	No.13
pH	-	6.5~8.5	6.8	6.7	6.6	6.5
Colour (True)	TCU	15 TCU	20	15	6	6
Turbidity	FTU	5 FTU	65	18	34	40
Total Hardness	mg/l as $CaCO_3$	500mg/l as $CaCO^3$	271	214	194	167
Total Alkalinity	mg/l as $CaCO_3$		316	256	258	207
Calcium Hardness	mg/l as $CaCO_3$		133	127	68	54
Magnesium Hardness	mg/l as $CaCO_3$		138	87	126	113
Chloride(as Cl^-)	mg/l	250 mg/l	5.5	6.0	3.0	3.0
Suspended Solids	mg/l		70	20	10	30
Dissolved Solids	mg/l	1000 mg/l	312	276	216	262
Odour			← Objectionable →			

* Tests are carried out with samples taken and sent by the sender. Results can be significantly influenced by sample quality.

Lab: Technician Lab: Incharge Head of the Department

Annexure 4: Cross-section of Lake

Cross-section of Lake

West Bank (SHWEMYINTIN PAGODA)

Distance (mile)	Distance (Km)	Depth (ft)	Depth (m)	Water Surface	Latitude (N)	Longitude (E)	Remarks
0	0.0	0	0.0	0	20° 35.22'	96° 52.40'	Near Brinjal field
0	0.0	-3.5	-1.1	0	20° 35.22'	96° 52.40'	Near Brinjal field
1	1.6	-8.2	-2.5	0	20° 34.58'	96° 53.30'	Inside Lake
2	3.2	-8.4	-2.6	0	20° 34.36'	96° 54.21'	Inside Lake
3	4.8	-9	-2.7	0	20° 34.15'	96° 55.11'	Inside Lake
4	6.4	-7.9	-2.4	0	20° 34.04'	96° 56.09'	Inside Lake
4.5	7.2	-5	-1.5	0	20° 33.56'	96° 56.38'	East bank near AUREUM Palace Hotel
4.5	7.2	0	0.0	0	20° 33.56'	96° 56.38'	East bank near AUREUM Palace Hotel

East Bank Location

Distance (mile)	Distance (Km)	Depth (ft)	Depth (m)	Water Surface	Latitude (N)	Longitude (E)	Remarks
0	0.0	0	0.0	0	20° 34.50'	96° 56.22'	Near MAING THAUK village
0	0.0	-5	-1.5	0	20° 34.50'	96° 56.22'	Near MAING THAUK village
1	1.6	-9.1	-2.8	0	20° 35.02'	96° 55.25'	Inside Lake
2	3.2	-6.8	-2.1	0	20° 35.28'	96° 54.36'	Inside Lake
3	4.8	-8.2	-2.5	0	20° 35.54'	96° 53.48'	Inside Lake
4	6.4	-4.1	-1.2	0	20° 36.23'	96° 53.03'	KHAUNG DAING village Jetty
4	6.4	0	0.0	0	20° 36.23'	96° 53.03'	KHAUNG DAING village Jetty

Annexure 5: Broad characteristics of the selected villages

Type of villages	Villages selected for survey	Differentiating characteristics	Number of households approached
Villages on Inle Lake	10	The major livelihood of these villages is tomato cultivation	149 households (15 per village)
Villages on fringes of the Inle Lake	8	These villages carry out most of their economic activities in dry land	96 households (12 per village)

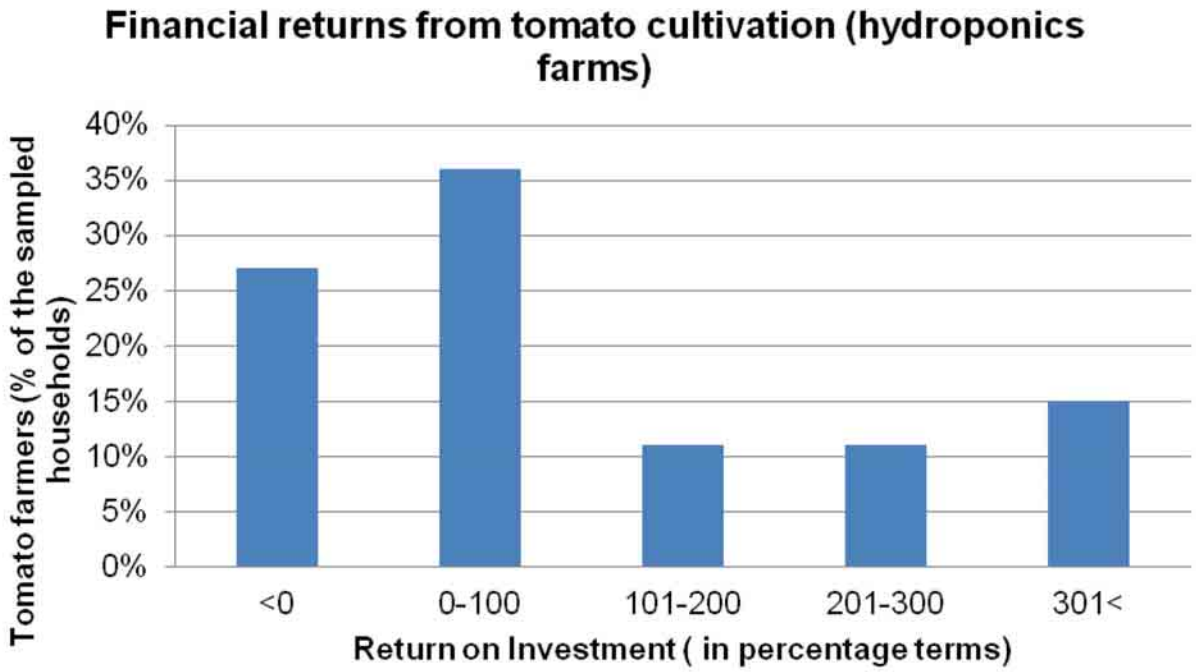
Villages within Inle Lake

Sl	Name of village	Households surveyed
1	*Lwe kin*	15
2	*Kay lar*	15
3	*In baw hkon*	15
4	*Nga Pe gyaung*	15
5	*Let thit*	15
6	*Zayat Gyi*	15
7	*Aing Taung Gyi*	15
8	*Shwe Wagyi*	14
9	*Ma gyi Seik*	15
10	*Kye zar gon*	15

Villages on fringes and hills

Sl	Name of village	Households surveyed
11	Ye Pu San	12
12	Maing thauk	12
13	Loi nyein	12
14	Shwe le pho	10
15	Taung bo gyi	12
16	Ti law	12
17	Kyauk ye oh	12
18	Tha le` gon	13
19	Paung Pine	12
20	Mya Thein Tan	13
21	Kan tan	12
22	Ohn Hne Pin	12
23	Maing Pyo Gyi Thit	12
24	Loi Mwe	12
25	Loi nyein	12
26	In gyin gon	11

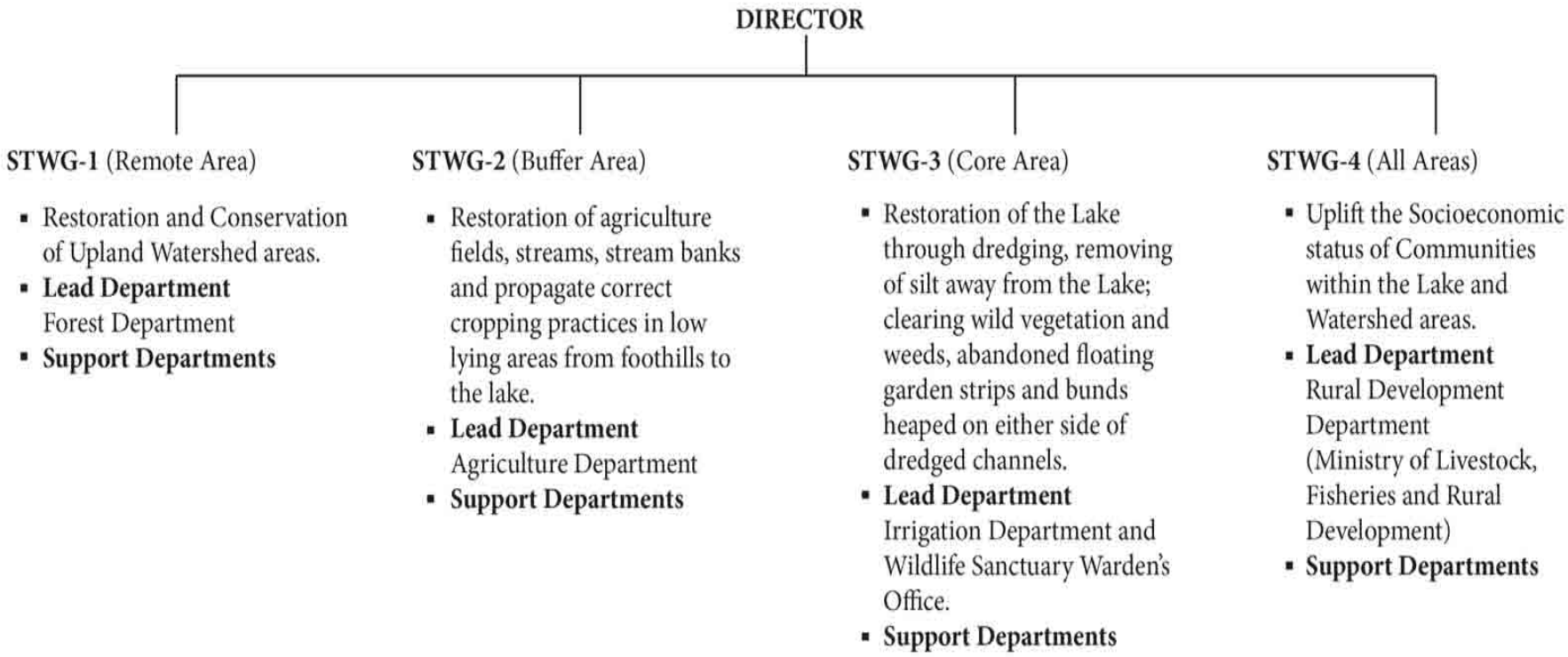
Annexure 5 Cont.



Annexure 6: Organizational Chart of STWGs

Organizational Chart

Implementation Command Headquarters (Nyaung Shwe)



Remarks: Support Departments are stated in detail in Chapter 5: Section;

Annexure 7: References

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4. Presentation about the Inle lake Wildlife Sanctuary, April 2004. Wildlife Sanctuary Warden's Office, Inle Wildlife Sanctuary, Nyaung Shwe Township.
5. Inle Wetland Wildlife Sanctuary Pamphlet; 2005.
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7. Lake threatened by environmental dangers, by Khin Nhin Phyu, The Myanmar Times, march 27-April 2, 2006.
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12. Ministry of Environmental Conservation and Forestry; "Action Plan for Environmental Conservation and Sustainable Management of Inle Lake (2010 – 11 to 2014 – 15)".
13. Presentation of the Shan State Fisheries Department to Sustain Inle Lake through the rehabilitation of the previously favourable environmental situation. By U Saing Kyaw Myint, Shan State Director of the Fisheries Department, June 2010.
14. The Irrigation Department's Management efforts for the Sustainability of Inle lake. By Kyaw Kyaw Oo, Staff Officer, Nyaung Shwe Assistant Director's Office, June 2010.
15. A Brief presentation on the basic data relating to Inle Lake and measures undertaken to conserve it. By the Forest Department, February 2012.
16. Report on Project activities performed in relation to forests, water resources, land resources, wildlife conservation to enhance greening of the environment within a perimeter of 20 miles radius of Inle Lake. By the Irrigation Department.

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19. Work Progress Report relating to the construction of the "Upper Bi-lu Chaung Hydroelectricity Project", August 2012.
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24. Report on the accomplishment of Water Supply Project for the Lake villages and various Community Development works by Nyaung Shwe Township Municipal Department.
25. List of villages that have received electricity and clean water supply, as surveyed by the Nyaung Shwe Township Department.
26. Brief Report on breeding of Rabbits / Hares in Nyaung Shwe Township by the Lilypad Co. Ltd. to bring about income generation among communities living within the Lake and it's surrounding area.
27. List of villages and villagers within Inle and Saga Lake who are indulging in the prohibited practice of breeding "African Catfish" within net cages in the submerged areas.
28. Report to the people by the "Inle Drinking water Supply Organization – IDWSO", established by the Chief Monk of the "Naga Bwet" Bhuddist Theological Centre, Taunggyi, on tasks accomplished since its inception in October 2012.
29. List of legal action taken against offenders by the Wildlife Sanctuary Warden's Office, Nyaung Shwe from 2004 – 2005 to 2011 – 12.
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31. Project Proposal by the Extension Section of the Nyaung Shwe Township Myanma Agriculture Services Department.

Documents acquired from international sources

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Annexure 8: Dignitaries and related persons met by the team

1. H.E. U Win Tun, Union Minister, Ministry of Environmental Conservation and Forestry.
2. U Sann Lwin, Director General, Planning and Statistics Department, Ministry of Environmental Conservation and Forestry.
3. U Aye Myint Maung, Director General, Forest Department, Ministry of Environmental Conservation and Forestry.
4. U Tin Tun, Deputy Director General, Planning and Statistics Department, Ministry of Environmental Conservation and Forestry.
5. H.E. U Kyaw Thu, Chairman, Union Civil Service Board.
6. U Kyi Htut Win, Director General, Department of Water Resources Utilization, Ministry of Agriculture and Irrigation.
7. Mr. Srinivasa Popuri, outgoing Country Programme Manager, UN-HABITAT, Yangon.
8. Mr. Bijay Karmacharya, incumbent Country Programme Manager, UN-HABITAT, Yangon.
9. Mr. Denzil Abel, Senior National Advisor, UN-HABITAT, Yangon.
10. Professor U Kyaw Htun, Environmental Advisor, UN-HABITAT, Yangon.
11. Mr. Akbar Usmani, Senior Deputy Resident Representative, United Nations Development Programme – UNDP (Myanmar), Yangon.
12. Mr. Arne Jan Flolo, charge`d`Affaires a.i., Diplomatic Mission of Norway, Yangon.
13. Dr Min Htut Yin, Assistant Resident Representative, UNDP, Yangon.
14. Mr. Joern Kristensen, Director and Representative, The Institute for International Development – IID (Myanmar), Yangon.
15. Mr. John Leake, Director, IID.
16. H.E. Sao Aike Paung, Shan State Minister for Forests and Mining, Taung Gyi.
17. H.E. U Saing Hsar Lu, Shan State Minister for Agriculture and Irrigation, Taung Gyi.
18. H.E. U Win Myint, Shan State Minister for Inn-thar (lake dwellers) Affairs, Nyaung Shwe.
19. U Win Zaw, Director of the Forest Department, Shan State, Taung Gyi.
20. U Htay Oo, Director of the Irrigation Department, Shan State, Taung Gyi.
21. U Tin Hlaing, Director of the Shan State Planning and Economic Department, Taung Gyi.
22. U Tin Tun Aung, Director of the Shan State Fisheries Department, Aye Thar Yar.
23. U Maung Maung Soe, Assistant Director, Forest Department, Taung Gyi District.
24. U Tin Maung Win, Staff Officer, Forest Department, Nyaung Shwe Township.
25. U Sein Tun, Staff Officer, Park Warden Inle Wild life Sanctuary, Nyaung Shwe.
26. U Soe Aung, Assistant Director, Irrigation Department, Nyaung Shwe.
27. U Kyaw Kyaw Oo, Staff Officer (Engineer), Irrigation Department, Nyaung Shwe.
28. U Soe Naing, Director, Shan State Hydro-electricity Planning Department, Ministry of Energy, Aye Thar Yar.
29. U Han Min Tun, Project in-charge, the Upper Bilu Chaung Hydro-electric Project, Indein village, Nyaung Shwe Township.
30. Dr. Daw Aye Aye Win Kyi. Professor / Head of the Botany Department, Taung Gyi University, Taung Gyi.
31. Dr. Daw Nwe Nwe Yin, Associate Professor, Zoology Department, Taung Gyi University, Taung Gyi.
32. Dr. U Tin Hlaing, Retired Professor / Head of the Geology Department, Taung Gyi University, Taung Gyi.
33. U Maung Maung Soe, Staff Officer, Department of Water Resources Utilization, Aye Thar Yar Town.
34. U Aung Than Oo, Branch Manager, Myanmar Agriculture Development Bank, Nyaung Shwe.
35. U Kyaw Zin, Administrator, Township Municipal Department, Nyaung Shwe.

36. U Zaw Win Tun, Staff Officer, Agriculture Extension Section, Agriculture Department, Nyaung Shwe.
37. U Hla Aung Min, Township Project Assistant, UNDP, Nyaung Shwe.
38. U Kyaw Zwar Win, Head of the PACT (INGO) Branch, Nyaung Shwe.
39. Daw Sann Sann Oo, Staff Officer in-charge of the Fish Hatching and Breeding Station, Department of Fisheries, Nyaung Shwe.
40. U Saw Tun, Secretary of the Shan State Central Fishery Board (NGO), Nyaung Shwe.
41. U Hla Kyaw, Vice Chairman of the Shan State Central Fishery Board and Private owner of a Fish Hatchery and Breeding Business, Nyaung Shwe.
42. U Hla Pwint, Fisherman, Nyaung-taw-le`-shay village, Nam Pan village tract, Nyaung Shwe.
43. U Po Shwe, Fisherman, Nyaung-taw-le`-shay village, Nam Pan village tract, Nyaung Shwe.
44. U Hla Tun, Secretary of the Inn-thar Literature, Culture and Regional Development Association, Nyaung Shwe.
45. U Hlaing, Village Head, Kyay-Sar-Gon village, Nyaung Shwe Township.
46. U Myint Thu, UNHCR Shan State, Taung Gyi.
47. U Myo Myo, Director, Sun-Supreme Private Bio-fertilizer Production Company. Nyaung Shwe.
48. U Ye` Win, Sun-Supreme Bio-fertilizer Production Company, Nyaung Shwe Township.
49. U Soe Myint, Head of the Shan State Tomato Trading Association, Nyaung Shwe.
50. U Soe Maw, Tomato Trader, Nyaung Shwe.
51. U Moe Thu, Tomato Trader, Nyaung Shwe.
52. U Maung Maung Tun, Manager, Ecosystem Conservation and Community Development Initiative (NGO), Nyaung Shwe.
53. U Nay Myo Shwe, Project Officer, Friends of Wildlife (NGO), Nyaung Shwe.
54. U Thet Naing, Assistant Director, Department of Water Resources Utilization, Ministry of Agriculture and Irrigation, Yangon.
55. U Soe Naing, Assistant Engineer, Irrigation Department, Ministry of Agriculture and Irrigation, Yangon.