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Australian Centre for International Agricultural Research

SRA Report

Small research and development activity

SRA

Towards a multidisciplinary program for improving rural livelihoods through integrated management of the Inle Lake catchment, Myanmar

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prepared by	Jennifer Bellamy, Roy Sidle, Julian Prior, Neal Menzies, Laura Wendling, Joern Kristensen and Ohn Win
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Research program manager	Robert Edis, Soil Management and Crop Nutrition

SRA Research Team Members Visiting Myanmar 29 March – 6 April 2015

Name	Agency and position	Discipline and role in project
Jennifer Bellamy	Honorary Senior Research Fellow, School of Agriculture and Food Sciences, The University of Queensland	Project Leader. Integrated Catchment Management; governance systems for linking science-policy-community; institutional and policy analysis; interdisciplinary research management & evaluation
Prof. Roy Sidle	Prof. of Geography & Associate Director of the Sustainability Research Centre, University of the Sunshine Coast	Collaborating Scientist. erosion & sedimentation; catchment hydrology and management; water quality and pollution
Dr. Julian Prior	Senior lecturer, School of Environmental and Rural Science. University of New England	Collaborating Scientist. Rural livelihoods; agricultural extension; policy & institutional analysis and capacity development; Myanmar agricultural development research
Prof. Neal Menzies	Professor of Soil and Environmental Science; Head, School of Agriculture and Food Sciences; & Dean of Agriculture, The University of Queensland	Collaborating Scientist. Soil and environmental science; environmental biogeochemistry; soil and water pollutants and contaminants; agricultural production systems.
Dr. Laura Wendling	Senior Lecturer, School of Agriculture and Food Sciences, The University of Queensland	Collaborating Scientist & Research Co-ordination. Soil & environmental science; environmental biogeochemistry; soil and water pollutants and contaminants
Joern Kristensen	Executive Director, Myanmar Institute for Integrated Development (MIID)	In-country partner for co-ordination and stakeholder engagement; Institutional specialist on Myanmar political, cultural and socio-economic development
U Ohn Win	Advisory Board for Myanmar Institute for Integrated Development (MIID)	In-country partner for co-ordination and stakeholder engagement; Former DG of the Myanmar Department of Forestry; Inle Lake and catchments and hill country specialist.

SRA Report Outline

Acronyms

ACIAR	Australian Centre for International Agricultural Research
APSC	Australian Public Service Commission
ASEAN	Association of South East Asian Nations
BMPs	Best Management Practices
CSOIL	Committee for the Sustainability of Inle Lake
DA	Department of Agriculture
DAP	Department of Agricultural Planning
DAR	Department of Agricultural Research
DOF	Department of Fisheries
FD	Forest Department
FRI	Forest Research Institute
GAP	Good Agricultural Practices
ID	Irrigation Department
IID	Institute for International Development
ILA	Inle Lake Authority
ILCDA	Intha Literature and Cultural Development Association
IPM	Integrated Pest Management
LUASC	Land Use Allocation and Scrutinising Committee
MAB	Man in the Biosphere Programme (UNESCO)
MAS	Myanmar Agricultural Service
MLFRD	Ministry of Livestock, Fisheries and Rural Development
MIID	Myanmar Institute for Integrated Development
MOAI	Ministry of Agriculture and Irrigation
MOECAF	Ministry of Environmental Conservation and Forestry
MOHT	Ministry of Hotels and Tourism
MOIP	Ministry of Immigration and Population
NGOs	Non-government organisations
NIVA	Norwegian Institute for Water Research
NORAD	Norwegian Agency for Development
SGECC	Shan State Greening and Environmental Conservation Committee
SRA	Small Research Activity
SPDC	State Peace and Development Council
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UOF	University of Forestry
YAU	Yezin Agricultural University
WHO	World Health Organisation

1. Executive Summary

1.1. Overview of report

The Research Context

Inle Lake is a place of significant ecological, social and cultural value. It is listed as an ASEAN Heritage site and on the Tentative List of UNESCO World Heritage Sites. The Lake and its catchments are a vital part of the economy of Shan State and the nation, providing many goods and services that support the diverse livelihoods of its agricultural, fisheries, forestry and tourism communities. It also acts as the main water source for the Law Pi Ta hydroelectricity power plant. About 90,000 people inhabit Inle Lake and its nearby environs, while 800,000 people inhabit its four catchments. Renown for a number of cultural and livelihood practices (floating gardens, weaving industry, traditional leg-rowed boats), the lake is one of the main tourism attractions in Myanmar, with over 300,000 international and domestic tourists visiting each year, providing a critical boost to the local and national economies.

According to official figures, 35% of the Inle catchment is forested, 33.8% is agriculture with other uses being another 28.8%. Agriculture, forestry and fisheries have traditionally been the main livelihoods and sources of income for the people of Inle Lake catchments and also the region is important in national economic terms as the main region in Myanmar for vegetables (e.g., cauliflower, cabbages, potatoes, tomatoes, etc.) and flowers. Lake-based smallholder farmers use a mixture of traditional and modern cultivation practices (floating gardens, conservation agriculture, chemical usage, fish hatcheries, and community forestry). Highly important in economic terms for rural livelihoods, the production system of floating gardens however is complex and controversial. It is not only a cultural problem but there is quite a lot of conflicting information and perspectives concerning their management practices, ecological functions, environmental impacts and recent rapid expansion.

Tourism is growing in importance with clear evidence of an increased reliance upon tourism-related employment by lake communities as a key contributor to rural livelihoods. International visitors to the Inle Lake area increased from 20,000 tourists in 2009-10 to 110,000 in 2013-14. With such rapid growth, tourism brings new economic opportunities, but it is also creating uncertainty and pressures including environmental, social and cultural change. Although tourism has important benefits, it has its own detrimental consequences for the Lake. The cumulative impact of increased human waste and the potential for increased nutrients and pollution within the lake are of particular concern. For example, no centralised waste water treatment plant exists. It was also noted that rapidly expanding and poorly engineered road networks for tourism development is providing a conduit for sediments and pollutants into the lake.

A number of other biophysical issues facing Inle Lake have the potential to have a significant impact on human health and the sustainability and profitability of rural livelihoods. Across the Inle Lake catchment, deforestation, soil erosion and sedimentation issues have been recognised as a major issue, since the early 1900s. However, eutrophication and pollution issues emerged In the early 1990s as major problem impacting on the health of the catchments as well as the communities that depend upon them for their livelihoods. Despite the acknowledgement of these issues in national policies and plans and some research on soil erosion and conservation, these sedimentation and contamination issues have persisted; largely unabated. As such, Inle Lake is facing significant and increasing pressures from the interaction of rapid population growth, growing tourism, expansion of agriculture, unsustainable management practices, and the uncertainty of the dynamics of climate variability and change. The outcome has been:

- Accelerated soil erosion and sedimentation;
- Nutrient enrichment (impacts on lake water quality);
- Contamination (human wastes, pesticides, fertilizers);
- Deforestation and forest conversion;
- Loss and degradation of aquatic habitats;
- Decline in fish stocks; and
- Decline in the area of open water.

Governments of Myanmar over a number of decades have attempted to conserve Inle Lake and its catchments and to improve the lives of the people who live there. However, the failure to achieve substantive outcomes is threatening the sustainability of Inle Lake, its catchments and the ecosystems services they provide and, in turn, the livelihoods of diverse agricultural communities that depend upon them. These problems are commonly experienced in many parts of Asia undergoing rapid social and economic change.

The Challenge

In Myanmar, there is a high level of political will (e.g. the President) to address these issues facing the Inle Lake catchment communities, but it is a slow process of cultural and structural change. In this context, the Myanmar Government developed a Long Term Conservation Plan (2010-25) for Inle Lake and two associated rolling 5-year Action Plans (2010-15; 2015-20) to implement the Long Term Plan. In addition, it established a three tiered structure for the overall management of Inle Lake; at the National/Union (policy) level; the Shan State (supervisory) level and the Township (implementation) level, and it also initiated a process of decentralisation (but rarely devolution) of responsibilities from the Union level to the Shan State and Township levels. Notwithstanding, weak institutional capacities and their dysfunctionality in practice have inhibited efforts to effectively manage the biophysical, socio-economic and institutional drivers of the lake's problems. The outcome has been:

- A lack of information, baseline data and analytical capacity to support the development of a more holistic understanding of the problem and its management;
- Lack of capacity for co-operation and coordination across agencies and levels of decision-making;
- Minimal consultation, connections and engagement by Government with local communities to better understand the problem and its solutions and to take action; and
- Poor in-country capacity for inter-disciplinary research to address the cross-sectoral and cross-cutting issues facing Inle Lake and to support an integrated catchment management approach to improving the Inle Lake environments and the sustainability and profitability of the livelihoods of the Lake catchment's diverse rural communities (agricultural, forestry and fisheries.

The Myanmar Union Government's reform process since 2008, that has led to rapid and significant changes to institutional arrangements is opening up opportunities for broadened engagement of NGOs, international financial institutions, the United Nations, and other international donor agencies to help build the government's capacities to address the challenges facing the long-term health of Inle Lake and the livelihoods of the people that depend on it. Long term and on-going technical cooperation from donors, NGOs, etc. is urgently needed. However, the cooperative technical initiatives that did ensue have only had limited impact to-date due to a number of inter-related factors including:

- The complex and wicked nature of the Inle Lake problem;
- The inadequacies of Myanmar's institutional capacities to:
    - implement the Action Plans collectively across all government agencies; and
    - engage the diverse Inle Lake and catchment communities has meant.

- Fragmented activities; all largely doing their own thing and lacking co-ordination, connection or synergy with each other, and thus with little long-term impacts;
- Government agencies at all levels lack the capacity to monitor and evaluate environmental and social parameters effectively or to follow up on project activities undertaken; and
- Monitoring and evaluation (M&E) has focused on project activities identified in the Action Plan and rewarding their implementation (e.g. tick the box) to the neglect of understanding the impacts / outcomes for the catchment system itself as well as rural livelihoods in a holistic whole of catchment way.

The Research Opportunity

Over the last twenty five years, in seeking more sustainable futures to complex cross-sectoral and cross-cutting management issues, Australia has had a challenging but unique experience with linking policy, science and community through integrated approaches at a catchment or regional scale for enabling more sustainable resource use and economic development. Many lessons have been learnt from the challenges faced. The integrated approach focuses on:

- working cooperatively across institutional boundaries and multiple levels of governance;
- developing a systematic understanding of the catchment including approaches to catchment processes and their management; and
- engaging government and communities through collaborative processes to work together to better understand management problems and to collective take action.

The key overall research gaps identified through the situational analysis presented above can be summarised as:

- Understanding the institutional capacity needs for an integrated catchment management approach to cooperating within and across Ministerial portfolios, at the Union, Shan State and local Township levels, and to collectively address key issues affecting the long term future of Inle Lake's catchment system and its communities; and
- A better understanding and situational analysis of the Inle Lake catchment system, including the impact of the interaction of land use, sedimentation, water quality, lake ecosystem, and community livelihoods.

As identified in this SRA Report, the Myanmar Government has been challenged by not only a lack of cooperation amongst government agencies but a lack of appropriate institutional capacities to implement an integrated management approach that can address the complex cross-sectoral and cross-cutting issues facing Inle Lake and its catchment system. This failure is threatening (a) the long-term conservation and sustainability of Inle Lake and its catchment system, and (b) the sustainability and profitability of the livelihoods of the communities that depend upon the services that system provides.

In this context, the situational analysis provided in this SRA report gives rise to a number of research questions for shaping the proposed overarching program of research (possibly over 5 or more years). These questions are relevant to the Inle Lake catchment situation and also to many other contexts in Myanmar, as well as more broadly to developing nations in Asia where complex wicked policy problems affect the sustainability and profitability of rural livelihoods. These questions are:

1. What institutional capacities can enable integrated community-based management approaches that contribute to minimising adverse impacts on the catchment system and improving the sustainability and profitability of rural livelihoods; and how can these capacities be strengthened and adapted to changing circumstances over time?

2. How can integrated catchment management approaches contribute to:
    a. enhancing smallholder farming and fishing capacities for managing change (technological and behavioural);
    b. improving rural livelihood outcomes;
    c. minimising adverse losses of sediments and nutrients from managed lands and, thus, increase agricultural productivity and protect the lake environment; and
    d. providing food security for the region?
    e. Recognising and addressing gender-related issues.

3. What technical understanding, analytical capabilities, and assessment mechanisms support an integrated approach to:
    a. identify and manage 'hot spots' within the lake and contributing catchments; and
    b. understand the inter-connectedness of different drivers or causes with impacts or outcomes; and
    c. Improve the sustainability of agricultural practices while avoiding adverse impacts on human health and the environment?

4. What are the intrinsic values of Inle Lake to the residents in and around the lake as well as its contributing catchments? Are these values related to: sources of long term revenues; environmental attributes; a food supply; cultural significance: or (e) other amenity, social or livelihood outcome?

A series of shorter-term research for development components will underpin and be directly inter-linked to the overarching research program. The program and its supporting components will be purposefully designed to:

- Provide a better technical understanding of specific aspects of the linked natural and social science systems affecting the wicked policy problem and will include technology transfer to improve the sustainability and profitability of rural livelihoods;
- Recognise Myanmar's transitional context as a long term process; thus activities will be tailored to local context and capacities;
- Strengthen partnerships with key stakeholders in Myanmar including community interests that build on existing capacities and enable the achievement of outcomes in a more coordinated, coherent and complementary way;
- Be inclusive of the different stakeholders and address issues related to gender in a proactive but sensitive way wherever appropriate;
- Allow for flexibility to enable implementation to be adjusted as appropriate to changing political and institutional contexts; and
- Engage in partnership with a number of key government and research institutions to boost institutional capacities, including training opportunities for promising young talents.

The overall project will be implemented at a number of institutional levels (national, state/regional and local) and may involve selected "pilot" sub-catchment studies. The criteria for selection of these will be developed based on the outcomes of initial assessments (e.g. hotspots – biophysical, institutional, capacity-building, livelihoods) to be undertaken at the initial phase of the project and will be established in co-operation with research partners.

2. Introduction

2.1. Background to SRA

Inle Lake and its catchments, located in southern Shan State, Myanmar, covers an area of approximately 3,640 km^2 of significant environmental, economic, social and cultural value to the Myanmar people. Inle Lake has been listed as an ASEAN Heritage site, it is on the Tentative List of UNESCO World Heritage Sites and UNESCO is currently investigating the possibility of listing Inle Lake as a Man in the Biosphere Reserve (MOECAF 2013; 2014). The Lake and its catchments are also a vital part of the economy of Shan State and the nation, providing many goods and services that support the diverse livelihoods of its agricultural, fisheries, forestry and tourism communities. It also acts as the main water source for the Law Pi Ta hydroelectricity power plant. Some 890, 000 people inhabit the lake and its four contributing catchments. Renown for a number of cultural and livelihood practices (floating gardens, weaving industry, traditional leg-rowed boats), the lake is one of the main tourism attractions in Myanmar, with over 300,000 international and domestic tourists visiting each year, providing a critical boost to the local and national economies (IID 2012a; MoHT 2014).

Increasing population growth, growing tourism, the expansion of agriculture and unsustainable livelihood practices are threatening the sustainability of Inle lake and its catchments and the ecosystems services they provide, as well as the sustainability and profitability of livelihoods of the people that are dependent on them. The challenging and complex nature of the problem regarding Inle Lake and its catchments is identified in Myanmar Government's "*Long Term Restoration and Conservation Plan for Inle Lake, 2010-2025"* (MOECAF 2013) and the related rolling 5-year "Action Plans" (2010-2014; 2015-2020). Collectively these plans aim to restore the Lake and provide sustainable and long term solutions through an integrated community-based catchment approach to more coordinated action.

Although the Lake has been the focus of past research and development investment and numerous efforts by different Government Departments, donors, NGOs and other agencies, the problem has continued to deteriorate. Part of the issue relates to the limited availability of data and information and also that what is available is poorly integrated, often sectorally-focussed and lacking a holistic perspective of both the problem and solutions; therefore of limited value and impact. There is also broad recognition of the need to develop the capacity of the Inle Lake catchment institutional framework to work more effectively with integrated and community-based catchment approaches to better support collective action IID 2012; MOECAF 2013; 2014). A three tiered institutional arrangement (national, state and local) supports the implementation of these plans. However the fragmentation of problem understanding as well as responsibilities for management and action across government, industry and community are well recognized as major on-going challenges for effective solutions for the lake and its agricultural, forestry and fisheries communities.

ACIAR is examining the feasibility of a research for development program to improve the sustainability and profitability of smallholder farming and fisheries in the Inle Lake catchment of Myanmar. In October 2014, ACIAR commissioned a study to determine the feasibility of a long-term, multi-disciplinary research for development program around Inle Lake (Roth et al, 2014). The study verified that there is a strong business case for investment in research for development and strongly endorsed an integrated catchment management approach. To this end in March 2014, ACIAR commissioned a Small Research and Development Activity (SRA) to further develop the program as a potential phased multidisciplinary multi-project program of work that could occur over a period of up to 8 years (see TOR, Appendix 6.1).

2.2. SRA Aim and objectives

The overall aim of the proposed ACIAR research program is to develop a long-term, multi-disciplinary research for development program to improve the sustainability and profitability of smallholder farming and fisheries in Inle Lake and its catchments, Myanmar. The staged objectives of this ACIAR Small Research and Development Activity (SMCN/2014/050), "*Towards a multidisciplinary program for improving rural livelihoods through integrated management of the Inle Lake catchment, Myanmar*" are to outline an approach for a larger research program and to:

1. Build relationships and establish commitments with Myanmar Government agencies and research institutions, NGOs, international donors, and community organisations associated with the management of Inle Lake and Catchments.
2. To develop with the local partners an outline research Program that addresses research questions for sustainable biophysical, economic and social development of Inle Lake catchment.
3. Determine the detail of the first project of the program that will act as the umbrella project for the whole program.

The SRA will establish the program goals, activities, outputs and impact pathways and provide a framework of potential projects; including a process for reviewing and adapting the framework to manage risks and opportunities as they emerge and evolve. It will consider program delivery and monitoring and evaluation. The outputs will be an SRA Report, followed by ACIAR Phase 1 and Phase 2 project proposals for the first project of the program (SMCN/2014/050). The first project will be designed to: (a) collect targeted baseline data and information and undertake priority research on fundamental catchment and lake processes, as well as the social and institutional aspects of integrated catchment management for sustainable and profitable rural livelihoods; (b) act as an integrative platform for the research and delivery of outputs; and (c) provide management and evaluation of the program.

2.3.1 Scoping Phase

The SRA Research Team travelled to Myanmar from 29 March to 6 April 2015 to scope the project and to build relationships and establish commitments with Myanmar Government agencies and research institutions, NGOs, international donors, and community organisations. Focusing on a holistic integrated catchment approach for Inle Lake and its catchments that includes both problem assessment and solutions, the SRA Research Team engaged with a diverse range of stakeholders (see Appendix 6.3) to establish interest in and capacities to collaborate in a possible program of research. This is to be achieved through:

- Developing a better situational understanding of Inle lake and its catchments' livelihood systems, environmental status, institutional arrangements and management capacities;
- Developing a better understanding of technical options for addressing the lake and catchment degradation and associated unsustainable practices, whilst improving livelihoods;
- Addressing the difficult issues of co-ordinated and collective action and the related institutional deficiencies in government to enable key stakeholders in government and community to work better together ; and
- Supporting the Ministry of Environmental Conservation and Forestry's (MOECAF) 'Long term Plan' and 5-year 'Action Plans.

This SRA Report overviews the findings of this initial scoping phase of the SRA, as a basis for further development of a collaborative research initiative.

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3. Overview of the Inle Lake catchment system

This section of the SRA Report presents a situational analysis (i.e. bio-physical, socio-economic, institutional, and livelihoods) of the Inle Lake catchment system. It provides the context for a discussion of key issues and gaps in knowledge and understanding and to identify potential targeted research opportunities. It is based on a selective review of previous studies and the findings/outcomes of meetings and interviews held during the SRA Research Team's visit to Myanmar from 29 March to 7 April 2015 (see Appendix 6.2).

3.1. Bio-physical conditions

Understanding the biogeophysical processes within the catchments that drain into Inle Lake, as well as in the lake itself, is essential to assess the impacts of land use practices, land use change and livelihood trajectories on the sustainability of this ecosystem. In turn, improved knowledge of the cumulative effects of land management and development practices (e.g., agriculture, roads and trails, residential/tourist development) on biogeophysical processes is critical to achieving sustainable solutions for lake and catchment management.

3.1.1 Inle Lake Context

Inlay Lake is located in the Taunggyi District of the southern Shan State of Myanmar (Figure 1). Certain biophysical characteristics and ecological conditions are documented in recent studies and research papers (e.g. Jensen 2012; IID 2012; MOECAF 2013; 2014; Sidle 2007; Furuichi 2008) which underpin the following brief overview description the Inle Lake catchment system.

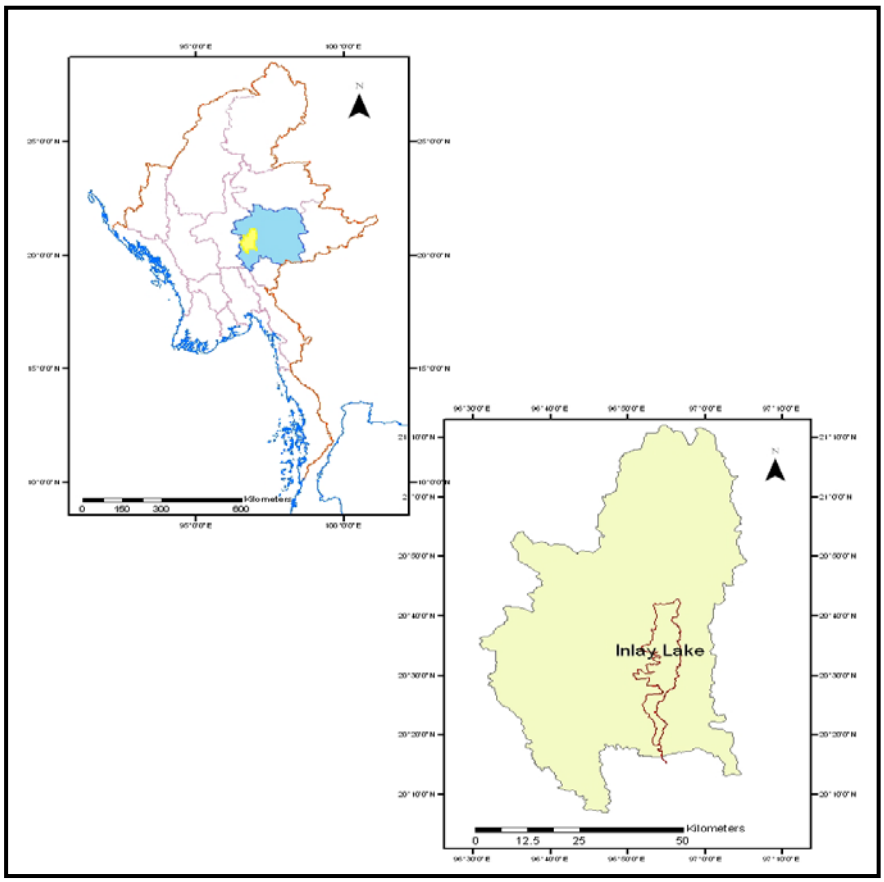

Figure 1. Location of Inle Lake in southern Shan State of Myanmar (Source: Roth et al. 2014)

Inle Lake is a shallow high-altitude water body lying at about 900 metres altitude in an elongated, flat-bottomed valley that runs almost north – south and is bordered by parallel mountain ranges of mostly limestone base rocks that rise up to 1500 m in altitude. The lake, formed by solution processes, receives most of its run-off from four major sub-catchments, Namlet, Negya, Kalaw (Thandaung) and Indein (Upper Balu), which have a total catchment area of 3,640 km^2 (MOECAF 2013). The lake has one outlet which flows to the south entering the Thanlwin River via a weir. Inle Lake is the first of a series of three lakes flowing into the Myobe Reservoir, which supplies the Law Pi Ta hydro power station. IID (2012) argues that the two deeper downstream southern lakes largely control the supply of water to the 168MW power station, and the influence of Inle Lake is only significant in very dry conditions.

3.1.2 Lake Conservation

Myanmar relies largely on ecosystem services for the livelihood of its population and economic growth. This is particularly pertinent to the agriculture and forestry sectors. About two-thirds of the Myanmar population is dependent for their livelihoods on agriculture in rural areas (MOIA 2014, p. 126). Forests are also fundamental to the socio-economic well-being of the people of Myanmar, providing local villagers not only numerous forest products to fulfill their basic needs but also contributing substantial foreign exchange earnings to the State economy, notably through timber trade (Tint et al. 2011). However, mature commercial forests do not now exist to any great extent in the dry regions of the catchments draining into Inle Lake.

Inle Lake and its wetlands support fisheries and aquaculture resources for the communities of the Shan State, and important habitats for migratory bird species in the East Asian Flyway (MOECAF 2013). Inle Lake has been on the Tentative List for World Heritage Listing since 1996, and it was recognized as an ASEAN Heritage Site in 2004 (IID 2012). In 2013, MOECAF submitted an application to UNESCO for the declaration of Inle Lake as a UNESCO Man and the Biosphere Reserve (MOECAF 2013). Notwithstanding, it is commonly perceived that Inle Lake is suffering environmental degradation from the combined effects of a range of factors including: land use change; unsustainable resource use (e.g. forest conversion, overfishing), introduction of alien species, increasing population pressures, climate variability and change, increasing urbanisation and rapid tourism development (Jensen 2012; IID 2012a; MOECAF 2014; MoHT 2014).

- The Inle Lake wetland and watershed area is important for migratory birds, particularly water birds migrating between Siberia and Australia (IID 2012a). A 10.36 km^2 sanctuary in the northern fringe of the lake is designated as a Bird Preservation Area, where approximately 25,000 to 30,000 birds, consisting of approximately 270 species, gather during the cold season (MoECAF 2013).
- The Inle Lake Wildlife Sanctuary, Park Warden's Office in Nyaungshwe has conducted some basic biodiversity surveys to characterize the flora and fauna in and around the Lake (MoECAF 2013).
- There are reports of decreasing native fish populations, declining habitat and biodiversity values, and decreasing numbers of migratory water birds (IID 2012a). However, no comprehensive baseline surveys have been conducted to determine the present status of biodiversity in the lake, or to monitor change over time.

3.1.3 Declining Lake Levels

A key functional driver and limitation in the greater Inle Lake ecosystem is water. A recent concern that has been expressed by most agencies and groups working around the lake that we met is the declining water levels, especially since the 2010 drought. A severe drought in 2010 exposed a

number of management issues resulting in severe water quality and navigation problems in the Lake (MOCAF 2013). Water levels in the lake affect almost all biogeophysical processes around the lake and in the upper catchments (e.g., erosion, water and sediment routing, nutrient fluxes, contaminant transport). These processes are all scale-dependent and a major challenge is to determine which spatially and temporally distributed land uses exert the major impacts on particular processes and attributes of the lake.

Currently, there is considerable concern that another severe drought may be recurring, creating a range of major management issues that threaten the long term sustainability of the lake and also the sustainability and profitability of smallholder agricultural and fishing livelihoods. It is not clear how much of the current 2015 drought conditions and lower lake levels are related to the rather severe 2010 drought (especially since 2011 was a La Niña year with heavy rains and considerable flooding reported).

Notably, there is a lot of ambiguity and even controversy over the reality of Inle Lake's changing dimensions and the perceived loss of open water area (see Figure 2).

- MOECAF (2013) states that the lake area pre-1900 was 271 km^2, but by 2007 it had decreased to 163.2 km^2, of which only 62.2 km^2 remained as open water surface area.
- Sidle et al. (2007) quantifies the loss of open water as a 32.4% reduction in area from 1935 to 2000, with the primary cause being expansion of floating island agriculture from the 1960's and the resultant placement of derelict gardens around the lake shores (Figure 2).
- Jensen (2012) points out that although there is a general perception that Inle Lake is filling with sediment, it appears to be restricted to the edges and near floating gardens, villages and navigation channels. Significantly, the overall depth of the lake is reported at similar values in 2010 as were reported in 1918; that is, at 6.0 m deep at the deepest point in the wet season (Jensen 2012).
- An investigation by Furuichi (2008) undertaken in 2005-2007 found that the water holding capacity of Inle Lake did not significantly decrease by sedimentation, with only 1% of sediment retained in the lake, and 5% flowing through into the outlet stream.
- The depth of the lake fluctuates with the seasons. The lake is 6.0 m deep at the deepest point in the wet season, and 3.6 m in the dry season, with mean depth of 4.0 m (IID 2012a). The volume of water flowing into the lake as a rule is replaced every three months by the relatively high flow of run-off and through flow, although water on the lake edges has a slower exchange rate (IID 2012a).

A major research challenge is to analyse the scant rainfall data available together with documented changes in lake levels to ascertain whether the changes that have been mentioned are: (a) significant; (b) prolonged; and (c) driven by changes in rainfall inputs and regime. The effects of climate anomalies and possibly climate change on lake levels need to be separated from anthropogenic impacts (e.g., water use in the catchment, diversions, changing land use).

In conjunction with these concerns regarding change in area of the lake and increase in area of floating gardens, there is a perception amongst villagers and many community-based people the SRA Research Team interviewed that the lake is degrading due to a number of factors, including:

- Agricultural expansion in shallow water areas;
- Overuse of fertilizers and pesticides (possibly exacerbated by rapid migration of chemical inputs through the porous and wet organic mats that comprise the floating gardens);
- Establishment of human settlement and congregation of domestic animals in and near the lake - in particular, human and animal pathogens/viruses in faecal matter and the problems associated with disposal of these and other solid wastes in the lake;
- Invasive species, such as water hyacinths;

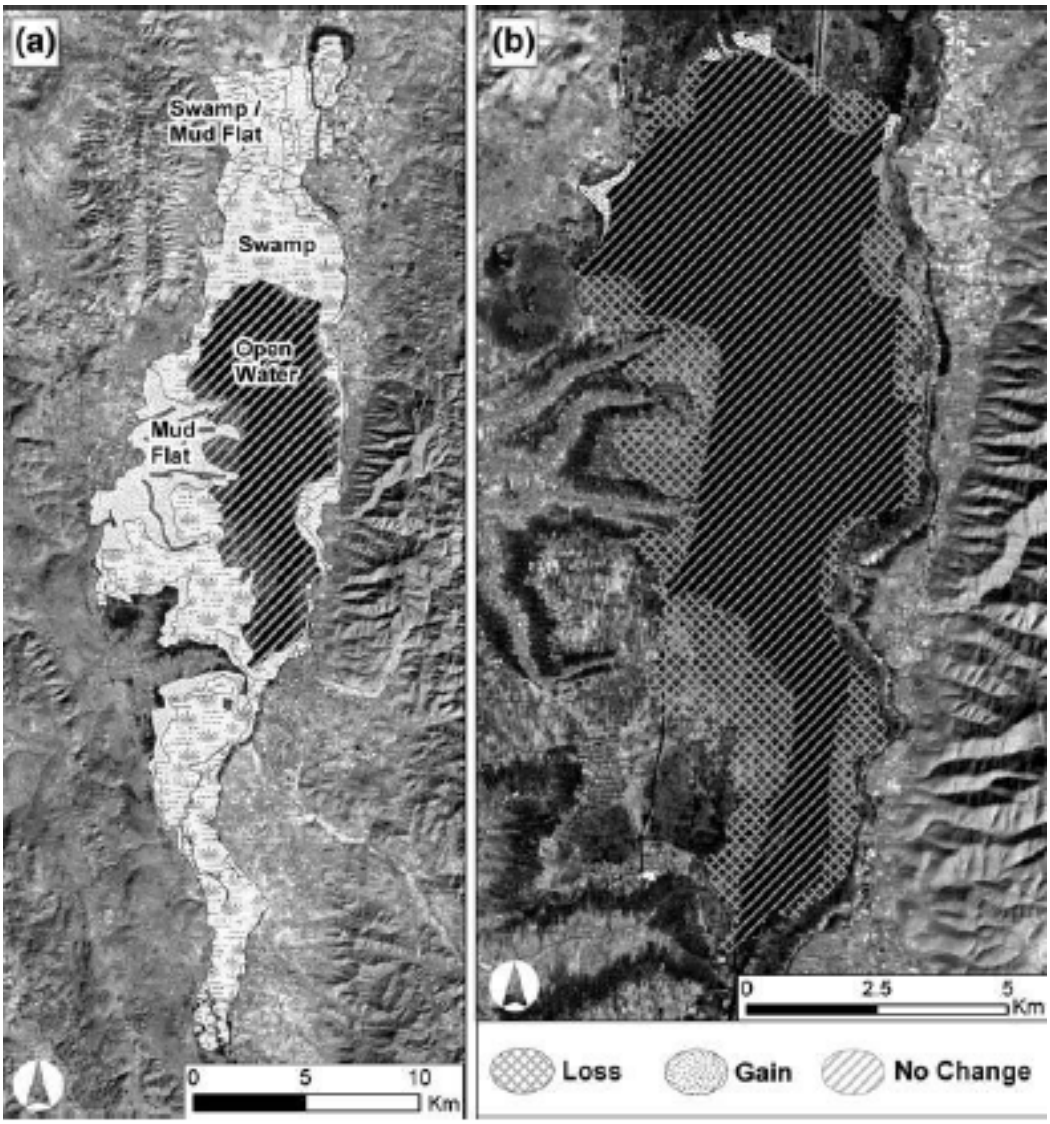

Figure 2. Comparison of open water area in 1935 and 2000, showing 32% reduction mainly due to expansion and disposal of floating gardens particularly around the western margins of the lake and at major deltas on western coastal plains. (Source: Sidle et al. 2007).

- Reduced lake surface area and volume
- Reduced biodiversity in the lake;
- Poor water quality;
- Impact of increased tourism;
- Introduction of exotic fish species;
- Lower yield of agricultural production; and
- Scarcity of clean drinking water.

3.1.4 Forest Conversion

There is some evidence suggesting most of the Inle Lake watershed was heavily forested until more recent times with significant deforestation occurring during the later 19th and early 20th centuries due to a combination of factors including: change in land use, commercial timber harvesting, illegal logging, and intensifying pressure on remaining forests for livelihood needs, especially fuelwood and shifting cultivation (Thomson 1944; Tint et al. 2011). However, Sidle et al. (2007) found no evidence

of clearing (or even mature forests) near the lake; only a few isolated areas along the west side of the lake supported harvestable trees. This was also the situation observed by the SRA Research Team during their recent visit.

Under Myanmar law the forests belong to the government but it is a complex situation. Forest law is incomplete and often management is covered more by other laws. Land tenure can also contribute to resolving forest conversion through community forestry, but it is difficult for farmers to commit to long term investment if tenure is not secure. New laws expected to be introduced however will permit private ownership of some types of trees (e.g. teak).

In the last 20 years, the country has lost 20% of forest cover (stated by MOECAF Minister March 2015). The SRA Research Team was also advised that MOECAF have satellite imagery of Inle Lake going back to pre-1990 and there appears to have been a large decrease in forested catchment area between 2010 and 2015 (during the 1st 5-yearAction Plan period) due to:

- Population pressure;
- New village settlement;
- Expansion of agricultural land;
- Change in forest laws; and
- Land grabbing – criminal activity (cronyism)

Forest conversion continues to be an issue of some concern in Myanmar today. Forests are being cleared for agriculture, and procuring wood for cooking as well as constructing containers for exporting tomatoes (MOECAF 2014). Rates in the Inle Lake watershed have been described as unsustainable (MOECAF 2014).

- In 2010, the Inle Lake watershed was 35% forested, 33.8% agriculture, and 28.8% other (IID 2012). Dense forest canopies comprised 6% of forested lands, sparse canopies 30%, and 14% of the area was considered in between these two categories (IID 2012a).
- Midgley et al. (2012) argues that changing land management practices and introducing conservation vegetation to protect the soil from raindrop impact are valid solutions for reclaiming areas of shifting cultivation (now only 1.5% of the catchment) and hill agriculture.
    - Since 1995, the Myanmar Government has been implementing a system of community forestry to re-establish stable vegetation and reduce erosion that is achieving a measure of success. The secure forest rights implicit to community forestry allows communities to use forest resources to diversify and strengthen their livelihoods. However, community forestry is insufficient in scale, not focussed enough spatially to address 'hotspots', and not attractive enough to be taken up by communities and maintained with an establishment phase of at least 5 years (Tint et al. 2011; ID 2012a). (Note: the Forest Research Institute (FRI) in Yezin is the focal point for community forestry in Myanmar).
- Some limited reforestation projects are underway in the uplands. Assuming these are focusing on native species or at least drought tolerant species, this could reduce erosion from localized 'hot spots'. However, the impact on the lake would likely be minimal.
- Fuel wood has long been the main source of energy for the rural communities of the Inle Lake catchments and currently is a significant cause of forest clearance (particularly in the upland areas) and possible also water pollution due to the flow of ash into the lake (MOECAF 2014). The Department of Forestry (DOF), who has responsibility for the conservation of forests, has promoted the use of energy efficient stoves as alternative sources of fuel.
- MOECAF (2013; 2014) suggest that alternatives to wood-based containers for packaging tomatoes can significantly reduce wood consumption; 90,000 tonnes of tomatoes are produced annually (including 300 tonnes per day during peak season), and over 75% of this harvest is exported to Yangon and other states.

3.1.5 Soil erosion and sedimentation

Sediment produced by erosion and transport downstream is a natural catchment process, which has historically formed the basis for irrigated agriculture on alluvial flat lands and on the lake shores (Jensen 2012). The shallow form of the lake and the natural flows of water and sediment have created extensive marshes and wetlands on the edges of Inle Lake.

Erosion in the Inle Lake and its catchments are commonly perceived as a major issue, with sediment loads being transported to the deltas and the lake, especially in the wet season (IID 2012b). However, the process of sedimentation is complex and controversial in relation to its impacts on Inle Lake and its catchment. Additionally, sediment may carry adsorbed nutrients and contaminants that can contribute to lake degradation. Particularly, phosphorus can be tightly bound to sediments and some nitrogen is exported via sediments as well. These not only affect lake chemistry, but also promote aquatic plants and affect benthic organisms within the lake. Some relevant considerations include:

- There is much evidence to indicate that these erosion and deposition processes have greatly accelerated in the Inle catchment areas over the last 50 – 100 years due to forest conversion and cultivation pressures (Thompson 1944; Furuichi 2008; Midgley et al. 2012). Given the naturally shallow nature of this solution lake, climate anomalies, and the dynamics of sediment inputs, it is understandable that the lake margins may fluctuate from year to year.
- Furuichi (2008) concluded that sediments accumulating on the Indein and Kalaw deltas provide farmers with benefits in fertility for agricultural crops. However, this also results in significant shallowing of near-shore areas around the edge of the lake, as silt accumulates around villages and under floating gardens.
- Furuichi (2008) and Midgley et al. (2012) have argued that most sedimentation comes from a few “hot spots” within the catchment and that efforts should be focussed on these sites.
- Erosion around the lake appeared to be concentrated in ‘hot spots’ associated with: (a) hotel (especially the new ‘hotel zone’ on the east side of the lake) and residential development; (b) associated roads and trails, including in agricultural areas; (c) selected over-grazed sites; (d) some poorly managed tilled fields; and (e) other areas of disturbance. Other erosion directly connected to the lake occurred from: (a) boat traffic along excavated channels and raw banks; (b) bank erosion itself; (c) soil loss from floating gardens (both active and derelict): and (d) dredging activities, although these appeared to be restricted to boat transport channels.
- The Shan State Irrigation Department (ID) is dealing with some of the sediment issues and is in charge of:
    - Dredging the lake;
    - Removing water hyacinths (300 acres/yr) and old floating gardens;
    - Check dams which are cleared once a year, especially Nanlet catchment. (Note: it was suggested to ID they measure the quantity of sediment they remove).
- While some of the agency and smallholder people we spoke with indicated that while they welcomed ID dredging activities to move these sediments out of the lake transportation and irrigation channels, these are not sufficient for the task.
- Sidle et al. (2007) as well as some farmers and fishers interviewed by the SRA Research Team expressed the view that both floating gardens and ‘wild gardens’ act as sediment ‘traps’ at times of low water that might otherwise move into the lake and go out with the faster main flow.
- While the SRA Research Team did not encounter extensive areas of erosion during the field trip, local serious gully erosion, and some sheet and rill erosion were observed. Remote sensing and GIS analysis would enable some form of macro-assessment of erosion hotspots within the catchment.

- Erosion was observed to be significant by the SRA Research Team in some poorly managed upland areas, but connectivity of sediment flow to the lake is questionable – except possibly for colloidal material. Gully systems were observed in upland areas where scrub forest cover was converted to pasture and then over-grazed, sometimes exacerbated by road runoff. Better upland soil and water conservation measures would benefit on-site erosion, but it is not clear whether this would have any impact on sediment delivery and associated nutrients to the lake. Prevailing ideas were that local erosion data were needed, but there was no conceptualization for the need to link upland erosion to downstream environments (e.g., the lake).
- There is a conspicuous lack of hydrology data. To the best of our knowledge, there are no active stream or river gauges with the greater catchment area and there is no systematic collection of flow and sediment data. We heard contradicting stories about sedimentation monitored behind several check dams, although there was no convincing evidence that any of these had reliable records that could be used for sediment production from the influent streams. Additionally, the number of rain gauges is insufficient to assess rainfall-runoff relations even if a stream gauging station is later implemented. There appears to be no recording rain gauges; thus it is impossible to evaluate temporal changes in storm dynamics and size.

3.1.6 Nutrients and other Contaminants

Nutrient flows through a landscape are a natural process that supports production of ecological goods and services. Although nutrients are moving into the lake with some sediments much of this is being deposited in deltas where it is useful to agriculture (Jensen 2012). However, this production of goods and services can be overwhelmed by unusual disturbances to the natural buffering system that exist in the food chains. Issues related to nutrient and contaminant influx to the lake include:

- Jensen (2012) note that there is evidence of vegetative blooms and declines in fish stock occurring in Inle Lake. Reports suggest the major source of nutrient inputs into the lake is linked with natural or artificial fertilizer run-off (particularly with the growth of floating tomato gardens on the lake) and population growth pressures.
- Water quality assessments reveal that drinking water supplies for lake villages do not meet WHO guidelines (IID 2012a).
- Tomato cultivation on the floating gardens has been practised for a long time on Inle Lake. but with the transition to a market economy from the early 1990s, the number and size of tomato floating gardens has greatly expanded (Okamoto 2012; see Fig. 2).
- Farmers routinely use chemical fertilisers, pesticides and organic fertilizers for the tomato gardens. Butkus and Su (2001) and Kywe (2014) have identified the volume of pesticides used often far exceeds the recommended rate. Daw and Kyaw (2000 quoted in Alkaishi et al. 2006) claim that the mass of the floating gardens contain nitrogen levels six to eight times higher than those of the soil.
- The problem is exacerbated because farmers use hybrid seeds for popular crops (e.g., tomatoes) that require more fertilisers and pesticides than non-hybrid crops (MOECAF 2013).
- A recurring theme from the various agencies and universities we spoke with was also the excessive nutrient and pesticide leaching into the lake from applications on floating gardens, but they were poorly documented – particularly in terms of water and sediment quality. Capacity for analysis of these components may emerge in the near future, but data need to be collected in a systematic manner. We did not see massive algal blooms in the lake, but aquatic weeds were abundant and have increased dramatically in the past decade. However, the SRA Research Team did not explore the marginal waters where lake turnover

would be slower. It will be necessary to review the existing data on water quality (or collect some baseline water quality data) before determining how to proceed.

- Many people are highly dependent on floating gardens which is putting pressure on the lake:
    - It was suggested by people met by the SRA Research Team that: (1) the Survey Departments has collected annual data on the area of floating gardens for about 20 years or more; (2) following the transition to the new Government in 2010, there has been an expansion of floating gardens and in-lake housing. These need to be followed up.
    - Concerns exist about over-use of chemicals (fertilizers and pesticides) but tomatoes are high money making commodities, which makes the costs of extra input potentially worthwhile.
- Fishermen depend on Lake Inle for their livelihoods. However the Lake has been undergoing environmental degradation for some years. These changes have reduced the fisherman's catch especially that of species unique to the lake (Su and Jassby 2000). Adding to the long term decrease in the catch because of this degradation, fishermen not only faced extremely low water levels in 2010, but the introduction of fish (including non-endemic species), which is changing the playing field/situation.
- Other lake contaminants: Domestic wastes directly enter the lake through homes built on the lake and sewage drainage from homes and hotels along the perimeter. Treatment is minimal and better, low-cost methods and facilities are sorely needed as is a monitoring program to determine the extent of the problem. Additionally, the issue of oil/gasoline spills into the lake related to increasing tourist boat traffic needs to be addressed.
- Concerns were raised over biodiversity issues in the lake. From a fisheries standpoint, this appears to be a 'lost cause' because exotic species have already taken over the lake and the focus now seems to be on commercial fisheries production. Waterfowl could be a different issue, especially related to pollutants in the lake.
- Jensen (2012) points out that water and sediment parameters are now above the WHO guidelines for drinking water. However no measurements are available to establish natural baseline conditions in the lake, for example the natural level of alkalinity due to the dominance of limestone in the watershed (Jensen 2013).
- Oo et al. (2010) identified that until 2005, instructions leaflets on chemical products use were not translated into Burmese, and farmers had to use chemicals by trial and error. Since then, imported products require a Burmese instruction manual but this obligation cannot be enforced on the black-market.
- Climate change as a driver of lake change (often unspecified) was noted in several discussions, but absolutely no real evidence was presented. It appears that anthropogenic change and climate anomalies (La Niña or El Niño events) have much more impact on the lake than climate change. This underlines the importance of establishing better rain gauge networks (including some recording gauges).
- Changes in nutrient flows and the impact on water quality and sediments and the follow on impacts on human health and the 'health' of flora and fauna on and in the lake is an area of concern. Analyses by Alkaishi et al. (2006) found the main problem was eutrophication largely from human activities. The situation with nutrient transport and chemical transformations due to agriculture in the delta and on the lake is quite complex and requires a more detailed analysis. For example, it is important to understand nutrient budgets in the lake, including fluxes into the lake from terrestrial sources and the floating gardens, release of nutrients from sediments, transformation of nitrogen from organic to mineral phases, and nutrient export from the lake.

3.1.6 Conclusion and Issues

Jensen (2012) and IID (2012a) emphasized the limitations of data that are available in the Inle Lake region and the research that has been done. This was confirmed in our meetings with agency and university people during our scoping visit. Some key issues are:

- In the IID ecological status report, Jansen (2012) concluded that:
    - No long term data sets for environmental parameters have been found, which makes it impossible to assess the degree of change in the different parameters, or trends of change.
    - it was not possible to determine the extent of changes in individual environmental parameters (e.g. increases in nutrients or pH of lake water, or the date when changes were first detected). Thus, general conclusions can be drawn, but more data are required to provide a sound scientific basis for management recommendations.
    - There are insufficient historic data to establish the natural baseline condition in Inle Lake, in order to assess the extent and rate of change in key processes affecting water quality and ecosystem condition.
- There is continuing controversy over the source of sediments in the lake (eg. relationship to soil erosion in the uplands) and more updated analysis is needed regarding hotspots to be managed (Furuichi 2008; Sidle et al. 2007). In addition there is controversy over whether the marshes are causing siltation or are sinks as part of their ecosystem function (Jensen 2012). Both of these controversies have implications for management responses, such as dredging or management of derelict floating gardens.
- More information is required to identify if the Inle Lake is eutrophic. No particular reference has been found which presents the evidence for this assessment. Statements that the lake is eutrophic are attributed to other authors, but all papers only contain the generalised statement that the lake is eutrophic without substantial data to support this conclusion. The most evidence available is that limited spot samples of lake water have contained nitrogen and phosphorus at levels which are high enough to cause eutrophication. There is no a baseline for natural levels of nitrogen and phosphorus in the lake, or dates or rates of increases (Jensen 2012).
- Water quality assessments conducted in Inle Lake reveal that only a few parameters meet WHO standards (MOECAF 2014). Understanding the impacts on water quality and the food chain will be critical for finding ways to ensure sustainable future management of Inle Lake for supporting sustainable and profitable farming and fishing livelihoods.
    - Consistent monitoring data will be essential to understand the trends of change in the lake, and to monitor the effectiveness of management actions. (Jansen 2012).
- No surface hydrology data exists for any of the streams/rivers draining into Inle Lake. As such, there is no way to construct meaningful nutrient or sediment budgets, even if these parameters are measured at specific periods. Thus, there is a clear need to establish at minimum one stream/river gaging station. Accumulated streamflow records can then be analysed together with an improved rainfall collection network (preferably with the inclusion of a few recording rain gages) so that data from the gauged catchment can be extrapolated via hydrology models to other contributing catchments. This will provide the needed dynamic water input data to better assess water quality and lake level issues.
- In the absence of traditional sampling data in long term data sets, useful data could be obtained by (Jensen 2012; IID 2012a):
    - Develop a coordinated monitoring system for lake condition, with systematic data collection from a comprehensive grid of points measured regularly with consistent methodology, covering key parameters to measure water quality, water level, water

depth, sedimentation rates at identified hot spots, aquatic plant communities, status of native fish, and status of invasive species.

- Using satellite imagery to detect historic conditions at Inle Lake, particularly on the composition and distribution of aquatic plant communities of the lake. The data should also be assessed for useful information on the status of vegetation communities on hill slopes adjacent to the lake.

3.2. Socio-economic conditions

Inle Lake has a unique social, cultural and economic significance to the Myanmar people. Its conservation and sustainable management is of high priority to the Myanmar Government. As discussed in Section 3.1 of this report, the ecology and water levels of the lake are affected by almost all biogeophysical processes around the lake and in the surrounding catchments, including anthropogenic effects on these processes. The protection of the Inle Lake and its catchment system as a national asset is essential to sustaining local communities and sources of income (MOECAF 2014). Thus an understanding of the socio-economic processes and pressures, as well as the institutions involved in their management is needed; particularly the implications for the sustainability and profitability of smallholder agricultural and fishing livelihoods.

This section of the report outlines some of the socio-economic characteristics of Inle Lake and its catchments and Section 3.3 examines the institutional aspects.

3.2.1 Population, Social Structure and Livelihoods

- Population data are unreliable and contested in Myanmar (Nixon et al. 2013). Some reasons for this, include:
    - The lack of credible information re: the population numbers and projections for Inle Lake and its catchments (IID 2012a).
        - There are many different boundary definitions used in the literature for 'Inle Lake' and the broader 'Inle Lake region', which are not necessarily catchment-based (e.g. Township boundaries) and so, for example, population trends identified in different reports etc. cannot necessarily be legitimately compared.
        - As MOECAF (2013) states "Population estimates for Inle Lake and its catchments 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".
    - Moreover, due to the lack of appropriate/reliable census data for Myanmar, the population numbers used by the Myanmar Government are projected estimates based on the population trends observed in the 1990's (MOCAF 2013). Based on these projected population estimates, MOECAF (2013) provides the following population characteristics for Inle Lake region:
        - The population in the catchment has been growing at 11.5% per annum during the last two decades. The 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.km of the lake. In 2012, this number rose to 278; a 23% increase in 17 years;
        - The villages in the lake make up for 17% of the lake plus catchment population, whereas three times this population resides in the wetland village tracts (comprising 52% of the catchment population). The remaining 30% of the population resides in villages that are situated on Upland tracts.

- Using catchment boundaries, the population of Inle Lake and its four catchments is estimated to be approximately 890,000 (IID 2012a).
    - Of these, it is estimated that about 90,000 people inhabit Inle Lake and its nearby environs, while 800,000 people inhabit its four catchments (IID 2012a; MOECAF 2014).
    - Estimates of the numbers of villages and population living over water and in the seasonally inundated margins of Inle Lake are so variable that it is not possible to arrive at a consistent estimate, and Jensen (2012) concludes "San San Ye (2010) lists all the villages and the individual populations, so maybe she has the best estimate, with 135 villages in 22 village tracts, and a total of 60,025 people living over water".
    - With regard to Inle Lake and its periphery, which are either fully or partially inundated during the year, a commonly accepted estimate by IID (2012a) identifies 22 village tracts and 311 villages having a population of about 160,000, and a population density of about 300 persons per sq. mile (MOECAF 2013)
- In March/April 2014 however the Government of Myanmar conducted a full census for Myanmar. Only some provisional results are available to-date and these show the total population of Myanmar is only 51,419,420 (MOIP 2014). This is about 10 million less than the Government's previously projected population estimate of 61 million people by 2015 that has commonly been used in many of the policy-related publications and planning documents quoted above.
- Population pressure increases in the Inle Lake area was a common theme amongst agency, university and community people the SRA Research Team met on the Scoping Study. Perceptions were that the increasing population rate of about 1% pa was predominantly 'natural' growth and not imported from outside the Inle Lake area.
- Population density due to increasing urbanization, tourism development and settlement near the lake raises issues concerning waste disposal (sewerage, rubbish, animal manure used in floating gardens). This issue is not just confined to the near lake environment but also extends up into the catchment.

The diverse livelihoods in the region include floating agriculture, commercial fishing within the Lake, textile cottage industries (cotton and silk fabric weaving and dyeing), goldsmiths and carpentry (furniture making), domestic and international tourism, fish farms (ponds on land and cages within the Lake), metal smiths and motor driven boat transportation (MOECAF 2013).

3.2.2 Ethnic Groups

The dominant ethnic groups settled in the Inle Lake region are Inthas, Shans, Pa-O and Da-Nu. Sidle et al. (2007) identified that the population of Inle Lake is 70% Intha and 15% Shan. The ethnic inhabitants of Inle Lake and catchments are unique in the way they have adapted their lifestyle and livelihoods to their biophysical environment (ID 2012a):

- Most of the inhabitants of the lake and its near environs, the *Inthas*, earn their income by traditional methods of hydroponic farming and fishing. *Intha* farmers practice one of the most famous types of agriculture in the world, floating island agriculture, locally called 'Yechan' (IID 2012a). They grow vegetables, especially tomatoes, and fruit on the floating islands. As water is abundant for irrigation, crop cultivation on the floating gardens is very productive and provides significant economic benefits. Tomatoes, the primary cash crop, comprise about two-thirds of the region's agriculture (Butkus and Su, 2001).
- *Intha* fishermen are also famous for their unique leg-rowing style, which enables them to see fish from a greater height, and leaves their hands free to manage the fishing net. They have a particular affinity with the endemic *Intha* carp species, which is their prime catch

species and regarded as having special value in their culture (Ma Thanegi, 2005 quoted by IID 2012a).

- *Shan* people in the Inlay Lake area generally live a simple pastoral life. They are devout Buddhists but some believe in traditional spirits (Nats). Most of them earn their income by traditional methods of hydroponic farming and fishing (IID 2012a).
- *Pa-O* villages are found along the spurs of western and eastern ranges of Inlay Lake. The Pa-O people are Buddhists and they are primarily agriculturalists, although some are traders. They traditionally practiced shifting cultivation agriculture but many have now adapted to fixed farms and plant rice, cheroot leaves, tea leaves, garlic and potatoes on their farms (IID 2012a).
- Da-Nu people are mostly found in the western portion of the lake. Although they are mostly Buddhist, the Da-Nu deeply believe in spiritual and supernatural beings. Traditionally, their main occupation was farming but now most of them are traders, especially in textile and other religious goods and wares (Thi Dar Win, 1996 quoted by IID 2012a).

The *Intha Literature and Cultural Development Association* (ILCDA) is a community-based organisation established five years ago to conserve and maintain the Intha culture and traditions as well as the environment of Inle Lake and its surrounds in which the Intha people live.

- ILCDA provides an important social network for the people of the Intha community of Inle Lake who include fishermen, agriculturalists, weavers, restaurant and tourist facility operators, boat operators, and hotel operators.
- Each year ILCDA holds a ceremony and conference that brings together the Intha people for three days to promote activities and the Intha culture of Inle Lake.

3.2.3 Land Use and Land Use Change

Myanmar has had no land use policy since British rule. However as part of a major reform process, the Myanmar Government is developing a new land use policy (LUSASC 2014). It encompasses all uses of land resources and land use rights of the whole country, including rural and urban areas. It will specifically aim to harmonize existing laws relating to land and their implementation. To this end the objectives of this reform are:

- to benefit and harmonize the land use, development and environmental conservation of the land resources of the State; and
- to protect people's land use rights and to improve the land administration system.

Assessments of land use and land use change are critical to understand both social and economic change, as well as changes to biophysical processes within the catchment. There appears to be a paucity of extensive spatial assessment of land use and land-use change for the catchment. However, one recent assessment based on the Satellite imageries for 2010, identifies the current land use pattern as (MOECAF 2013):

Land under agriculture	2298.91 km^2	16 %.
Forests with sparse canopies	890.09 km^2	42 %
Forests with dense canopies	360.97 km^2	7 %
Other forms of Land use	1622.15 km^2	30 %.
Water Surface area	257.73 km^2	5 %.
Total	5429.85 km^2	100 %

This study also identified changes in the land use between 2005 and 2010 as follows:

Land under agriculture/other uses	+2%
Area under forests cover	-5.6%
Other Land use	-
Open water Surface area	-6.7%
Total	10.3%

The significant decrease in the forest cover and the open water surface area within a short period of five years indicate the severity of the 2010 drought situation. Thus these changes may be transient only.

Some other land use issues include:

- Opinions commonly expressed by government staff throughout the various meetings suggested that there had been an increase in shifting cultivation (presumably with shorter rotation periods), resulting in forest conversion and increased soil erosion particularly in the hill country. It is difficult to assess the veracity of this claim without further analysis. During the SRA Research Team visit, areas were pointed out to the group that were formerly State-owned forests, and which are now privately owned and being cleared for agriculture; however, most of these areas appeared to only support scrub forests.
- MOECAF have imagery of Inle Lake and its catchments going back to 1990. The Shan State Forestry Department suggested that these show that during the period of the first Five-Year Action Plan (2010 to 2015) there has been a large and sudden decrease in forested catchment area due to population pressure, new village settlement, expansion of agricultural land, changes to the forest laws and land grabbing (illegal activity and possibly cronyism)**.**
- During the field trip, the study group observed that parts of the mid-slopes in the north of the catchment included larger farms where repeated annual cropping was undertaken.
- It is possible that irrigated agriculture for rice and horticultural production has increased on the floodplains immediately adjacent to Inle Lake. Again, remote sensing analysis and GIS would be able to assess the scale of irrigation development over time. This also raises the question of whether there has been an increase in the extraction of water from rivers, streams and aquifers for irrigated agriculture, and if so, whether this has contributed in a reduction of streamflow into the Lake.
- Many unresolved issues remain related to land use change within the catchments draining Inle Lake and this deserves a high priority for further investigation as it relates to biophysical impacts on the lake and socio-economic considerations.

3.2.4 Human Health

Communities living on the lake and in the catchments are heavily dependent on their environment for their livelihoods. As identified in Section 3.1, environmental issues facing Inle Lake have the potential to have a significant impact on human health. Perceptions often expressed during our trip were that people are suffering as a result of pollution problems in the Lake (e.g. village interviews).

Notably, the Draft Inle Lake Conservation 5-Year Action Plan (2015-2016 to 2019-2020) identifies that a lack of safe drinking water, proper sewage treatment facilities, and use of chemical fertilizers and pesticides poses serious potential health threats to local communities of Inle Lake and its catchments (MOECAF 2014). The Plan identifies the reduction in threats to human health and improvements to overall living conditions for Inle Lake residents, as one of nine core areas of priority action.

Other health-related issues arising were:

- The need for inexpensive human waste treatment systems suitable for use on the lake. Bio-septic tanks for individual household are very expensive for most Lake residents (e.g. $1,000 USD for a fibro tank).
- Problem of effects of wave action from boat traffic that entrains/erodes sediments from canal/river banks.
- Noise pollution from the large volume of boats used in tourism.
- Contamination of fish tissue with pesticide residues.

3.2.5 Economic Conditions of Communities

The economic conditions of the communities residing within the Lake and its catchment have a high bearing on the ecological stability of the lake ecosystem. Uplifting the economic standards of households is challenging. There are insufficient financial instruments to improve their livelihood (saving and credit based services) and help families survive economic downturns and other vulnerabilities (MOECAF 2013; MIID 2014b, 2014c):

- The households in the lake and the upland catchment have limited access to financial instruments.
    - The three basic instruments available (savings, loans and insurance) 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.
    - Majority of the households in the catchment reportedly have taken loans from the local Micro Finance Institution; 12% had taken it from the Government bank; and 33% of the households reported that they had taken loans from the moneylenders.
    - None of the households from on lake villages had access to a formal banking system.
    - There are huge variations in the cost of loans, the government sources are the cheapest (8%p.a.), microfinance institution (30% pa), whereas private money lenders charge rates which are extremely exploitative (48 – 120 %).
    - Agricultural households require periodic loans to support their activities; this is particularly true for tomato farmers, as they require 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 the traders) or in cash when money is available. Farmers do not pay any interest for such deals.
- Shifting cultivation is the traditional farming system in sloping lands around Inle Lake and the catchment uplands.
    - In many places, shifting cultivation is now transformed to more sedentary rain fed agriculture, which is the primary economic activity for the villages (MIID 2014b). Upland households that indulge in shifting cultivation are far from the markets, and given the remoteness of the villages, the households have almost no access to any type of financial institutions (MIID 2014c). The households sometimes use their cattle as a fall-back option, and some have recently started to cultivate cash crops in their home gardens (MIID 2014c). These two comprise the major source of cash income.
- There is a real need for a financial support program to enhance income generating opportunities of the inhabitants of Inle Lake and in the upland areas of its catchments.

3.2.6 Energy

Only 25% of the population has access to electricity supply In Myanmar. Shan State Government can have only access to 50 MW from the Law Pi Ta hydroelectric plant; the remainder belongs to the Union Government.

- State Government has distributed high efficiency cooking stoves free to 5,000 villages.

3.2.7 Gender

Gender was not an issue of note that arose in meetings the SRA Team had with government agencies and universities during our visit. However gender issues do exist, including:

- In terms of participation in policy, research and livelihood systems, there were quite a number of women (some in senior positions) involved in our discussions and as potential research collaborators. The impression the Team had however was that the forestry and fishery sectors might be an exception to this. However this was a very small sample, so it needs further investigation.
- The lack of electricity supply in rural areas impacts on the livelihoods of women due to the time they spend in firewood gathering
- There is an apparent differential gender impact related to access to freshwater supplies and implications for human health. This particularly impacts households in the lake villages as well as rainfed farming in upland villages:
    - The lake water is no longer considered suitable for drinking, so lake villagers have to use springs. ILCDA estimate that 60% of villages now get their household water from springs via pipes to a central location in the village. However 40% do not have access to springs and have to transport water (e.g. in containers / cans by boat).
    - In the upland hill country, people face severe water scarcity problems for household and agricultural use especially during the dry months. These villages face acute water shortage and have insufficient rainwater storage and low access to alternative sources. This has particular impacts on women for household needs in the dry season (MIID 2014a).
    - In general groundwater resources are deemed too expensive to develop or, at least, there have been very few attempts to develop these.

3.3. Institutional Arrangements and Capacities

3.3.1 Background

Since the introduction of the 2008 Constitution, under the leadership of the President Thein Sein, Myanmar's Union Government has been undergoing rapid and significant changes. These reforms have opened opportunities for broadened engagement by non-governmental organizations, international financial institutions, the United Nations, and donor agencies (Nixon et al. 2013). Subnational governance institutions are a critical component of the reform processes as Nixon et al. (2013) identify:

> The Republic of the Union of Myanmar comprises seven states and seven regions named in the 2008 Constitution, six self-administered zones or divisions, and one union territory containing the capital Nay Pyi Taw and surrounding townships. The smallest formal administrative unit is the village, with several grouped together into village tracts. Urban wards, towns and village tracts are grouped into townships, where the lowest levels of government offices are generally located. Collections of townships are organized as districts, which in turn form the region or state (p. 9).
>
> State and region governments consist of a partially elected *hluttaw*, an executive led by a Chief Minister and cabinet of state/region ministers with appointed military representatives equal to one quarter of the total. The Chief Minister is selected by the President from among *hluttaw* members, and confirmed by the *hluttaw* … The Chief Minister selects the civilian ministers from among *hluttaw* representatives or other candidates, and these are assigned portfolios by the President (p. v).

Although the creation of partially-elected bodies at the sub-national level is a major reform, the new subnational institutions are facing significant capacity constraints. There are significant on-going changes occurring regarding the relationships between national and subnational governance institutions in Myanmar. In particular, both decentralisation and less commonly devolution of responsibilities from the national/Union level to states/regions are posing considerable challenges (Nixon et al. 2013; p. vi -vii):

> The division of responsibilities has created a blurry distinction between those state and region departments that are meant to report to the state/region government, and the state/region-level offices of union ministries that do not. The formally decentralized state and region departments have an ambiguous (and changing) relationship with both their "parent" union ministries, and the new state/region government. They do not form standalone administrative units, and they do not correspond neatly with the state/region ministerial portfolios. The status of their civil servants is ambiguous, with human resource management still being handled by the corresponding union ministry and the national civil service organization …… In effect, the state and region government has ministers, but does not yet have its own ministries. The General Administration Department (GAD) of the military led Ministry of Home Affairs forms the administrative Office of the Region/State. Government and the workings of the state/region government are dependent on the support of this unit. Recent reform directives from the President are aimed at resolving some of these ambiguities, but significant challenges remain in bringing clarity to the accountability relationships involved.
>
> Alongside these state/region departments, many of the more significant departments and ministries remain centralized, although many of these union ministries are pursuing significant reforms to give more authority to their state/region offices. The lack of political and fiscal devolution of these areas means that issues of clear, local concern—responsive delivery of services, ethnic identity, and the management of natural resources—are outside the political framework of state and region government (p. vi -vii).

Given these national reform processes, the Myanmar institutional arrangements relevant to environmental management and the sustainability and profitability of smallholder farming and fishing livelihoods for Inle Lake and its catchments are in transition; particularly in relation to the decentralisation of some responsibilities from Union to State levels including the proposed establishment of an Inle Lake Authority (ILA).

3.3.2 The Problem

In the light of the biophysical and socio-economic situation (as outlined in Sections 3.1 and 3.2 above) and the transitional and complex nature of the multi-level governance arrangements discussed above, the policy and planning context for the integrated management of the Inle Lake and its catchments is complex and can be framed as a 'wicked' policy problem (Rittel and Webber 1973). Typical characteristics of wicked problems are (ASPC 2007):

- going beyond the capacity of any one organisation to understand and respond to alone;
- involving tensions about the causes of the problems and the best way to tackle them;
- with many interdependencies, multiple causes and conflicting goals; and
- socially complex and often with unforeseen consequences.

Managing wicked problems (such as integrated catchment management) involves understanding the motivations and changing behaviours of diverse stakeholders, collaborating and working together across institutional boundaries, and engaging community stakeholders in developing an understanding of the problem and in the implementation of management processes. Moreover, managing wicked policy problems requires a reassessment of some of the traditional ways of working and solving problems. ASPC (2007, p.iii) argues that "there are no quick fixes and simple solutions. Tackling wicked problems is an evolving art. They require thinking that is capable of grasping the big picture, including the interrelationships among the full range of causal factors underlying them. They often require broader, more collaborative and innovative approaches".

The SRA Research Team's visit highlighted the importance placed on Myanmar's institutional systems by many people that the Team interacted with; particularly regarding its dysfunctionality, and the critical need to develop institutional capacity to enable better coordination and collaboration amongst Myanmar institutions, towards collective action. Notably, there is widespread recognition within Myanmar of the need to develop the capacity of the existing Inle Lake catchment institutional arrangements to engage more effectively in integrated catchment management approaches (IID 2012; MOECAF 2013; 2014).

Thus the challenge of a catchment/basin management approach in Myanmar is that it is not just complicated but it is complex as well, as it involves multi-level governance and management of a broad range of cross-sectoral and cross-cutting issues. From a wicked problem framing perspective, it requires concurrent attention to:

(a) *coordination and cooperation* across union, state/region and township administrative levels, which are hierarchical (but not neatly so) and often lacking clarity regarding responsibilities (largely due to ambiguities associated with recent major reform processes); and
(b) *collaboration* amongst environmental conservation, agriculture, forestry and fisheries government and non-government agencies; and
(c) Engagement of government and community through *collective action* at all levels of decision-making (which in previous administrations has been largely lacking).

This Section of the report overviews: (a) the evolution of institutional arrangements and policy processes relevant to the sustainable management of Inle Lake and it catchments; (b) the current situation regarding Inle Lake and catchment institutional arrangements and their performance; (c) challenges of implementation; and (d) institutional capacities for a long term integrated approach to basin management for Inle Lake and its catchments.

3.3.3 Evolution of Institutional Arrangements

Soil conservation and sedimentation have been an on-going concern of Burmese governments since the late 19th century in the Shan State due to soil erosion on steep slopes in upper catchment areas (Thompson 1944). From 1915, awareness within successive administrations of the need for the protection of the Inle Lake developed, but the emphasis was on the control of soil erosion and sedimentation and not on the rehabilitation and protection of the lake itself. In this period, the line of responsibility fell on national level forestry departments.

From the mid- 1990s, a number of initiatives and events focussing on protecting the sustainability of Inle Lake evolved (MOECAF 2013)

- The Inle Lake Wildlife Sanctuary was established in 1985 by order of Central Government;
- From 1986 to 1994 the Forestry Department with support from UNDP and FAO, introduced a new concept of 'watershed management' including community participation and new techniques for producing land capability and maps from aerial photographs for the Kinda watershed;
- The Kinda Watershed Pilot project was transformed in 1995 into the "Watershed Management for Three Critical Areas Project" involving the Kinda, Inle and Phugyi watersheds. It introduced new techniques such as land use planning and utilising remote sensing and GIS technology.
- In 2000, the 'Inle Lake Greening Project' under a Shan State Steering Committee was initiated, involving a diverse range of government agencies including the Forestry Department, the Irrigation Department and Department of Agriculture.
- An article by Su and Jassby (2000) recognised the problems of the Lake and its watershed together for the first time. The floating gardens, pollution of lake water, over extraction of the forests for fuel and timber, severe soil erosion in the mountainous regions, 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 ecosystem.
- Sidle et al. (2007) contested some of Su and Jassby's observations, noting that shifting cultivation and 'deforestation' did not appear to be major contributors of sediment in the near-lake environs.

Since the 1990s, Myanmar government policies and planning processes have continued to draw attention to the "severe environmental and physical degradation due to several human, natural and anthropogenic factors" of Inle Lake and its catchments (MOCAF 2013). Despite continuous efforts made by different Government Departments, NGOs and other agencies, the deterioration of the Inle Lake basin continued unabated (MOCAF 2013).

In mid-2010 when there was a sudden fall in volume of the Lake water due to a prolonged drought, The Chairman of the State Peace and Development Council (SPDC) toured Inle Lake and made some well published comments regarding the management of the Lake that triggered various Government Departments working in the Shan State to focus their activities in and around the lake area. This visit along with a subsequent visit by the President in 2012 led to:

1. The preparation of the first rolling "*Action Plan for Environmental Conservation and Sustainable Management of Inlay Lake, 2010 - 2015*", to be implemented in 5 year stages.
2. A "*Long-term Restoration and Conservation Plan for the Inle Lake Catchments*, March 2013" (MOECAF 2013), which promoted a watershed management approach to address the management problems of the lake. The focus was to conserve the watershed area, erosion prevention, increased public awareness, biodiversity conservation, and the socio-economics of the Intha people.

Collectively, these plans aim to restore the Lake and its catchments and to provide sustainable long term solutions through an integrated community-based catchment management approach. Significantly there was also recognition of the need to "consolidate, coordinate all stakeholders so that they will willingly cooperate in the restoration efforts" (MOECAF 2013).

The Myanmar Government established a three tiered structure for the overall management of Inle Lake, "at the National (Policy) level; the Shan State (Supervisory) level and the Township (Implementation) level" (MOECAF 2013). This involved the establishment of three committees (MOECAF 2013):

1. At the national/Union level, the *Central Steering Committee for the Sustainability of Inle Lake (CSOIL)* was formed in September 2010 with 14 members and is chaired by the MOECAF Minister to:
    a. Supervise and give guidance to timely implementation of the activities of sustainability of Inle Lake where necessary;
    b. Foster co-operation and co-ordination among stakeholders for the protection of Inle Lake from further degradation and move towards sustainable futures;
    c. Supervise the activities for maintaining and conserving Inle Lake watershed area and for the conservation of waterways in the lake and surrounding areas.
2. At the State level, the *Shan State Greening and Environmental Conservation Committee* (SGECC) was formed in July 2011. It is chaired by the State Minister for Forests and Mines and has over 40 members. One of its major tasks being the implementation of the rolling Five-Year Plan for the Conservation and Restoration of Inle Lake (2010-2015). Key aspects are (MOECAF 2013):
    a. SGECC was established to deal with environmental issues concerning all of the Shan State, comprising eight major tasks including the Conservation of Inle:
        i. The Shan State Government is the physical owner of the Lake, and takes an interest in its restoration and long term conversion efforts.
        ii. SGECC 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.
        iii. It also supervises implementation tasks at the Township level.
        iv. The focus for the SGECC is to closely coordinate with relevant line departments and support conservation and rehabilitation activities
    b. SGECC is subordinate and also responsible to the CSCOIL. It has to act in accordance with the Policy Directives laid down by the CSCOIL
    c. The Forest Department is the lead agency and is required to support a total of 12 institutions / departments (including Forestry, Agriculture, Health, Livestock, Irrigation, Fisheries and Tourism) to work together through a number of working committees on different functions of the Inle Lake rehabilitation and conservation.

    However significant challenges have been identified by people the SRA Research Team spoke with and were involved with the SGECC including:
    a. Institutional arrangements are very weak;
    b. Underfunding is a problem and the capacity to get funds is very weak;
    c. Inefficient use of human resources;
    d. Weak policies and rule of law; law enforcement is very poor;and
    e. Poor participation of local people.

3. At the local / township level, the *Nyaung Shwe Township Inle Region Development Implementation Committee* was established mainly to address the human resources development aspect of the Inthas (MOECAF 2013). Patrons are the Minister for Inthar Affairs and three Union Parliament members. The Township Officer-in-charge of the 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 entrepreneur and stakeholder groups are incorporated as members.

   MOECAF (2013) identify that 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:

   a. Lack of coordination and cooperation between Ministries and their subordinate departments.
   b. Inadequate staffing, funding and equipping of the departments undertaking actual implementation at the operations level.

The functionality and the impact of this three-tiered system needs examination,

3.3.4 Challenges of Implementation

The implementation of the first 5-year Inle Lake Action Plan (2010-2015) to-date is widely perceived as having failed expectations (MOECAF 2015; IID 2012; MOECAF 2013; UNDP 2013). For example, MOECAF (2013) concluded that the *Long Term Restoration and Conservation Plan of Inle Lake* could be achieved with the present organizational set up, but will require the organization of "special task force" type of set up, if any tangible results are to be achieved.

The implementation process was confronted with a complicated and fragmented institutional and policy environment including ambiguities and uncertainties associated with the Union to State government decentralization complications, as identified above in Section 3.3.1. Government authorities have limited institutional capacity to deliver many of the activities needed to meet the 5-year Action Plan objectives. Moreover the problems of the Lake and its catchments persist and are widely perceived as getting worse.

A review of lake conservation efforts performed as part of developing the 2010-2015 Action Plan revealed that a number of factors were holding back effective implementation (IID 2012; MOECAF 2013):

- there is inadequate cooperation and coordination among agencies, even when responsibilities are related, with actions often undertaken in isolation, with unintended outcomes;
- lack of secure ongoing funding at sufficient scale to implement recommendations effectively and continuously;
- A need to improve the current information and communication network;
- lack of evaluation of the results of actions, particularly where these interact with other actions highlighted the need for a monitoring and evaluation system for tracking progress of conservation and catchment management efforts; and
- A formal institutional framework was needed to develop and enforce relevant regulations, procedures, and guidelines for conservation activities; improve stakeholder coordination; foster research and facilitate information exchange; promote communication and awareness-raising; and monitor and evaluate progress.

Significantly, these factors are evident across projects and programs undertaken by government agencies, aid agencies and NGOs. A key observation by a local representative was that many hundreds of projects and millions of dollars had already been spent to address the problems at Inle Lake, without visible results (Jensen & Saw Mon Theint, 2012a).

It is clear that the problems of Inle Lake are widely known, and preferred actions to address the problems have been identified. Local communities and stakeholders are willing to take action, but need technical support, funding and capacity building to achieve effective action.

Advice from the Shan State Government provided to MOECAF at the completion of the first five-year Action Plan included:

- Some small improvement achieved in institutional set up, financial mechanisms, and policy frameworks;
- Increased involvement of NGOs in Inle Lake and catchments issues;
- Before 2010, there were no donors active in the Inle Lake region, but since 2010 a bit of improvement;
- Recommendations for the next phase of the rolling Action Plan:
    a. Formation of an Inle Lake Authority (ILA).
    b. Establishment of an Inle Lake Trust fund and a process for using it.
    c. Improvements to government capacity to implement the plans, including more human and financial resources.

3.3.5 New Institutional Arrangements and Policy Processes

With the completion of the first rolling 5-Year Action Plan (2010-2014), MOECAF is currently reviewing a draft of the second phase 5-year Action Plan (2015-16 to 2019-20). The draft Action Plan was prepared through a participatory process with stakeholders and has a new emphasis on (MOECAF 2014):

- the protection of human health and livelihoods as a key overall principle;
- the need for Inle Lake conservation planning to be in harmony with economic development;
- the need for integrated basin management principles to be applied including consideration of governance, environmental, social and economic factors in a holistic manner.

The 2nd Action Plan (2015-2020) thus aims to provide a balance between the need for rehabilitation and conservation for preserving ecological integrity of Inle Lake and ensuring sustainable livelihoods for communities. Its five agreed objectives are (MOECAF 2014):

1. To conserve and protect Inle Lake with active participation of local communities and key stakeholders;
2. To implement remedial measures to reduce environmental degradation and improve the Inle Lake ecosystem;
3. To improve socio-economic conditions and protect livelihoods of local communities in the Inle Lake watershed;
4. To maintain the cultural values of the communities living in the Inle Lake area; and
5. To establish effective long-term monitoring and management systems for evaluating future progress of conservation efforts.

This new Action Plan aims to shift:

1. the overall emphasis to “a balanced approach between conservation and sustainable economic development of Inle Lake”;
2. the lead responsibility for implementation from the Union level to the Shan State level;

3. the 'watershed management' approach to an Integrated Lake Basin Management (ILBM) approach, modified to suit the Myanmar context. This ILBM approach aims to improve environmental management, socio-economic development and promote conservation of Inle Lake. It has six key components:
    a. adequate institutions for implementing change;
    b. efficient, effective and equitable policies;
    c. meaningful participation of all stakeholders;
    d. technical measures to ameliorate any problems or issues;
    e. appropriate information about current conditions (baseline information and monitoring); and
    f. sufficient financing.

Importantly, the Draft Action Plan (2015-2020) identifies nine priority issues to be addressed (MOECAF 2014):

1. Institutional framework for Inle Lake conservation is required.
2. Baseline data on the natural and social environment are essential for future conservation and development of Inle Lake. Data and information management systems are required.
3. Threats to human health must be reduced, and overall living conditions improved for Inle Lake residents.
4. Improved environmental awareness is required at all levels: national, state and local.
5. Deforestation rates are unsustainable, and reforestation in the watershed is essential.
6. Biodiversity conservation and fisheries resource management are critical for sustaining livelihoods.
7. Sustainable agricultural practices are required, especially reductions in the use of chemical fertilizers and pesticides.
8. Sedimentation and soil erosion rates impact lake health and productivity.
9. Promotion of sustainable tourism practices, including improvement in infrastructure, training and capacity building for local people

The Draft Action Plan provides a detailed listing of proposed activities, and for each activity the responsible lead agencies and a schedule and the budget for their implementation. The Action Plan covers the period from April 2105 to March 2020 (see MOECAF 2014 Appendix 2).

3.3.6 Institutional Capacities for an Integrated Approach

The interactions the SRA Research Team had with government agencies and universities identified the relatively weak capacity and at times dysfunctionality of the current Inle Lake institutional systems, particularly in relation to: (a) technical knowledge, understanding and skill and (b) the capacity for cooperation and collaboration within and among Myanmar institutions. As one key stakeholder said 'no harmony between the hardware and software exists'. In addition, the MOECAF Minister noted that he was not entirely pleased with existing collaboration, and that "the Shan State has Working Committees with representation from multiple Ministries but it can improve". Some key issues include:

1. Many uncertainties and ambiguities exist regarding the Inle Lake problem and its solutions due largely to:
    a. lack of scientific / technical understanding / knowledge;
    b. a tenancy to believe myths perpetuated by some donor organizations without sufficient supporting data;
    c. many actors involved, many different perceptions of the problem and the solutions;
    d. problem understanding and the knowledge and data for appropriate action is fragmented across government, science, industry and community actors; and

   e. Fragmentation (with only loose coupling) of responsibilities for management and action across multi-level and cross-sectoral administrative and policy arenas.
2. A complex policy and institutional environment characterised by inadequate and sometimes dysfunctional structural arrangements including (IID 2012; MOECAF 2013, 2014; Nixon et al. 2013):
   a. Complex cross-Ministerial arrangements across all institutional levels (Union, State, Township) regarding sustainable management of Inle Lake and the social and economic impacts, Including:
      i. Three key Ministries at the national / Union level (MOECAF, MOAI and MLFRD) who do not have an established ethos of working together (e.g., coordinating or collaborating on implementing activities beyond participating in high-level Committee meetings);
      ii. A historically strong hierarchical but blurred framework of lines of authority with many ambiguities (as outlined in Section 3.3.1 above), with poor relationships between and even within Ministries, as well as between Union and State levels.
   b. A broad range of stakeholders were at pains to point out that an institutional ethos of cooperation and coordination amongst the key institutions is lacking and that the existing arrangements for collaboration for collective action are not working out or proving to be effective:
      i. Staff from multiple Ministries (and within Ministries) needed to actively work together - that is, beyond participation on Committee / Working Committees;
      ii. MOACAF Watershed Management group and MOAI/Department of Irrigation have poor linkages and opposing perspectives on solutions.
      iii. Community engagement was considered a significant deficiency of the implementation of the first Inle Lake 'Action Plan, (2010-2015) just concluded.
   c. Consequently, different and often conflicting perspectives of the problem and its solutions exist, and there are very limited institutional capacities to deal with these.

In summary, the key research needs from an institutional perspective are:

1. Addressing the difficult issues of co-ordinated and collective action and the related institutional deficiencies in government to enable key stakeholders in government and community to work better together.
2. Supporting the Ministry of Environmental Conservation and Forestry's (MOECAF) 'Long term Plan' and rolling 5-year 'Action Plans.
3. Ensuring that these respective agencies are working with sound biophysical and socioeconomic data as a basis for decision making and planning.

In addition to developing a better understanding of 'what is the problem' from both the biophysical processes and socio-economic perspectives (see Sections 3.1 and 3.2 above), institutional capacity building is critical to moving forward and supporting the Myanmar Government's new 5-year Action Plan (2015-2020) for Inle Lake (i.e. MOECAF 2014). This requires seeing 'capacity' twofold as Woodhill (2010) suggests:

- Developing technical knowledge and skills;
- Enabling a collective ability for effective relationships.

While recognising the complexity of the Myanmar institutional arrangements (as outlined above) for implementing the Inle Lake 'Long-term Plan' and its new Draft 'Action Plan' (2015-2020), to achieve impact the proposed ACIAR Inle Lake research initiative will need to:

(i) Recognise the need for high level political buy-in;
(ii) Develop strong partnerships with the national and Shan State leadership.

3.4. Smallholder agriculture, forestry, fisheries and tourism: production and management, constraints and opportunities

3.4.1 Background

About two-thirds of the Myanmar population is dependent for their livelihoods upon agriculture (MOAI 2014, p.126). Agricultural production in the Inle Lake and catchments region is important in national terms, for example (IID 2012; Jensen 2012; Roth et al. 2014; SRA Research Team interviews and meetings):

- Shan State is the main region in Myanmar for vegetables (cauliflower, cabbages, potatoes, tomatoes, etc.) and flowers;
- Most crops are rain-fed; although there is some irrigation in floodplain and delta area flowing into Inle Lake;
- Annual tomato production for Inle Lake is up to 90,000 tons, of which 75% is exported to other parts of Myanmar (IID 2012c);
- Rice yields are high by national standards and sugar is also significant;
- Soils in the Inle Lake area are generally reported to be reasonably fertile but require supplemental fertilisers to achieve good yields; some concerns exist for soil degradation in hillslope agricultural areas due largely to forest conversion and over grazing, and issues of pollution from smallholder agricultural activities both in the Lake and also its catchment cropping areas;
- Smallholder croppers in the upper hillslope areas of the Inle Lake catchments are constrained by limited growing seasons (800 - 1000 mm rainfall), and disease pressure on the key cash crop (potatoes), as well as low levels of mechanisation (largely animal draught and manual harvesting) and poor access to capital (Roth et al. 2014);

A high level of poverty exists in Shan State, including the Inle Lake region and and in general the level of income and food security is quite low (IID 2012c). Growing population pressure and a decline in the resources of both the Lake and its catchments are one of the causes of a decline in incomes, continued poverty, and health issues within Inle Lake communities (MOECAF 2013). Some key issues are (IID 2012c; interviews):

- Poor hygiene and sanitation, and limited access to clean water and quality health care are noticeable, and affect the level of agricultural production;
- Rising staple food prices are an additional factor adding to food insecurity for families who spend on average more than 70 % of their income on food;
- Traditionally diets are too heavily biased to rice which has poor nutrition consequences. The consumption of rice is very high on world standards and overconsumption may lead to significant health issues (interviews);
- Many cases of illness due to eating unwashed vegetables and applying pesticides and animal wastes without awareness of correct rates of application and safety precautions.

The Inle Lake Region is a large, multi-use area with a diverse agricultural economy that is in transition. About 60,000 people depend on the lake for their livelihoods through agriculture, fishing and rapidly increasing tourism (IID 2012c). Tourism is emerging as a significant provider of alternative and supplementary livelihoods for the local people in the Inle Lake area. In addition, the distinction between agricultural and fisher folk is changing (Roth et al 2014). For example, there is a trend for tomato and other vegetable gardeners to supplement livelihoods through additional fishing and/or other employment (e.g. tourism). Similarly with issues of declining fish numbers and reduced lake levels, some fishers are engaging in agriculture (e.g. floating gardens and permanent agriculture, such as vegetables, on lake margins) to supplement incomes.

This section of the report examines the changing context for different livelihood types for Inle Lake and catchments and the constraints and opportunities for improving their sustainability and profitability. It draws on Roth et al. (2014), IID (2012) and other relevant reports, as well as meetings / interviews conducted by the SRA Research Team in Myanmar (including three community-level interviews with an in-Lake fisher family/household, an in-Lake floating gardener, and six villagers of Lwen Yeint Village (fishermen, floating gardeners, vegetable growers and community foresters). It adopts the livelihood types distinguished by Roth et al. (2014), for Inle Lake (i.e. lake-based, land-based cropping, and forestry-based) but includes an additional fourth category of tourism due to its growing importance to the livelihoods of Inle Lake communities.

3.4.2 Agriculture

Agriculture, forestry and fisheries have traditionally been the main livelihoods and sources of income for the people of Inle Lake catchments. According to official figures used in the MOECAF Long Term Lake Conservation Plan (MOECAF 2013), 35% of the watershed is forested, 33.8% is agriculture with other uses being another 28.8%.

Lake-based agricultural livelihoods

The study group was unable to identify instances of household livelihood surveys having been conducted with those communities dependent upon the Lake for their livelihoods. However, lake-based smallholder farmers use a mixture of traditional and modern cultivation practices (conservation agriculture, chemical usage, fish hatcheries, and community forestry).

The system of floating gardens is complex. It is not only a cultural problem but there is quite a lot of conflicting information and perspectives concerning there functions and use. The following points draw largely on Jensen (2012) and farmer interviews by this SRA Research Team:

- Many people living on or near the lake are highly dependent on floating gardens (as identified in Sections 3.1 and 3.2 above). Floating gardens were already present in the earliest descriptions of the lake in the early 1900s (Thompson 1944). However a greatly increased area of gardens in recent years (reportedly increasing by five times from 1991 to 2012 - interviews; Sidle et al. 2007), new hybrids, and overuse of chemicals (fertilisers and pesticides) and lack of appropriate technical advice for farmers for their use and management is placing increasing pressures on the lake ecology and straining the buffering capacity of the lake (Butkus and Myint Su, 2001; Jensen 2012).
- Lake water is considered quite widely to be getting shallower. Due to this decline in lake level, it is argued by some that many floating gardens are effectively they are no longer floating. In addition many floating gardeners are changing their livelihoods or growing other vegetables (e.g. potatoes, chilli etc.) on land instead.
- Although there is a legal base for removing people from the Lake, they need viable alternative livelihood options to make changes (e.g. sustainable agricultural cropping options, or livelihoods other than floating farms, including silversmith, weaving, and tourism).
- Vegetables, especially tomatoes, are produced on floating gardens which are the basis for hydroponic nutrition for the plants. In order to achieve highest yields and to protect the crops from pests, farmers use more fertiliser and more pesticides to ensure high production, and are generally unaware of much lower effective rates of application or safety issues in applying pesticides. The excessive use of some fertilizers and pesticides goes far beyond the recommended rate (Butkus and Myint Su, 2001) and may often be based on distributor/input seller's advice only. People are commonly aware that pesticides are a problem, and have concerns about how to handle them, but they are unsure of alternative

options. They report that hospital people are noticing issues with "some people's organs". Some NGOs were conducting awareness campaigns.

- Many people noted the need for integrated pest management (IPM), both in the lake and in the uplands, to reduce dependence on pesticides. Chemicals used by farmers include mostly organophosphate pesticides which are very hard on fisheries. So there is a need to consider more modern pesticides less harmful to fish, and also to replace chemicals with IPM for horticulture or other modern technologies, such as BMPs.
- It has been shown that derelict floating gardens have occupied the lake margins, thus reducing the lake surface area, but not with lake levels apparently declining (a contentious issue that needs further investigation). Other issues arising that need to be investigated further in terms of the biophysical condition of Inle Lake:
    - 'floating' gardens that are attached to the lake bed; and
    - decayed organic material (apparently derived from derelict gardens) accumulating to several meters depth on the bottom of the lake (above sediments).

- *Case*: *Inle Lake tomato farmer* interviewed stated that his grandparents were fishers, and his parents were tomato farmers. While this farmer had access to 4 acres, he only grows tomatoes on one acre for each crop, and grows two crops a year. He uses NP fertiliser (16:16). He claimed to produce around 500 baskets per year (at 31 viss/basket), and earned between 800 - 1000 Kyat/vis (AUD$1.00 – $1.20/viss) [note 1 viss=1.63kg], thus grossing between AUD $15,500-$18,600 /year. Credit is available from some of the tomato buyers/brokers but at a high rate of 10% per month. There was no estimate of this farmer's input costs, but it is likely that this larger scale grower is making good profits. The Department of Agriculture used to gather tomato growers together to show them how to use pesticides. This tomato farmer stated that he gets much of his production extension advice, including pesticide usage advice, from tomato brokers and input sellers. [Comment: thus both brokers and input sellers, as part of the existing, limited, knowledge network, would appear to be high priority extension targets for improved tomato growing practice.]

- *Case: Lwen Yeint Village* visited by the study group, where farmers now practice largely-land based agriculture, has developed a community forestry program that has been running since 2000. [Comment: this community, and any similar community forestry examples, could be used as a case study to examine the process of building social capital and the development of positive NRM behaviours - to inform the future development of community-based NRM approaches.] Since the low water level of the 2010 drought, this village has observed its floating garden area decrease, and has commenced utilising old floating garden materials as raised beds for dryland horticulture, in particular for potato and onion production. Small scale floating garden farmers in this village claimed that many floating gardens are no longer viable due to the fact that the lower water level results in gardens putting down roots into the sediment at the Lake bottom, and thus they no longer float. During the rainy season when the water level rises, these floating gardens are then flooded and can no longer support agriculture. These farmers said that tomato farmers are generally aware of the need to reduce fertiliser and pesticide use but there were no departmental persons to give advice to them. The villagers expressed a strong view that floating garden tomato farmers commonly suffer internal organ damage from occupational pesticide exposure. This group also said there was no level of social organisation of tomato farmers beyond the village level that they were aware of. Significantly, these farmers' parents and grandparents were floating gardeners (e.g. tomatoes, vegetables and flowers). Although now involved in land-based agriculture on old marshlands, villagers have a high dependency on tourism (e.g. children were actively working in the tourist industry, e.g. in restaurants and hotels, and as boat drivers) and by receiving domestic visitors in the village (i.e. ecotourism activity).

- The study group received conflicting information regarding the profitability of tomato production on floating gardens within the Lake. Some sources claimed that it was highly profitable, and much more profitable than a fishing-based livelihood, while others claimed that it was difficult to earn a living from this livelihood. A brief interview with one larger-scale floating garden operator highlighted considerable revenue from this operation, although the input and marketing costs were not assessed. It is possible that economies of scale operate in the floating gardens, as with many enterprises, and smaller operators struggle, while larger operators may be profitable.

Land-based cropping livelihoods

Three broad cropping systems were distinguished in relation to land-based cropping livelihoods of the Inle Lake catchments by Roth et al. (2014, p.11):

- Shifting cultivators on steeper slopes and in higher altitude forests on lands under the administration of MOECAF; these smallholders represent a smaller fraction of agricultural land use, with lower impact on sediment export to the lake. In the Pinlaung area (SW part of the catchment; upper reaches of the Upper Balu river), some of these shifting cultivators may be involved in poppy growing.
- Mainly irrigated and intensively farmed, alluvial and floodplain rice and sugarcane growing areas of the Negya and Nanlet valleys. This category also covers a significant land area and may be an important source of nutrient and pesticide input to the Inle Lake.
- Smallholder farmers on primarily rainfed, undulating, intensively cropped plateau areas (upland rice, maize, potatoes, Pigeon pea, wheat, Niger seed, vegetables), with soils of varying depth and fertility, who have or are in the process of acquiring long term land and forest resource use rights from MOECAF, and who have varying degrees of access to residual forest land on steeper hill slopes. These farmers are found mainly in the upper and mid reaches of the Neyga (Heho valley) and Kalaw catchments and constitute a significant proportion of agricultural land use. Their livelihoods are at greatest risk due to loss of soil productivity as a result of high rates of sheet, rill and gully erosion, while also constituting a source of sediment export to lower catchment reaches. These areas may also be highly vulnerable to climate change.

Relatedly, it was not clear how much irrigation is being used in the uplands (or lower parts of the catchment), although we saw some irrigation operations. It is also not clear how much (and when) water is diverted from streams or whether it is mainly supplied from groundwater (unlikely). Increasing use of stream water for irrigation would affect lake water levels; there was evidence of large diversion channels in some floodplain areas with intensive cropping.

Many of the 'conservation measures' currently implemented for addressing management impacts for both land-based and lake-based livelihood systems seem to be very narrowly focused, for example:

- *Dredging of lake sediments* for improved navigation – impacts on lake water quality and sedimentation have not been considered related to dredging or placement of dredged materials.
- *Check dams* seem to only address localized sedimentation issues, not integrated with catchment management.
- *Terracing in upland areas* – some areas may be too steep and risers may create more erosion opportunities than can be saved by terraces; terraces in wet swales create other erosion issues.

3.4.3 Forestry-based systems

Although some official figures used in MOECAF (2013) identify that 35% of the Inle Lake catchment area is forested, much of the land classified as forests actually contains much hillslope and shifting agriculture. Moreover much of the forest cover is now degraded as a result of firewood cutting, among other timber uses (Midgley et al. 2012). Thus the distinction between forestry and agricultural land use is changing. With population pressure and growing demands for fuel wood, in recent years there has been a tendency for people to cut forests for charcoal and building materials and to convert forest land to food production. Roth et al. (2014) ague that there is no longer a distinct group of forest dwellers; rather, all the land-based livelihood groups use the forest areas to complement their livelihood portfolios to varying degrees. However, shifting cultivators living in forest areas will require a different strategy to enhance forest-based livelihoods than for smallholder croppers and lake dwellers, who access forest fringes (Roth et al. 2014).

Case: Community forestry: In Lwen Yeint Village on the shores of Inle Lake visited by the study group, farmers now practice largely-land based agriculture. They have developed a community forestry CF program that has been running since 2000. The forests near their village used to be much degraded. People used to cut wood illegally including sticks suitable for floating garden. Since forming the CF group, the villages collectively have developed agreed by-laws re: forest practices and they police the activities in forests. The CF Group was initiated after the Village Chairman attended a DF educational workshop and was encouraged to plant trees and to manage the forest resource. They replant to cover the village needs for firewood, etc.

Case: Hillslope Agriculture – based on MIID (2015; 2014b; 2014c). In the surrounding hills of the Inle lake catchment, the traditional livelihood system of shifting cultivation has been largely transformed to more sedentary rain fed agriculture in sloping lands. In these lands, water remains one of the major issues. People in this region are fully dependent on highly seasonal rainwater to meet their irrigation and drinking water requirements. People face severe water scarcity problems for household and agricultural use especially during the dry months. Water available from the existing system is hardly sufficient for domestic uses. Farmers have recently started to cultivate cash crops in their home gardens which are the major source of cash income. Without appropriate land and water management practices, there is a high risk of soil erosion and land degradation. Proper management of water throughout the year for household and agricultural uses therefore remains a challenge as well as an opportunity for water users and managers in integrating land, water and watershed management with improved livelihoods.

3.4.4 Fisheries

Fishing and lake-based agriculture co-exist in Inle Lake. Like floating tomato gardens, fishing is deeply rooted in Intha culture and history. Okamoto (2012) estimated that in 2009-10, about 1500 fishing families were living on Inle lake. The Lake is also famous for fish endemism with more than 25% of endemic fishes being found in Inle Lake (MOECAF 2013). Fishing is undertaken dominantly for subsistence and local consumption (e.g. small cash sales and to local restaurants).

The lives of Inle Lake people, who depend on the lake for their livelihoods, have been changing rapidly in recent years due to a number of inter-related factors, including:

- the expansion of the number and size of floating tomato gardens (with the transition to a market economy in Myanmar since the early 1990s), which is credited with reducing the fishermen's catch (Su and Jassby 2000; Okamoto 2012);
- The shrinkage of area of open water in Inle Lake by 34% between 1935 and 2000 (Sidle et al. 2007; see Figure 2);

- climate change and forest conversion (including cutting trees for firewood) is frequently highlighted as increasing the risk of erosion, and increasing sedimentation (interviews);
- Decline in the lake's water quality is often attributed to population pressures, increased floating garden cultivation, the use of agro-chemicals (Akaishi et al. 2000) and the unregulated use of pesticides (Su and Jassby 2000). There are high community concerns about the potential impact of this chemical use on aquatic resources (e.g. killing fish eggs & accumulating in fish tissues);
- The growth in the number of fisher folk. Many farmers or temporary workers have to fish to supplement their incomes – the drop of fish stock can be linked with the environmental deterioration;
- The severity of the impact of the 2010 drought (see section 3.1) which contributed to very low water levels which may have an adverse impact on fish stocks; and
- The introduction of fish species to the lake and appearance of other invasive aquatic species (such as Water Hyacinth and the pest Golden Apple Snails).

Other issues are:

- Dredging of the lake occurs under Irrigation Department (primarily for navigation purposes) but the impact on water quality is unknown. The Department of Fisheries (DOF) has no water quality data for the Lake and currently has no capacity (i.e. skilled staff or laboratory facilities) to measure it themselves. Moreover they do not receive data from other departments or Universities. Currently DOF does not do research with other Ministries but it does some with development partners.
- Community concerns regarding dramatic falls in average daily fish catches since the mid-1990's appear to have triggered the introduction of a number of exotic fish species in an attempt to enhance the fishery (Roth et al 2014). The species introduced included the highly invasive Tilapia (species/strain unknown), which now dominates catches (90% according to some reports). Experience elsewhere would suggest that this has resulted in irreversible changes to the fish fauna of the Lake (Roth et al. 2014).
- Escalating fishing pressure through increases in numbers of fishers and increased efficiency of fishing techniques, the latter due to a move from traditional cone nets and traps to the wide use of monofilament gill nets (Roth et al 2014).
- Given the evident decline in native fisheries, coupled with consistent descriptions by those interviewed of general fishery decline within Inle Lake, it is likely that the fishery-based livelihoods are also declining - though this would have to be verified by targeted household research (Roth et al 2014).

- *Case: The Inle Lake fisher household* interviewed had 13 children, some of whom are now working in the tourism sector. This fisher house was on stilts within the Lake, and he practised cage aquaculture (apparently using common carp) in the area underneath the house. The Department of Fisheries provided the fish fry for the aquaculture enterprise. The changes this fisher had seen during his lifetime included the following: 56 village households in his village, when he was young and had now grown to the current number of 226 households; increasing employment for the villages in the tourism industry; his household income is much less now than previously, though it is now supplanted by the income generated through children working in the tourism industry; confirmed that there was no higher level of social organisation among the fishers beyond the village level; the village now had a nursery school and library; 20 years ago the villagers could drink the water from the Lake, but not now; now they carry water from an adjacent spring on the shore; the water level of the Lake is now much shallower, and there is much more sediment in the Lake; water table is now lower due to 'climate change'; tomato farmers are polluting the Lake with pesticides; traditional fish species have now almost disappeared; snake head fish (a native

species) has almost disappeared; the Department of Fisheries seeds the Lake with fish three times per year with tilapia, common carp and grass cutter carp. [Note: at a later meeting, the Department of Fisheries representative stated that they did not release tilapia into the Lake, and in fact had instituted an eradication campaign for this invasive species.] Fishers are given 200 fish fry annually by the Department of Fisheries to grow out using aquaculture. There is a local NGO ('Shwe Indu'?) giving village households improved water supply, large plastic drums, solar panels, fly-proof toilets etc.

- *Case: LweNyeint Village (Three Inle Lake Fishermen)*. A major issue impacting on fishing livelihoods is that nearly all native fish species (carp, snakehead fish, etc) are all gone due to water pollution and introduced predatory tilapia, which are worth much less money in the markets (native fish fetch $8K, Telapia only $1K). Fishermen are now forced to grow rice and other vegetables. In addition, since water levels are much lower, the edge of the lake has moved out considerably and it is not possible to have fish cages under the house. When the rains come, fishermen can go out and fish; but during the dry season they are reliant on tourism for income. There is a long history of fishing livelihoods in the village; all their parents and grandparents were fishers, but now the children are all working in tourism industry. Households have to pump water from lake for washing and showering and garden use; and they get their drinking water from a tap/well at the monastery nearby. There were no social networks of tomato growers or fishers that the village has links to.

3.4.5 Tourism

Renown for a number of cultural and livelihood practices (floating gardens, weaving industry, traditional leg-rowed boats), tourism around Inle Lake is growing rapidly with the lake and its heritage values being one of the major tourism attractions in Myanmar. Over 300,000 international and domestic tourists visit Inle Lake each year, providing a critical boost to the local and national economies (MOECAF 2014). International visitors increased from 20,000 tourists in 2009-10 to 110,000 in 2013-14 (MoHT 2014). With such rapid growth, tourism brings new economic opportunities, but it can also create uncertainty and pressures including environmental, social and cultural change (MoHT 2014), for example:

- There is considerable evidence of tourism and tourism-associated commercial and infrastructure development adjacent to and within the Lake.
- There is also some evidence of an increased reliance upon tourism-related employment by communities surrounding and within the Lake. The *Destination Management Plan for the Inle Lake Region 2014 to 2019* (MoHT 2014) highlights the expected tourism growth, and the likely increased employment demand and opportunity.
- The SRA Research Team noted considerable hotel development on the foreshores and hinterland of the Lake. The Inle Lake Hotels Zone, established in 2012 on the eastern side of the Lake, has been leased to the MoHT by MOECAF. This 622 acre (252ha) area, comprised of 87 hotel plots, has three areas: Zone A reserved for regional investors; Zone B, reserved for international investors; and Zone C reserved for national investors (MoHT 2014). There is an extensive, poorly designed, road network associated with this development.
- Revenue raised from tourism includes a Tourist fee of $10 USD with the proceeds going to the Shan State government budget. In turn, Shan State Government has established $1.5 billion kyat ($1.5 M USD) trust fund for the people in and around the Lake to use for activities such as: drinking water supply, health, education, electricity, water hyacinth control, and highland farming.

- Although tourism has important benefits, it has its own detrimental consequences for the Lake:
    - The MoHT (2014) Plan highlights environmental challenges confronting the Lake, in part due to the increase in tourism traffic, and proposes some strategies for addressing these degrading processes.
    - The problems of inadequate solid waste management are evident on the Lake foreshores where several areas are used as garbage dumps. A restaurant owner within the Lake highlighted increasing concerns by tourism businesses about escalating waste management problems.
    - The cumulative impacts of increased human waste and the potential for increased nutrient and pollution within the lake are of particular concern.
    - Human waste disposal was also raised as a significant environmental issue by the Intha Literature and Cultural Development Association. No centralised waste water treatment plant exists. Some hotels have septic system and then release to the lake.
    - Expanding road networks provide conduits for sediments and pollutants into the lake.

3.4.6 Constraints and Opportunities

Our situational analysis presented in this SRA Report notes a number of constraints (or barriers) to sustainable and profitable livelihoods but also reveals related opportunities for innovation and change. A number of these constraints and opportunities are common across all the different livelihoods types and relate largely to:

a. Technical/scientific and socio-economic aspects of catchment/basin management and problem understanding (i.e. 'technical'); and
b. Institutional capacities for coordination and collaboration across all levels of decision-making and action (i.e. institutional').

1. ***Poor data availability, management and access*** to baseline biogeophysical, socio-economic, and livelihoods data and information (as previously mentioned in Section 3.2).
   Constraints:
    - For Inle Lake, a lack of long term data sets for environmental parameters (e.g. rainfall, water quality, sedimentation, stream discharge, nutrients, biodiversity, etc.) exists. General conclusions may be drawn in some cases from the limited data available but it very difficult, if not impossible, to assess the degree of change, the trends of change, or the effects of management actions (e.g. Jensen 2012)
    - For the catchments, daily total rainfall exist for about 7 stations in the catchment since 2000, but no rainfall intensity data (for erosion, flooding analysis), and very limited hydrology information (e.g. at least 8-10 years stream discharge data are needed for land use impact assessments, etc.).
    - Lack of a framework for information management and dissemination about resources that is accessible to Inle Lake communities is a major capacity issue.

   Opportunities:
    - The new Action Plan (2015-2020) identifies as a high priority that baseline data and long-term monitoring programs established for "several areas, including: water quality and quantity, biodiversity, meteorology, chemical and other pollution, sedimentation rates, socio-economic and health issues, etc.", as well as a "knowledge management and information sharing system is required to properly store, manage and share the data collected". There is an opportunity for the proposed ACIAR research initiative to support decision-making on how to collect and analyse the data required for the

appropriate assessments and to suggest other needed data (e.g. rainfall and stream discharge), and assessment methods and frameworks. More specifically, to complement other international donor initiatives and contribute to strengthening the capacity of institutions to collect and analyse data, the SRA Research Team can help the Inle Lake Authority (or whichever institution has the responsibility) to set management priorities and develop appropriate policies and plans.

2. There is limited ***capacity for integrated analysis*** due in part to the fragmented nature of data, information and problem understanding across poorly linked institutions / sources of knowledge. Many issues are cross-sectoral and cross-cutting and require an integrated approach to analysis.

   Constraints:

   - In relation to understanding 'what is the problem' and possible solutions, the SRA Research Team noted a tendency amongst key stakeholders and responsible agencies for a narrow disciplinary or sectoral focus on 'the usual suspects' on the one hand (e.g., shifting agriculture on steep slopes, deforestation, lower lake levels), and on the other 'the symptoms and not the causes' (e.g., dredging, fish population) and other 'myths' (often lacking any substantive evidence). This situation greatly hinders an integrated and holistic approach to catchment management and may lead to the failure to see the connections between drivers and impacts within Inle Lake and its catchment systems.
   - Livelihoods of the communities in Inle Lake and its environs are being affected by deterioration of water quality in Inle Lake and poor agricultural practices in floating gardens and terrestrial cropping systems. For example:
     - With the increasing use of chemicals (fertilisers and pesticides) to improve agricultural production, there is growing concern about the risk of build-up of pesticide residues in horticultural products, fish, and lake water (used for drinking water and its consequences for human health), and the sustainability of the lake ecology and the services it can continue to provide. There is a lack of capacity within government agencies to systematically measure and determine water quality in the lake and its consequences, including pesticide residue levels in fish and horticulture products produced on the lake. It has been suggested that pesticide residue levels are above permissible health thresholds and that water quality assessments do not meet WHO standards. However these issues need to be investigated further.
     - Lack of proper sewerage and wastewater treatment facilities and waste management in general for townships near the lake and also for in-lake communities.
     - Lack of a soil, water quality and pollution testing facility in a suitable location in or near the Inle Lake region with the capacity to analyse the necessary parameters needed for understanding / assessing the issues of concern regarding Inle Lake and the agricultural systems in adjacent cultivated lands.
     - Upland shifting cultivation systems are shifting to more 'permanent' cropping systems, as are some systems around the Inle Lake itself; these more intensive agricultural practices may impact lake water quality as experienced elsewhere in Southeast Asia (Sidle et al., 2006).

   Opportunities:

   - One response to water quality concerns has been the capping of the area of floating gardens, which is not allowed to expand further. In fact, there is pressure from the Shan State and Nyaungshwe Township levels to further restrict the area of floating gardens and its management.
   - The agricultural sector within the Inle Lake watershed area has very high potential for development of sustainable agricultural practices and improved markets, but they

require the provision of appropriate training and extension support (e.g. Jensen 2012). Key areas requiring support include information on sustainable land and water management practices including the application of fertilisers and pesticides backed by sound research on agricultural and extension technologies, as well as alternative livelihood options.

- Opportunities to increase the profitability of floating gardens while minimising environmental impacts include Good Agricultural Practice (GAP) and Integrated Pest Management (IPM) technologies. GAP standards were mentioned several times by Department of Agriculture staff, though it seems that farmers have little knowledge of the existence or potential utility of these standards (designed largely for export market access). Nevertheless the Inle Lake tourism development plan intends to market a sustainability image, consistent with the Inle Lake 'brand', which suggests that there may be broader private sector support for the GAP standards being introduced into this area. Consequently, in time, there may be potential for GAP-accredited produce to attract a local market premium. However, it is imperative that GAP standards are developed using a systems-based approach with considers not only on-site issues (productivity, erosion, alternatives to pesticides, etc.), but also off-site impacts (e.g., runoff, leaching to groundwater).
- There are concerns over pesticides in water and in fish and food chain impacts including bioaccumulation and human health impacts. However there are no monitoring systems for the use of fertilisers and pesticides and farmers have limited understanding or capacity to assess their needs in practice or human safety needs. Opportunities exist for developing a better understanding of:
  - The comparison of current practice with BMP (modern) or IPM technologies to reduce use of pesticides;
  - How to establish criteria for smallholders or extension people to assess fertiliser applications, including the efficiency of different nutrient management practices (N, P, pH control, micronutrients);
  - Alternative horticultural crops to tomatoes.
- There is considerable Interest in agricultural livelihood alternatives. Some suggestions needing further investigation are:
  - Bamboo to reduce runoff / erosion as considered to be less of a problem than forestry regrowth for soil and water conservation. It is also a useful economic product – reportedly returning up to USD $6 per pole at maturity and providing a good market for construction work (replaces timber);
  - Cultivating drought tolerant crops in the uplands, and improving soil-water conservation practices (e.g. mulching and limited tillage);
  - Introducing nitrogen-fixing crops on a rotational basis.
- Opportunities to improve fish production require: a clear long term road map; a contemporary fishery assessment; and the development of a draft management plan to sustain and where possible enhance fisheries livelihoods and rebalance aquatic biodiversity (fish and aquatic plants) within the system. Elements of such an approach could be to (e.g. Roth et al. 2014):
  - Describe structure and dynamics of current fishery and lake flora;
  - Develop community supported management options or strategies to improve productivity/profitability of the fishery;
  - Evaluate and develop options to better manage/ameliorate non fishery impacts (propeller wash, etc.);
  - Examine realistic potential and possible initiatives to rebalance exotic/indigenous fish diversity within the Lake;

- Assess scale and impacts of aquatic weed collection for on-lake use (garden building and cage culture), and for sale for near lake pond culture of grass carp.

- An opportunity that exists to support fishers to achieve additional income is the development of more productive fish rearing systems. This could lead to improved profitability and a modest expansion of existing under house cage culture (grass carp/common carp) systems located in lake edge villages with adequate year round flowing water to increase resilience of fisher families.
- Roth et al (2014): The following constraints for forest-based livelihoods were identified. Uncontrolled burning to clear land and provide green pick for free range grazing and hunting, as well as illicit removal of logs, is constraining more productive use of degraded forest lands for all of these groups. Poor implementation of existing forest use policies by government agencies as well as policy restrictions on the production and marketing of high value commercial species (e.g. teak) and use of forest lands for other purposes (e.g. agroforestry) both constrain the establishment of viable community forestry groups and limits the desired transition to forest restoration and long term sustainable forest use.
- A new water quality testing laboratory is expected to be established through international donor funding (reportedly UNDP and the Norwegian Government but currently unconfirmed). Without this facility any research on chemical use, nutrients and pollutants in water and soils cannot be undertaken locally. The establishment of this facility is an action of the new Draft Inle Lake Action Plan (2015-2020) in the first two years of its implementation.
- A sewerage waste water treatment system is a high priority action in the new Inle Lake Action Plan (2015-2020) for Nyaungshwe and other lake communities.

3. ***Limited and infrequent access to technical support services*** limits the ability of smallholder farmers, gardeners and fisher folk to gain access to new technologies to improve their practices, to protect their health, and access to better market knowledge (Roth et al. 2014; interviews). For example:

   Constraints:

   - In the case of lake dwellers, some technical support is provided by the Shan State Department of Fisheries through the production and distribution of fish fry and fingerlings for under house cage culture.
   - Technical support for managing floating gardens primarily comes from input sellers, as does information to smallholder farmers on chemical use (fertilisers and pesticides) for horticulture. These sellers may have little knowledge of GAP, BMP or IPM approaches and practices.
   - There was evidence of a strong Myanmar Agricultural Services (MAS) presence in the intensive, irrigated rice areas, with multiple demonstration sites visible promoting modern, high input rice management systems. This presence appeared limited or non-existent elsewhere, but requires clarification.

   Opportunities:

   Provision of better technical advice on (Roth et al. 2014):

   - More efficient methods of fish rearing.
   - In relation to land-based cropping livelihoods, applying Conservation Agriculture principles to stabilise the soil resource, improve soil fertility and increase profitability of crop production, for example:
     - Intensifying rotational cropping with a higher proportion of legumes;
     - There are many potentially under-utilised crops (e.g. wild buckwheat);
     - Investigating the nutrition of traditional crop plants.

- Effective community forestry groups by drawing on successful models of community forestry to determine the key factors that enable the transfer of these models to other areas within the catchment. This will likely need to be underpinned by value chain analyses to identify novel market opportunities for forestry products that could open up additional sources of income. An MIID/ICIMOD project is investigating some aspects of this issue (MIID 2014a, 2014b, 2014c).
- In the case of shifting cultivators, a move to agroforestry systems based on permanent tree crops (tea, coffee, fruit and nut trees) in combination with under canopy food crops needs to be explored.

4. A lack of ***access to economic infrastructure***, ***reliable markets and value-adding options*** renders the communities vulnerable (e.g. to moneylenders), and may push the communities into a debt trap (MOECAF 2013).

   Constraints:

   - Lack of financial linkages (such as to banking and credit facilities) has a high socio-economic impact on local communities, restricting the economic performance of the households. For example:
     - In many places in upland areas, shifting cultivation is now transformed to more sedentary rain fed agriculture, which is the primary economic activity for the villages (MIID 2014b). Upland households that indulge in shifting cultivation are far from the markets, and given the remoteness of the villages, the households have almost no access to any type of financial institutions (MIID 2014c). The households sometimes use their cattle as a fall-back option, and some have recently started to cultivate cash crops in their home gardens (MIID 2014c). These two comprise the major source of cash income.
   - Alternative livelihood options such as handloom weaving, silversmith, ironsmith, and woodcraft are taken up by only a few households which may be due to lack of information about market demands, required skills and product designs (Roth et al. 2014). Consequences of any expansion of such livelihoods need to be explored.
   - Farmers lack a reliable market beyond local villages and towns. The SRA Research Team found that farmers and fishers they met mostly individually marketed their produce as they do not seem to have farmer associations or other avenues. However, the degree to which markets for agricultural and fisheries products can be enhanced is unclear. Roth et al. (2014) observed that all categories of farming and fishing communities interviewed seemed to be able to readily market their produce through buyers coming to the villages, as well as through established markets in the immediate Inle Lake surrounds.
   - In addition, there appeared to be 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 and innovative practices (Roth et al 2014).

   Opportunities:

   - MOECAF (2013 recommended a well-structured and exclusive Program of Micro and Small Enterprises be developed. A critical requirement associated with micro enterprise development is the availability of working capital to small entrepreneurs. Households commonly have very limited access to financial instruments. None of the households of in-Lake villages, for example, had access to any formal banking system.
   - There is a need to support not only local people in obtaining microfinance to improve their livelihoods, but also to promote environmentally sustainable cottage industries and other value-added commodities There are some financial initiatives emerging that may prove to be real opportunities for livelihoods. Some examples that need examining / assessment are:

- In early 2015, DOF introduced a 'Backyard Hatchery Program' in 4 villages. Each village gets a 50 leks ($5,000 USD) loan from the government to develop their own hatchery with only 1 person per village being permitted to sell to the other villagers. The loan is provided at no interest for 3 years and then the villagers pay back the loan. Initially 4 villages have taken up the program so far. In addition, through a Greening project, 8 villages have also been given a small loan of $30K USD each at a minimal interest rate - other details need to be checked.

- Whether there is scope to increase the share in market return on products through streamlining or enhancing market value chains needs examination.
- If farmers have a strong market, Integrated Pest Management (IPM) for example is a possibility that could improve their practices (Roth et al. 2014).

5. The ***limited capacity of institutions implementing the Inle Lake 'Action Plan*** to take action on: (i) an integrated approach to catchment management; and (ii) technologies for improving the sustainability and profitability of agricultural livelihoods while minimising environmental impacts was highlighted at all levels of decision-making and action during the SRA Research Team's visit (see more details in Section 3.3.1, 3.3.2).

   Constraints:

   - Policy divergence, overlap and conflict between the various line agencies involved are common where the governance boundaries and lines of responsibility are uncertain or ambiguous (e.g. Roth et al. 2014). Enforcement of laws on natural resource management and environmental management is also weak and sometimes inconsistent (MOECAF 2013). While the Myanmar national reform process is improving the situation slowly (Nixon et al. 2013), the silo mentality and strict adherence to lines of authority commonly prevails within the key ministries, providing a challenge to achieving the required levels of cooperation and coordination necessary to deliver effective catchment scale management action along the lines envisaged in the Inle Lake 'Long term Plan' (MOECAF 2013) and its related Action Plans (MOECAF 2014).
   - The lack of social or sectoral relationships or networks amongst farmers and fishers beyond the individual village level (at national, state/regional or Township levels), for interacting, knowledge exchange on particular problems, livelihood options, alternative or more sustainable agricultural practices, etc.
     - With one notable exception (i.e. Intha Literature and Cultural Development Association (ILCDA) in Nyaung Shwe Township), the SRA Research Team found no social organisation or knowledge networks amongst farmer or fisher groups beyond the individual village level. There was no knowledge or experience sharing within any networks of vegetable growers, floating gardeners or fishers identified by in-lake fishing village or LweNyeint Village (on the banks of Inle Lake). Extension people noted that there were no farmer groups within Shan State (i.e. no commodity-based organisations at the state level) and that this made it difficult for them to target specific groups. The lack of a higher level of social organisation beyond the village poses challenges for the delivery of extension services targeting fishers and farmers, as well as other socio-economic initiatives and innovations. These need investigation.

   Opportunities:

   - The establishment of an Inle Lake Authority (ILA) will have the potential to overcome some of these constraints. Beyond structural change, ILA requires appropriate processes to support innovation and change as well as purposeful capacity building of Ministry staff across diverse agencies, at both national and state levels. The SRA Research Team could affect positive change by interacting and consulting with the ILA once established.

- There is political momentum to focus and better coordinate the activities of government (e.g., as articulated by the new/second Inle Lake 'Action Plan'). As Roth et al. (2014) argue, if at the same time government and research for development initiatives are underpinned by a strong ethic of community engagement and empowerment, and recognition of ethnic cultural differences, there is a clear opportunity to foster more equitable and community-supported solutions to managing Inle Lake and its catchments. This would not only help sustain the values of the Inle Lake environs, but it could also provide significant potentially relevant lessons for other catchments of Myanmar.
- Any solution to these problems will require a sustained community engagement process, underpinned by solid social and institutional research.
- ILCDA includes fishers, agriculturalists, weavers, restaurant and tourist facility operators, boat operators and hoteliers among its members. The ILCDA holds an annual workshop, and promotes culturally-based environmental stewardship, focusing on the Lake-based and land-based livelihoods. This organisation may prove to be a useful network for information and knowledge exchange and research collaborator to improve the management of the Lake and of the associated catchment.
- The trans-disciplinary nature of the ACIAR SRA Research team would provide a major opportunity and initiative in moving towards an integrated, sustainable approach to improving the Inle Lake environment and supporting local livelihoods in the region.

4. Past, current and future investment

4.1. Government priorities for investment

Myanmar Government Issues and Priorities

Since the late 1980s, Myanmar government policies and plans have drawn attention to the "severe environmental and physical degradation due to several human, natural and anthropogenic factors" of Inle Lake and its catchments (MOECAF 2013). In response to a severe drought in 2010, MOECAF developed a rolling "*Action Plan for Environmental Conservation and Sustainable Management of Inlay Lake, 2010 - 2025*", to be implemented in 5 year stages. The first phase Action Plan (2010-11 to 2014-15) had a focus on 'sustaining the lake to sustain the community'. MOECAF also prepared the "*Long-term restoration and Conservation Plan for the Inle Lake Catchments, March 2013*", which promotes a community-based ICM approach to address the management problems of the lake.

A second five-year phase of the Draft Action Plan (2015-16 to 2019-20) is currently being finalised for implementation in 2015 (MOECAF 2014). It was prepared through a participatory process with diverse stakeholders and has a new emphasis on (MOECAF 2014):

a. the protection of human health and livelihoods as a key overall principle;

b. the need for Inle Lake conservation planning to be in harmony with economic development;

c. the need for integrated basin management principles to be applied including consideration of governance, environmental, social and economic factors in a holistic manner.

The new five-year Action Plan (2015-2020) aims to provide a balance between the need for rehabilitation and conservation for preserving ecological integrity of Inle Lake and ensuring sustainable livelihoods for communities. The eight priority areas for investment are (MOECAF 2014):

1. Institutional framework for Inle Lake conservation is required
2. Baseline data on the natural and social environment are essential for future conservation and development of Inle Lake. Data and information management systems are required.
3. Threats to human health must be reduced, and overall living conditions improved for Inle Lake residents.
4. Improved environmental awareness is required at all levels: national, state and local.
5. Deforestation rates are unsustainable, and reforestation in the watershed is essential.
6. Biodiversity conservation and fisheries resource management are critical for sustaining livelihoods.
7. Sustainable agricultural practices are required, especially reductions in the use of chemical fertilizers and pesticides.
8. Sedimentation and soil erosion rates impact lake health and productivity.
9. Promotion of sustainable tourism practices, including improvement in infrastructure, training and capacity building for local people

Australian Government Priorities

The proposed Program of research for development directly aligns with ACIAR and Australian Government priorities. For example:

- Australia's new development policy and performance framework (2014) and ACIAR's Annual Strategy Refresh (2014);

- The Program will support economic diplomacy by directly improving agricultural sustainability and profitability in and adjacent to Inle Lake and indirectly by supporting a sustainable tourism industry. Where possible, the Program will engage the private sector to achieve development outcomes.
- The Program will support a gender-sensitive approach by directly promoting women's participation in its engagement activities, and purposefully recognising the differential impact on women of Inle Lake management issues and livelihood strategies examined by the Program wherever appropriate.

- ACIAR's Strategic Plan (2014-18) and Annual Operational Plan (2013a):
  - The Program will learn from and build upon the lessons and relationships developed in ACIAR's current multi-disciplinary program in the Central Dry Zone and Ayerwaddy Delta. (ASEM/2011/043)
  - Capacity building is urgently required and will underpin all components of work.

4.2. Who's doing what and where?

As previously noted (see Section 3.3), the Myanmar Government is implementing some key policies and plans on Inle Lake and its four catchments (e.g. MOECAF 2013; 2014; MOHT 2014). In support of these, national/Union and Shan State Governments, government departments, UN and other international donor agencies, NGOs and community-based organizations (CBOs) have been supporting the conservation and rehabilitation of Inle Lake through various projects over a number of years. Some recently completed, current and proposed initiatives that the Research Ream is aware of are noted below. Most need further investigation.

<u>Recently Completed Projects:</u>

- "The Inle Lake Conservation and Rehabilitation Project" commenced In 2012, with funding of $2.47 million (jointly from UNDP and Norwegian Government) with the aim to restore the environmental stability and to improve the quality of life of local community in and around the area of Inle Lake. The 2-year project activities in 3 townships included improvement of water supply system, hygiene and sanitation facilities, environmental conservation awareness (UNDP and MOECAF 2013). A mid-term evaluation identified a number of challenges including the limitations of the focus on micro-catchments rather than a more territorial (or regional) approach (UNDP & MOECAF 2013)
- Institute of International Development (IID) with funding from the Norwegian Ministry of Foreign Affairs recently completed the project "Inle Lake: A Plan for the Future" which aimed to assist the Ministry of Environmental Conservation and Forestry (MoECAF) in developing its rolling *Action Plan for Environmental Conservation and Sustainable Management of Inle Lake 2010-2025* (IID 2012; Jensen 2012).
- UNESCO Myanmar Office has provided technical assistance to Ministry of Environmental Conservation and Forestry to submit the Nomination Dossier for Inle Lake as a Biosphere Reserve (under the Man in the Biosphere (MAB) Programme) to UNESCO in September 2013 to promote sustainable development based on local community efforts and sound science (MOECAF 2014). The application supported by the Norwegian Government did not get up in 2014, and it is being re-submitted this year but it is considered likely to be a hard call given the current situation of the lake.
- Some local NGOs and the ethnic community based organizations, such as Inthar Literature, Cultural and Regional Development Association (ILCDA), are implementing partners of international organizations for the community-based environmental conservation and development projects – e.g. under UNDP Small Grant Facility for CBOs and NGOs. These are

mostly concerned with reforestation, natural forest conservation, fishery and livestock practices, etc. (UNDP and MOECAF 2013).

Current /on-going Projects:

- Myanmar Institute for Integrated Development (MIID) funded by the EU and ICIMOD is implementing a climate change adaptation project in the upper catchment, including community forestry and soil and water conservation in Kalaw and Nyaung Shwe townships (MIID 2014a, 2014b, 2014c). Key objectives include:
    - An increased ability to plan and adapt to change in natural resources (e.g., climate change, deforestation, tourism pressures, changing livelihoods, limited water, population pressure).
    - Pilot project working with five villages (ethnic minorities) to increase their incomes so they are better able to adapt to change.
    - Villages have weak social capital and the aim is to build their capacity on a range of areas (e.g. water management, using value chains to improve incomes / futures, alternative crops e.g. bamboo, date and ginger).
- ACIAR projects in Myanmar:
    - Strengthening institutional capacity, extension services and rural livelihoods in the Central Dry Zone and Ayerarwaddy Delta regions of Myanmar project. (2013-2016).
    - Diversification of rice-based system in lower Myanmar (2012-2016) collaborative with MOAI DOA and DAR.
    - Increased production of legume-based farming system in the central dry zone of Myanmar (2013-2016).
- Initiative by the Hydropower Company to pay the community to replant forest or move to cash crops. 1-2% of hydropower profits will be returned as subsidies for improved management of forest areas (e.g., control sediment, monitor forested areas). [Note: Status unknown – current or proposed?].

Possible Proposals (in early stages of development):

- New Norwegian water quality project with MOECAF involving the Norwegian Institute for Water Research (NIVA) –possibly funded by NORAD (Norwegian Agency for Development) - to increase Myanmar's capacity for water quality monitoring - includes possible upgrade of analytical laboratory in Nay Pi Taw. [Note: conflicting information on this initiative].
- Norwegian Institute for Water Research (NIVA) activity focuses on water quality in forestry areas: Links to REDD++ initiatives [Note: Unsure whether this is a separate initiative or part of the previous initiative].
- MIID with Canadian AgriTeam have proposal for a 5 year project being considered by the Canadian Government for funding (possibly more aid related versus research per se), whose core objectives include: .
    - Aspects of the establishment of an Inle Lake Authority and a GIS/database management system;
    - Farmer field schools (fertilizer and pesticide application)
    - Tourism training schools –focus on transforming from agriculturally-based to tourism-based livelihoods.
    - Land degradation project in upland area
- German project proposal on sustainable management of tourism on Inle Lake – dominantly a technical approach focussing on:
    - Water management
    - Generation of electricity via solar power
    - Waste water management (but maybe not sewerage, just greywater)
- Ecosystem services of degraded lands proposal – no details.

Focus of Some Government and Other Research Institutions

Some observations from the Research Team on the Myanmar Government agency general focus and on specific activities are:

- Ministry of Environmental Conservation and Forestry (MOECAF) is responsible for environmental impact assessments (EIAs). They are currently establishing forest plantations within the catchments and curtailing shifting cultivation (although we did not see much shifting cultivation). They have a priority on erosion control and environmental conservation and biodiversity in the lake. The Watershed Management Division of MOECAF is focused on forest conservation and check dams for sediment control, and it is also the lead agency for the implementation of the Inle Lake Long Term Conservation and Rehabilitation Plan and its related rolling five-year 'Action Plans'.
- Forest Research Institute, at Yezin, is a government R&D agency with a long history of forestry research in Myanmar, spanning over 35 years. It has limited resources but it is very keen to collaborate on research on Inle Lake and its catchments. One of its divisions is the Forest Development Division whose interests include natural resource management and watershed management).
- MOAI Department of Planning acts as the Secretariat to the Minister. Its other main functions include adoption of agricultural policies, agricultural statistics, relations with international governments, and strengthening cooperation and coordination among agencies.
- MOAI Department of Agriculture Research seem to have a rather limited research agenda in relation to this Inle Lake project and was not interested in collaborating with this project. Its dominant focus is food production and security. Working with JICA on water harvesting.
- The Irrigation Department (ID) of the Ministry of Agriculture and Irrigation (MOAI) is mostly staffed by engineers and is heavily engaged in dredging and groundwater management. For example, through the 'Inle Lake Long Term Maintenance and Conservation Project, NyaungShwe' the ID removes sediment in the lake by dredging and claims that channel maintenance in Inle Lake is becoming increasingly difficult because channels are filling quickly. The ID has some rainfall data as well as recorded lake levels (surface elevation) since 1992 and sometimes the depth of lake (but not necessarily yearly). Some limited data may be available of fluctuation of water level during the year.
- NyaungShwe Township Office focus is on increasing farm production and improving environmental conservation, including water quality, soil conservation, and better use of fertilizers and pesticides. Mentioned the wish to continue the sedimentation research that Dr. Taka Furuichi has been doing, particularly related to identifying 'hotspots'.
- Shan State Government is very focused on Inle Lake and is very concerned about hotel development, dredging, and increased agricultural/forestry operations around the lake. They also raised the issue of aquatic plants in the lake as well as road construction in the catchments. Pesticide usage was also discussed.
- Yezin Agricultural University (YAU) is the only level of higher education in agriculture in Myanmar and the only apparent institution with the capacity for research collaboration with the ACIAR proposed Inle Lake research initiative. It is by far the strongest University re: research capacity, with the most resources, and high quality students. In particular it ha capacity for socio-economic research and livelihood analysis for agriculture (only such capacity identified in research institutions visited) an as a consequence it has a significant overload problem in this area. It has a big focus on lowland rice and appears less committed to Inle, although some recent research on chemical use. However, the Rector was one of the first to respond very positively to email sent on the Team's visit and has identified three focal people

to interact with on possible collaboration. YAU's Aungban Research Station, has a focus on crop production in the uplands.

- Taunggyi University has a big interest in the lake but very limited research capacity. There was indication that some research had been done on sediments in four streams flowing into Inle Lake, but no specifics. Very interested being a potential partner; they have a young geologist on staff. The fisheries work was not impressive and seemed to lack relevance to this project.

4.3. What's working, what's not?

Governments of Myanmar over a number of decades have attempted to conserve Inle Lake and its catchments and to improve the lives of the people who live there. However, they have all failed to stem the decline in the health of the lake and its catchment system. Despite the acknowledgement of the severity of the problem in national policies and environmental plans, the degradation of the health of Inle Lake has persisted largely unabated; thus threatening the sustainability of Inle Lake, its catchments and the ecosystems services they provide and, in turn, the livelihoods of diverse agricultural communities that depend upon them. So what is happening and why have many efforts not worked?

Firstly, Inle Lake is facing significant and increasing pressures from the interaction of rapid population growth, growing tourism, expansion of agriculture, unsustainable management practices, and the uncertainty of the dynamics of climate variability and change (see Sections 3.1 and 3.2 of this report). The outcome has been:

- Accelerated soil erosion and sedimentation;
- Nutrient enrichment (impacts on lake water quality);
- Contamination (human wastes, pesticides, fertilizers);
- Forest conversion;
- Loss and degradation of aquatic habitats;
- Decline in fish stocks; and
- Decline in the area of open water.

Secondly, although there has been high level political will (e.g. the President) to address these issues facing the Inle Lake catchment communities, but it is a slow process of cultural and structural change. In this context, the Myanmar Government developed a Long Term Conservation Plan for Inle Lake catchments and an associated 5-year rolling Action Plan to implement these. It also established a three tiered structure for the overall management of Inle Lake; at the National (Policy) level; the Shan State (Supervisory) level and the Township (Implementation) level and initiated a process of decentralisation (but rarely devolution) of responsibilities from the Union level to the Shan State and Township levels. Notwithstanding, weak institutional capacities and their dysfunctionality in practice have inhibited efforts to effectively manage the biophysical, socio-economic and institutional drivers of the lake's complex cross-sectoral and cross-cutting problems. The outcome has been:

- A lack of information, baseline data and analytical capacity to support the development of a more holistic understanding of the problem and its management (see Sections 3.1.7, 3.2.1, and 3.4.6 of this Report);
- Lack of capacity for co-operation and coordination across agencies and levels of decision-making to work more collaboratively together to implement agreed policies and plans and take collective action , even when responsibilities are related (see Sections 3.3.4, 3.3.6, and 3.4.6 of this Report);
- Minimal consultation, connections and engagement by Government with local communities to better understand the problem and its solutions and to take action. Some community

sectors are concerned and some awareness exists within the diverse communities of Inle Lake, but some of the concerns (or non-concerns) may be misdirected. Technology transfer to communities to recognise the drivers of and outcomes for human health, environmental pollution and land degradation issues in Inle Lake and across its catchments is needed. The Myanmar Agricultural Services (MAS) has a strong presence in the intensive, irrigated rice areas and some upland areas but their presence is limited in the Inle Lake region. [Beyond single culturally-based village groups, there is also a lack of community networks and sectorally-based associations within the lake and its catchments (e.g. commodity-based farmer groups); the notable exception being the culturally-based Intha Literature and Cultural Development Association (ILCDA) which may provide a useful opportunity for connecting with the Intha community.]

- Poor in-country capacity for inter-disciplinary research to address the cross-sectoral and cross-cutting issues facing Inle Lake and to support an integrated catchment management approach to improving the Inle Lake environments and the sustainability and profitability of the livelihoods of its diverse communities. A key issue is the lack of appropriate and sufficient research and analytical capacity (e.g. skills, financial resources, and technical facilities) – see Section 4.2 above on the research capacity of institutions the SRA Research Team visited. [Note: Universities and other relevant research institutions in Myanmar have previously been under the responsibility of sectorally-based Ministries (e.g. YAU under the MOAI; FRI under MOECAF). However, as of 1 April 2015 these institutions all came under the responsibility of the Union Ministry of Education. It remains to be seen what impact this may have on research capacity.]

Thirdly, since the introduction of the 2008 Constitution, Myanmar's Union Government has been undergoing rapid and significant changes to its institutional arrangements. These reforms have opened up opportunities for broadened engagement of NGOs, international financial institutions, the United Nations, and other international donor agencies to help build the Myanmar's government's capacities to address the challenges facing the long-term health of Inle Lake and the livelihoods of the people that depend on it. Long term and on-going technical cooperation from donors, NGOs, etc. is urgently needed. However, the complex and wicked nature of the Inle Lake problem and the inadequacies of Myanmar's institutional capacities to: (a) implement the Action Plans collectively across all government agencies; and (b) engage the diverse Inle Lake and catchment communities has meant these cooperative technical initiatives (international donors, NGOs, etc.) have generally only had limited impact to-date. Some issues have been:

- There have been numerous relatively short-term initiatives (one-to two years) between the Myanmar Government and International Donors and NGOS (some well-funded) but their efforts have largely been piecemeal, sometimes self-serving, poorly integrated/inter-connected and commonly narrowly focussed; that is, largely fragmented activities, all doing their own thing and lacking co-ordination, connection or synergy with each other, and thus with little long-term impacts.
- Government agencies at all levels lack the capacity to monitor and evaluate environmental and social parameters effectively or to follow up on project activities undertaken. The case in point was highlighted recently when MOECAF did not have the capacity to appropriately evaluate the outcomes c of the completion the first phase of the rolling five-year Inle Lake Conservation Action Plan (2010-2015) to inform future action. Thus the monitoring and evaluation (M&E) focus has been on project activities identified in the Action Plan and rewarding implementation (e.g. tick the box) to the neglect of also understanding the impacts / outcomes for the catchment system itself in a holistic way.

4.4. Gaps where Australia could offer a comparative advantage

Over the last twenty five years, in seeking more sustainable futures to complex cross-sectoral and cross-cutting management issues, Australia has had a challenging but unique experience with linking policy, science and community through integrated approaches at a catchment or regional scale for enabling more sustainable resource use and economic development. Many lessons have been learnt from the challenges faced. The integrated approach focuses on:

- working cooperatively across institutional boundaries and multiple levels of governance;
- developing a systematic understanding of the catchment including approaches to catchment processes and their management; and
- engaging government and communities through collaborative processes to work together to better understand management problems and to collective take action.

The key overall research gaps identified through the situational analysis presented above can be summarised as:

- Understanding the institutional capacity needs for an integrated catchment management approach to cooperating within and across Ministerial portfolios, at the Union, Shan State and local Township levels, and to collectively address key issues affecting the long term future of Inle Lake's catchment system and its communities; and
- A better understanding and situational analysis of the Inle Lake catchment system, including the impact of the interaction of land use, sedimentation, water quality, lake ecosystem, and community livelihoods.

As identified in this SRA Report, the Myanmar Government has been challenged by not only a lack of cooperation amongst government agencies but a lack of appropriate institutional capacities to implement an integrated management approach that can address the complex cross-sectoral and cross-cutting issues facing Inle Lake and its catchment system. This failure is threatening (a) the long-term conservation and sustainability of Inle Lake and its catchment system, and (b) the sustainability and profitability of the livelihoods of the communities that depend upon the services that system provides.

In this context, the situational analysis provided in this SRA report gives rise to a number of research questions for shaping the proposed overarching program of research (possibly over 5 or more years). These questions are relevant to the Inle Lake catchment situation and also to many other contexts in Myanmar, as well as more broadly to developing nations in Asia where complex wicked policy problems affect the sustainability and profitability of rural livelihoods. These questions are:

5. What institutional capacities can enable integrated community-based management approaches that contribute to minimising adverse impacts on the catchment system and improving the sustainability and profitability of rural livelihoods; and how can these capacities be strengthened and adapted to changing circumstances over time?

6. How can integrated catchment management approaches contribute to:
    a. enhancing smallholder farming and fishing capacities for managing change (technological and behavioural);
    b. improving rural livelihood outcomes;
    c. minimising adverse losses of sediments and nutrients from managed lands and, thus, increase agricultural productivity and protect the lake environment; and
    d. providing food security for the region?
    e. Recognising and addressing gender-related issues.

7. What technical understanding, analytical capabilities, and assessment mechanisms support an integrated approach to:
    a. identify and manage 'hot spots' within the lake and contributing catchments; and
    b. understand the inter-connectedness of different drivers or causes with impacts or outcomes; and
    c. Improve the sustainability of agricultural practices while avoiding adverse impacts on human health and the environment?

8. What are the intrinsic values of Inle Lake to the residents in and around the lake as well as its contributing catchments? Are these values related to: sources of long term revenues; environmental attributes; a food supply; cultural significance: or (e) other amenity, social or livelihood outcome?

A series of shorter-term research for development components will underpin and be directly inter-linked to the overarching research program. The program and its supporting components will be purposefully designed to:

- Provide a better technical understanding of specific aspects of the linked natural and social science systems affecting the wicked policy problem and will include technology transfer to improve the sustainability and profitability of rural livelihoods;
- Recognise Myanmar's transitional context as a long term process; thus activities will be tailored to local context and capacities;
- Strengthen partnerships with key stakeholders in Myanmar including community interests that build on existing capacities and enable the achievement of outcomes in a more coordinated, coherent and complementary way;
- Be inclusive of the different stakeholders and address issues related to gender in a proactive but sensitive way wherever appropriate;
- Allow for flexibility to enable implementation to be adjusted as appropriate to changing political and institutional contexts; and
- Engage in partnership with a number of key government and research institutions to boost institutional capacities, including training opportunities for promising young talents.

The overall project will be implemented at a number of institutional levels (national, state/regional and local) and may involve selected "pilot" sub-catchment studies. The criteria for selection of these will be developed based on the outcomes of initial assessments (e.g. hotspots – biophysical, institutional, capacity-building, livelihoods) to be undertaken at the initial phase of the project and will be established in co-operation with research partners.

Further details of the project design will be provided in an Outline Research Report to follow.

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6. Appendices

6.1. SRA TOR

6.2. List of Meetings and Participants

Australian Government

Australian Centre for International Agricultural Research

TERMS OF REFERENCE FOR DEVELOPMENT OF SMALL RESEARCH AND DEVELOPMENT ACTIVITY

Project Leader: Jennifer Bellamy
Position: Honorary Senior Research Fellow
Organisation: The University of Queensland
Phone: +61 7 3365 2163; +61 407 696 207
Email: jenny.bellamy@uq.edu.au

BACKGROUND

The Australian Centre for International Agricultural Research (ACIAR) is examining the feasibility of a research for development program to improve the sustainability and profitability of smallholder farming and fisheries in the Inle Lake catchment of Myanmar. Inle Lake is an iconic site of major cultural value in Myanmar and has been listed as an ASEAN Heritage site and on the Tentative List of UNESCO World Heritage Sites. Increased population, rapid growth in agriculture and tourism and on-going unsustainable livelihood practices are however threatening the Lake and the ecosystems services they provide. The challenging and complex nature of the problem is identified in Myanmar Government's Long Term Restoration and Conservation Plan for Inle Lake (MOECAF 2013) and its related 5-year Action Plans (2010-2014; in prep 2015 -2020) which aim to restore the Lake and provide sustainable and long term solutions through an integrated community-based catchment approach to coordinated action.

Although the Lake has been the focus of past research and development investment and numerous efforts by different Government Departments, NGOs and other agencies the problem has continued to deteriorate. Part of this issue relates to the efforts being based on limited data and information that is poorly integrated, often sectorally-focussed and lacking a holistic perspective of both the problem and solutions and therefore of low impact. There is also broad recognition of the need to develop the capacity of the Inle Lake catchment institutional framework to work more effectively with integrated and community-based catchment approaches.

In October 2014, ACIAR commissioned a study to determine the feasibility of a long-term, multi-disciplinary research for development program around Inle Lake (Roth et al, 2014). The study verified that there is a strong business case for investment in research for development and strongly endorsed an integrated catchment management (ICM) approach. ACIAR now wishes to commission a Small Research and Development Activity (SRA) to further develop the program as a potential phased multidisciplinary multi-project program of work that could occur over approximately 8 years.

SCOPE

The SRA will develop the program goals, activities, outputs and impacts and provide a framework of potential projects; including a process for reviewing and adapting the framework to manage risks and opportunities as they emerge within a complex and uncertain development and institutional environment. It will also consider program delivery and monitoring and evaluation. The outputs of

the SRA will be an SRA Report, followed by ACIAR Phase 1 and Phase 2 project proposals for the first project of the program. The first project will act as an integrative platform for the research and delivery of outputs and provide management and evaluation of the program. The first project will also undertake research on ICM, community engagement and institutional and development capacities. The SRA team will be required to travel to Myanmar to build relationships and establish commitments.

OBJECTIVES

The SRA contains three objectives:

1. Build relationships and establish commitments with Myanmar Government agencies and research institutions, NGOs, international donors, and community organisations associated with the management of Inle Lake and Catchments.
2. To develop with the local partners an outline research Program that addresses research questions for sustainable biophysical, economic and social development of Inle Lake catchment.
3. Determine the detail of the first project of the program (SMCN/2014/050) that will act as the umbrella project for the whole program.

METHODS AND OUTPUTS

The SRA team should follow the methods outlined in Table 1 to deliver the outputs by the specified dates.

Table 1: Methods, outputs and delivery dates as they relate to the SRA objectives.

Obj.	Method	Output	Due Date
1	The SRA team will: 4. Review Roth et al. (2014) and other relevant literature; 5. Travel to Myanmar in March/April 2015; 6. Engage with appropriate Myanmar Government Ministries and Departments; 7. Engage with other key stakeholders; 8. Develop greater situational understanding of the environmental, social, economic and governance factors and rural livelihood systems within the catchment, from a holistic perspective 9. Develop greater understanding of other relevant technical interventions and their interactions within the catchment. 10. Undertake consultation and feedback with key Burmese and Australian agencies to build relationships and establish commitments. 11. Engage with the Myanmar Government's Committee for Environmental Conservation and Sustainability of Inle Lake, at both national/Union and Shan State levels, and other relevant implementing bodies.	SRA Report. The report should follow the format outlined in Appendix 1.	1 May 2015

Obj.	Method	Output	Due Date
2	Develop the Inle Lake program goals, activities, outputs and impacts and provide a program of potential projects: • Undertake research into Integrated Catchment Management for Inle Lake and its catchments, addressing issues of effective institutional capacity for enabling community –based approaches and action concerning common pool resources and sustainable and profitable rural livelihoods; • Include umbrella program components, such as processes for identifying, reviewing and adapting the suite of technical interventions to manage emergent risks and opportunities. • Establish a monitoring and evaluation framework; • Provide an integrated communications and stakeholder engagement strategy; • Determine approaches to tackle institutional deficiencies; • Identify initial technical interventions to improve livelihoods of smallholders, and; • Support the Myanmar Government's "Long-term Restoration and Conservation Plan for Inle Lake" and its related "Action Plans".	An outline research program Proposal.	15th May 2015
3	Develop SMCN/2014/050 Phase 1 Project Proposal. Once the Phase 1 Proposal is approved at ACIAR's in-house Review, the SRA team will develop the Phase 2 Proposal. This will require further travel to Myanmar (probably in July/August 2015). The SRA team should continue strong engagement with the Inle Lake Long Term Plan implementing institutions. The Team should undertake relevant desk-top background research activities identified through these engagement activities, as deemed appropriate	Phase 1 Project Proposal Finalised Phase 2 proposal ready for in-country sign-off.	17th June 2015 1st Oct 2015

APPENDIX 1: SRA Report Outline

The SRA report should include the following:

7. Executive Summary

7.1. Overview of report

8. Introduction

8.1. Background to SRA

8.2. Aim and objectives

9. Overview of the Inle Lake catchment system

9.1. Bio-physical conditions

9.2. Socio-economic conditions

9.3. Institutional arrangements

9.4. Smallholder agriculture, forestry and fisheries: production and management, constraints and opportunities

10. Past, current and future investment

10.1. Government priorities for investment

10.2. Who's doing what and where?

10.3. What's working, what's not?

10.4. Gaps where Australia could offer a comparative advantage

11. Program design

11.1. Define the **long term goals, activities, outputs and impacts** of the program.

11.2. Define the **specific geographical foci** of the program (i.e. specific provinces and districts).

11.3. Identify potential **technical components** (projects) of the program, including (i) their key research questions, (ii) relative importance, and (iii) impact pathways.

11.4. Develop a process for identifying, reviewing and adapting the framework of technical components to manage emergent risks and opportunities that might be encountered

11.5. Identify the desired, achievable **outcomes**.

11.6. Describe the **key performance indicators** for the program.

11.7. Identify **existing research for development activities** (in Myanmar and Australia) on which the program could build, integrate with, or seek collaboration.

11.8. Suggest activities that will provide significant **early impacts**.

11.9. Provide direction on the **proportional allocation of budget and technical resources** to research (applied and basic), scaling-up and adoption, communication and stakeholder engagement, monitoring and evaluation, capacity building, and private sector engagement activities.

11.10. Identify **key risks** that might be encountered, assesses their relative importance (both likelihood and consequence), and describes what mitigation measures could be applied.

12. Conclusion and Recommendations

6.2. List of Meetings and Participants

List of Meetings, Inle Lake SRA Research Team Visit, 29 March – 6 April 2015

Date	Meeting	Who
10am Mon 30 March	Ministry of Agriculture & Irrigation (MOAI), Dept of Planning (DAP),	Dr.Tin Htut, Director General, DAP (Secretariat to Ministerial Office)
11am Mon 30 March	Ministry of Agriculture & Irrigation (MOAI), Dept of Agriculture (DA), Land Use Division, Nay Pyi Taw	Dr. Daw Thu Zar Myint, Deputy Director + 2 others
1:30pm Mon 30 March	Ministry of Environmental Conservation and Forestry (MOECAF), Nay Pyi Taw	H.E.U. Win Tun, Union Minister H.E. Dr.Thet Thet Zin, Union Deputy Minister H.E. Aye Mint Maung, Union Deputy Minister Dr.Nyi Nyi Kyaw, Director General, Forestry U Nay Aye, Director General, Environmental Conservation U Sein Tun Linn, Deputy DG, Planning & Statistics Dept
Mon 30 March	Ministry of Livestock, Fisheries and Rural Development (MLFRD), Dept of Fisheries (DOF)	U Nyant Win, Deputy Director U Saw Ag Y Htut Win, Deputy Director Dau Ni Lau Kwe, Deputy Director Yin Yin Moe, Deputy Director Aye Aye Zaur, Deputy Director U Saw Lah Paw Wah, Deputy Director (Aquaculture)
9am Tues 31 March	Ministry of Environmental Conservation and Forestry (MOECAF),Forest Department (FD), University of Forestry (UOF), Yezin, Nay Pyi Taw	Dr. Myint Oo, Rector, GIS Dr. San Win, Prorector, Agro Forestry Dr. San Thwin, Prof, Silviculture U Ohn Lwin, Prof, Genetics
10am Tues 31 March	Ministry of Agriculture & Irrigation (MOAI), Dept of Agricultural Research (DAR), Yezin, Nay Pyi Taw	Dr. Ye Tint Tun, Director General U Thant Lwin Oo, Director Dr New New Yin, Director Dr. Tin Tin Myint, Director Dr. Khin Mar Htay, Research Officer
11am Tues 31 March	Forest Research Institute (FRI), Yezin, Nay Pyi Taw	U Myint Aung, Deputy Director - (Director away on day - Dr Thaung Naing Oo) Dr Rosy Ne Win, Research Officer Dar Thidar Swe, Assistant Research Officer Daw Khin Thidar Tun, Research Officer U Yan Myo Aung,, Assistant Research Officer U Tun Tun Win, Assistant Research Officer
1pm Tues 31 March	Yezin Agricultural University (YAU), Yezin, Nay PyiTaw	Dr Myo Kywe, Rector Dr Nang Hsang Hom, Pro Rector (Admin) Dr Soe Soe Thein, Pro Rector (Academic) Dr Kyaw Kyaw Win, Professor Agronomy Dr Mie Mie Aung, Professor Plant Breeding Dr Cho Cho San, Professor Agric Economics Dr. Tin Tin Aye, Prof Academic Affairs Dr Kyaw Ngwe, Assoc Professor, Soil &Water Dr Theingi Myint, Assoc Prof, Agricultural Economics Dr Myint Thuzar, Lecturer, International Relations

Date	Meeting	Who
3pm Tues 31 March	Ministry of Environmental Conservation and Forestry (MOECAF), Forest Department, Watershed Management Division, Nay Pyi Taw	U Win Marrong Aye, Staff Officer U Myo Auny, Staff Officer (Director Bo Ni, away on intensive training course on day)
1:30pm Wed 1 April 2015	Shan State Government Offices, Taunggyi	H.E. U Sai Aik Paung, Minister of Forests and Mines U Myint Aung, Secretary of Shan State Government U Maung Maung Win, Director of Forest Department U Toe Wai, Deputy Director of Dept of Agriculture Dr Ne Lin, Deputy Director of Livestock Dept U Tin Tun Aung, Deputy Director, Department of Fishery U Thant Zin Swe, Staff Officer, Dept of Irrigation (*H.E.U Sao Aung Myat, Chief Minister away)*
4pm Wed 1 April 2015	Shan State Forest Department Office, Taunggyi	U Maung Maung Win, Director U Htay H Laing, Assistant Director
5pm Wed 1 April 2015	Ministry of Agriculture and Irrigation (MOAI), Shan State Agricultural Department Office, Taunggyi, Shan State	U Toe Wai, Deputy Director Daw Khin Lay Swe, Staff Officer (Planning) U Khin Maung Tint, Staff Officer (Land Use) Dau Mi Mi Hlaing, Staff Officer (Plant Protection) Dau Khin Su Ye, Staff Officer (Plant Protection) Dau Win Thandar Aye, Deputy Assistant Agriculture Officer (Planning)
10am Thurs 2 April	Taunggyi University, Taunggyi, Shan State	Dr Aung Khin Myint, Pro-Rector Dr Daw Aye Than, Prof Geography Dept Dr Aye Aye Win Kyi, Prof, Botany Dpet Dr Pe Than Kyaw, Lecturer, Zoology Department Dr Nam Mon Mon Thaw, Demonstrator, Geology Dept (*Rector away on day - Dr Mu Mu Myint*)
pm Thurs 2 April 2015	Paung Par Village, Daw Shire Myint	U Moe Soe – Fisherman U Pe – Floating gardener
9am Fri 3 April	Intha Literature and Cultural Development Association, NyaungShwe Township, Shan State	U Thet Tun, Chairman U Tin Auny Kyaur, Vice Chairman U Than Doe, Member
10am Fri 3 April	NyaungShwe Township, Shan State Government Officers, Shan State	U Kyaw Zaw Hla, Township Administration Officer (TAO) U Htay Lwin, MOECAF, Forest Dept, Staff Officer U Sein Htun, Warden, Inlay Lake Wildlife Sanctuary, Nature and Wildlife Conservation Division, , Forest Depart, U Kyaw Kyaw Oo, Staff Officer (Civil), Inle Lake Conservation and Rehabilitation Project, Irrigation Dept (ID) U Sai Aung Linn, Executive Officer, Township development committee U Aye Naing, Staff Officer, Department of Rural Development U Nay Aung, Staff Officer, General Administration Department

Date	Meeting	Who
2pm Fri 3 April 2015	LweNyeint Village, Taunggyi Bo Giyi Village	U San Tun, Chairman, Community Forestry & fisherman U Chun Min, Floating gardener U Ye, Floating gardener U Kyaw Than, fisherman U Ba Oo, fisherman
10am Sat 4 April	Fish Hatchery, Shwe Yan Pye	Daw San San Oo, Officer in charge
12am Sat 4 April	Aungban Satellite Campus, Yetzin Agricultural University, Aungban, Shan State	Dr Kyawt Sandar Aung, Principal,
5:30 pm Sat 4 April	MLFRD, Dept of Fisheries, Southern Shan State, Taungghi (previously met in Chief Ministry Office, ??Shan State)	U Tin Tun Aung, State Fishery Officer, DD of DOF Shan State