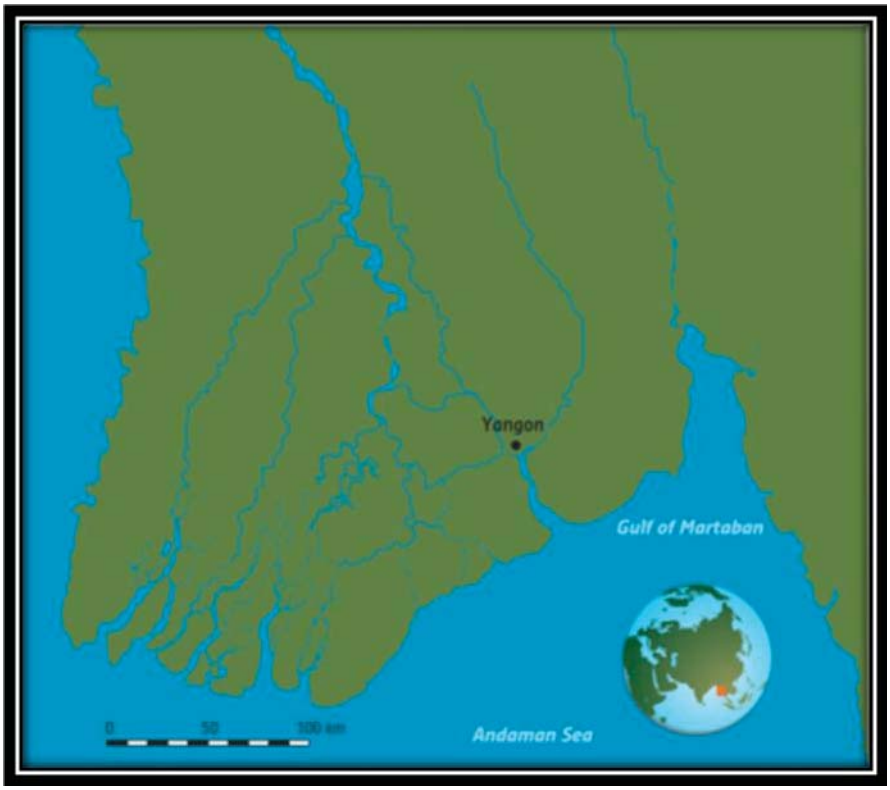
Vulnerability and Resilience Assessment Ayeyarwady Delta, Myanmar

Scoping Phase



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Wim van Driel
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Contents

1 Introduction

1.1 Context

This mission report responds to the recent request of Dr. Chris O'Brien, the Regional Coordinator of the Bay of Bengal Large Marine Ecosystem Project (BOBLME), to realize a vulnerability and resilience assessment for the Ayeyarwady Delta in Myanmar, comparable to the "Comparative Assessment of the Vulnerability and Resilience of 10 Deltas" executed in 2010/2011 for 10 other deltas in the world. This study was realized by a team from Deltares and Alterra in close cooperation with experts in each of the deltas (Bucx et al, 2010).

Figure 1.1 Comparative Assessment of the Vulnerability and Resilience of 10 Deltas plus the Ayeyarwady Delta (#11)

The BOBLME Project is interested in this delta assessment, as it provides a baseline of the current state of the Ayeyarwady Delta and it provides the possibility to compare the Ayeyarwady Delta to other deltas in the world. Apart from the vulnerability and resilience assessment, the study will also make an inventory of current adaptation measures and will identify knowledge gaps.

The Global Water Partnership (GWP) has also shown a keen interest to undertake activities in Myanmar within the framework of the preparation of the "Enabling Delta Life Initiative": a joint Global Program of Action on Deltas of GWP and Delta Alliance. GWP, therefore, is co-financing the delta vulnerability assessment. In addition, the Myanmar representatives and partners of GWP play an active role in the realization of the assessment. Besides the inclusion of the vulnerability assessment, Myanmar is also offered to propose a pilot or demonstration project in this Global Program.

The Ayeyarwady Delta fans out from the limit of tidal influence at Myan Aung to the Bay of Bengal and Andaman Sea. The delta region is densely populated, and plays a dominant role

in the cultivation of rice in rich alluvial soil as low as just 3 meters above sea level, although it also includes fishing communities in a vast area full of rivers and streams (Wikipedia, 2012). It is mainly populated by farming and fishing communities in several villages besides market towns, mostly located along the main rivers.

On 2 May 2008, the delta suffered a major disaster, devastated by Cyclone Nargis, which reportedly killed 84,537 people with 53,836 people missing, and left about 2.4 million affected. Total damage and loss is approximately 11.7 trillion Kyats, i.e. 4.1 billion US$ (Ministry of Social Welfare, Relief and Resettlement, 2012).

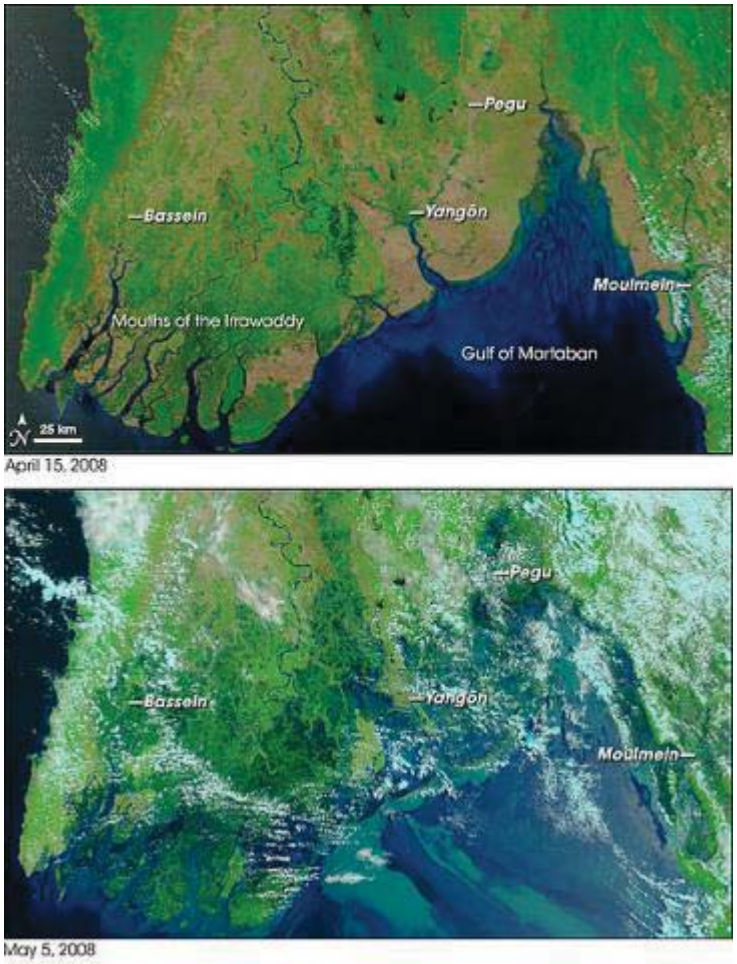

Figure 1.2. Overview of the Ayeyarwady Delta before and after by Cyclone Nargis, impacting severely around 50,400 km^2 of the low-lying delta (NASA images courtesy the MODIS Rapid Response Team. Caption by Rebecca Lindsey)

Following this flooding disaster there is a clear need for an assessment of the vulnerability and resilience of the Ayeyarwady delta.

Since it was unknown how much data will be available and whether the right experts can be found to contribute to the project a phased approach was proposed:

- Phase 1: Identification mission
- Phase 2: Elaboration of the Ayeyarwady Delta description and assessment

This mission report describes the phase 1 activities. After phase 1 a go – no go decision has been built in on the basis of the possibilities and constraints identified during phase 1. In case of a go-decision a more detailed proposal will be developed for phase 2 based on the findings of the identification mission.

As a result the mission report describes the possibilities and constraints of conducting an assessment of vulnerability and resilience of the Ayeyarwady Delta.

1.2 Objectives of the project

The objectives of this phase 1 study are:
- Identify the possibilities and constraints of conducting an assessment of vulnerability and resilience of the Ayeyarwady Delta
- Prepare a plan for conducting a full assessment of vulnerability and resilience
- Preliminary description of the vulnerability and resilience of the Ayeyarwady Delta.

The objectives of phase 2 will be:
- Elaborate an assessment of vulnerability and resilience of the Ayeyarwady delta according to the delta assessment approach as applied in the Delta Alliance project 'Comparative Assessment of 10 deltas'
- Make a brief comparative analysis related to the other 10 deltas already studied

1.3 Activities and results of phase 1

The project proposal describes the following activities for phase 1:
- Identify the most important challenges in the Ayeyarwady Delta
- Identify potential cooperation partners in the Ayeyarwady Delta, that could contribute to the vulnerability assessment (and that could ultimately establish the Myanmar Wing of the Delta Alliance network)
- Further discuss the cooperation possibilities with the BOBLME project in order to prepare a detailed proposal and project plan on the assessment of the Ayeyarwady Delta
- Make a brief inventory of accessible literature and data that can be used for the assessment (including Remote Sensing data, hydrological data, socio-economic data etc.), and
- Provide a preliminary description of the Ayeyarwady delta on the basis of this inventory.

With the following results:
- Mission report describing the possibilities and constraints of conducting an assessment of vulnerability and resilience of the Ayeyarwady delta.
- Plan for conducting a full assessment of vulnerability and resilience
- Preliminary description of the Ayeyarwady delta

1.4 Terms of reference of FAO contract

The ToR of the FAO describes the tasks as follows:
- Facilitate/lead a meeting of key of partners and collaborating agencies in Myanmar;
- Lead a familiarisation mission to the Ayeyarwady Delta with local partners and co-consultant to obtain first-hand information of the current situation and status;

- Identify potential cooperation partners that could collaborate in a future detailed vulnerability assessment;
- Prepare a preliminary description of the Ayeyarwady Delta including information gaps, challenges and opportunities, and
- Prepare a proposal and project plan for a future detailed vulnerability assessment of the Ayeyarwady Delta.

With the following key performance indicators as expected outputs:

- A scoping study that identifies partners, baseline information, information gaps and logistical options and a proposal for a future detailed assessment of the vulnerability and resilience of the Ayeyarwady Delta - by 31 October 2013;
- A brief (1-2 page) report on the activities undertaken as they relate to the description of the tasks listed above – by 31 October 2013.

1.5 Identification of a pilot project for the 'Enabling Delta Life Initiative'

In addition to the above the mission has been asked by GWP and the Delta Alliance to identify a pilot project that could be formulated and submitted for inclusion in the Enabling Delta Life Initiative: a joint GWP and Delta Alliance Global Program of Action on Deltas.

2 Methodology Vulnerability and Resilience Assessment

In the Delta Alliance study 'Comparative assessment of the vulnerability and resilience of 10 deltas' (Bucx et al, 2010) a framework has been developed (Figure 2.1) for describing deltas in a uniform format which enables a comparison of deltas with regard to sustainability and resilience. This framework links the DPSIR approach (OECD, 1993) with a layer model for spatial development (Marchand & Ruijgh, 2009).

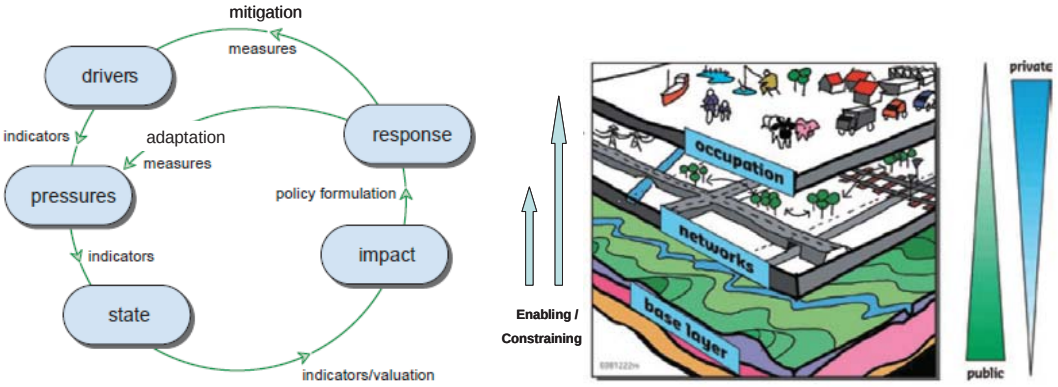

Figure 2.1. DPSIR cause-effect chain analysis (adapted after OECD, 1993) and Layer Model (VROM, 2001)

The framework also provides a linkage with governance issues and with the different actors and agencies involved in delta development and management.

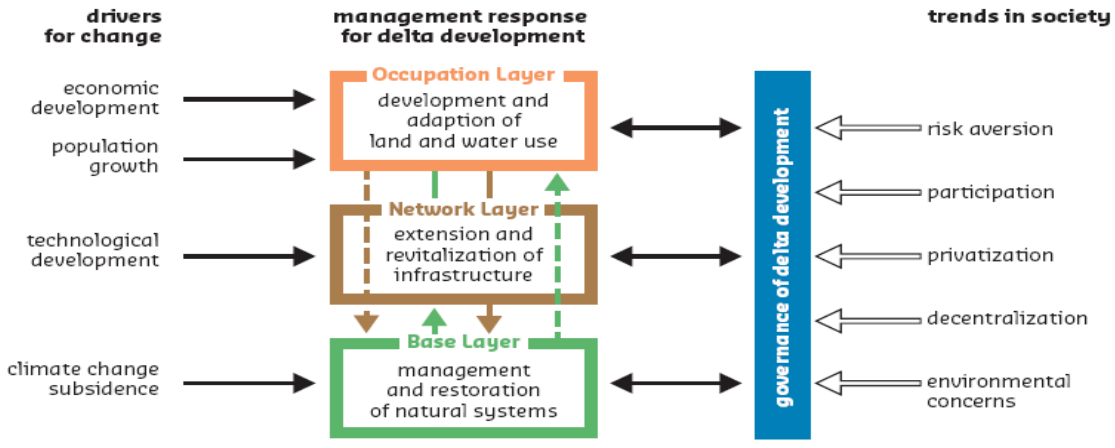

Figure 2.2 Framework for Delta Assessment (integrated the DPSIR and the Layer models)

Population growth, economic development, climate change and subsidence are the main drivers of change in deltas. These developments pose extensive demands on the available natural resources. But also technological development can be seen as a driver of change: it may provide opportunities for more cost-efficient and innovative infrastructure or exploitation of previously untapped natural resources. Box 2.1 provides a general description of the main drivers of change.

Box 2.1: Drivers of change

Population growth: The global population still grows with some 2 percent per year, although there are distinct regional differences. The migration of people towards coastal urban areas often yields in a greater than average growth of the population in delta areas. The number of people to be served and to be protected against natural hazards will increase.

Economic development: Despite the current financial crisis, economic growth may be expected over longer periods of time, resulting in larger demands to be met, higher values to protect, more energy to be generated and more goods to be transported. This may also lead to upstream developments (dams etc.), which are also recognized as important drivers of change for deltas.

Climate change: There is general consensus that the rise of global temperature is inevitable, with its associated (local) impacts on sea-level rise and the hydrological cycle (larger and more frequent droughts and floods).

Subsidence: Most deltas are subjected to the natural geological process of long-term subsidence. Additionally, extraction of groundwater and fossil fuels, may cause significant lowering of the delta surface on the short term. Other short-term processes leading to delta surface lowering at a more local scale are shallow compaction and oxidation of organic sediments, which may also result from human activities.

Technological development: Innovations may open opportunities to enhance the functionality of infrastructure solutions, to extend the lifetime of infrastructure and/or to develop more cost efficient designs.

There are a number of societal trends that affect the organization and outcome of delta planning and development (Box 2.2). Of these trends decentralization and privatization may be viewed as autonomous developments. The challenge is to utilize the advantages of both trends, while minimizing their undeniable drawbacks. This calls for a selective enhancement of governance structures, reflecting the regional scale, an integrated and long-term perspective of more resilience and sustainable delta development.

Box 2.2: Trends in society

Decentralization: brings delta issues closer to the stakeholders involved. Due to lack of national coordination, there is, however, a sincere risk of uncontrolled and/or chaotic developments.

Privatization: Public-private partnerships are becoming the modus operandi for many infrastructural projects and services. Increased efficiency of tax payer's money is a key motive. The risk of privatization, however, is a focus on the short term as well as a neglect of the public interest.

Participation: Involvement of stakeholders and citizens is important to promote societal support of development projects as well as maintenance of infrastructure. Planning may benefit from the tacit knowledge of stakeholders.

Environmental concern: Worldwide concern about a changing climate and environmental degradation has raised the environmental awareness. Sustainability of development has become accepted as a basic policy concept for many deltas.

Risk aversion: Acceptance of risk is decreasing in our modern societies. Hence considerable efforts are made to further reduce or control the risks of natural hazards.

In order to understand how the drivers lead to changes in the pressures and state of the delta, a multitude of relations between human activities, and physical and ecological delta

conditions needs to be accounted for. To provide insight into this complex system, a simplified structure is applied in the form of a Layer model. This Layer model recognizes three physical planning layers (Figure 2.1): the Base layer (water and soil and including all related elements such as fisheries resources, mangroves), the Network layer (infrastructure, but also elements such as agricultural implements, fishing craft and gear) and the Occupation layer (zoning of land use functions and livelihood elements such as agricultural and fishery practices), each with different but interrelated temporal dynamics and public-private involvement. The model indicates a physical hierarchy in the sense that the Base layer influences the other layers through both enabling and constraining factors. For instance, the soil type determines to a large extent the type of agriculture that can be performed in the Occupation layer.

Unfavourable conditions (constraints) posed by the Base layer can to a certain extent be mitigated through adaptations in the Network layer or Occupation layer. For example, farmers can use agrochemicals to improve soil conditions. And dykes can be constructed to protect low-lying land from flooding. But these adaptations to the original physical geography of an area require investments and need to be managed.

The essence of the Layer model is the difference in dynamics and vulnerability between the layers, which results in a logical order in planning for the various layers. The layers enable and/or constrain activities in another layer. Besides for analysing the physical interactions between the layers, the model is also useful in positioning the roles of different actors, such as government agencies, private entrepreneurs and stakeholders. The development and maintenance of infrastructure in the Network layer is traditionally the responsibility of the government. The government also has a main role in the protection and management of the Base layer. Moving towards the Occupation layer the role and influence of the government becomes more restricted and the influences of private parties and citizen's interests become more dominant.

The Layer model is largely compatible with other well-known approaches, such as the ecosystem functions approach (De Groot, 1992; De Groot, 1994; De Groot et al., 2002).

Using the Layer model, it becomes clear that there are three main response themes on which delta management could focus, i.e. the development and adaptation of land and water use (Occupation layer), the extension and revitalization of infrastructure (Network layer) and the management and restoration of natural systems (Base layer), see Figure 2.1. Regarding the Base layer it should be noted that in deltas especially the sediment dynamics (balance) between sea, river and hinterland is important. Many deltas suffer from a sediment deficit, because sediments from the catchment are trapped in reservoirs upstream. Embankments along the delta distributaries prevent flooding and vertical accretion of the delta plain. The disturbance of natural delta sediment dynamics (i.e. lack of sediment) leads to land loss and increased flood vulnerability.

The governance required for sustainable delta development extends over all three layers and is characterized by a mix of government responsibility and private or non-governmental actor roles. The stronger private role in the Occupation layer is most clearly symbolized in the land ownership, which is legitimised through property rights legislation and often embedded in deep values of ownership and values associated with entrepreneurship. Land ownership induces private investments (e.g. farms, houses) and can be traded on the free market. The government can enact its influence through zoning regulations and building codes and, under very stringent conditions, can expropriate land for a public cause of national or local

importance (such road networks). Informal and formal arrangements exist for (participatory) planning processes and their legitimacy.

Although in the Base layer the role of the government is strongest, its management is often done in a rather fragmented way. Management responsibilities originate from a deep belief of stewardship to maintain the qualities of water, soils and subsoil natural resources. But the actual management instruments are mostly partially effective or inadequate to stop degradation and quality loss. These instruments are legitimized through national or international laws and obligations and enacted in the form of licences, concessions and covenants.

As the governance is almost one of the most important driving forces in sustainable delta development it is not enough to only discuss roles of government and private sector in each of the layers. The three layer model can be combined with the institutional layer model of Williamson which thus gives a clear picture to link human-environment systems with different modes of decision-making (Marchand & Ruijgh-Van der Ploeg 2009). This helps to classify the different 'agencies' and 'domains' (Agarwal et al. 2002) and improve the multi-level and multi-sectoral cooperation and efficiency.

Figure 2.3 summarizes typical delta issues as a sequence of drivers, pressures, impacts, governance and responses, for each of the three layers.

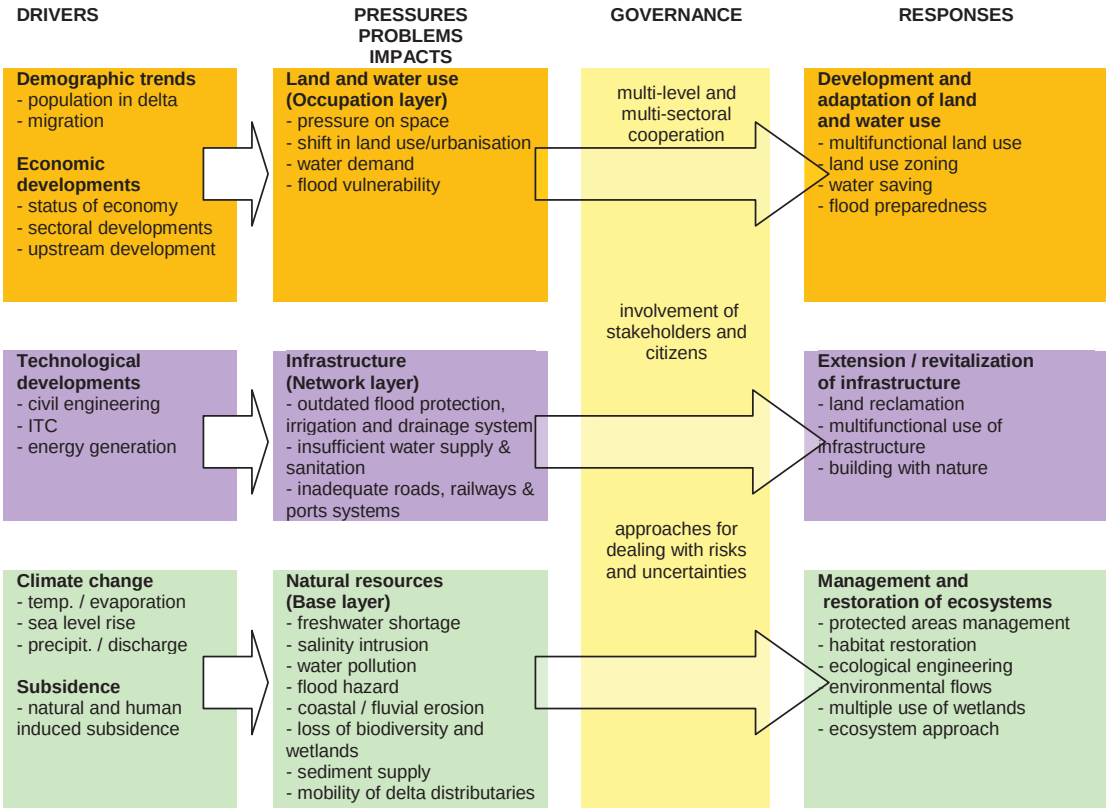

Figure 2.3: Sequence of drivers, pressures, impacts, governance and responses in deltas (nb: this is a simplified representation as the vertical interactions between the layers are not included).

3 Present Situation Ayeyarwady Delta

3.1 Natural System

3.1.1 Geographical Situation

The delta system of the Ayeyarwady River extends in a great alluvial fan from the limit of tidal influence near Myan Aung (18°15'N) to the Bay of Bengal and Andaman Sea, 290 km to the south. This alluvial plain is bounded to the west by the southern Rakhaing Yoma range and to the east by the Bago Yoma. The city of Yangon, situated on the southernmost spur of the Bago Yoma, lies at the south-eastern edge of the delta. Most of the delta area falls under the present Ayeyarwady Region, the remaining part in Yangon Region and Bago Region (see Figure 3.1).

Figure 3.1 Ayeyarwady region

3.1.2 *Climatic Conditions*

Monsoonal climate for the delta leads to an average annual rainfall of about 1,500-2,000 mm in the north increasing to 2,500 mm in the southeast and 3,500 mm in the southwest. Over 90 percent of the rain falls between mid-May and mid-November. During the monsoon season, the maximum and minimum temperatures in the coastal zone are about 37°C and 22°C, respectively. The seas may be very rough, and there are often strong winds from the south and southwest. The period from mid-October to mid-February is generally dry and cool. Temperatures rise after February, and April and early May are characterized by hot, variable weather with pre-monsoon squalls.

3.1.3 Hydrology and Hydrodynamics

The discharge in the Ayeyarwady River is at its lowest in February and March and there is a sharp rise in April-May as a result of melting snow in the upper catchment, followed by a further steep rise in May-June with the onset of the monsoon. The maximum flow occurs in July or August. Most waterways are un-engineered natural water courses, and there is no extensive system of dredged canals, the only major canal being the Twante canal which links Yangon with the western part of the delta.

The tide in the Ayeyarwady Delta is diurnal. The tidal variation shows a distinct pattern of spring and neap tides. The tidal influence enters deep into the delta, which offers opportunities for tidal irrigation.

Given all the projected water uses (hydropower, irrigation, drinking water supply, industrial and mining abstractions) water allocation priority problems may arise and an impact on the minimum environmental flow requirements may exist. Water balances and allocation studies are necessary to address these future water resources problems.

3.1.4 Soils and Sediment

The entire area is overlain by a thick layer of recent alluvium brought down by the Ayeyarwady River. Three main types of soil have developed: meadow gleyey clay soils, meadow swampy soils and saline gleyey soils.

Despite the large sediment load delivered annually to the gulf by the Ayeyarwady and Thanlwin (Salween) Rivers, the coastline has been largely stable for 156 years, advancing at an average rate of no more than 0.34 km per century since 1925. The long-term average rate of increase in land area across the study area between 1925 and 2006 is 4.2 km^2/year, but this masks a period of more rapid accumulation between 1925 and 1989 (8.7 km^2/year), followed by a period of net erosion at a rate of 13 km^2/year until 2006 (Hedley et al., 2010). It is suggested that the coastline encompassing the Ayeyarwady Delta and the Thanlwin (Salween) River is more or less in equilibrium, and that sediment deposition currently balances subsidence and sea level rise.

However, due to planned extensive damming projects losses in sediment supply are expected to occur, leading to possible retreat of the delta. This process will be further enhanced due to potential sea level rise (Salmivaara, 2009). This could impact the densely populated delta region and Yangon, and further exacerbate the impacts of extreme events such as Cyclone Nargis in 2008. Decreased sediment yields may also be caused by the increased sand mining activities in the river beds.

Decreased sediment yield has significant impact on the agriculture on the floodplains as the river brings less nutritious sediment to the croplands. This could furthermore increase the need to use fertilizers, and thus, cause potential water quality problems.

On the contrary, it is believed that the sediment influx in the Ayeyarwady River may be increasing as a consequence of deforestation in its fragile upstream landscape and widespread land use changes across the basin. Irrigation canals appear to be silting up 2-3 times the rate that was assumed when the systems were being designed; any irrigation rehabilitation would therefore require a serious reconsideration of sediment management.

3.1.5 Cyclones, Storm Surges, Riverine Floods and Tsunami's

Myanmar is prone to cyclones and April, May and October to December are considered to be the cyclone months as per last 100 years record. The coastal region is also prone to storm surges. During Cyclone Nargis, 90 percent of the deaths were caused as a direct consequence of the storm surge.

Myanmar receives almost all of its rainfall between mid-May and mid-November and (riverine) floods are quite common in the delta.

The intensity of tsunami's in terms of round-up and the extent of inundation in the Ayeyarwady Delta, as indicated by computed tsunami amplitudes, was comparatively lower than other countries in the region during the 2004 Indian Ocean Tsunami. Compared to other coastal areas in Myanmar (North and South) the amplitudes are slightly larger off the Ayeyarwady Delta, because the shallow delta extending offshore caused an increment of the tsunami wave amplitude (Ministry of Social Welfare, Relief and Resettlement, 2012).

3.2 Socio-economics

3.2.1 Population

Population of the country was estimated at 58.38 million during the census of 2008-2009. Taking into account a growth rate of 1.52 percent the actual population will be approximately 62 million. Ayeyarwady Region, covering a large part of the Ayeyarwady Delta has a population of 8,041,084 on an area of 35,032 km^2, hence a population density of 230 inhabitants/km^2. Ayeyarwady Region can be considered as a rural region with relatively low level of urbanisation. These numbers only concern the Ayeyarwady Region and not the other two regions in which the remaining part of the Ayeyarwady Delta is located: the Yangon Region, including the urban agglomeration of Yangon (some 5 – 7 million inhabitants) and Bago Region.

This population density in Ayeyarwady Region is e.g. relatively low compared to the one of the Mekong Delta (approx. 500 inhabitants/km^2, excluding Ho Chi Minh City) and the Ganges-Brahmaputra-Meghna Delta (more than 1200 inhabitants/km^2).

3.2.2 Political Changes/History in Delta Management

Mya Than (2000) discusses in his paper the "Changing faces of the Ayeyarwady Delta" the political, social, economic and environmental changes between 1850 and 2000. It seems that political, particularly leadership, and environmental changes are more apparent than any other. To evaluate these changes, his study has taken the chronological approach. Since the

period of study is long, it has been divided into four sections. The first section describes and analyses the changes in the pre-British period (under the rules of Myanmar kings) up to 1852. Changes in the Ayeyarwady Delta during nearly one hundred years of colonial rule (1852-1947) have been assessed in the second section and the third section examines the post-independence period (1948-2000). As the post-independence saw several changes in political leadership, it has been divided again into three sub-periods; democracy period, Burma Socialist Program Party (BSPP) period, and the present State Peace and Development Council period (SPDC). For further details reference is made to the original article. More recently, Myanmar has opened up to the outside world and is going through a political transformation.

3.2.3 Economic Development

The country is one of the poorest nations in Southeast Asia, suffering from decades of stagnation and isolation. The lack of an educated workforce skilled in modern technology contributes to the growing problems of the economy over the last decades. The country lacks adequate infrastructure. Goods travel primarily across the Thai border and along the Ayeyarwady River. Railways are old and rudimentary, with few repairs since their construction in the late 19th century. Highways are normally unpaved, except in the major cities. Energy shortages are common throughout the country including in Yangon and only 25 percent of the country's population has electricity. An Economist special report on Myanmar points to increased economic activity resulting from Myanmar's political transformation and influx of foreign direct investment from Asian neighbours. Agriculture has a major role in Myanmar economy, as it accounts for 41 percent of the Gross Domestic Product (GDP) and 68.9 percent of labour force (UNDP, 2007, CIA World Factbook, 2009).

In March 2012, a draft foreign investment law emerged, the first in more than 2 decades. This law oversees unprecedented liberalization of the economy. Foreigners will no longer require a local partner to start a business in the country, and will be able to legally lease land. The draft law also stipulates that Myanmar citizens must constitute at least 25 percent of the firm's skilled workforce, and with subsequent training, up to 50-75 percent. The draft includes a proposal to transform the Myanmar Investment Commission from a government-appointed body into an independent board. This could bring greater transparency to the process of issuing investment licenses, according to the proposed reforms drafted by experts and senior officials.

In a first ever countrywide study the Myanmar government found that 37 percent of the nation’s population are unemployed and an average of 26 percent live in poverty. Myanmar on January 28, 2013 has announced deals with international lenders to cancel or refinance nearly US$ 6 billion of its debt, almost 60 percent of what it owes to foreign lenders. For instance, Japan wrote off US$ 3 billion, nations in the group of Paris Club wrote off US$ 2.2 billion and Norway wrote off US$ 534 million.

3.2.4 High Percentage of Landless People in the Delta

In Myanmar all the land belongs to the Nation. Farmers can obtain Land Use Certificates. Inhabitants in almost all rural areas in Myanmar are divided into tiller’s right holders and landless people. Almost all of tiller’s right holders are into paddy cultivation by employing farm workers except those who own tiller’s right of smaller areas. Landless households account for more than 40 percent of the people in Myanmar, but according to the Post-Nargis Joint

Assessment Report (PONJA, 2008) it increases to around 75 percent in all 34 polders after the cyclone.

The average farm size per household in Ayeyarwady Delta is 11.2 acres (some 4.5 ha) according to UNDP (June, 2007), which is ranked at 1st among the Union in terms of farmland size per household. It is probably because the process of settling of immigrants in the delta started only around 100 years ago, so that it was not difficult for people to expand their lands. However, due to the high rate of population increase, the ratio of landless farmers in the delta reaches to not-negligible level. Some people lost their land tiller's right to cover school expense or medical payment.

Severely affected townships by Nargis are characterized by their high percentage of landless people, for instance, 62 percent and 71 percent of people in Bogalay and Labutta is landless, respectively, according to the Post-Nargis Joint Assessment (PONJA, 2008). On the other hand, there is a case of one person holding 60 acres of farmland. The JICA (2011) survey shows that in the area around Lubatta the ratio of households which have the tiller's right on farm land falls between 39.7 percent of villages in Kyaiklatt Township and 22.6 percent of villages in Bogalay Township (70 percent at the maximum and 9.9 percent at the minimum at village level). The majority of households are landless farm workers, accounting over 50 percent except in Labutta and Bogalay townships on average.

Average farm size of land holders who have tiller's right in the sample villages of the JICA (2001) assessment is more than 15 acres per farm household except in Kyaiklat Township. The range of farm size is large in some polders indicating maximum holding area of 200 acres and minimum area of 1.7 acres. There is a big difference between land right holders and landless households in terms of household income. Average household income of the land right holders is more than double than that of landless households.

3.2.5 Problems on Livelihood and Income Sources

It seems that the landless households are generally much more vulnerable than the householders with tiller's rights. Problems of landless households in the target area of the PONJA (2008) are identified as follows:

1) *Low level of income*: The main problem of landless households is low income and lack of income generation opportunities. Many have an income below poverty threshold of "one dollar per day", which is the target of the United Nation Millennium Development Goal.

2) *Little opportunity of increasing income*: Opportunity of increasing income for landless households is generally limited. Many of landless people are paddy workers and casual labour who do wage work or fishery as fishery worker, while very few landless households get income as tenant of paddy cultivation.

3) *Lack of skills for production*: Landless households have very limited skills. They have low capability to generate income themselves due to low education level and little opportunity for learning modern technology/technique for generating new income. This means they have little knowledge and experience of income generation activities.

4) *Lack of outside support*: Systematic supports from outside for enhancing their capacity is not generally available though there were many direct supports (in-kind, projects) in the years following Cyclone Nargis. Market information has not been collected in the target area and it may cause discrepancy of production/harvest volume and amount of income.

5) *Limited usable natural resources*: Natural resources are limited for landless households. Land is largely used for paddy production and other land use is not common. Water inside

polders is actually saline but it becomes fresh again after dike embankments and sluices are rehabilitated.

3.3 Administrative System

In Myanmar land and water are managed by many ministries, agencies and departments. Several departments, under their respective ministries, remain for instance responsible for the supply and management of water for agriculture, industrial, domestic and sanitation purposes. Different departments have different acts, proclamations and laws, but most of them need to be strengthened in order to overcome problems caused by the lack of regulations on land and water. There is also a lack of coordination and collaboration between the different institutions, including a lack of sharing of data and information.

Table 3.1 includes an overview of duties and functions for some of the most important Agency /Department (overview after first set up by Prof. Dr. Khin Ni NiThein).

Table 3.1 Overview of duties and functions for some of the most important Agency / Department (especially related to water)

Agency / Department	Ministry/City/Other	Duty and function
Irrigation Department	Agriculture & Irrigation	Provision of irrigation water to farmlands
Water Resources Utilization Department	Agriculture & Irrigation	Pumped irrigation and rural water supply
Directorate of Water Resources and Improvements of River Systems	Transport	River training and navigation
Department of Meteorology and Hydrology	Transport	Water assessment of main rivers
Ministerial factories	Industry (1), Industry (2)	Industrial use
Department of Fisheries	Livestock, Breeding and Fisheries	Fishery activities
City Development Committee	Yangon, Mandalay and Naypyitaw	City water supply and sanitation
Department of Rural Development –	Ministry of Livestock and Fisheries and Rural Development	Domestic water and rural supply, and sanitation
Private Users	private entrepreneurs	Domestic water supply, navigation, irrigation and fisheries
Forest & Environment Department	Ministry of Environmental Conservation and Forestry	Reforestation, conservation of (mangrove) forests and environment
Public Works	Construction	Domestic and industrial water supply and sanitation
Department of Human Settlement and Housing Development	Construction	Domestic water supply
Department of Health	Health	Environmental health, water quality assessment and control
Department of Health Planning	Health	Social mobilization, health, etc.
Yangon Technological Universities	Science and technology	Training and research
Myanma Port Authority	Transport	Port development in Yangon
Special Economic Zone Department	Planning	Planning of SEZ's - Thilawa
Myanmar Development Resource Institute	President's Office	Think tank for governance, socio-economic development and legal affairs

Regarding land and water management it can be concluded:

- With exception of the main cities and some township development councils planning and budgeting is governed by the central ministries and delegated, regarding execution of activities, to district offices.
- Administratively, Myanmar is divided into seven states (named after the major national group that inhabits the region) and seven regions (generally areas with Bamar majority). Apart from the national capital Naypyitaw, each state and division has a designated regional capital. In a descending order of administrative hierarchy, there were 64 districts, 324 townships, and 2,471 wards as well as 13,747 village tracts (grouping of villages).
- The influence and role of the academic sector is negligible. Also the role of NGO's is still limited.
- Although the private sector (mainly Myanmar people living abroad and interested to start investing in their home country) is looking into opportunities in Myanmar with great interest, it should be noted that only 30 percent of the transactions is successful according to McKinsey (2013). This is mainly due to the lack of knowledge and legislation in Myanmar, e.g. in the specific field of Public Private Partnerships.

3.4 Agriculture

3.4.1 Importance of the Agricultural Sector

Agriculture is traditionally a very important driver for the Myanmar economy. Although the Ayeyarwady Region occupies only 5 percent of all national land in the Union, it is known as the rice bowl of the country as it produces most of the rice requirements of the country. Annual rice production of Ayeyarwady Region of about 6 million tons accounts for 30 percent of total production in Myanmar of which about 22 million tons annually (FAO, 2001/2002). This situation is mainly due to increase of farmland area, especially, 25 percent increase between 1990 and 1994.

Table 3.2 Land use in the Ayeyarwady Region 2012 – 2013 (Source: Irrigation Department)

Type	Area in ha	%
Cultivatable Land	1,818,467	51.91
Forest and Reserved Forest	720,088	20.55
Cultivable Waste Land	149,168	4.26
Virgin Land	23,020	0.66
Other Area	792,447	22.62
Total	3,503,190	100

The increase of the rice production in the Ayeyarwady Delta got an important boost in the period 1976 – 1988 with the implementation of the Paddy Land Development Projects 1 and 2 (World Bank Projects). The projects consisted mainly of the construction of polders in the lower delta provided with embankments, sluice gates and drainage systems, hence protecting the land from salt water intrusion. For instance in Pyapon District the paddy cultivation area increased by the construction of 7 polders from 12,000 hectares in 1976 to 34,500 hectares in 1985. In the Laputta District the embankment enclose an area of 42,000 hectares.

Rice accounts for 97 percent of total food grain production by weight. Through collaboration with the International Rice Research Institute (IRRI), 52 modern rice varieties were released

in the country between 1966 and 1997, helping to increase national rice production to 14 million tons in 1987 and to 19 million tons in 1996.

In addition to rice farming, aquaculture, poultry and pig farms are being operated. Moreover, some areas (like Labutta Township) are famous for salt production. Some vegetables are grown for home consumption and the surplus as other source of income. Rice is followed by black gram as winter crops.

Table 3.3 Crop area in 2011-2012 for Ayeyarwady Region (Source Irrigation Department)

Name of Crops	**2011-2012 (hectare)**	
Paddy	**1,933,654**	
Monsoon		1,473,564
Summer		460,090
Corn	**6,280**	6280
Oil Seed Crops	**96,672**	
Ground nut		46,545
Sesame		10,900
Sunflower		39,227
Pulses	**547,127**	
Black gram		455,295
Green gram		89,910
Pigeon pea		1,922
Cotton	**126**	126
Sugar cane	**117**	117
Total	**2,583,976**	2,583,976

Cash crop production like vegetables is an important income source mainly for landless farmer. For instance, some farmers in Labutta North Polder cultivate cauliflower, cucumber, water melon, pumpkin, leaf on small scale farm land. According to the farmers, profit of vegetable production is higher than paddy production.

Livestock is an important asset and work force for farmers. Most of farmers own water buffalo, pig and/or poultry. It is reported that many villages in the Ayeyarwady Region have inadequate work force due to the loss of huge numbers of water buffalos caused by Cyclone Nargis.

3.4.2 Agricultural Practices

Agricultural practices are generally still very low tech. Land preparation (by ploughing) is hard work for the farmer due to very hard soil dried up by strong sunshine in dry season. Usually, the water buffalo is used for ploughing at the beginning of the monsoon season. Use of hand tractor is limited because of its low availability in the village area, financial deficit and also low quality of machinery (or low durability against hard soil).

A distinction has to be made between the rainfed monsoon paddy and the irrigated summer paddy. For the monsoon paddy only local rice varieties and low input levels are applied. Data

obtained from the Irrigation Department indicate that for monsoon paddy in the Ayeyarwady on average only 32.5 kg/ha of fertilizer is being used. The High Yielding Varieties (HYV) are not suitable for the rather uncontrollable water levels in the paddy fields during the monsoon season. Also the taste of the local varieties is preferred above the one of the HYV.

Due to unavailability of fresh water in the lower delta the irrigated summer paddy can only be cultivated in the middle and higher regions of the delta, unless special water conveyance canals are constructed for the transport of fresh water from upstream tidal reaches of the river. Better water control permits the use of HYV and the application of higher input levels of fertilizer and pesticides.

3.4.3 Crop Yields and Prices

Cropping yields are still low. According to the Agricultural Census 1985-86 to 1995-96, average cropping yield of paddy in Ayeyarwady Region is 3,250 kg/hectare. Information obtained from the Irrigation Department in the Pyapon District during the mission indicates an average production of 55 baskets/acre (2,890 kg/hectare) for rainfed monsoon paddy and 95 baskets/acre (4,990 kg/hectare) for irrigated summer paddy. Potential cropping yield of local variety is originally low because of low response to fertilizer, etc.

Therefore, application of HYV (High Yielding Variety) to a larger extent is necessary, if drastic increase of paddy production is required. For applying HYV, constraints like i) high investment cost, ii) unstable paddy price and iii) unverified appropriateness and cropping technology of HYV in field, should be solved to reduce farmer's risk. In addition, the quality (taste) of HYV is considered low by the people compared to the local varieties. Under the above mentioned situation, improvement of both production amount and quality is indispensable to secure stable supply of high quality rice for the country and to grow paddy as an export crop.

A minimum price for rice is guaranteed by the Government. Because of its quality the price of the local varieties is considerably higher than for HYV. The prices can triple in the course of the season. Due to low storage capacity, lack of farmer organisations, need for cash for daily life and reimbursement of credits, the farmers tend to sell their products for a low price directly after the harvest. The large variation in price during the year provides high margins for the merchants. This issue should get special attention in view of the desired improvement of the resilience of the rural communities.

3.4.4 Agricultural Damage by Cyclone Nargis

Inflow of saline water into paddy fields by Nargis decreased agricultural production instantly. According to farmers in Labutta North Polder, cropping yield of paddy of immediate crop after Nargis attack was decreased to 10-20 baskets/acre equivalent to minus 50-75 percent from 40-50 baskets of cropping yield before Nargis (local variety) (JICA, 2011). However, cropping yield of 2009 cropping season has recovered with a yield of 40-50 baskets/acre. By puddling the soil and subsequent surface drainage the salt deposit in the soil could be removed. Main farming constraints are lack of input of farming tools, draft animal, fertilizer and access to agricultural finance. These constraints became worse after Cyclone Nargis. Especially, the number of farmers without draft animal increased from 4 percent to 35 percent.

3.4.5 *Polders: Embankments, Sluices and Drainage System*

The monsoon paddy cultivation in the lower delta is only possible if the land is effectively protected against intrusion of saline water through the construction of polders mainly consisting of embankments, sluice gates and drainage systems. Figure 3.2 presents the progressive salinity intrusion in the delta during the dry season.

Figure 3.2 Average salinity intrusion in the Ayeyarwady Delta (1 ppt line)

In view of the precipitation quantities supplementary irrigation is not needed during the monsoon season. There is also no need to store abundant rainwater during the rainy season. Contrary, due to the heavy rainfall intensities, the role of the drainage canal is very important. The slide gates of the sluice are kept open from 15 May to mid-September and the drainage is controlled by the flap gates of the sluice to keep the water level of the drainage canals as low as possible. The old river courses are functioning as major drainage channels and small artificial drainage canals are connected as required in the areas with embankment. Whereas in the areas surrounded by polder dikes, artificial drainage canals are predominant.

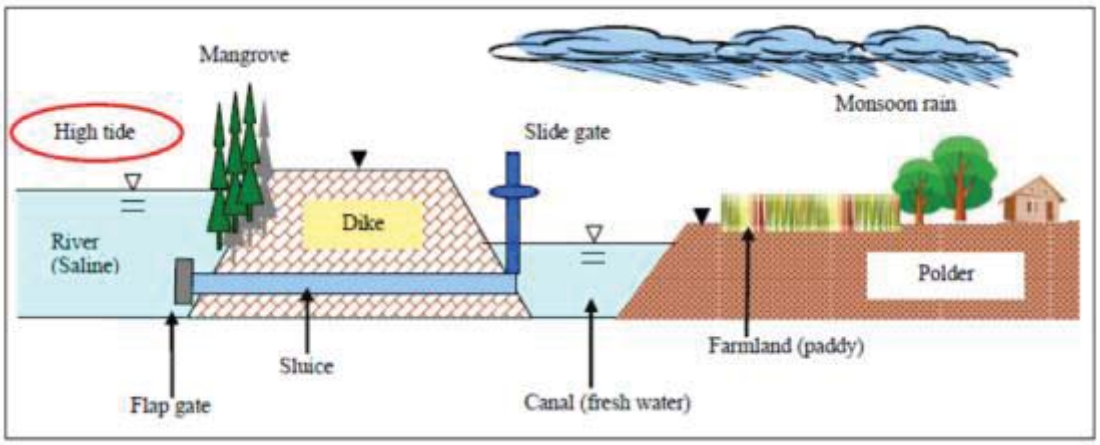

Figure 3.3 Functioning of a polder in the lower delta (JICA, 2011)

In the final stage of the rainy season the slide gates of the sluice located end points of the drainage canal are closed to store the fresh rainwater in the drainage canals. However, the salt water intrusions are occasionally found through the degraded slide gates and also

through leaking flap gates; hence the water impounded in the drainage canal is contaminated with salty water.

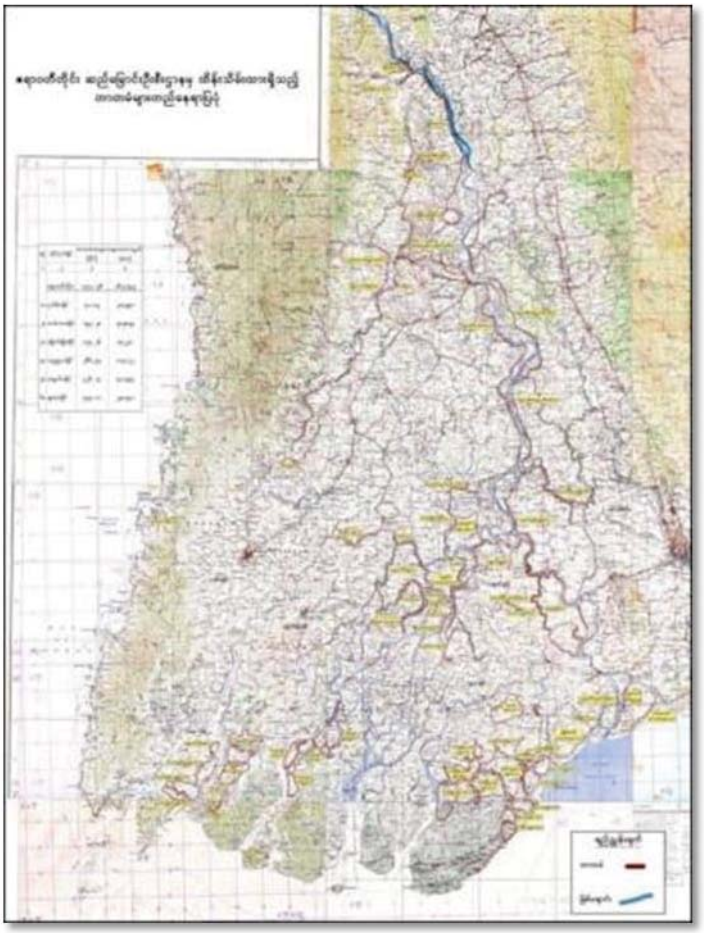

Figure 3.4 Embankments (red lines) in Ayeyarwady Region.

3.4.6 Irrigation

As the average annual rainfall can be more than 3,000 mm and concentrated in the rainy season from May to October, no irrigation is practiced for rainy season paddy cultivation in the area. At the end of the monsoon season the fresh rainwater is stored in the drainage canal for irrigation, livestock and miscellaneous purposes for the dry season.

In the lower delta irrigation is practiced during the dry season from November to April in the limited paddy fields located nearby the larger drainage canals by pumping the water from the canal. Diesel pumps are used and lifted water is conveyed through small ditches or in plot to plot method.

There are however also several special polder areas where irrigation water is conveyed from the intake of the upstream reach of the tidal river where the water is fresh and free from salt water contamination (JICA, 2011). For instance in Labutta North polder, the irrigation water in the dry season from October to April is conveyed from the sluice gate intake located 16 miles (26 km) from the north boundary polder dike in the upstream of Ywe River. The irrigation water is conveyed through the feeder canal and it is filled into the drainage canals. Then the irrigation water is to be supplied to the field along the drainage canal by pumping. The project

was completed in the year 2000, and the beneficial area is 2,500 acres (1,000 ha). However, it seems that the project did not accomplish the initially proposed target of the irrigation area and paddy production.

Tidal irrigation during the dry season is extensively practiced in the middle delta, while in the upper delta irrigation takes place by gravity (in case of upstream intake) or pumping.

3.4.7 Problems with Agricultural and Rural Infrastructure

JICA (2011) identified the problems with agriculture and rural infrastructure after Nargis as follows:

1) *Low height of polder dike*: Emergency rehabilitation work to restore the crest elevation of the dike to its original height before the Nargis has been completed already by the Government (Irrigation Department).
2) *Poor water tightness of sluice gates*: Salt concentrations of water in the drainage are too high due to saline water intrusion through damaged sluices. This seriously affects farming in the serviced areas. In addition, inundation of farms occurs due to poor drainage caused by uncontrolled sluice gate in wet season.

3.4.8 Problems on Farming

As far as the present farming system in the Ayeyarwady Delta is concerned, the World Bank study (August, 1999) described it concisely as follows:

"The Ayeyarwady Delta of southern Myanmar is a fragile and intricate ecosystem of mangrove swamps and tidal estuaries. Non saline arable areas are limited and becoming scarce due to the erosion of riverbanks, saltwater intrusion, and increasing soil salinity. Poor water control and drainage works contribute to periodic flooding and crop losses. Most poor households cultivate a single crop of traditional monsoon paddy. Better-off farmers able to grow early maturing, high-yielding varieties of paddy benefit from an additional winter crop such as groundnuts or soybeans. In the very few areas where irrigation facilities are available, summer paddy is grown. Marginal farm households cannot afford to use chemical fertilizer or manure and suffer from declining crop yields. In some townships such as Laputta, Bogalay and Mawlamyaingyun, it is estimated that more than half of the population is landless. Many marginal farmers engage in fishing and crabbing. Those who fish typically do not own fishing gear or boats and depend on fish traders for such resources. Some households raise pigs, chickens, or ducks. Others crop during the slack growing season by borrowing from more well-off farmers; loans are paid back through labour or through a portion of paddy crop. The effective interest rate charged by fish traders, rice traders and others in these loan arrangements typically amount to 10 per cent a month"

According to JICA (2011) the major problems on farming in the Nargis areas can be summarized as follows:

1) *Poor farming techniques*: Since natural soil condition of polder areas have been deteriorated, adequate farm management is essential to reduce such risk. Most of farmers in polder areas have practiced traditional farming such as "use of ordinary (low quality) seed", "inadequate use of fertilizer", "non-regular row transplanting method", etc. which have kept the productivity low.

2) *Lack of support on farming technique*: the number of staff of the Myanmar Agriculture Service MAS (now change its name as Agriculture Department), which is the responsible agency to provide extension services to farmers, was drastically decreased during the past 10 years. Consequently it has resulted to the slowing of agricultural developments.
3) *Lack of farming inputs*: Lack of seed, fertilizer, animal-power and agricultural finance have become serious especially after Nargis. Inputs such as seed and fertilizer are required at every cropping season on a permanent basis. Therefore, supply of these inputs should be secured to realize agricultural recovery and further development in the polder areas on medium and long term basis. Lack of adequate agricultural loans is also a serious issue and farmers have to consider private agricultural loans, which require very high interest rates. As a consequence some farmers are forced to sell their paddy immediately after harvest in order to repay their loan.

In addition, the lack of farm-to-market roads or roads in general in the southern delta should be added as a serious constraint.

3.5 Fisheries

3.5.1 Fisheries in the Ayeyarwady Delta

The fishery sector is the most important sector in the Ayeyarwady Delta after the agriculture sector. The fishery sector maintains a high per capita consumption of about 43 kg/year according to the statistics of year 2008-2009. The main fishery resources in Myanmar include:

- Freshwater through:
  - Fish culture
  - Leasable resource
  - Open fisheries
- Marine fishery through:
  - In-shore fisheries
  - Off-shore fisheries

These fishery practices take place in three main ecological zones in the delta which are related to distance to the sea and salinity level:

- a floodplain zone characterized by freshwater or a very low salinity maximum, the presence of freshwater fish species, large scale fencing for fishing and an unknown percentage of migratory species;
- an estuarine zone characterized by multiple waterways, temporary brackish water, typically estuarine species, degraded mangroves along waterways and a patchwork of rice fields, trees and villages;
- a coastal front characterized by a very flat land, quasi- permanent brackish water, salty soils, almost no vegetation and fishing activities targeting the coastal and marine zones.

A JICA (2011) study confirmed that fishery stands as the second important source of income after farming in all survey villages located in survey areas of six townships in the delta. Fishing and processing of fishery products provide an opportunity for landless people to earn income for their livelihood. Based on information from the key informants' survey, prawn is the most important source of income in the aquaculture industry in the villages and is given first priority for earning income. Dry prawn, fried fish and prawn paste making industries are performed in most of the surveyed villages.

Figure 3.5 Ecological zones (MyFish, 2012)

The FAO report (2003) on Myanmar Aquaculture and Inland Fisheries gives the best overview of current fishing practices and developments. The MYFISH report (2012) on 'Delta draft scoping report ''Improving Research and Development of Myanmar's Inland and Coastal Fishery' provided a recent update.

In this MYFISH report (2012) it is concluded that there is an increasing loss of connectivity in floodplains due to the extension of rice farming. Like in the Mekong, there is a trade- off between rice production development and sustainability of the capture fish resource.

In the past years, in the diversity of catches and in biomass; the main species characterized by a strong reduction are snakeheads and catfishes. It seemed that the fish species composition looks richer in the floodplain zone than further downstream, which is surprising (the biodiversity of estuarine zones is generally much higher than that of rivers since they combine representatives of the freshwater, brackish and estuarine faunas. Similarly the contribution of migratory species to the biodiversity and to fish yields in this ecological zone is not clear. This zone is characterised by substantial collective efforts in the past to restock water bodies in order to sustain the productivity (lease holders must invest into restocking, and hatcheries provide fingerlings). However water bodies are stocked with mainly aquaculture farmed species (rohu, tilapia, catla and silver barb), and there is no assessment of: (i) the efficiency of the restocking efforts, or (ii) their impact on the natural biodiversity.

There is clearly an opportunity for research on the effect on natural productivity of current restocking efforts and on possible improved options in terms of stocking densities, stocking

periods, species stocked, water bodies to be stocked, etc. However, there is also a risk that this research ultimately demonstrates that either the former efforts were not effective, which would not be politically welcome, or that they were actually effective, which would not be very useful in terms of applied research.

From a national perspective the fisheries economics of the estuarine zone are clearly more influenced by coastal and marine fisheries than by local catches, however local fisheries and the lease system play an important role for small shareholders and local communities. The respective role of changes in policies, in competition and in the resource base are not clear and deserve clarification; from that perspective research in biology could focus on medium to long- term trends in species composition, catches and dominance.

Dwellers of the coastal zone are clearly among the poorest of the delta; they suffer from harsh natural conditions and from a social and economic disintegration following Nargis.

Table 3.4 Inland and marine fisheries production (in thousand metric ton, rounded figures)

Year	Inland	Marine	Aquaculture	Total
2001 - 2002	131	298	87	516
2002 - 2003	145	306	132	583
2003 - 2004	195	308	158	660
2004 - 2005	220	330	219	769
2005 - 2006	121	267	276	664
2006 - 2007	320	395	302	1017
2007 - 2008	368	441	348	1157
2008 - 2009	406	532	404	1342
2009 - 2010	306	316	202	824

Aquaculture production in Myanmar has grown in the past decade, see also Table 3.4. Commercial fish farming, including some large scale fish farms, have grown successfully in Myanmar in recent years, but now appear to be facing considerable difficulties in sustaining commercial operations. Large scale aquaculture production in Myanmar is characterized by low productivity and low diversity. The main focus of the production system is on the slow growing, low value commercial species. Ponds are typically large (often 20 hectares by pond) with slow grow-out periods of between 18 to 24 months. Pond resources are not efficiently used. Farms provide seasonal low levels of employment. The low productivity of the aquaculture system is compounded by increasing input costs (feed, labour and electricity) and low outputs benefits raising concerns about the long term sustainability of the model, the species economics and markets. Large scale export oriented enterprises have reverted to selling on domestic markets, practices in themselves which may be influencing competitiveness of smaller scale commercial producers. Commercial aquaculture enterprises could provide employment, food security and extension and inputs that can support a small scale household oriented aquaculture development. Hatcheries appear to be underperforming, and carp breeding and hatchery programs need revitalisation.

Employment opportunities in fisheries and aquaculture are seasonal in nature.

Production systems for fish are dominated by extensive and semi- intensive ponds, with some marine and cage culture and rice- fish farming. Scale of production varies, but particularly in the Ayeyarwady delta region, large ponds and more commercially oriented enterprises appear to make most significant contributions to fish supply.

Small scale household level aquaculture is surprisingly absent; it can be found with mixed success. Institutional, policy and services appear not yet to be favourable to development of

this part of the sector, and it is uncertain whether the present investments will sustain and are able to move to a scale where they can make significant differences to the income and nutrition of the many poor and vulnerable households in the Ayeyarwady delta, or elsewhere in the country (which remains to be investigated).

The Australian Government through the Australian Centre for International Agricultural Research (ACIAR) is funding a $AUD 10 million multi-disciplinary Research, Development & Extension program in Myanmar that is focussed on improving food security and livelihoods for small holders in the Central Dry Zone and Ayeyarwady Delta. WorldFish is the implementing agency for the AUS$ 2 million fishery component of the program and has developed a project for "Improving research and development of Myanmar's inland and coastal fishery" over the next 4 years, which is called MYFish (Myanmar WorldFish). The project has been developed together with a number of local partners and in particular the Department of Fisheries (DoF) and the NGO association the Food Security Working Group (FSWG). MYFish aims to improve the capacity for management of Myanmar's inland capture and culture fisheries and facilitate the emergence of co management of fisheries and small-scale aquaculture as cornerstones of rural food security and livelihoods.

Three project objectives have been identified to achieve this aim:

1 To characterise the fisheries sector in the Ayeyarwady Delta and to assess the scope for fisheries development in the Central Dry Zone.
2 To identify, test and then demonstrate new approaches to increase productivity, efficiency, sustainability and equity in fisheries production systems in the Ayeyarwady Delta and the Central Dry Zone.
3 To strengthen the capacity of Government, private sector and non-government organisations to carry out appropriate research & development for the fisheries sector.

The project has carried out a scoping mission in November 2012 in the Ayeyarwady Delta, with the objective to undertake a rapid assessment of the fishery sector, to develop a framework for researchable projects and to contribute to a characterisation study of the Delta in 2013.

3.5.2 Problems on Fisheries

According to WorldFish, the Ayeyarwady Delta has the potential to be as productive as the Mekong Delta. However, pressures (such as overfishing, destructive fishing practices, reduced fish migration routes due to dams) exploitation mangroves, limited research and development and monitoring, increasing water pollution) are now being exerted on fish stocks and the natural resources that support production in the Delta and there are concerns that current fish production, consumption and export earnings levels may become difficult to maintain. Anecdotal information from fishery communities also suggests that fish catches have yet to return to pre-Cyclone Nargis levels.

3.6 Industry

Since the development of the delta has been launched only from early 20th century, industries apart from those related to farming (e.g. rice mills) and fishery (e.g. ice factories) are not found yet.

The opening up of the country to the outside world and the accompanying liberalisation of the economy will attract more industry to Myanmar. This industry will mainly concentrate in the economic free zones, of which Thilawa, near Yangon, is located within the Ayeyarwady Delta.

3.7 Water Quality

3.7.1 Drinking Water Supply

Arsenic contamination of drinking water sources is an emerging public health issue in Myanmar. In early 2000, Save the Children UK's (SC UK) Water and Sanitation Programme identified arsenic contamination of groundwater in rural parts of the Ayeyarwady Delta (Tun, 2003). Since that time, there has been growing interest, concern and action related to arsenic testing, communication and mitigation in Myanmar. However, the magnitude of arsenic contamination of groundwater sources in Myanmar is still rather unknown, as no comprehensive studies have been conducted. Recommendable activities are:

- Retesting and confirmation of arsenic levels of water sources
- Arsenic education/awareness raising
- Community mobilization and immediate protection measures
- Identification and implementation of alternative drinking water sources

Water scarcity has become a daily challenge in Myanmar's Ayeyarwady Delta in the dry season, with thousands still struggling after damage to water sources by Cyclone Nargis in May, 2008. The delta's inhabitants traditionally source drinking water from rainwater harvesting, communal water ponds and tube and open wells, since most villages do not have access to piped water and nearby tidal rivers are saline. The ponds help villagers during the dry season, which stretches from November to May, but can be insufficient. Many ponds and wells were heavily salinized when a 3m tidal surge inundated much of the low-lying area when the cyclone struck.

Likewise, groundwater is widely used as a water resource in the Ayeyarwady Delta. The salinity of the groundwater is affected by the flood and high waves through cyclones or monsoons (Miyaoka et al, 2012). However, surface water – groundwater interaction differs per each season.

3.7.2 *Surface Waters*

Due to various policy reforms the agricultural sector changes the way it operates and functions. As a result agricultural inputs, such as chemical fertilizers and pesticides are increasingly distributed either partially or wholly by the private sector (Zaw, 2011). Moreover, the utilization rate of chemical fertilizers in the delta happens to be the highest among the agricultural regions in Myanmar. This will result in an increasing state of pollution.

Water quality concerns are also being raised with regard to mining activities and the growth of cities and industrial zones. The disposal of untreated domestic wastewater will lead to increased oxygen demand and deteriorating hygienic conditions of the surface waters and the increase in industrial and mining activities will further affect the water quality in the delta with a range of additional parameters (heavy metals, organic micro-pollutants and oils).

3.8 Nature and Wetlands

Myanmar is undergoing a rapid transition from one of the world's most isolated countries to an emerging democracy and opening up to the world through increased international investment. Hence, environmental conservation in parallel with economic development opportunities is one of the greatest challenges for Myanmar in the 21st century (Wildlife

Conservation Society, 2013). Human encroachment, commercial overexploitation of animals and fish, agricultural expansion / conversion of wetlands and logging are seen as the greatest current threats. However, expected environmental and water quality deterioration will add to this soon.

The natural vegetation of the lower, tidal delta is mangrove forest (today 46 percent of the total area of mangroves in Myanmar are found in the Ayeyarwady Delta), but this has been heavily exploited and are largely in a degraded state due to human activities such as harvesting and coastal development. Most of the remaining forest is in various stages of regrowth. Four types of forest are recognized (Salter, 1982):

1. low mangrove forest, colonizing soft mud submerged at every tide; characterized by species of Ceriops, Avicennia, Kandelia and Bruguiera;
2. tree mangrove forest, developing on mud banks inland of low mangrove forest and at the edges of tidal streams; dominated by species of Rhizophoraceae;
3. saltwater Heritiera forest, on the landward side of the above two types, but still flooded at every tide; dominated by Heritiera tomes;
4. freshwater Heritiera forest, a closed evergreen high forest, flooded at high tide by only moderately brackish water; comprised mainly of Bruguiera and Heritiera.

Mangroves in Myanmar appear to be classified as primary or secondary areas (FAO, 2003; Wildlife Conservation Society, 2013). Primary areas are protected under jurisdiction of the Ministry of Environmental Conservation and Forestry, are not available for aquaculture and are essentially forest reserve. Significant jurisdiction of the secondary areas seems to be devolved to the Department of Fisheries for availability to conversion to aquaculture. The delineation of primary and secondary areas does not appear to be very clear and even primary forests are exploited by the local communities.

Climate change and sea level rise poses major new challenges to biodiversity conservation and nature in general. However there are yet no studies on the potential impacts of climate change and sea level rise in Myanmar (Wildlife Conservation Society, 2013). The root causes of these threats are low conservation awareness, poverty, weak systematic biological monitoring systems, low grassroots support for conservation and weak law enforcement.

It is known, however, that sea level rise and increased water temperatures are projected to accelerate coastal erosion and cause degradation of the mangroves and more offshore coral reefs, which in turn will negatively influence fisheries productivity.

4 Summary of Findings

The Ayeyarwady Delta will inevitably factor significantly into Myanmar's economic development and emergence as a major regional trade route. At present, however, the Ayeyarwady Delta is still largely undeveloped and the uncoordinated exploitation of its resources in some (upstream) areas may pose serious threats to the health of the delta. Thus one of the country's major challenges will be to develop effective, cross-sector management of this system in order to ensure that its development will be sustainable and that decisions made now will not bring later regret, as can be seen in deltas elsewhere.

Delta ecosystems like the Ayeyarwady Delta have a substantial adaptive and resilient capacity. In contrast to e.g. inland forests, which require decades to centuries to reach a climax succession stage, delta ecosystems, such as mangroves and marshes develop fairly quickly into rich habitats once the environmental conditions are favourable again. Worldwide successful examples show the importance of good knowledge of the basic physical and ecological processes, early involvement of local stakeholders leading to a participatory planning process and an integrated and sustainable approach to manage and develop the delta to cope with the new economic situation in Myanmar.

At present the Ayeyarwady Delta already demonstrates the first signs of significant changes (exploitation of the mangroves, overfishing, river bank erosion and deterioration of water quality). However, using the ecosystem approach, deltas can be used by the local people without compromising the integrity of these systems or overexploiting their natural resource. This approach is also advocated by the Convention on Biological Diversity (Wildlife Conservation Society, 2013) and denotes a strategy for the integrated management of land, water and living resources. The strategy promotes conservation and sustainable use in an equitable way. At the same time it is stressed that additional measures should be adopted like improving conservation awareness, fighting poverty, improving the weak systematic biological monitoring systems, stimulate grassroots support for conservation and strengthen law enforcement.

Ensuring the integrity of the linkages between delta and the river usually requires to take measures upstream. Although the highly dynamic estuarine ecosystems and their species are adapted to seasonal changes in freshwater flows, upstream activities that permanently change the total flow (such as dams, deforestation, climate change) may have significant consequences.

Summary of Pressures in Occupation Layer

Pressure on Space: With some 230 inhabitants/km^2 the delta is one of the most densely populated regions in Myanmar.
Vulnerability to Flood: Most of the delta is still active with unstable river branches and the delta is prone to tropical cyclones with high storm surges. Floods are a permanent threat.
Freshwater Shortage: Due to upstream developments, climate change and sea level rise, critical low flow conditions of the Ayeyarwady River tributaries are likely to increase. Increase of salinity intrusion in the coastal areas is making existing water supply sources (domestic and agricultural) and freshwater ecosystem vulnerable.

Summary of Pressures in Network Layer

Ageing Infrastructure: Management of embankments and irrigation systems is a recurrent problem. Infrastructure to support transportation, water supply, communications, and power supply is rather poorly developed.

Summary of Pressures in Base Layer

Coastal Erosion: Riverbank and coastal erosion is one of the major issues.

Loss of Biodiversity: Especially the mangrove forests are highly valuable but also under high pressure from encroachment and exploitation. It is also vulnerable to accelerated climate change and sea level rise.

Salinity Intrusion: Salinity and its seasonal intrusion gradients are dominant factors for coastal system, fisheries and agriculture. Therefore, any changes on present spatial and temporal variation of salinity will affect the biophysical system of coastal area.

Cyclonic Storm Surge: Due to its geophysical setting the Ayeyarwady Delta is often visited by cyclone-induced storm surges and incidentally these cyclones have devastated the coastal area (1974 and 2008). Nargis (2008) resulted in 84,537 casualities with 53,836 people missing.

Summary of Governance Issues

Cooperation between (scale) Levels and Sectors of Government: Efforts are underway to improve core governance systems and to improve sectoral governance.

Cooperation between Government and Private Sector: The privatization of public sector industries need to be further developed.

Involvement of Stakeholders and Citizens: Stakeholder consultation at planning and implementation phase of a project in different parts of the country needs to be further encouraged.

Approaches for Dealing with Risks and Uncertainties: To reduce loss of lives and property, Myanmar needs to focus on the development of flood forecasting and warning systems. Coastal area has already been practiced the early warning system for cyclonic storm surge and got the benefit.

During the second workshop the combined DPSIR and Layer model was discussed. The results of the group discussion are depicted in Table 4.1. Besides the (potential) pressures and impacts, some first responses in order to cope with these pressures and impacts and the existing gaps in knowledge are identified in this table.

Table 4.1 – Combined DPSIR and Layer Model for the Ayeyarwady Delta

Drivers	Pressures		State	Impact	Response	Gaps in Knowledge
Demographics ***Population in delta*** ***Migration***	Base layer	Flood hazards	Enhanced flood risks (consequences)	Increased unsafety and occupancy requirements	Evacuation plans (road network, drills) / more shelters Insurances Flood early warning systems / communication systems. Embankments strengthening	Need for overview of all hazards and consequences. There is need of socioeconomic and livelihood profiling of the population to understand the actual vulnerability. Migration both into the delta and out of the delta, due to loss of livelihoods, needs to be considered.
		Exploitation of coastal resources	Wetland degradation	Reduced safety and loss of habitats	Mangrove reforestation, regulations and enforcement	Size of loss of wetlands
	Network layer	More demand for transportation (roads, ports and waterways)	Demand for space and investments	Need for corridors / interconnectivity	Spatial planning and modern transport systems, PPP legislation	Present status + future plans (Ministry of Public Works)
		Sea dikes / river embankments	Space occupation, canalisation	Altered delta functioning, no room for the river	River training (DWIR + Irrigation Department) L+W Management plan, blocking of waterways (roads).	Current programs, plans, etc.
		Lack of water supply and sanitation	Affected public health, ecosystem health	Domestic water supply needs, water quality	Need for supply and treatment plants / use of PPP's	What is currently in place. Township development (Min. of Border Affairs, DRD)
	Occupation layer	Need for more livelihood opportunities	Irrigation and drainage, fishponds, industry, etc.	Altered land use	Spatial planning, increased agricultural and aqua-cultural production, multi-sectoral development	Population / density, current unemployment, projections. More insight in fishing rights, not aquaculture alone, but capture fisheries in river, estuary and those on delta dependent on marine fisheries as well.

Drivers	Pressures		State	Impact	Response	Gaps in Knowledge
		Shift in land use upstream	Reduced sediment supply to the delta (due to dams)	Erosion of the delta	Alternative safety measures (dikes, Building with Nature concepts, etc.)	Long year trends in sediment load, aerial photo's on retreat of delta (30% reduction, aggregation rate from 2 to 1.4 mm/yr ,Sivitski). Information on Ayeyarwady tributary behaviour and characteristics.
				Reduced nutrient supply to the delta	Enhanced use of fertilizers (Irrigation Department)	Leading to water quality problems. Any information on trends. Baseline conditions.
			Enhanced sediment supply (deforestation, more intense or wrong land use)	Navigation problems, clogging of irrigation drainage systems	Dredging	Trends, programs
			Water pollution (mining, industry, agriculture, domestic wastewater)	Public health, aesthetics and ecosystem functioning	Legislation and enforcement Spatial planning Clean technologies / best practices Need of responsible Ministry / Department for WQ monitoring.	Trends, need for baseline (Env. Cons. and Forestry) EIA legislation) / Fisheries Department. Search for carrying capacity.
		Pressure on space in the delta	More congestion	Urbanisation, increased traffic	Spatial planning	Existing plans
		Freshwater shortage due to increased demand	Enhanced groundwater abstraction	Water allocation Arsenic pollution Use of brackish water	Implementation of treatment facilities,	The reduction in water flow, risking the minimum environment flow requirement should also be looked into and mitigation measures recommended. Current situation UNICEF study / Water utilization department
				Subsidence	Regulations and enforcement	What is known about anthropogenic subsidence Ministry of Public Works / city development / DID (Domestic Water supply). construction (permitting) - recommendation

Drivers	Pressures		State	Impact	Response	Gaps in Knowledge
		Overfishing	Resource depletion	Ecosystem functioning (with impacts on e.g. fisheries), loss of biodiversity, livelihood	Regulations and enforcement	Records, measures -> research
Economic development ***Status of economy Sectoral developments Upstream developments***	Base layer	Sectoral developments / altered rural and urban development	Loss of nature		Introduction of livelihood alternatives	Township planning, planning of sectoral developments
	Network layer					
	Occupation layer	Migration to urban centres	More landless and young people to urban centres	Lack of labour for agriculture	Mechanization	Opportunities, records
Natural developments	Base layer	Climate change	Temperature, precipitation, storms,			Downscaling
		Sea level rise	Vulnerability	Reduced safety	Enhanced coastal protection (soft and hard measures) Spatial planning Emergency management	Any studies Relative change 3.4 – 6 mm relative SLR (Syvitsky ref's)
			Functioning of the delta	Increased salinity intrusion	Monitoring and modelling Awareness raising Mitigations	Monitoring plans in place
		Natural subsidence				
	Network layer	Aging of infrastructure	Performance of operation	Inefficient operation and malfunctioning	Asset management program	Current state (before / after Nargis)
	Occupation layer	More mechanization	Less labour needed	Unemployment	Alternative employment schemes, Multi-sectoral development plans	Records
		Value chain agricultural production	Bad storage conditions, low product prices,	Reduced income farmers	Better transport, better credit system, Better storage facilities Farmers organisations	Present status
Technological development **ICT** **Food / agricultural / aquacultural improvements energy generation**	Base layer					
	Network layer	Transport improvements (roads, waterways)	Socio-economics, agricultural / fisheries output			
	Occupation layer	Water treatment technology (salinity, arsenic)	Public health			

Drivers	Pressures		State	Impact	Response	Gaps in Knowledge
		New agricultural practices (cropping technology, storage capacity, fertilizers, farming tools, etc.)	Agricultural output	Higher income, less employment,		

5 Recommendations for Second Phase of the Vulnerability Assessment

5.1 Recommendations phase 2

As described in section 1.1, after phase 1 a go – no go decision has been built in on the basis of the possibilities and constraints identified during phase 1. The possibilities and constraints would be related to the availability of potential cooperation partners, baseline information and accessible literature and to logistical options.

Recommendation 1: The mission recommends to realise also the second phase of the vulnerability assessment.

The conditions for a full assessment are favourable:

- All parties met during the mission (see Annex A) confirmed the need for such an assessment.
- The Irrigation Department of the Ministry of Agriculture and Irrigation has given full support to the scoping mission and is prepared to give the same support to phase 2.
- During the workshops also delegates from other ministries declared to be able and committed to contribute to phase 2.
- The GWP representatives and partners in Myanmar are very dedicated to contribute to the full assessment.
- The MyFish project team offered to cooperate with the team that will realize the full assessment.
- The consultancy firm NEPS with 13 engineers retired from governmental services has a lot of knowledge on the delta (institutional memory) and has been involved in many studies and implementation projects. If needed, this firm could play a role in phase 2 of the assessment.
- The team has collected already quite some literature, data and other information. The willingness to provide additional data on request is great. More data will become available within a few months within the framework of a Dutch funded project on the IWRM data collection.
- During phase 1 all logistics have been perfectly arranged by the Irrigation Department. They are prepared to arrange also the logistics for phase 2.

Recommendation 2: Realise the full assessment for four distinct different zones of the Ayeyarwady Delta.

During the scoping mission it became clear that the degree of salt water intrusion has a major influence on the agricultural activities in the delta. Moreover, there is a very distinct difference (in terms of land and water use, livelihoods, economic activities, vulnerability) between the urbanised region around Yangon and the rural delta. For a useful vulnerability assessment the Delta should therefore be divided in 4 different zones, each with its own assessment:

- The Lower delta, permanently under influence of salt water intrusion.
- The Middle delta, under seasonal influence of salt water intrusion.
- The Upper delta, beyond the reach of salt water intrusion.
- The Urbanised delta around Yangon.

5.2 Proposal for phase 2

5.2.1 Objectives

For phase 2 the following objectives are proposed

- Elaborate a full assessments of the vulnerability and resilience of the Ayeyarwady delta according to the delta assessment approach as applied in the Delta Alliance project 'Comparative Assessment of the Vulnerability and Resilience of 10 deltas' for four distinct different zones:
    a. The Lower delta, permanently under influence of salt water intrusion.
    b. The Middle delta, under seasonal influence of salt water intrusion.
    c. The Upper delta, beyond the reach of salt water intrusion.
    d. The Urbanised delta around Yangon.
- Compile on the basis of these four assessments an overall assessment for the Ayeyarwady Delta.
- Make a comparative analysis related to the other 10 deltas already studied.
- An additional proposed objective for phase 2 which will be crucial in the long run is the development of technical expertise within Myanmar to underpin the sustainable development of the Ayeyarwady delta. While the scoping team has no specific recommendations at this time regarding actions that can support the development of a base of technical expertise, this issue should be tracked.

5.2.2 Activities

To reach the objectives the following activities are foreseen:

- Compile a comprehensive delta description according to the delta assessment approach, based on already available literature, data and on expert knowledge. The description resulting from the scoping phase 1 (Chapter 3 of this report) will be refined and complemented. Distinction will be made between the four distinct zones.
- Describe all relevant aspects regarding drivers, pressures, state, impact, responses and knowledge gaps for the occupation, network and base layers and for governance. The preliminary findings of phase 1 as described in chapter 4 of this report will be checked, refined and complemented for each of the four zones.
    a. Overview of adaptive measures currently applied in the Ayeyarwady delta
    b. Overview of methods and tools to support delta management
    c. Lesson learned on delta management
    d. Research gaps and related information needs
- Make 'summary blocks' of the main issues of the delta description
- Develop the Delta Scorecard for each of the four zones of the Ayeyarwady Delta including brief description.
- Compile on the results of the four zones an overall assessment and Delta Scorecard for the Ayeyarwady Delta.
- Make a comparative analysis related to the 10 deltas assessment report.
- Layout and printing of a high quality report

5.2.3 Result

The final result will a high quality report with a comprehensive delta description and vulnerability assessment for each of the four zones as well as for the whole Ayeyarwady delta, including a brief comparative analysis related to the 10 deltas assessment report.

5.2.4 Planning

Activities Phase 2	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**
Compile draft, more comprehensive delta descriptions for the 4 zones	xxx	xx				
Mission with field visits to and workshops in the 4 zones, collect data and elaborate delta description,		xxx				
Make 'summary blocks'		xx				
Develop the Delta Scorecard			xx			
Make comparative analysis			xxx			
Delivery draft report				D		
Comment round					xx	
Layout and printing of high quality report						xx
Delivery of final report						F

D: The draft report will be delivered end April 2014
F: The final report will be delivered end of June 2014

5.2.5 Proposed project team

***Phase* 2** (final composition to be determined after identification mission)

- Deltares: Tjitte Nauta, Marcel Marchand, Tom Bucx, Cees van de Guchte
- Alterra Wageningen UR: Wim van Driel, Bart Makaske
- Staff of the MyFish project
- Dr Ir. Khin Ni Ni Thein (expert, member of GWP Global Steering Committee)
- Mr. U Hla Baw (Chairperson GWP-SEA Regional Steering Committee)
- Dr. Zaw Lwin Tun (National representative GWP)
- Experts from several Myanmar ministries / institutes (to be determined)
- Experts from NEPS

6 Recommended Follow-up for the GWP- Delta Alliance Global Program on Deltas

GWP and Delta Alliance are currently developing a joint "Global Program of Action on Deltas" which consists of 4 components:

- *Work Package 1: Capacity Development* - facilitating structured learning and information sharing among stakeholders.
- *Work Package 2: Demonstration Projects* - developing and implementing pilot activities in specific deltas.
- *Work Package 3: Knowledge and Awareness* -developing a framework that would guide the management and sustainable development of delta's worldwide.
- *Work Package 4: Governance and Fundraising* - Build internal capacity of partners and enhance regional/country level partnerships' key competencies in fund raising, project coordination, financial management, stakeholder engagement, monitoring and evaluation.

The Global Program Initiative has been launched during the Stockholm World Water Week 2013. Myanmar is asked to participate in this Global Program, amongst others by proposing a demonstration/pilot project for Work Package 2.

During the second discussion the following subjects for a proposal for follow-up projects were discussed and ranked:

- Salinity intrusion- drinking water supply (++) / Salinity intrusion – adaptive water management for agriculture, fisheries and nature (+)
- Adaptive flood risk management (plan) (++)
- Coastal defence using the Building with Nature principles(++)
- Set up early of advanced (coastal + river) flood warning system (++)
- Study on the implementation of new irrigation polders (++)
- Stakeholder participation program in delta planning (++)
- Water allocation modelling (+)
- Water quality baseline program (+)
- Solid waste awareness program (+)
- Asset management program (+)
- Subsidence (+)
- Geomorphology of river / estuarine behaviour (+)
- Soil categories survey ->soil suitability study (+)
- Research on overfishing (-)

As a first possible project, that can be submitted to GWP, the issue of salinity intrusion was discussed. Saline intrusion and salt accumulation in the delta soils, resulting from increased seepage, floods, future sea level rises and future more intense irrigation practices seriously affects public health and reduces the agricultural activity and as such livelihood opportunities. Hence, alternative practices may have to be introduced to cope with the changing environmental conditions. These include alternative water supply schemes, treatment technology, awareness raising, re-establishing of dike systems and compartmentalisation, desalting of agricultural soils, genetic manipulation of existing crop species to enhance

biological tolerance, cropping of salt tolerant species and introduction of mixed farming practices.

Salinity intrusion in relation to **drinking water supply** An integrated approach based on salinity monitoring, modelling and stakeholder participation to improve water safety plans. In the Ayeyarwady Delta saltwater intrusion is threatening drinking water resources on a large scale and is therefore confronting the population with a serious health issue. Water Safety Plans need to be updated and upgraded, taking into account this new challenge, on top of the more acknowledged water contamination issues such as arsenic and bacterial contamination.

Currently, however, awareness of the salinization issue is relatively low in Myanmar. Moreover, local people are lacking the knowledge and skills to effectively anticipate on salinization of drinking water resources. This project aims to increase the level of awareness as well as the level of knowledge and skills required for water management in the face of salinization of resources. It should focus on:

- A better understanding of the process of salinization of drinking water including the mapping, monitoring and understanding of the surface and groundwater system in the Ayeyarwady Delta by means of innovative complex monitoring techniques, acquisition of local knowledge and density-dependent surface and groundwater modelling.
- Monitoring salinization, which should target both the local and the regional level. Local monitoring information is needed for local-scale water management decisions (where to install a pump, when to shut down a well, when to stop using a pond, what local-scale mitigation and adaptation strategies are possible, etc.). Regional-scale monitoring is needed to increase the understanding of “the bigger picture”, i.e. the ongoing salinization process, in terms of scale and time etc., so that insight is gained into expected problems and regional-scale solutions, enabling to anticipate in a timely fashion
- Effective water planning is only possible if water managers are presented with possible courses of action, should salinization indeed hamper the supply of drinking water of a good enough quality. The success of mitigation and adaptation strategies depends on many factors. Guidance is needed as of which mitigation and adaptation measures are applicable in what situation.
- The final goal of this project should be to provide effective assistance in the translation of the project outputs into “salinization robust” Water Safety Plans.

Salinity Intrusion – Agriculture, Aquaculture/Fisheries and Nature: Integrated approach to ensure a tailor-made and feasible development of an adaptation strategy with a focus on salinity intrusion across the agriculture, aquaculture and nature sectors. In addition to the monitoring and modeling capacity, the project should deliver capacity building for setting up a science based policy process, and stimulate knowledge sharing with a strong orientation towards implementation of possible adaptation policies. More specific, the project aims at:

- Building the capacity of various actors and stakeholders playing a role in design and implementation of adaptation strategies for agriculture, aquaculture and nature. Possible adaptation techniques will be identified and elaborated in stakeholder workshops and a consultative process. Training modules will be refined with practitioners, management organizations and users in the delta.
- Facilitating a policy, science and stakeholder dialogue throughout the design, development and strategic planning of the adaptation strategy. The project targets the conversion of generic impact assessments and scenarios into localized hydrological impact assessments and adaptation opportunities within production and conservation practices.

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Annex A: Mission Report

Preparation Phase

BOBLME Project
Contacts with the Bay of Bengal Large Marine Ecosystem (BOBLME) Project started during the UNEP Global Conference on Land-Oceans Connections in Manila on 23rd and 24th January, 2012, where Mr. Wim van Driel gave a presentation on the Delta Alliance "Comparative assessment of the vulnerability and the resilience of 10 deltas" during a special session on deltas. The Regional Coordinator of the BOBLME Project, Dr. Chris O'Brien, suggested at that occasion to explore the possibilities to undertake a similar assessment for the Ayeyarwady Delta in Myanmar. Since that date the following activities have taken place: formulation of project proposal(s), establishing contacts with the national representatives of the BOBLME Project, contract negotiations and collection and review of documentation.

Global Water Partnership (GWP)
In April 2013 also the Global Water Partnership (GWP) has shown a keen interest to undertake activities in Myanmar within the framework of the preparation of a joint Global Program of Action on Deltas of GWP and Delta Alliance. During meetings with GWP in Stockholm in April and May 2013 the project has been discussed with the staff of GWP and a contract concluded. Subsequently, contacts have been made with GWP partners in Myanmar, respectively the National representative of GWP (Dr. Zaw Lwin Tun), the Chairperson GWP-SEA Regional Steering Committee (Mr. Hla Baw) and a member of GWP Global Steering Committee (Dr. Ir. Khin Ni Ni Thein).

Participation in a seminar on IWRM in Nay Pyi Taw
To familiarise with the specific water related issues in Myanmar Mr. Nauta and Mr. Wim van Driel participated in (and helped to organise) a seminar "Towards Safe and Sustainable Water Management" on 29th May 2013 in Nay Pyi Taw, organised at the occasion of the visit of the Dutch Minister for Infrastructure and the Environment, Ms. Melanie Schultz van Haegen. It appeared to be a perfect occasion to make the necessary preparations for the scoping mission and to discuss the objectives, program, content and timing of the mission with the key partners of GWP and BOBLME.

Irrigation Department, Ministry of Agriculture and Irrigation
The Director General of Irrigation Department, Mr. Kyaw Myint Hlaing, was asked by a formal correspondence to support the organisation of the scoping mission. By return mail he underlined the importance of the assessment not only for the delta area but also for whole Myanmar. He assigned Dr. Zaw Lwin Tun, Director of the Design Branch of his Department to provide and coordinate all the necessary support. Through numerous mail contacts a draft program for the scoping mission was established.

Scoping Mission, 9 – 17 July 2013
The scoping mission was realised between 9th to 17th July by Mr. Tjitte Nauta and Mr.Wim van Driel.

Time schedule of the mission

Date	Time	Activity
Tu 09/07	14.00	Departure from The Netherlands
We 10/07	15.00	Arrival in Yangon
	17.00 – 18.00	Meeting Dr. Zaw Lwin Tun
Th 11/07	09.00 - 14.00	Workshop 1 at Irrigation Department (MoAI)
	15.00 – 16.30	Meetings NEPS in Yangon
	Evening	Reviewing documentation
Fr 12/07	All day	Reviewing documentation
Sa 13/07	05.30 – 20.00	Field trip to the Ayeyarwady Delta
Su 14/07	All day	Reviewing documentation, analyses, preparation workshop
	Evening	Meeting with Simon Langbroek, Director CDN (Consortium of Dutch NGOs)
Mo 15/07	09.00 – 14.00	Workshop 2 at Irrigation Department (MoAI)
	15.00 – 16.30	Meeting with WorldFish Project "MyFish", Department of Fisheries
	Evening	Report writing
Tu 16/07	09.00 – 10.00	Wrap up meeting with Dr. Zaw Lwin Tun and Ms. Hla Oo Nwe
	10.00 - 15.00	Report writing
	15.00/17.00	Departure from Yangon
We 17/07	Morning	Arrival in The Netherlands

Wednesday, 10 July: meeting with Dr. Zaw Lwin Tun
During that meeting the program of the mission has been discussed and finalised. In view of the long distances, the bad road conditions and the relatively short duration it was decided to skip the foreseen field trip to Labutta on the second day and to limit the field trip to a one-day visit to the Pyapon District.

Thursday, 11 July: Workshop 1 at Irrigation Department (MoAI)
The workshop was attended by more than 30 participants from various ministries (Agriculture and Irrigation, Transport, Livestock and Fisheries, Forestry and Environment, Social Welfare), NGOs, private consultancies and universities. See attendances list (Annex B).

Opening speech by U Hla Baw
U Hla Baw, Chairperson GWP-SEA Regional Steering Committee, held the opening speech in which he thanked the GWP, the BOBLME Project and the Myanmar officials for their support to this important initiative. He underlined the importance of the Ayeyarwady Delta, one of the most densely populated regions in Myanmar, as the rice bowl of Myanmar. Also the fishery sector plays a dominant role as main livelihood of the people of the delta. He referred also to the devastating impacts of Cyclone Nargis on 2nd and 3rd of May 2008, most severe in the Ayeyarwady and Yangon Regions. The balance of the sudden upsurge of sea level caused many casualties (70,000 people died and 50,000 people missing), and enormous damage to polders and embankments. He stated that climate change is likely to

increase the risks of flooding and droughts. Therefore, adapting to climate change is essential for delta regions.

Major activities still have to be undertaken: reconstruction and rehabilitation of embankments, sluice gates, drainage canals as well as the construction of drinking water ponds. “With the hope of the new Myanmar Government policy, I do hope that the aforementioned activities will start up in the near future, and I fully believe that the assessment of the vulnerability and resilience of the Ayeyarwady Delta will provide a baseline for further assessment”. He concluded with expressing the hope that “our cooperation and coordination activities will be sustained for a longer time and could contribute to the development of the Ayeyarwady Delta and the livelihood of the local community in the region”.

Presentations
Subsequently, a number of presentations have been given. Mr. Wim van Driel started with a presentation of the Delta Alliance, a global network for the resilience of deltas.

Mr. Tjitte Nauta followed with a presentation on the methodology applied for the Delta Alliance “Comparative assessment of the vulnerability and resilience of 10 deltas”. The assessments results in a comparative score card on resilience, an inventory of research gaps and an overview of adaptation measures for each of the deltas. The same methodology and expected results apply also for the assessment of the Ayeyarwady Delta.

Next, all the department and organisations present were invited to give a presentation on how they could contribute with expertise, data and documentation to the assessment. Most of them had prepared a power point presentation; others gave an oral presentation, all very informative.

Discussions
The presentations were followed by a very lively exchange of information on the availability of documentation and a number of studies, mainly originating from the seventies and eighties. The discussions elucidated also on a number of problems: lack of (particularly recent) data and studies, vulnerability against flooding, necessary reconstruction of infrastructure, salinity intrusion, overfishing, natural resource degradation, destruction of mangroves, poor livelihood of the rural communities, threats to drinking water supply (salinity and arsenic), water pollution, public health, lack of research grants, scattered data,

At the end of the workshop it was concluded that the field trip to the Pyapon District should take place on Saturday.

Thursday, 11 July: meeting with NEPS (National Engineering and Planning Services)
Meeting with Aye Myint, Aung Kyaw Zan, Myint Sann, Khin Khin Cho and Khin Latt.
NEPS is a consultancy firm with 13 engineers retired from governmental services, mainly from the Irrigation Department. Having been involved in many studies and implementation projects in the past, they represent a wealth of knowledge on the Ayeyarwady Delta. From that perspective NEPS is very able and willing to contribute to actual assessment later this year. Also after the meeting NEPS has provided the mission delegation with a number of very relevant and useful documents.

Saturday, 13 July: Field trip to the Ayeyarwady Delta
Nearly 20 people participated in the fieldtrip to the Pyapon District, which was very well organised by the Irrigation Department. A first presentation was given during a stop at the bridge across the Toe River near Dedaye at the border of the Pyapon District. A second more comprehensive power point presentation on the Pyapon District was given at the Irrigation District office in Pyapon Town. During the discussion more information was collected on the rice cropping system, yields and prices and on farm sizes etc. The field trip continued to the village of Wegyi, southwest of Pyapon where a reconstructed embankment of the WB Paddy Phase 1 project was visited, followed by a boat trip to a recently rehabilitated sluice gate and dredged drainage canal and outflow of the same polder. After a lunch at the district office the return trip went through Ma-ubin and Twante Canal area (with extensive areas of fish ponds) to Yangon. The field trip provided the mission delegation with a lot of information and insights on the functioning of the delta. The mission delegation appreciated the enthusiastic atmosphere and the commitment of the participants.

Monday, 15 July: Workshop 2 at Irrigation Department
The workshop was held with the participation of the Deputy Director General of the Irrigation Department, U Tint Zaw, and GWP-SEA Chair U Hla Baw. The aim of this second workshop was to share and discuss with the approximately 25 participants (see Annex B for list of participants) the preliminary findings of the mission delegation. Most of them had also participated in the first workshop and in the fieldtrip. Also the follow up activities were discussed.

Analysis of the most important drivers, pressures/impacts and possible responses
In line with the methodology of the vulnerability assessment the mission delegation has presented its findings mainly in a table with potential drivers of change, pressures, impacts and (possible) responses. During the workshop this table has been discussed extensively, which has given quite some additional information and insights.

Discussion on the finalisation of this scoping mission
For the finalisation of the scoping mission report the participants were invited to send as much information to the mission delegates as possible. The draft report will be ready by 26 August, 2013 and will be send to Dr. Zaw Lwin Tun to be distributed to the participants of the workshops for comments, review and additions. After having received the comments the mission delegation will finalise the report by the end of August.

The mission delegation intends to realise the actual assessment in October and November, but that will largely depend on the appreciation of the scoping mission report by GWP and the BOBLME Project and their funding possibilities for the second phase of the project. It was

concluded that the vulnerability assessment would give more insights if the delta would be subdivided in a number of regions.






Discussion on a proposal for a pilot project to be included in the GWP-Delta Alliance "Global Program of Action on Deltas"
GWP and Delta Alliance are currently developing a joint "Global Program of Action on Deltas" which consists of 4 components: The Global Program will essentially be based around four work packages as follows:

- Work Package 1: Capacity Development - facilitating structured learning and information sharing among stakeholders.
- Work Package 2: Demonstration Projects - developing and implementing pilot activities in specific deltas.
- Work Package 3: Knowledge and Awareness -developing a framework that would guide the management and sustainable development of delta's worldwide.
- Work Package 4: Governance and Fundraising - Build internal capacity of partners and enhance regional/country level partnerships' key competencies in fund raising, project coordination, financial management, stakeholder engagement, monitoring and evaluation.

The Global Program will be launched during the Stockholm World Water Week. Myanmar is asked to participate in this Global Program, amongst others by proposing a demonstration/pilot project for Work Package 2.
During the discussion the following subjects for a proposal have been mentioned:

- Salinity intrusion- drinking water supply
- Salinity intrusion – adaptive water management for agriculture, fisheries and nature
- Adaptive flood management – plan approach
- Coastal defence- building with nature
- Set up early coastal/flood warning system
- Water allocation modelling
- Water quality baseline
- Asset management program
- Study on the implementation of new irrigation polders
- Stakeholder participation in delta planning

No final decision has been taken on the subject to propose.

Monday, 15 July: Meeting with WorldFish Project "MyFish", Department of Fisheries
Meeting with Mr. Gareth Johnstone (Project Director MyFish, WorldFish Center), Ms. Yumiko Kura (Regional Program Manager, Greater Mekong Region, WorldFish) and U Khin Maung Soe (National Project Advisor MyFish).
Information on the Delta Alliance, the intended vulnerability assessment of the Ayeyarwady Delta and the objectives and activities of the MyFish Project were mutually exchanged and possibilities for cooperation were discussed.
The MyFish Project is mainly focussing on a sector wide, participatory approach of the inland fisheries and aquaculture. Their 1st objective is to study the characteristics of the fisheries: to define the status and a baseline by making use of existing data and ground truthing. A well-functioning GIS system and database would be very helpful for that purpose, but is non-existing in Myanmar. They have observed a decline in fish stocks, most likely due to overfishing and a lack of connectivity due to the construction of dams, embankments and sluices. The MyFish Project is working with 7 universities: 4 in Yangon and 3 in the delta. They are performing a small scale survey on livelihood through the Department of Fisheries.

They know the BOBLME well, but there is for the time being limited cooperation between the two projects. BOBLME focusses more on the marine ecosystem while MyFish is mainly looking at the inland fishery sector.

Conclusion: i) the MyFish team showed great interest in cooperating with and participating in the vulnerability assessment; ii) they offered to review the draft report of the scoping mission; iii) we will keep exchanging information; iv) they will nominate a member for the assessment team.

Tuesday, 16 July: Wrap up meeting with Dr. Zaw Lwin Tun and Ms. Hla Oo Nwe

Satisfaction was expressed from both sides on the very effective and efficient organisation of the mission. The finalisation of the scoping mission was confirmed as mentioned above. Dr. Zaw will send additional information and maps on the districts in the Ayeyarwady Delta. The mission delegates will send the draft mission report to Dr. Zaw for further distribution among the participants of the workshops and the MyFish project requesting them to review the report.

For the 2nd phase it was discussed that a selective team of maximum of 4 or 5 people should actively participate in the actual vulnerability assessment for 2 to 3 weeks. They should preferably represent several disciplines and organisations: ministerial departments, NGO's (e.g. FREDA), Private sector (e.g. NEPS), MyFish Project.

It was also discussed that, if sufficient funds are available, the delta should be subdivided in four distinct areas, each of them receiving its own assessment: lower delta, middle delta, upper delta and Yangon Region.

During the 2nd phase the mission will also visit the Pathein-Labutta Districts.

The mission delegation will, in line with the current development of the Global Program of Action on Deltas, in Consultation with GWP and in complementarity with the proposals coming from other deltas, propose a subject for further elaboration into a proposal for the Global Program.

Finalisation Phase

Steps for the finalisation of the scoping mission:

25 July	Draft report will be sent to Dr. Zaw for review by participants of workshops and field visit
15 August	Deadline for sending comments on the draft report
1 September	Presentation of the Myanmar case by U Hla Baw during the Stockholm World Water Week in the Source to Sea session
10 September	Final report will be send to Myanmar and to GWP and the BOBLME Project