AN APPROACH TOWARDS AN INTEGRATED AYEYARWADY DELTA STRATEGY

DRAFT CONCEPT NOTE BASED ON THE TECHNICAL DELTA MISSION OF THE DUTCH HIGH LEVEL EXPERT TEAM IWRM MYANMAR (HEIM) IN AUGUST 2015 AND THE DISCUSSIONS BETWEEN THE MYANMAR ADVISORY GROUP OF THE NATIONAL WATER RESOURCES COMMITTEE AND THE HEIM IN AUGUST 2015 AND JANUARY 2016

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1 INDEX

1 INTRODUCTION: WHY FOCUS ON THE AYEYARWADY DELTA?

1.1 DELTA AS NEXT STEP IN THE COOPERATION BETWEEN MYANMAR AND THE NETHERLANDS

Like other urban delta's worldwide, the Ayeyarwady Delta faces challenges related to pressures on the natural system, availability of infrastructure, land and water use, and governance. Because there are many opportunities for knowledge exchange between Myanmar and The Netherlands on delta related issues, the Dutch High level Expert Team IWRM Myanmar (HEIM) visited Myanmar between 16 and 21 August 2015 to explore the situation in the delta. Specific attention was directed during the mission at the impact of cyclone Komen on the upper and middle delta, allowing the HEIM to provide input for the scope of a Disaster Risk Reduction (DRR) team that visited Myanmar early September 2015.

The HEIM-mission included dialogues with several involved government departments and a High Level Strategic Dialogue with the Advisory Group of the Myanmar National Water Resources Committee. During this dialogue the situation in the Ayeyarwady Delta and the next steps towards sustainable integrated solutions for this area were discussed. The participants agreed on the necessity for the participatory development of an Integrated Ayeyarwady Delta Strategy for the sustainable development of the area. The AG and HEIM decided to write this concept note as a scoping document for the development of the Integrated Ayeyarwady Delta Strategy. This strategy includes a long term vision for a sustainable, safe and prosperous Ayeyarwady Delta and identifies short, medium and long term measures.

1.2 WORLD BANK AYEYARWADY INTEGRATED RIVER BASIN MANAGEMENT PLAN

The World Bank has initiated the development of an Ayeyarwady Integrated River Basin Management Plan (AIRBMP). The delta is one of the element in this AIRBMP. Because of the Dutch experience with delta areas, being a low-lying flood-prone country with one of the most densely populated deltas in the world, the World Bank asked The Netherlands to focus their cooperation with Myanmar on the development of a strategy for the Ayeyarwady Delta area. This strategy will be a building block for the more global River Basin Master Plan under component 1 of the AIRBMP project. More information on the link between the development of the Integrated Ayeyarwady Delta Strategy and the AIRBMP is included in chapter 4 on 'Project Governance'.

2 DESCRIPTION OF THE AYEYARWADY DELTA

The Ayeyarwady Delta (Figure 1) may be divided in three regions: the upper, the middle and the lower Ayeyarwady Delta. The urban Yangon region requires specific attention as well as the connection with other river basin's particularly the Bago and Sittaung. Each of the regions has a different physical and socio-economic setting and deals with specific issues.

Figure 1: The Ayeyarwady Delta[1]

Issues in the Ayeyarwady Delta are related to pressures on the natural system (base layer), availability of infrastructure (network layer), land and water use (occupation layer) and governance. The people living in the delta area are dealing with amongst others issues related to flood security (cyclones, floods from rivers, ocean and local precipitation, dike stability, early warning), land use changes (including deforestation of mangrove deltas and upland forests), food security (agriculture, fisheries, aquaculture, including entire related value chains), quality of surface and ground water (pollution, salt intrusion, safe drinking water), erosion and sedimentation (navigability, influence of upstream developments) and infrastructure development (e.g. roads, flood prevention, irrigation and drainage systems). The lower delta experienced severe flooding in 2008 by cyclone Nargis and the upper and middle delta suffered from cyclone Komen in 2015. Also issues related to socio-economic developments, urbanization, industrialization, legal and institutional arrangements and capacity needs are important to consider.

Most of these issues are strongly related to each other and should be considered collectively, taking into account the water-energy-food nexus, and making use of IWRM and the principles of an integrated delta approach based on the lessons learned in other delta countries. Collective assessment of the delta in relation to the upstream basin and the neighboring basins is needed.

For the urban Yangon area focus should be on the connection with the Ayeyarwady Delta, but the relation with the Bago an Sittaung rivers has to be made clear as well. The Integrated Ayeyarwady Delta Strategy will not include a full study for resilient city design of the Yangon area, but will include an assessment and advice on developments in the

[1] *Source:* *http://reliefweb.int/sites/reliefweb.int/files/resources/C9FF21BF51CED76B85257450004D0EB1-sertit_CY-REF_mmr080520.pdf*

Ayeyarwady Delta area that have effects on the urban Yangon area, as well as developments in the Yangon area that have impact on the Ayeyarwady Delta area.

Some important issues in the Ayeyarwady Delta are highlighted below. The resource documents used as input for this text[2] provide information in much more detail, including more specific information on the distinguished regions of the Ayeyarwady Delta. These document should be used as important background reports for the development of the Integrated Ayeyarwady Delta Strategy.

2.1 BASE LAYER: MANAGEMENT AND RESTORATION OF NATURAL SYSTEMS

HYDROLOGY

The area, especially the lower delta, is particularly prone to cyclone-induced storm surges. Especially the lower Ayeyarwady Delta is undergoing strong salinity variations over the season. The highly dynamic estuarine ecosystems and their species are adapted to these seasonal changes in freshwater flows. However, climate change and upstream developments that permanently change the total flow (such as dams and deforestation) may have significant consequences. Resulting salinity intrusion (both surface and ground water) is affecting agriculture, aquaculture, nature and water supply.

RIVER DYNAMICS

River dynamics play an important role in the Ayeyarwady Delta. Riverbank erosion and navigational difficulties due to sedimentation are major issues. The river dynamics are highly influenced by upstream developments, like deforestation, mining and dams. Coastal processes (including sand transport) also cross catchment boundaries.

SUBSIDENCE

Most deltas are subjected to the natural geological process of long-term subsidence. Additionally, extraction of groundwater and fossil fuels, and shallow compaction and oxidation of organic sediments, may cause significant lowering of the delta surface on the short term especially in densely populated areas. Occurrence of actual subsidence is extremely difficult to predict as it depends on the exact extraction rates and geological layers. However, in many deltas in South-East Asia subsidence due to groundwater pumping quickly followed electrification. Famous examples are Shanghai, Bangkok, Jakarta, and Ho Chi Minh City. So far, no data on subsidence in the Ayeyarwady Delta is available, but the Yangon Region is considered subsidence prone due to an expected increase in ground water extraction as the result of increasing urbanization, population growth and industrial development.

ECOLOGY

Delta ecosystems like the Ayeyarwady Delta are resilient and have a substantial adaptive capacity. In contrast to for example inland forests, which require decades to centuries to reach a climax stage of succession. Mangroves are the only natural protection against cyclones and floods and are of high ecological and economic importance, for example as forest resources, breeding and feeding grounds for birds and commercially important fish and shrimp species, nutrient cycling, soil stabilization, bio-filtration, water regulation and carbon storage. However, in the coastal zone and delta, deterioration of mangroves is

[2] *Sources: IWRM strategic study, the Full Assessment of the Vulnerability and Resilience of the Ayeyarwady Delta, HEIM-note 'Some thoughts on Myanmar coasts and the Ayeyarwady-Yangon Delta' by Marcel Stive and experiences during the HEIM delta mission.*

problematic. In the Ayeyarwady delta only 14% (relative to 1925) of the original mangrove forests survive. Recent business as usual deforestation scenarios by Webb et al. (2014) suggest that all unprotected Ayeyarwady mangroves could be lost in the next few decades. Mangroves are mainly cut down for agricultural expansion and fuelwood extraction. The study of the Hydrological Research Station of Wallingford from 1974-1978 advised to have 5 km of the coast located for mangroves. However, conservation will only succeed if live mangroves have a clear value to the local population. At this moment, even though agricultural areas in mangrove forest areas are less productive due to salinity and soil characteristics, landless people farm these areas because alternative rural non-fisheries and non-farm livelihood opportunities are limited.

COASTAL SQUEEZE

The term 'coastal squeeze' was introduced by Doody (2004) in recognition of the threat to the existence of coastal mangroves or tidal wetland habitats caused by the compound impacts of sea-level rise and human activities. Gilman, Ellison and Coleman (2007) note that when relative sea-level is rising, mangrove tend to retreat landward. However, blocking due to human activities such as urbanization, agriculture, aquaculture and infrastructure (including sea dikes), prevents the ecosystem to retreat, pushing the mangroves into a thinner and thinner layer to finally disappear totally (also cf. Feagin et al., 2010). A certain space, therefore, is needed for the ecosystem to be able to retreat when the sea-level rise affects the coast. This can only be done by taking into account the livelihood possibilities of the local people using the required land.

CLIMATE CHANGE

The Ayeyarwady Delta is already vulnerable under current climate conditions and due to the influence of human induced stress factors. Climate change will increase the vulnerability of the area further, due to increased weather variability, causing e.g. higher flood risks and increased pressure on fresh water resources.

2.2 NETWORK LAYER: EXTENSION AND REVITALIZATION OF INFRASTRUCTURE

Infrastructure to support e.g. transportation, water supply, communication and power supply is generally rather poorly developed. Maintenance of roads, embankments, polder sluices, water storage reservoirs drainage canals and irrigation systems is a recurring problem. Clear arrangements have to be made with regard to the financing and governance of maintenance. The infrastructure for transportation in the east-west direction is quite well developed in the middle delta, but very poorly in the lower delta area. Investment in connective infrastructure is a key factor in creating better access to economic opportunities, reducing costs, promoting trade, and attracting private investment into diverse geographic areas and sectors.

2.3 OCCUPATION LAYER: DEVELOPMENT AND ADAPTATION OF LAND AND WATER USE

FLOOD VULNERABILITY

The entire delta is subject to flood vulnerability. Different flood causes and protection approaches exist throughout the area:

- The *upper delta* is relatively well protected by a horseshoe shaped dike system. The area suffered from extreme high water levels due to cyclone Komen at the end of July and beginning of August 2015. During the HEIM-mission, shortly after these high water levels, several dikes with leakage, piping and erosion problems were visited in this area. Due to good inspections and emergency repairs most dikes however remained strong enough to withstand the high water levels. Concerns are that future high water levels will cause more severe problems. The protection of some towns in the area with higher population densities requires specific attention.
- The *middle delta* is unfortunately not easy to protect against high discharge river flooding and tidal penetration. In some areas without dike protection flooding occurs, inundating lower parts of the area and the populated islands within the main river channel. These areas suffered from large scale inundation due to high water levels as a result of cyclone Komen in combination with insufficient drainage capacity.
- There is wide spread belief that the *lower delta* is still progressing into the Indian Ocean with rates of tens of meters per year. This seems outdated information. Like the delta of the Mekong, the deltaic coast after thousands of years accretion is now meeting its 'tipping point'. Increasing sea level rise rates, increasing human impact due to drainage and ground water extraction, and decreasing suspended sediment availability are already causing and will increasingly cause coastal erosion. Degradation of mangrove (observed from remote sensing, Kroon and Rip 2015) will enhance these effects. Furthermore, the declining mangrove areas are the only natural protection against cyclone-induced storm surges, like cyclone Nargis (2008).
- The *urban Yangon region* differs physically from the other deltaic regions. The area is dealing with a fast growing population, industrialization and changes in land use. Agriculture or aquaculture are not really an issue. The area attracts national and international investments. Flood protection is important, especially in view of the economic growth of the city. Social Cost-Benefit Analysis and risk assessments are advised to assess future flood protection investments.

DOMESTIC WATER SUPPLY AND POLLUTION

The NWRC stated the importance of good water quality for domestic purposes. There is an increase in salinization, pollution, eutrophication and siltation due to upstream, local and downstream activities. For example upstream mining, deforestation, agricultural practices (fertilizers, pesticides, herbicides, fungicides), industrial and domestic pollution and solid waste disposal. The absence of clear rules, regulations, monitoring and enforcement creates an obstacle in taking legal action in many cases.

Only a small percentage of the rural population in the delta is connected to a public drinking water system. Arsenic contamination of groundwater is an emerging public health issue in Myanmar. Drilled wells are not feasible because the water quality is bad below 30 meters (AG Meeting 19 Sept 2015). However, the exact magnitude of arsenic contamination of groundwater in Myanmar is unknown, as no comprehensive studies have been conducted. Many people depend on available rain water, which is a challenge to store. People also try to store water that is captured during the flooding season. Urbanization and industrial development of Yangon (and some major cities in the Ayeyarwady Delta like Pathein and Hintada) will articulate the need for proper sanitation facilities, waste water treatment plants, improved drinking water supply and water quality monitoring. Due to climate change, future ground water depletion and sea level

rise the need for drinking water supply systems will only become more urgent, certainly in the areas that are affected by salinity intrusion and arsenic contamination.

ENERGY ACCESS

Less than 25 percent of Myanmar has access to electric power. According to a UNDP report on the acceleration on energy access in Myanmar (2013) “the official electrification rate is 13 percent, and a majority of households (95 percent) depend on solid fuels such as wood and rice husks for cooking and heating”. In the delta area many people still depend on local energy sources. In the lower delta fuelwood extraction from mangrove areas is one of the two main drivers for mangrove degradation. Efforts are currently being made to support the utilization of efficient and renewable energy sources throughout the delta. Solar lanterns and solar LED lighting systems are already cost competitive if there is access to (micro)credits.

ALTERNATIVE RURAL LIVELIHOODS

For their livelihood the people in the rural part of the Ayeyarwady Delta mostly depend on agriculture (including aquaculture) and capture fisheries or related activities. Near urban areas changes in land use can be expected due to the expansion of urban areas due to industrialization and urbanization. For a sustainable development of the Ayeyarwady Delta there is an urgent need for alternative non-agriculture and non-fisheries livelihood opportunities for the rural population. The majority of the people in the Delta is landless and therefore placed in a non-voluntary dependent position. Farmers depend on inputs and services (e.g. seed, feed, fertilizers, pesticides, herbicides, fungicides and credit) from suppliers and traders. Lack of or limited access to credit hampers economic development of the rural part of the Ayeyarwady Delta.

AGRICULTURE

In general inefficiency, low quality, and high farmer debt levels characterize agriculture in Myanmar. The Ayeyarwady Region is known as the rice bowl of Myanmar as it produces most of the rice requirements of the country. According to a 2011 presentation, the Ayeyarwady region produces a 29% share of Myanmar rice production or 38% if Yangon is included. Polder developments for agricultural production in the area are ongoing, mainly in the lower delta. Different rice varieties are used. Sometimes different crops are grown in succession in the same space, for example rice and beans or pulses. Agriculture is facing challenges due to amongst others erratic rainfall, droughts, floods, salinization, poor soil characteristics, coastal and riverbank erosion, floodplain sediment deposition and market effects (vulnerability to market demand and price fluctuations). Inputs for agricultural production (like fertilizers and seeds) are hard to obtain, especially for other crop species then the traditional rice varieties. The functioning of drainage, storage and irrigation systems is under pressure due to high costs for construction and maintenance, which cannot be borne by farmers alone. Furthermore improvements are needed in secure land tenure for rural farmers, permission in the change of land use, access to financial services (credit), market access and improvement of extension services.

To prevent ecological damage from agriculture (e.g. degradation of mangroves), it is important to integrate agriculture and ecology into one approach: make environment part of the tuning process.

2.4 GOVERNANCE

In Myanmar, land and water are managed by many different ministries, agencies and departments, at different levels (national, regional, township). Coordination and collaboration between the different institutions and governance levels has to be improved, including the sharing of data and information and arrangements for the financing and governance of operation and maintenance of infrastructure. Furthermore, inclusion of other stakeholders, like local communities and NGO's, needs to be encouraged to secure an integrated approach. Capacity building on the full range of IWRM-related topics, including maintenance aspects, is needed. Furthermore, there is a need to mainstream environmental and social impact assessments, improved land-use planning and significantly improve data collection and analysis.

Different departments have different acts, proclamations and laws. Most of them need to be strengthened and enforced. Available financial instruments (including water pricing and micro-finance) need to be developed further and security of land tenure has to be addressed.

3 AN APPROACH TOWARDS THE DEVELOPMENT OF AN INTEGRATED AYEYARWADY DELTA STRATEGY

There is an urgent need for long term and short term measures to improve the situation in the Ayeyarwady Delta. However, considering the many issues in the Ayeyarwady Delta, and the fact that most of these issues are related to each other, good understanding and analysis of the problems is necessary to identify adequate solutions. At this moment there is no broad integrated development strategy for the area. An integrated delta approach, paying attention to differences between the distinguished regions of the Ayeyarwady Delta, is of the utmost importance in the development of strategies for the delta area.

The Netherlands developed the Delta Approach[3] for integrated water management planning in delta areas. This approach is very successful in the Dutch Delta programme[4] but is not a blue print for other countries. The approach gives guidance for other deltas and the experiences and lessons learned in these countries can be useful for application of the delta approach in Myanmar.

The three key messages stated in the statement of declaration on water management of the HEIM and AG ("From Vision to Action", 2014) are important in the development of the Integrated Ayeyarwady Delta Strategy:

1. *Optimizing what you have*
2. *Taking a "broad view" in the analysis of the problems*
3. *Focus on education, capacity building and training*

The development of the Integrated Ayeyarwady Delta Strategy is a Learning by Doing project and has to include capacity building in the entire process. Involvement of actors and stakeholders in the strategy development is essential, disclosing local knowledge and using new approaches like visual stakeholder participation techniques.

3.1 GOAL OF THE INTEGRATED AYEYARWADY DELTA STRATEGY

The goal of the Integrated Ayeyarwady Delta Strategy is:

1. To develop a long term vision for a sustainable, safe and prosperous Ayeyarwady Delta
2. To identify short, medium and long term measures to realize the long term vision

The Integrated Ayeyarwady Delta Strategy will be used:

- As a reference document for the Myanmar government in reviewing and where necessary revising its socioeconomic development policy, water management, agriculture, industry and other relevant master planning for the Ayeyarwady Delta;
- As an important guiding document for future formulation and implementation of policy and legislation, institutional arrangements and investments in the Ayeyarwady Delta;
- To identify measures that can be implemented in the short term by Myanmar in cooperation with The Netherlands and other development partners like the World Bank;
- To identify and reflect in the process on "learning by doing" and capacity building.

[3] http://www.dutchwatersector.com/news-events/video-gallery/13-the-delta-approach-twelve-building-blocks-for-a-sustainable-delta-approach.html
[4] http://english.deltacommissaris.nl/delta-programme

The AG and HEIM recommend to distinguish three tracks in the development of the Integrated Ayeyarwady Delta Strategy:

- Track 1: Feasibility study of already identified short term measures
- Track 2: Development of a long term integrated delta strategy
- Track 3: Identification of short, medium and long term measures

After each track there will be time for reflection on lessons learned and the need for capacity building.

3.2 TRACK 1: FEASIBILITY STUDY OF ALREADY IDENTIFIED SHORT TERM MEASURES

There is an urgent need to take short term action in the delta. Several possible measures have been proposed during discussions and in previous reports. Before implementation of these measures it is important to evaluate whether they are indeed beneficial and robust in the short and long term (no-regret). The first track of the Integrated Ayeyarwady Delta Strategy development will focus on this evaluation. Both identification and evaluation of short term measures should be done in close cooperation with Myanmar authorities.

The following steps are suggested:

1. *Identification of existing ideas for short term measures* to cope with current problems in the Delta area. For this identification existing reports and plans for the area should be used. Measures to reduce flood risk, like the measures mentioned in the DRR-report (see textbox below) are urgent for the short term. Climate change adaptation measures, like the measures mentioned in Myanmar's National Adaptation Programme of Action to Climate Change, must be included as well. Furthermore there are several available reports on agricultural development and sectoral plans for the area that provide information on existing activities and (ideas for) short term measures. Information on existing initiatives of partner-organizations like IFAD, CGIAR, JICA, JWA and KOICA should be included as well.
2. *Quickscan of existing ideas for short term measures* to determine whether they are beneficial and robust in the short and long term (no-regret). This quickscan can be done using expert judgement. The following criteria can be used:
   - The measure generates direct or indirect benefits that are large enough to offset the implementation costs
   - Investing in the measure results in increased system flexibility and reduced vulnerability with regards to future uncertainties
   - There are co-benefits or no hard trade-offs with other policy objectives.[5]
3. *Pre-feasibility studies of identified no-regret measures* in order to select those measures that are most likely to be good investments on the short term. The pre-feasibility studies will provide more detailed information on the technical, environmental, economic and social feasibility, costs and benefits of the measures, and on the possibilities for short term implementation (including financial resources). Preferably they will identify well defined investment packages. The opportunity to apply new techniques and products has to be taken into consideration. The results of these pre-feasibility studies could subsequently be taken on by local, regional or international financing agencies.

[5] Based partly on: http://www.climatexchange.org.uk/files/6713/7365/7183/adaptation_noregret_actions.pdf

DISASTER RISK REDUCTION

A Dutch Disaster Risk Reduction team visited Myanmar from 31 August till 6 September 2015 to advice on a.o. flood protection in the dike protected areas of the delta. The team recommended to take the following short and medium term measures to improve flood security:

- Dike inspection tools: Introduction of 'Prikstok'
- Dike design tools: Introduction of ground drill and gouge
- Dike design tools: Upgrade of numerical methods
- Dike management tools: Data storage and inspection app
- Dike management: Review of existing guide
- River monitoring: Improvement of data management system
- River management: Improvement of predictive capacity based on river impact studies
- River sediment monitoring: Introduction of 'Van Veen grab' to obtain data on river bed composition
- Early warning: Flood forecasting system
- Risk approach: Preparation of flood hazard maps
- Risk approach: Application of pilot at Nyaung Done Township

More information on the proposed measures is provided in the mission report. Implementation of the proposed measures will be discussed with involved Myanmar government departments in the near future.

In January 2016 the Advisory Group and the Dutch High level Expert team identified two pilots for application of a broad IWRM approach to include in track 1:

1. Nyaung Done: "urban delta planning"
2. Toe estuary and Paddy III area: "delta planning on a local scale"

These pilots can be used as models for the approach for other areas in the delta and will be specified in more detail together the upcoming months. The ideas for measures included in Annex 2 of this concept note will be used as inspiration for elements to include in the two pilot projects.

3.3 TRACK 2: DEVELOPMENT OF AN INTEGRATED DELTA STRATEGY

It is important to develop an Integrated Strategy for the Ayeyarwady Delta with a long term vision on the development of the area. This strategy should be based on sound understanding and analysis of the current and possible future problems in the area, combined with different strategic choices for the desired development directions to be pursued.

In track 2, the following steps are suggested[6]:

1. Assessment of the Delta: current state, trends , opportunities and constraints
2. Development of an accepted long term integrated vision
3. Identification of long term scenarios to describe potential future developments
4. Development of a long term integrated delta strategy: strategic choices

These steps are further specified below.

[6] *Based on experiences in the development of a.o. the Mekong Deltaplan and the Dutch Delta Programme*

3.3.1 ASSESSMENT OF THE DELTA: CURRENT STATE, TRENDS , OPPORTUNITIES AND CONSTRAINTS

A prerequisite for developing the Integrated Ayeyarwady Delta Strategy is to collect, process and analyze the available information on the biophysical, social and economic setting of the delta. This includes the current state, trends, opportunities, constraints and existing plans for future developments. The assessment needs to take into account the differences between the distinguished regions of the Ayeyarwady Delta. Also connected (development in) upstream areas of the river basin have to be taken into account, as well as the connection with neighboring river basins.

It is extremely important to use the information that is already available and to not start over again. A lot of information is available from previous studies, like the IWRM Strategic Study, the Assessment of the Vulnerability and Resilience of the Ayeyarwady Delta and the study on the Ayeyarwady Delta by the Hydrologic Research Station of Wallingford in 1974. Available knowledge and information from different stakeholders, including local communities, government departments, NGO's and the private sector has to be used as well.

Additional studies might be needed to complement and improve existing knowledge. It is important that additional assessments are focused on the information needs for the development of the Integrated Ayeyarwady Delta Strategy. The additional assessments can be done in subsequent steps, progressively collecting data in more detail when working from a long term strategy (meta data) towards the first identification of measures (basic data) and the feasibility study of short term measures for implementation (detailed data).

Smart, innovative techniques are needed to bypass the lack of historic data collection and monitoring. An update of the 1974 study can be produced in a relatively short period due to improved capacity in cost efficient mathematical modeling and monitoring, both in situ and through satellite observations. Some early results have been obtained with remote sensing to assess coastline positions and land use over the last few decades for the lower Ayeyarwady delta region[7]. Also occurrence of subsidence can be evaluated very cost-efficiently through satellite observations (Interferometric Radar). With regard to water quality and supply new monitoring and modeling techniques can be used to arrive at cost efficient and quick results as well.

Specific assessment needs that should be addressed in the development of the Integrated Ayeyarwady Delta Strategy:

- Flood vulnerability throughout the delta area (risk analysis)
- Occurrence rate and effects of big intensity cyclones
- Possible impacts of climate change, specifying climate change scenario's for the delta area
- Monitoring of the water quality and water supply situation, including evaluation of arsenic levels of ground water sources and salinity measurements and saline front observations of both ground water and surface water
- Identification of production chains from water, earth and biota via value adding operations to national and international markets
- Land use and spatial developments (like trends in industrialization and urbanization), including identification of land use pressures and mapping of the area
- Infrastructure situation and needs
- Hydrologic situation and river dynamics in the delta, taking into account the entire river basin and the relation with neighboring river basins

[7] *Kroon and Rip, 2015*

- Influences of developments in upstream areas, like mining, deforestation and storage dams (present and future)
- Current subsidence rate and risks for increased subsidence
- Institutional arrangements and governance situation, including attention for maintenance and financial arrangements
- Capacity building needs on all levels: building at farmers level, government from national to local, education on vocational and university level
- Economic impacts of possible developments
- The interconnection between water issues, food security and energy supply
- Monitoring and modelling needs and requirements for applicable decision support systems (World Bank suggestion)

The assessment should include an analysis of the pressures causing the current state and trends (e.g. with regard to degradation of mangrove). This includes market demand elsewhere (for e.g. energy) and other pressures, like pressures on land use. Effects can only be mitigated when the causes are removed or reduced.

Since the above mentioned topics are highly interconnected, the assessment should use an integrated approach. Taking this into account, it is important to realize that it is not possible to cope with all the issues in the delta at once. Therefore the assessment has to identify the most important issues to prioritize at this moment in the development of the Integrated Ayeyarwady Delta Strategy.

3.3.2 DEVELOPMENT OF AN ACCEPTED LONG TERM INTEGRATED VISION

The development of a long term integrated vision includes 2 elements:

1. The development of an integrated vision for a sustainable, safe and prosperous Ayeyarwady Delta. This vision describes the desired direction of development, is long-term (order of 20-50 years ahead) and takes into account the differences between the distinguished regions of the Ayeyarwady Delta. In the IWRM Strategy the vision of the National Water Policy was used as starting point.

2. Before proceeding with the next steps, agreement on the vision to be made is needed at Myanmar side. In this process the relevant Myanmar Government departments and other relevant actors and stakeholders are included.

3.3.3 IDENTIFICATION OF SCENARIOS TO DESCRIBE POTENTIAL FUTURE DEVELOPMENTS

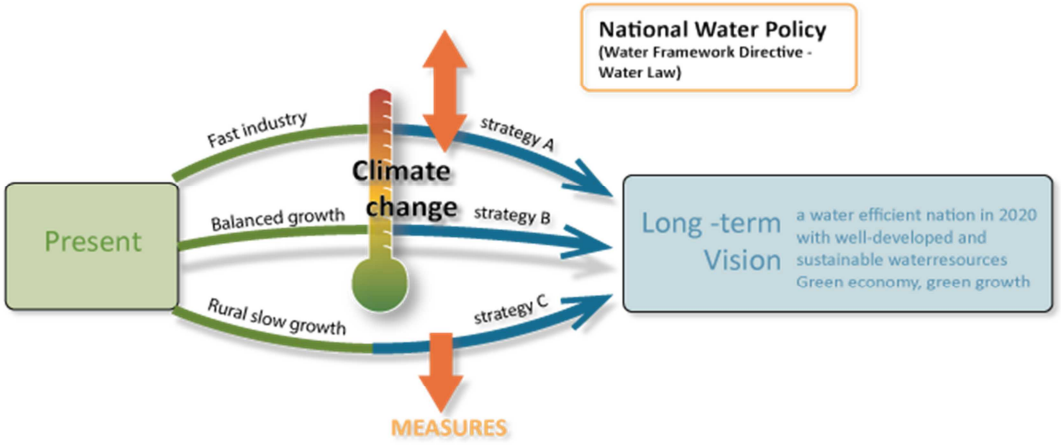
Socioeconomic factors, demographic developments, climate change and physical changes in the delta and upstream river basin can be influenced, but are by no means fully controllable. It is important to be aware of these uncertainties and take them into account during the development of strategies and measures for the area. A useful way to include uncertainties is the use of different scenarios for the future. A scenario is a consistent description of a possible future situation as determined by those factors that are both most important and most uncertain. Scenarios are stories about the way the world might turn out tomorrow. They help to identify possible pathways (strategies) towards a shared vision of the future. Based on these different scenarios strategic choices can be made.

SCENARIO USE IN THE IWRM STRATEGIC STUDY

The IWRM strategic study included a first exercise on the use of scenarios in strategic planning. Three different scenarios were defined during a workshop, covering a broad spectrum of possible future developments for the country and taking into account possible impacts of climate change. These scenarios are:

1. Rapid shift to industrial development
2. Progressive shift towards a balance between agriculture and small to medium scale industry
3. Prolonged agricultural based development

Combined with the Long-term IWRM vision for Myanmar of The National Water Resources Committee, as formulated in the National Water Policy, the scenarios have been used in the development of strategies.



A more thorough scenario development is requested for the development of the Integrated Ayeyarwady Delta Strategy, taking into account the different identified regions in the delta area.

3.3.4 DEVELOPMENT OF A LONG TERM INTEGRATED DELTA STRATEGY: STRATEGIC CHOICES

The next step is to describe the strategies. A strategy is a medium to a long-term planning framework to reach the vision. A strategy is translated in a coherent set of measures (track 3). The development of the strategies includes 2 elements:

1. Identification of different strategic choices that have to be made in order to pursue the long term vision based on the develop scenarios/future perspectives. In this phase priorities have to be made. This also includes choices related to the financing of strategy implementation.

2. Before proceeding to the next step an agreement has to be made about the strategies in Myanmar. In this process the relevant Myanmar Government departments and other relevant actors and stakeholders are included.

3.4 TRACK 3: IDENTIFICATION OF SHORT, MEDIUM AND LONG TERM MEASURES

The next step in the development of the Integrated Ayeyarwady Delta Strategy is the identification and selection of measures as a translation of the strategies developed in track 2 that contribute to the developed long term vision for the area. Measures can be identified in the base, network and occupational layers as well as on a governance level. The measures have to be combined into integrated sets of interventions, coping with the identified issues in an integrated, multi-level way. Differences between the distinguished regions of the Ayeyarwady Delta have to be taken into account.

Proposals for a governance and financing structure fit for the implementation of the Integrated Ayeyarwady Delta Strategy should be developed. Capacity building needs to be included to promote a real transition towards an integrated and adaptive approach for the Ayeyarwady Delta area.

3.4.1 IDENTIFICATION OF MEASURES

The identification of possible measures can be done by:

1. Further evaluation of the existing ideas for measures identified in Track 1. These measures will be screened on their contribution towards the long term vision.
2. Identification of measures that contribute to realization of the vision by using a "back-casting" approach (Figure 2). With the long-term vision and strategic choices in mind, the question will be asked: "What should be done today?" This approach will lead to a broader range of possible measures and policymaking choices.

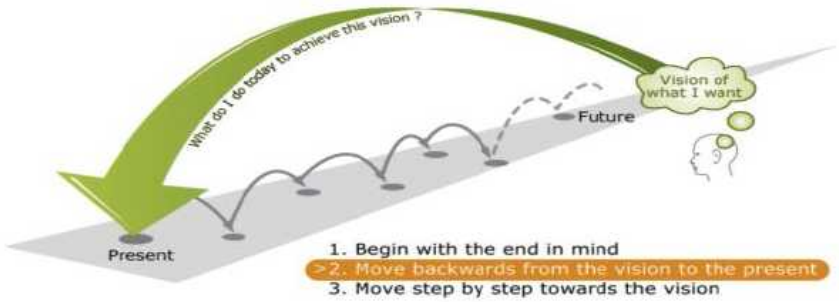


Figure 2: Back-casting model

Many possible measures have been mentioned in previous studies and during the HEIM-mission. Some of these measures are included, just for the purpose of inspiration, in Annex 2. It is suggested to develop a matrix as depicted in figure 3 to identify potential measures that are suitable for the different parts of the Ayeyarwady Delta, e.g. taking into account the different estuaries of the delta.

	Measure A	Measure B	Measure C	Measure XX
Entire delta				
Estuary 1				
Estuary 2				
Estuary 3				
Estuary XX				

Figure 3: Suggested matrix for the identification of potential measures

Measures can be distinguished in 3 categories:

- Short term (no-regret) measures (within 5 years): These measures need implementation in the short term;
- Mid term measures (within 5-20 years): These measures are probably needed, but there are still uncertainties. Implementation can be postponed. Further research is needed;
- Long term measures (within 20-50 years): Measures that might be needed in the longer term or that will be fully implemented over a long period of time. These measures might require planning now, for example leaving corridors open for infrastructural improvements.

To judge whether measures are no-regret, the criteria mentioned in track 1 can be used. Distinguishing between short, mid and long term measures helps to develop flexible adaptation paths, avoiding overinvestment and allowing Myanmar to cope at the right moment with foreseen and unforeseen future developments, like climate change. In The Netherlands this approach is referred to as 'Adaptive Delta Management'.

INSPIRATION FROM DELTAS WORLDWIDE

Deltas worldwide are facing identical challenges: increasing population pressure, increasing flood risk, pressures on water quality, pressures on spatial planning and degradation of scarce natural resources. Inspiration for possible measures and approaches can be derived from experiences in other countries, taking into account the lessons learned from made mistakes. However, due to big differences in local circumstances, solutions cannot be copied directly and need to be designed specifically for the local circumstances in the Ayeyarwady Delta.

3.4.2 SELECTION OF MEASURES

The selection of measures to incorporate in the Integrated Ayeyarwady Delta Strategy should be based on an evaluation of the technical, environmental, economic and social costs and benefits, combined with insight in financing possibilities. This will help to select only those measures that are indeed contributing towards a sustainable, safe and prosperous delta, to determine more closely if measures are indeed no-regret and to determine which measures and areas should get priority. The value (not only from a financial perspective, but also from an ecological perspective) of the coastal and estuarine assets needs to be included in this assessment. The first selection of measures can be based on a broad analysis and expert judgement. In the next step the measures can be evaluated in more detail.

3.4.3 PRE-FEASIBILITY STUDY OF IDENTIFIED SHORT TERM NO-REGRET MEASURES

In addition to the pre-feasibility study of short term measures already identified in track 1, this step entails a pre-feasibility study of the newly identified short term no-regret measures identified in track 3. For these measures opportunities for the application of new techniques and products should be taken into consideration. This pre-feasibility study will provide more detailed information on the technical, environmental, economic and social feasibility, costs and benefits of these measures, and on the possibilities for short term implementation (including financial resources). Preferably they will identify well defined investment packages. The results of these pre-feasibility studies could subsequently be taken on by local, regional or international financing agencies.

4 PROJECT GOVERNANCE

Myanmar will be the owner of the Integrated Ayeyarwady Delta Strategy. This requires close involvement of Myanmar authorities in the drafting of the strategy, on all relevant government levels and of all relevant stakeholders. To ensure an effective strategy development and implementation of the strategy after finalization, commitment of Myanmar high level authorities is requested. Therefore the strategy, including the strategic vision and measures to implement, has to be agreed upon at the highest level by the National Water Resources Committee.

A governance structure is in place, as depicted in Figure 3. This governance structure includes Multistakeholders Forums which are used for the AIRBM project. This governance structure could be used for the development of the Integrated Ayeyarwady Delta Strategy as well. After the installation of the new government in Myanmar on 30 March 2016 this governance structure has to be adjusted to the new situation.

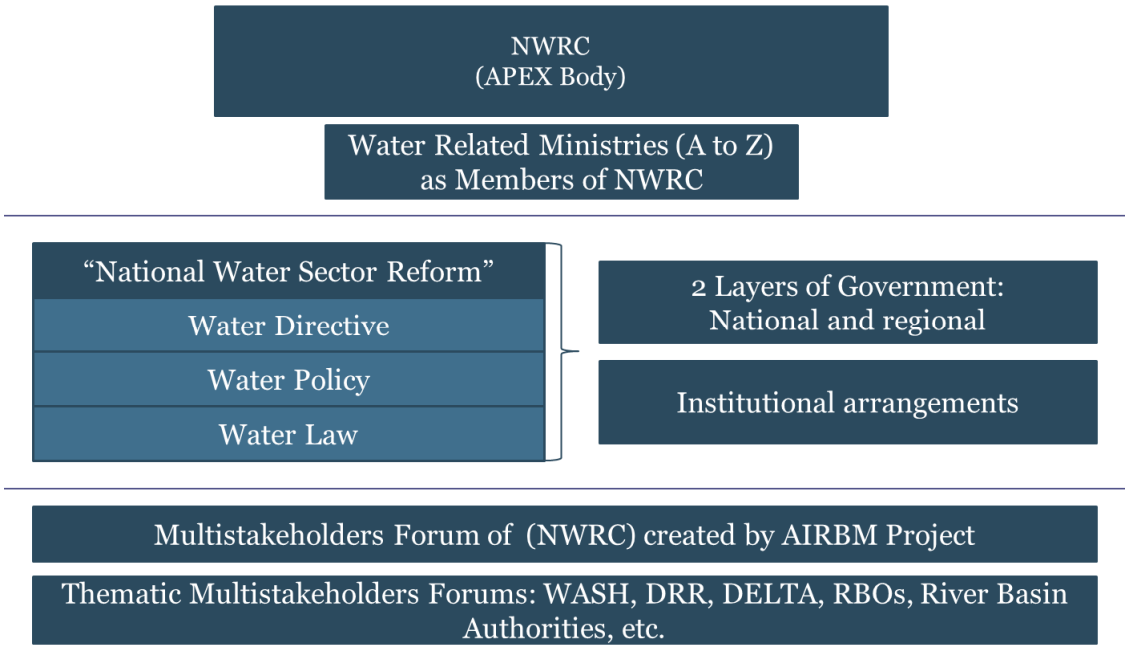


Figure 3: Existing governance structure that can be used for the development of the Integrated Ayeyarwady Delta Strategy

A stepwise approach is advised in which the Myanmar government will have the opportunity to decide after each step on the (strategic) choices to be made and how to proceed with the development of the Integrated Ayeyarwady Delta Strategy.

It is advised to use the Advisory Group of the NWRC and the Dutch High level Expert team IWRM for Myanmar as strategic advisors for the development of the Integrated Ayeyarwady Delta Strategy. Together the high level experts from both groups can play an important role in the quality control of the assessments and activities that have to be performed. Furthermore they can provide high level guidance to the Myanmar authorities with regard to the multi-stakeholder and decision making processes that have to be carried out for the development of the strategy.

DELTA COOPERATION IN MYANMAR

The Director General of DWIR and Secretary of NWRC stated several times that a coalition for the management of the delta between involved Myanmar ministries would be very beneficial. The most relevant three ministries (based on the organization of the ministries before the recent elections) are according to his thoughts:

- Ministry of Transport (MoT)
- Ministry of Environmental Conservation and Forest (MoECaF)
- Ministry of Agriculture and Irrigation (MoAI)

Other relevant ministries like the Ministry of National Planning and Economic Development and the Ministry of Finance have to be involved as well.

4.1 STAKEHOLDER INVOLVEMENT AND CAPACITY BUILDING

Many actors and stakeholder are active in the Ayeyarwady Delta area, with several of them already identified in previous studies. These actors and stakeholders need to be involved in all different steps during the development of the Integrated Ayeyarwady Delta Strategy and during the implementation of the strategy. The development of the Integrated Ayeyarwady Delta Strategy should therefore start with identification of all relevant actors and stakeholders and with a plan on how to involve them. New methods for stakeholder involvement need to be used, using a mutual gains approach and visualization methods to promote understanding of the situation and to promote productive discussions. Public education and awareness raising have to be an integral part of the capacity building program.

Capacity building has to be an integral part of the development of the Integrated Ayeyarwady Delta Strategy and should be fully integrated in every step of the process (learning by doing). The tender has to be explicit on how to accomplish this. Capacity building by joint cooperation has to focus on different government levels and other involved actors and stakeholders and should include all professional levels. Topics for capacity building include the full range of IWRM. International experience with an integrated approach, engineering expertise and agriculture expertise should be combined with local project experience. This requests availability of capacity on Myanmar side to work together in the development of the Integrated Ayeyarwady Delta Strategy.

During the development of the Integrated Ayeyarwady Delta Strategy the capacity needs for implementation of the strategy need to be assessed and a plan for future capacity building has to be developed. This plan has to be attuned to already existing capacity building initiatives.

4.2 CONNECTION WITH OTHER INITIATIVES

Several initiatives have been identified that are connected to the development of the Ayeyarwady Delta. Information on these initiatives will be shared by the involved Myanmar authorities and efforts will be made by all parties to make the necessary connections and to promote cooperation.

The Integrated Ayeyarwady Delta Strategy will be developed in close cooperation with the World Bank AIRBMP. The link between the AIRBMP and the Ayeyarwady Integrated Delta Strategy is depicted in Figure 4.

Goals of the Integrated Ayeyarwady Delta Strategy from AIRBMP/WB perspective are:

1. Feed into state of the basin report of AIRBMP component 1
2. Identify potential investments at the pre-feasibility level that could potentially be further developed through the project preparation facility of the World Bank
3. Provide a technical annex on monitoring and modelling needs

With regard to the last point, the suggestion is to include in the ToR requirements for an applicable decision support system. The Hydroinformatics Centre in Myanmar will be responsible for setting up a suite and the World Bank wants guidance for the delta, this being a complex part of the basin.

A LoI/MoU between the World Bank, the Government of Myanmar and the Government of the Netherlands for cooperation in the development and implementation of the Integrated Ayeyarwady Delta Strategy has to be considered.

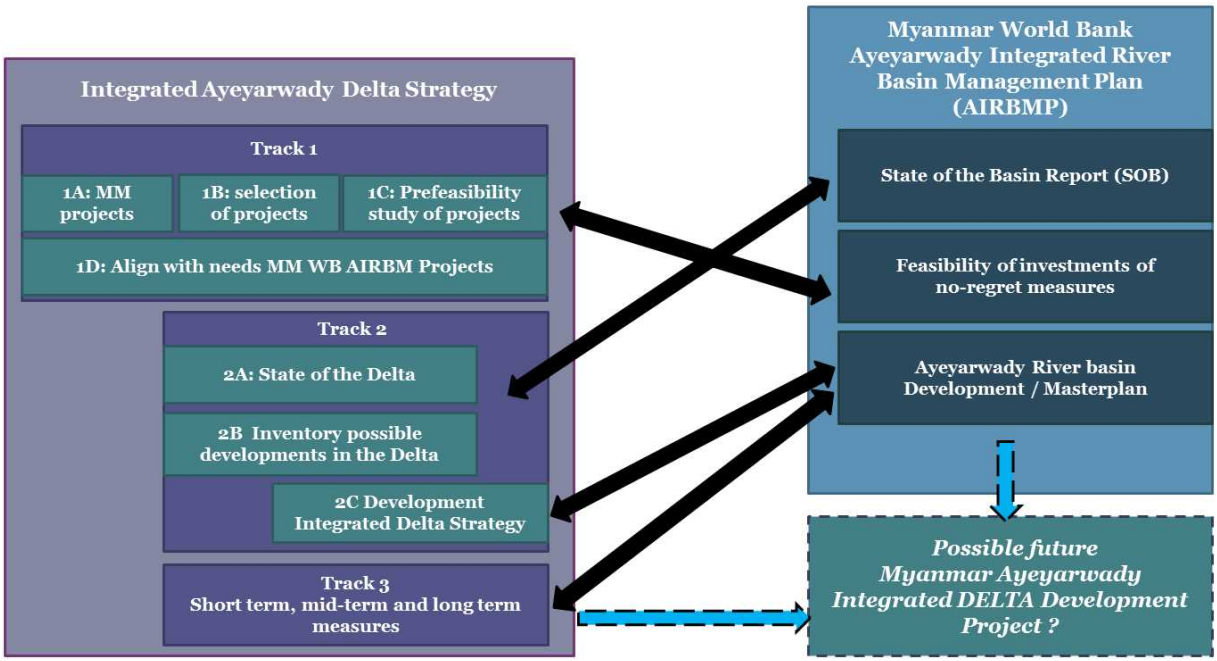


Figure 4: Link between the AIRBMP and the Ayeyarwady Integrated Delta Strategy

4.3 FINANCIAL ARRANGEMENTS

Sufficient financial resources for the development of the Integrated Ayeyarwady Delta Strategy have to be arranged. The NL funding available within the present budget for the Myanmar – Netherlands cooperation presents limitation to the level of detail and broadness of the scope of the project. The quality and impact of the project will greatly depend on the capability of the Myanmar counterparts to provide qualified staff to work on the project and cooperation of ministerial departments and institutes in providing relevant data and logistic support.

It is highly recommended to look for additional sources of funding and in kind contributions. Involvement of the World Bank and other relevant partners in the development of the strategy from the first stage will help to identify opportunities for cooperation.

Identified potential investments at the pre-feasibility level could potentially be further developed through the project preparation facility of the World Bank. Within the AIRBMP US$ 7 million is earmarked for feasibility studies for definition of no-regret investments.

It is recommended that during the development of the delta strategy financial arrangements for implementation of the next steps are included.

ANNEX 1: COOPERATION BETWEEN MYANMAR AND THE NETHERLANDS

On May 29th 2013, H.E. U Nyan Htun Aung, Myanmar Minister of Transport signed a MoU on behalf of the National Water Resources Committee with Minister Schultz van Haegen, Dutch Minister of Infrastructure and the Environment, on cooperation in the field of Integrated Water Resources Management. Since then Myanmar is one of the 7 delta countries in the Dutch Global Water Policy. The aim of the Dutch-Myanmar cooperation is to create a long-term sustainable water system in Myanmar that contributes to economic development with input of Dutch knowledge and expertise. On May 19th 2015, H.E. Kan Zaw, Myanmar minister of National Planning and Economic Development signed an additional MoU with Dutch Minister of Agriculture Dijksma on cooperation in the field of agriculture, food safety, livestock, fisheries and farmers' organisations.

As part of the cooperation in the field of IWRM, in 2014 the Myanmar Integrated Water Resources Management Strategic Study has been prepared. The study recommends to adopt a broad and long term view when planning for water resources development whilst also formulating a short term integrated plan with a definition of no-regret measures to be adopted. The study identified five Learning by Doing projects to gain experience with planning and implementation of integrated water resources development. These Learning by Doing projects are executed in 2015/2016, focus on different IWRM topics and locations and include capacity building on IWRM. Besides this, the cooperation between Myanmar and The Netherlands also includes specific capacity building activities. These are further specified in the Multi Annual Working Programme 2015 of the Dutch-Myanmar cooperation on IWRM.

DUTCH HIGH LEVEL EXPERT TEAM IWRM MYANMAR

The Dutch Ministry of Infrastructure and the Environment has established a Dutch High level Expert team IWRM for Myanmar (HEIM). This team focuses on knowledge transfer, consultation and strategic advice to support the Myanmar government in developing Integrated Water Resources Management. The HEIM works closely together with the Advisory Group (AG) of the Myanmar National Water Resources Committee (NWRC). The cooperation entails exchange and discussion on IWRM related issues in High Level Strategic Dialogues. In 2014 a shared statement of declaration on water management in Myanmar was drafted: "From Vision to Action".

The Dutch High level Expert team IWRM Myanmar is composed of:

1. Mr. Cees Veerman. President of the former Dutch Delta advisory Commission, Former Minister of Agriculture in several cabinets. Head of the expert team;
2. Ms. Renske Peters. Former director for Water Business and International Water Affairs at the Ministry of Infrastructure and the Environment. Water governance expert in realizing national government programs on water and cooperation between different ministries;
3. Prof. Marcel Stive. Professor on coastal engineering at Delft University of Technology;
4. Prof. Nick van de Giesen. Professor on water resources management at Delft University of Technology;
5. Prof. Han Vrijling. Professor of probabilistic design and hydraulic structures at Delft University of Technology;
6. Mr. Michiel van Haersma Buma. President of the Waterboard Delfland. Water governance expert specifically in relations between central, regional and local governments.

During the technical delta mission in August 2015 Mr. Arie Pieter van Duijn from Wageningen University & Research Centre joined the HEIM for expert advice on agriculture, fisheries and aquaculture.

ANNEX 2: IDEAS FOR MEASURES

Ideas for measures, to be used only for inspiration *Some general ideas for measures to evaluate. This overview is incomplete and not diversified for the distinguished regions of the Ayeyarwady Delta. No evaluation of these measures has taken place yet. Evaluating these measures application of new techniques and products has to be considered.*
HYDROLOGY
Improvement of the monitoring system by monitoring and modelling hydrology and salinity intrusion on a seasonal scale including a probabilistic approach
Prevention of salinity intrusion by e.g. improvements in water control infrastructure, closing of minor channels from the sea and perhaps bigger ones by dams with sluices for shipping
RIVER DYNAMICS
Establishment of a monitoring scheme and development of predictive models for river dynamics (erosion, sedimentation)
Drawing detailed maps of the river including land ownership to prepare for river training
River training, cutting meanders and dredging of water ways
Reclaiming river islands as part of the mainland
Protection of forest areas upstream
SUBSIDENCE
Establishment of a satellite-based subsidence monitoring system for the Ayeyarwady delta
Changing of the drinking water source from groundwater to river water to combat sinking in urbanizing areas with observed early signs of subsidence
Regulations and enforcement regarding ground water extraction in urbanizing areas with early signs of subsidence
ECOLOGY
Improving systematic monitoring systems for ecological status, coastal & riverine squeeze and mangrove degradation
Active mangrove rehabilitation/reforestation efforts, including placing dikes further inland to create more space for mangrove development. Taking the economic possibilities of the local people into account.
Government protection of mangrove habitat: zonation, regulation and enforcement. Taking the economic possibilities of the local people into account.
Improving conservation awareness as a basis for sustainable, safe and prosperous development of the delta
INFRASTRUCTURE
Systematic development of infrastructure and transport routes related to inputs and outputs for the area by spatial planning, including development of the east-west transport connection in a multi-modal system
Improving existing infrastructure, e.g. hardening ports up to a reasonable level against forces of nature or river training to improve shipping possibilities (with improved conveyance and possible land reclamation as possible by-products)
Adding new infrastructure: (fishing) ports, roads, rail roads, water ways, water control infrastructure to prevent salinity intrusion, flooding and to improve irrigation and drainage
Development of an asset management program to cope with aging infrastructure
FLOOD VULNERABILITY
Development of (an integrated) early flood warning system using modern modelling techniques like 3Di and FEWS
Strengthening of public resilience and improvement of civic response to floods, improvement of evacuation plans and improvements in the shelter scheme
Development of an economic strategy for flood risk management, to design the economically optimal flood preventions for different classes of agriculture, industrial and urban areas
Implementation of safety measures against flooding by rain or outside water: dikes, building with nature concepts, embankment strengthening, temporary dam constructions,

Ideas for measures, to be used only for inspiration *Some general ideas for measures to evaluate. This overview is incomplete and not diversified for the distinguished regions of the Ayeyarwady Delta. No evaluation of these measures has taken place yet. Evaluating these measures application of new techniques and products has to be considered.*
storage capacity for rain/floodwaters, new or improved drainage systems, relocation
Upper delta: Full encirclement of the area might be considers, but positive effects of flooding will be lost as well. Accruement of sediment will no longer counteract subsidence and flood level rise. This decision needs to be made extremely carefully as it is near impossible to return to undo without major losses.
Upper and middle delta: Protection of people living on river islands by dikes, attaching river islands to the main land by river training measures, relocation to the main land or improving evacuation schemes
Lower delta: Further development of typhoon proof shelters and typhoon proof fishery harbors, or large scale protection against cyclones
DOMESTIC WATER SUPPLY AND POLLUTION
Monitoring of water quality, pollution and arsenic levels of ground water sources
Improvement of sanitation facilities
Improving waste water/sewage treatment
New or improved water supply systems, e.g. by changing to river water as a source for domestic water supply
Construction and maintenance of reservoirs for water storage
Improvement and better enforcement of laws and regulations related to water pollution
Education/awareness raising and community mobilization on pollution and solid waste disposal, and to protection against arsenic pollution
ENERGY ACCESS
Improve access to modern energy services: e.g. rural electrification by improved use of the electricity grid or promotion of (small scale) use of renewable energy sources, like tidal and solar energy
LIVELIHOOD
Developing alternative livelihood opportunities for the local population (diversification)
AGRICULTURE
Production of different crops (e.g. other crop species, more salt resistant varieties) and use of different cropping patterns
Improved agricultural techniques, e.g. mechanization, improved fertilizer use, etc.
Construction, maintenance and operation of irrigations systems
Better storage facilities (e.g. rice crops)
Improved protection of agricultural land to floods and salt water intrusion
Reclamation of land for agriculture
Spatial planning of agriculture/aquaculture developments
Promotion of farmers & fisheries organizations in order to share knowledge and resources
AQUACULTURE & FISHERIES
Improvement of sustainable aquaculture/shrimp/soft shell crap farming practices, including possible combinations between sustainable aquaculture and mangrove restoration
Improving the potential of (deep) sea fishing
Regulations and enforcement with regard to overfishing/resource depletion, taking into account the economic situation and livelihood options of the local population
GOVERNANCE
Improvements in the security of land tenure
Improvements in the access to financial resources/credit
Taking away constraints in institutional setting, laws and regulations
Capacity building and awareness raising on different IWRM related subjects and the use of a stakeholder and mutual gains approach
Accurate mapping of the Ayeyarwady Delta area