



Decision-making

Site Assessment

Planting

Monitoring

Case Study:
Restoration

Mangrove Management

A manual to appropriate mangrove conservation and planting in the Mekong Delta

Mangrove Management

A manual to appropriate mangrove conservation and planting
in the Mekong Delta

GIZ in Viet Nam

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The Integrated Coastal Management Programme (ICMP) is being co-financed by the German and Australian Governments. In order to strengthen resilience and to reduce vulnerabilities to

climate change impacts, the ICMP supports Viet Nam in sustainably managing coastal ecosystems of the Mekong Delta affected by climate change. The Programme is being implemented by GIZ in close collaboration with the Ministry of Agriculture and Rural Development (MARD), as well as the provincial administrations of the five programme provinces An Giang, Bac Lieu, Ca Mau, Kien Giang and Soc Trang of the Mekong Delta.

For further information, please visit:

www.giz.de/viet-nam, and

<http://daln.gov.vn/en/icmp-cccep.html>

This publication also draws on experiences by the project “Adaptation to Climate Change through the Promotion of Biodiversity in Bac Lieu Province” which is funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) as well as lessons learnt by the project “Management of Natural Resources in the Coastal Zone of Soc Trang Province” funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the project “Conservation and Development of the Kien Giang Biosphere Reserve” funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and the Australian Government.

Preface

The Mekong Delta is home to 17 million people and is Viet Nam's most important agricultural region. But, the Mekong Delta is facing existential threats. Climate Change is leading to rising sea levels, and according to official studies, 38 % of the Mekong Delta area is likely to be below mean sea level by the year 2100. The mangrove forests along the coast which can protect the hinterland from floods and storms are decreasing. This decline is threatening the future of the Mekong Delta and its ability to provide the essential ecosystem services that not only the communities of the Delta depend on but also affects million people in a global scale.

The Integrated Coastal Management Programme (ICMP) aims to prepare the coastal area for a changing environment, and to lay the foundation for sustainable growth. Drawing on experience from previous GIZ projects in the region, ICMP is focusing on the institutionalization and scaling up of developed solutions.

The following pages, which outline the most important steps in regard to sustainable and adapted Mangrove Conservation, Rehabilitation and Restoration, are based on knowledge gathered and generated between 2007 and 2014 in the provinces of Soc Trang, Kien Giang, Bac

Lieu and beyond. This document can be described as a manual, a summary report or a reference work.

The heart of this publication, are five flow charts which guide through the steps of mangrove management, highlight the most important aspects and refer to detailed information and case studies. The adjoining report provides more background information on the use of the flow charts and lists further reading material.

The manual is intended for use by staff of the Forest Protection Departments, Management Boards, farmers and forestry professionals in the Mekong Delta who are engaged in mangrove rehabilitation and management. However, the concepts and principles covered have a wider application for the coastal zone of the Mekong Delta and beyond. Moreover the manual can serve as education material as well.

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1. Introduction

Mangrove Forest in the Mekong Delta

Mangroves are trees and shrubs that grow in intertidal zones along tropical- and subtropical coastlines and provide a wide range of ecosystem services (Barbier, 2007). These include the protection of coastlines from storms, waves and floods, reduction of erosion and carbon sequestration. They also provide nursery ground, food, shelter and habitat for a wide range of aquatic species and thereby serve as livelihood for the local population (Barbier, 2007). Despite their importance, mangroves all over the world have been degraded and converted to other forms of land-use on a large scale (Alongi, 2002; Duarte et al., 2009; Giri et al., 2011); also in Viet Nam. For this reason

Mangrove management, conservation and rehabilitation is of growing importance.

The Mekong River Delta (Figure 1) at the Southern tip of Viet Nam is a low-level plain formed by eroded sediments from the upper Mekong river basin. The area is one of the major rice-growing regions of the world (so called Rice Bowl of Viet Nam) and of high economic importance to the country. It is influenced by the flow regime of the Mekong River, the tidal regime of the East and Western Sea as well as the currents driven by prevailing monsoon winds (Thin et al., 2010). The combination of these influencing factors creates a dynamic process of accretion and erosion along the coast, where often only a narrow belt of Mangroves remains.

Mangrove forest, which usually grows along coastlines and estuaries, is suffering under anthropogenic influences in the Mekong Delta.

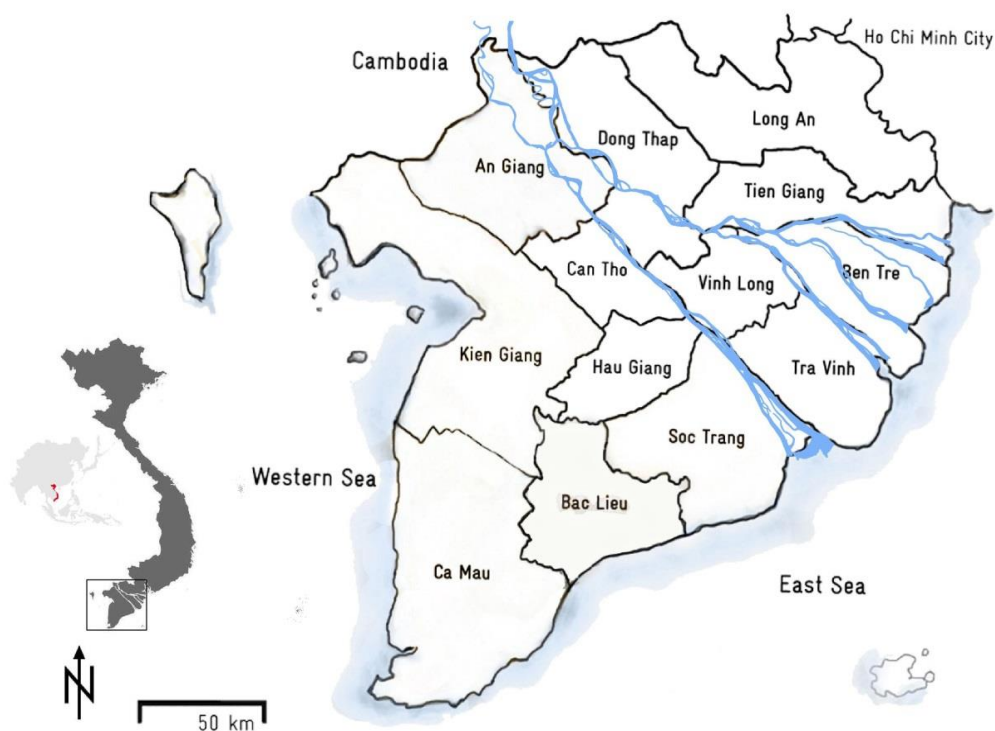


Figure 1: Map of the Mekong Delta

During the American war, large areas of forest were destroyed and this destruction increased in the years after, when land was converted for cultivation and shrimp production. Alone in Soc Trang Province the area of Mangrove forest decreased from 1.791,9 ha in 1965 to 719,3 ha in 1995 (Thin et al., 2009). Since the late 1990s the Vietnamese government has launched large planting projects in order to rehabilitate the forest.

Mangrove rehabilitation is defined as the re-establishment of the ecosystem's structural and functional characteristics (Field, 1998). As part of an Integrated Coastal Management approach it aims at restoring the ecological functionality and thereby increasing the protection function of the mangrove forest belt along the coast and its resilience to climate change.



Figure 2: Mangrove forests usually exhibit a clear zonation which enables the ecological functionality.

Given the population density in the area and its vulnerability to climate change impacts (IPCC, 2014), a healthy ecosystem along the coast should be considered essential to protect the hinterland. And due to the coast's heterogeneity, there is not one single approach which is applicable to the Mekong Delta but site specific, appropriate solutions are needed.

In the past years rehabilitation schemes in the Mekong Delta were not always successful nor did they always support the ecological functions (Thin et al., 2009), due to a focus on dense, single species planting and disregard of site specific factors, forest structure and human interaction. Therefore, this document aims to

give an overview of the process of appropriate mangrove conservation and planting, drawing on successfully tested approaches.

Objective of the manual

The objective of this manual is to guide effective mangrove planting; including all its process steps. Only the understanding of the complex system and the appropriate implementation of a site assessment, planting and monitoring can lead to a sustainably reforested, restored, rehabilitated or afforested forest, providing its ecosystem functions. This implies that the status quo is well known and objectives are defined before any action is taken. All of which shall be guided, in a hands-on manner, by this manual focussing on the Mekong Delta. This manual can however not only be used to develop management strategies; it can also serve as a guideline for capacity building, for advanced training of staff and teaching in specific study courses.

“Mangrove systems [...] are changeable, they are dynamic, they are unpredictable, they are subject to aperiodic and periodic fluctuations of the extreme kind, and [...] each mangrove community has a history” (Saenger, 2002, p. 229). This defining description of Mangrove forests gives an introduction to the challenges of generic conservation and planting guidelines. Given the wide range of where Mangroves grow, no generalized recommendations can be made for mangrove management; the importance of different regional approaches has been highlighted in reports such as Macintosh et al. (2012). Therefore, as this manual mainly draws on and references approaches that have been tested in the Mekong Delta, it is aimed to be applied in this region. It refers to and summarizes the best practices developed in the Mekong Delta as part of the Integrated Coastal Management Programme's initial projects in the provinces Soc Trang, Kien Giang and Bac Lieu as

well as from other successful planting schemes and projects in the Mekong Delta.

According to the different steps in mangrove conservation and planting, this manual focuses on: (1) Sound Decision Making for Mangrove Conservation and Planting, (2) Site Assessment, (3) Mangrove Planting and (4) Monitoring. Additionally, it includes one case study on Restoration as well as an overview of relevant reports. This manual does not outline conservation approaches but relevant information can be found in the reading compilation at the end.

Use of the Manual

The cores of this manual are four decision flow charts as a guide to the different steps of mangrove planting:

- Decision Making for Mangrove Conservation and Planting
- Site Assessment
- Mangrove Planting
- Monitoring

Each one of them contains the most important aspects to consider and refers to detailed documents for further information and reference. The case study gives two successful examples of mangrove restoration, including the necessary assessment, preparation and planting. The flow charts may be used individually or together to guide effective planning. They are designed as single A4 sheets to be taken to the field and can be printed as single poster or poster compilation in A3 or A2 for presentation or as a reminder. An overview of the referenced as well as additional material can be found at the end of this document and the full documents can be downloaded from:

<http://daln.gov.vn/en/dl/document-library.html>.

The following section sets the context of mangrove planting. The “user manual” section, gives information on the individual flow charts and their use. The actual charts can be found in the Annex. And the last section lists relevant documents and best practices which were developed with the support of GIZ since 2007.

2. Context of mangrove planting

Mangroves are increasingly being considered as a coastal ecosystem rather than vegetation type (Macintosh et al., 2011). This includes not only the actual mangrove trees but their associate species, physical structures and –processes as well as external influences. Therefore effective conservation, rehabilitation, restoration and sustainable management will be best achieved through an ecosystem-based approach and an integrated management strategy (Shepherd, 2008). As this document focuses on mangrove planting, the following section gives a short overview of the remaining important aspects of mangrove management. More detailed information on these aspects can be found in the documents listed in section four.

As mangroves usually grow in intertidal zones along coastlines and estuaries (Figure 3), effective management should follow an integrated approach to coastal area management (ICAM). According to Smith et al. (2013) ICAM, which is a governance framework for the achievement of sustainable socio-ecological systems, is guided by four key principles: integration of sectors and agencies, participation and co-management, ecosystem based management and adaptive management. Since management issues do not stop at administrative or natural boundaries, ICAM should also include trans-boundary collaboration. In the context of climate change adaptation, the planning should furthermore account for uncertainties, which are, along with diversity and connectivity, also best addressed through an ecosystem based strategy (Bernhardt and Leslie 2013).

Ecosystem-based Adaptation (EbA) integrates the use of biodiversity and ecosystem services

into an overall strategy to adapt to the adverse impacts of climate change. It includes the sustainable management, conservation and restoration of ecosystems to provide services that help people adapt to both current climate variability, and climate change (CBD, 2009). In case of the mangrove ecosystem these services include flood control, storm protection and shoreline stabilization, sediment and nutrient retention as well as water purification and carbon sequestration. Additionally the ecosystem is a breeding ground for marine species, a source of livelihood for coastal residents and bares cultural values. Ecosystem-based adaptation is not only the most holistic approach to climate change mitigation but also usually cheaper than alternative technical solutions (GIZ, 2013).



Figure 3: Mangrove forest in Soc Trang Province, Viet Nam (Photo: K. Schmitt ©GIZ)

The foremost priority in mangrove management should be the conservation of existing mangrove forests. Conservation does not only refer to protecting the forest but maintaining the health of the ecosystem, promoting natural regeneration, keeping it from damage and increasing its resilience. Local people can play an important role in mangrove conservation and sustainable management. The involvement of local communities, for example through Co-Management, can contribute to a more effective conservation and increase the people's livelihood. Only if mangrove conservation is no longer an option, should mangrove planting be considered, the detailed steps of which are outlined in the following section.

3. User Manual

Decision-making for mangrove conservation and planting

The first step in the mangrove planting process is to set clear objectives, based on which a decision regarding conservation, rehabilitation, reforestation, restoration or afforestation can be made. Given the clear dependence of species distribution on a specific set of site-conditions, attention must be paid to the selection of a suitable planting site, followed by selection of appropriate species, the best-suited planting technique and planting time, for the given site (Schmitt, 2014). Site-selection should be based

on an analysis and understanding of historic changes and natural processes, which can be gained from documents, maps and aerial photographs from archives and supplemented by analysis of satellite images (Joffre, 2010). This should be complemented by observation of natural regeneration, which indicates that a particular site is suitable for mangroves and provides information on the right species, planting techniques and time. The flow chart “Decision making for mangrove conservation and planting”, displayed in Figure 3, guides this process and refers to the other three flowcharts “site assessment”, “planting” and “monitoring” as well as to the case study for “restoration”.

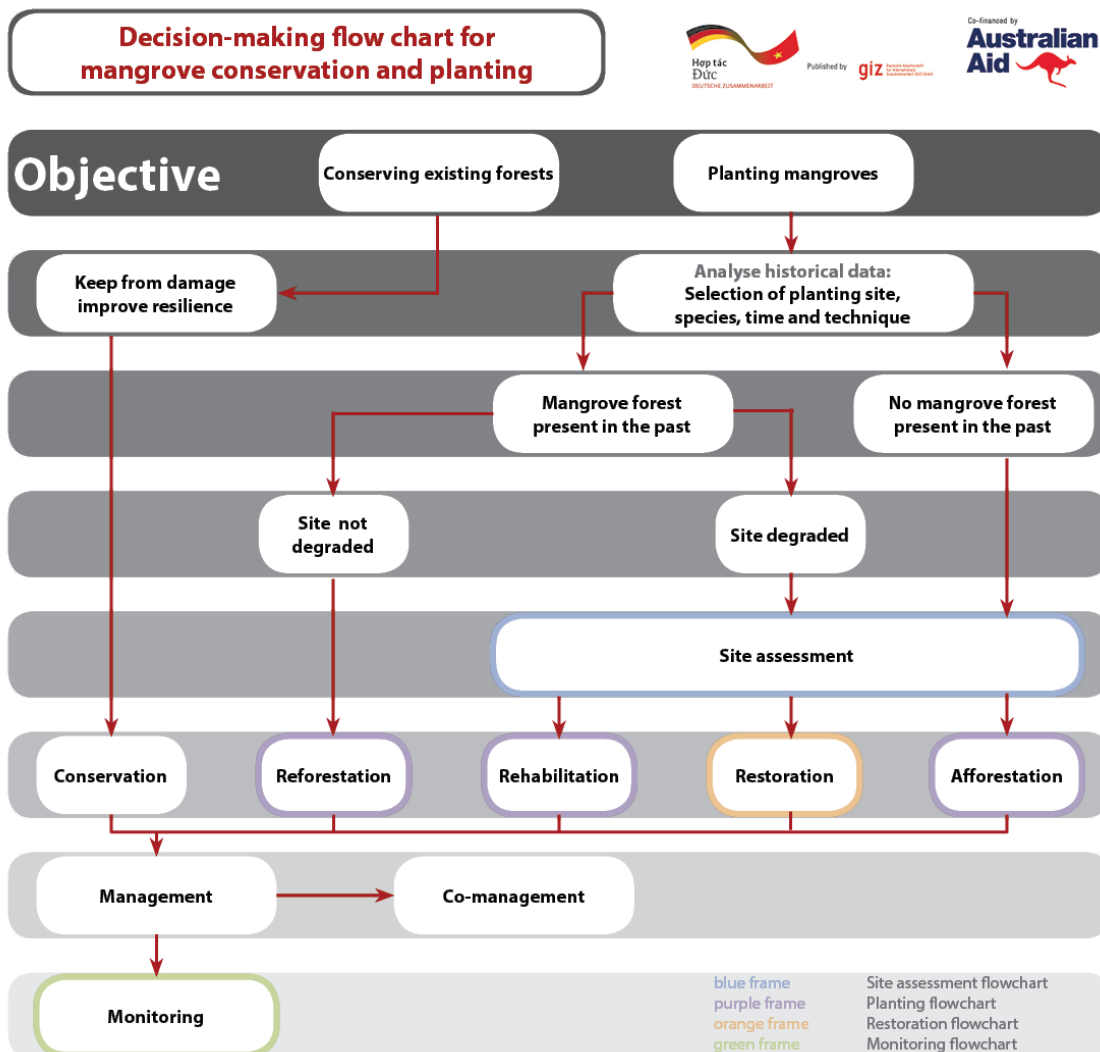


Figure 4: Decision making flowchart for Mangrove Conservation and Planting

Site assessment

Mangroves usually grow in intertidal areas and display a clear zonation of species in areas with different elevations and tidal characteristics. Therefore the implementation of a careful site assessment prior to rehabilitation or planting, in order to determine whether or not a site is suitable for planting or in need for restoration, and what kinds of site preparation or modification might be needed to improve the chances of success is fundamental (Clough, 2014a). Unfortunately, many efforts to restore or rehabilitate mangroves have not been successful due to unfavourable hydrology and other adverse site conditions, or the selection of inappropriate mangrove species by an incorrect site assessment.

Therefore, in order to provide a sound basis for developing an effective site rehabilitation strategy, site assessment is crucial. It is also necessary to provide baseline information against which to monitor and evaluate the success or failure of site rehabilitation, without which it is impossible to learn from mistakes and successes and to demonstrate that rehabilitation has been carried out in a robust and technically competent way (Clough, 2014a).

As Figure 5 shows, site topography (elevation and slope) and the tidal amplitude (difference between high and low tide) mainly determine the flooding and surface drainage characteristics of a site, whereas the physical properties of the soil mainly influence water infiltration, subsurface drainage and root penetration. All of these factors define mangrove regeneration, survival and growth.

The Site Assessment flow chart guides the different steps in determining the characteristics of a site: the remote visual assessment, on site assessment and eventual further on-site measurements (hydrology and/or soil conditions). Based on the mentioned

steps and according indicators, as well as by referring to the detailed description in the referenced material, an educated assessment can be made. Based on the gathered information a decision can further be made as to whether a site is suitable for mangrove planting or not. In case a site turns out not to be suitable since restoration would be too expensive or just not possible, other measures must be discussed. Further, if restoration is required an effective concept must be developed and suitable mangrove species and planting technique must be determined if natural regeneration should be supported with the next step: Mangrove planting.

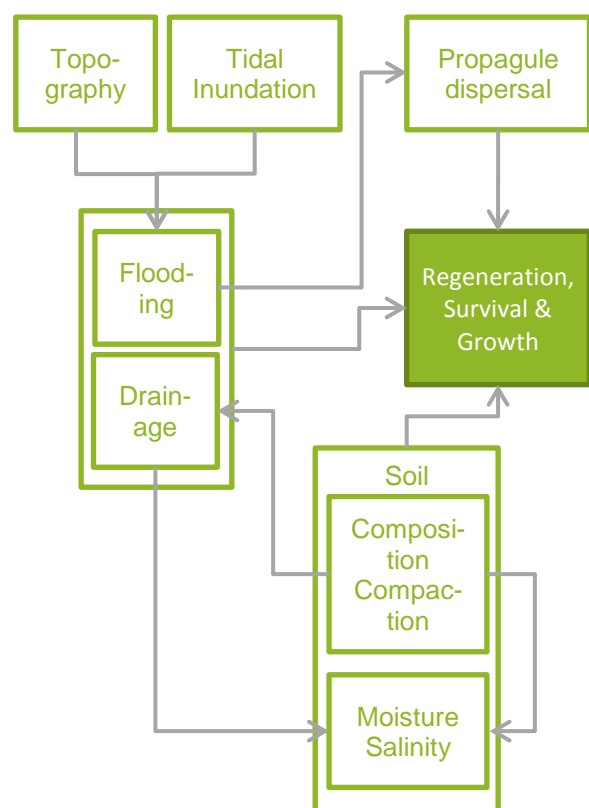


Figure 5: Factors influencing Mangrove Regeneration, Survival and Growth (Clough, 2014a)

Planting

The heterogeneity of the Mekong Delta coastline does not allow for one single mangrove planting technique. Depending on the objective it is important to choose species based on the site assessment: an understanding of the plants' ecology and community ecology, the hydrological patterns, tidal amplitude, soil conditions, salinity and morphodynamics of the site is required (Macintosh et al., 2012). Additionally, the right nursery and planting technique as well as planting period have to be selected.

Different sites and objectives require different planting techniques.

Table 1 lists a selection of successfully applied methods for common sites in the Mekong Delta.

A nursery can provide the required seedlings and the pertaining manuals by Thoi and Think (2010) as well as Nam (2010) give detailed instructions for the most common species of the Mekong Delta.

Apart from choosing appropriate species and techniques the success of planting is determined by the quality of execution. Seedlings should be transported carefully, covered by a plastic sheet and kept in the shade to prevent evaporation and water stress. The sapling should be handled carefully and planted in holes wide and deep enough to prevent root deformation. Only the hands should be used to compact the soil after planting to prevent all air spaces from being removed by stomping the ground. After planting is complete, a baseline should be compiled to serve as future reference and monitoring.

Site \ Technique	Monoculture	Barren land	Degraded barren land	Floodplain	(Former) Aquaculture pond	
Scattered planting	X					Seedlings are planted in existing or created gaps in the forest cover to diversify monocultures. (Think et al., 2009)
Mimicking nature	X	X			X	Seedlings are planted in close spacing to established shrubs or trees. (Think et al., 2009)
Multi species planting		X			X	Mixed species are planted in wide or close spacing on non-degraded land. (Think et al., 2009)
Restoring compacted saline soil			X			Mixed species are planted in wide spacing on created embankments and canals in the first and second year after land preparation. (Steurer and Clough, 2014)
Planting on (restored) floodplains				X		Pioneer mangrove seedlings are planted or propagules scattered on restored or sheltered mudflats where a natural supply of propagules is lacking. (Albers et al., 2013; Hoang, 2013)

Table 1: Selection of planting techniques for common sites in the Mekong Delta

Monitoring

Mangrove monitoring comprises the systematic collection of data, the storage and processing of the data into information about the condition or 'health' of a mangrove system. It therefore gives information about the direction of changes and their extent (Thin et al., 2011). It cannot only detect natural changes and their triggers but also reveal the effectiveness of measures which were carried out. Given the dynamic nature of mangrove ecosystems, knowledge of the processes is essential in order to distinguish between changes which may require interference and those which do not.

Monitoring can be summarized in four steps: (1) data collection, (2) data storage, (3) data analysis and (4) reporting. Depending on the demand, relevant data must be collected, systematically managed before it will be analysed and interpreted to provide the required information for sound decision making. It is important to set the objectives before starting the monitoring to prevent data-rich but information-poor situations due to large amounts of undefined, useless and unused data. To facilitate work, save budget and manpower, the monitoring concept should be streamlined, focussing only on relevant data.

Mangrove forest monitoring can generate different information; some development states should be monitored as a foundation for effective decision making. These include the forest health and development (natural regeneration), the survival rate of newly planted seedlings, erosion along the coast or waterways and the forest cover in a given area. In regard to forest health and survival rate, monitoring guidelines are given by the Vietnamese

government. The monitoring flow chart refers to "monitoring sheets" which are templates, focussing on the relevant data to be collected. Apart from the survival rate these often include tree height and number of nodes but can be expanded to suit the individual demand. An example of a monitoring sheet is given in the Annex.

The data storage is an important step in monitoring to ensure an effective, efficient and transparent data management. A comprehensive data management system (e.g. MS Access, etc.) will not only store the data in a suitable way, it will facilitate data analysis to get information, support the generation of reports, provide storage and availability for future reference. GPS data on erosion and forest area in particular must be accessible in future for time series. In order to ensure the compatibility of monitoring data, for example from different years, it is crucial that standards/definitions are agreed upon (i.e. how is the border of a forest area defined). Definitions should be valid for the whole Mekong Delta to allow comprehensive observations.

The monitoring flowchart supports the monitoring process by considering the four required steps, pointing out the tools for data collection (monitoring sheet, GPS device, satellite images, etc.), reminding for adequate storage management and provides hints for an efficient process. Supporting literature provides in-depth looks into applied concepts and developed strategies, giving information on successful solutions for the Mekong Delta.

Restoration- Case study

Restoration is defined as re-establishing pre-existing conditions which implies that mangrove conservation, afforestation or rehabilitation have failed or are not possible. The type and degree of degradation which makes restoration necessary, is site specific and so are the necessary interventions. In any case restoration should start with the definition of an objective and subsequent accurate site assessment.

The case study outlines two successfully applied restoration approaches from two different sites in the Mekong Delta. In both cases, following the objective of safeguarding the coastal protection function of the mangrove belt, monitoring and analysis of historic changes and the current state identified a needed for intervention. As such, one site presented numerous failed mangrove planting attempts on large barren areas within a narrow forest belt and the other site suffered from steady erosion threatening the stability of the sea dyke.

Restoration of degraded, barren land

Assessment of the barren land revealed that the soil was too saline, very compacted and dry, thus natural regeneration of mangroves could not take place nor was it suitable for planting. The elevation was too high for the tide to reach and the freshwater inflow had been cut off.

Based on the assessment's findings, the hydrology was improved by dredging canals through the site which could supply fresh water as well as make it accessible for the tide, thereby allowing the soil to be irrigated and the salt to be leached. To amplify the latter, this site preparation was conducted at the start of the rainy season. Nursery grown *Lumnitzera racemosa* seedlings were subsequently planted on the embankments at the end of the rainy season. By then, the salt content of the soil had decreased by almost 30 ppt (Clough, 2014b).

During the first year, the tides supplied fresh sediments which were deposited in the canals into which *Bruguiera cylindrica* were planted then; as shown in Figure 6. Monitoring over the first three years identified survival rates above 70 %, good canopy development and a substantial decrease in soil salinity.



Figure 6: Restoration of degraded, barren land within the mangrove forest. From left to right: Before and after 14 months (Photos: L. Steurer ©GIZ)

Restoration of floodplain

In order to rehabilitate mangroves at sites suffering from erosion, T-shaped Bamboo breakwaters were installed. The breakwaters aim at restoring the floodplain by reducing the wave energy, decreasing erosion and stimulating sedimentation.

The breakwaters are designed based on morphodynamic measurements, numeric modelling and physical testing and installed to connect existing headlands. Closing the gap

between headlands recreates the former coastline and therefore does not cause downdrift erosion.

Locally available material, such as Bamboo with its flexibility and strength, is ideal for the construction of the breakwaters while being cheaper than concrete alternatives. Over the course of two years, the expected slope of the mudflat was re-established and up to 27 % of the floodplain area has been restored to such an extent that successful natural regeneration of mangroves takes place.



Figure 7: Restoration of eroded floodplain through bamboo breakwaters (from top left to bottom right): before, after installation of breakwaters, first natural regeneration after nine months, and after 16 months. (Photos: R. Sorgenfrei ©GIZ)

4. Additional Documents

The following section lists documents relevant to Mangrove Conservation and Planting. These reports, case studies and best practices were developed between 2007 and 2014 in the provinces of Bac Lieu, Kien Giang and Soc Trang. They are sorted by year, categorized in the below mentioned subjects and summarized. All documents can be downloaded from:

<http://daln.gov.vn/en/dl/document-library.html>.

Mangrove Management

Site Assessment

Mangrove Restoration

Mangrove Planting

Mangrove Monitoring/Maintenance

Co-Management

ICAM/ICZM

Climate Change

Coastal Protection

Natural Resource Use/Livelihood

Title	Author	Year
Protection and sustainable use of coastal wetlands through co-management and mangrove rehabilitation with emphasis on resilience to climate change	Klaus Schmitt	2009
Co-Management		
The report gives an overview on the ecosystem services by mangroves, integrated coastal area management, co-management and new approaches for mangrove rehabilitation and management. Key Words: Soc Trang, ICAM, Co-management, Mangrove Rehabilitation		
Biodiversity in Kien Giang Biosphere Reserve 2009	Nguyen Xuan Dang	2009
Mangrove Management		
This report summarizes the findings of a rapid assessment of biodiversity in the Kien Giang Biosphere Reserve based on previous biodiversity and field studies. Key Words: Kien Giang, Biosphere Reserve, Biodiversity		
Tool box for mangrove rehabilitation and management	Pham Trong Thinh, Hoang Thoi, Tran Huy Manh, Le Trong Hai and Klaus Schmitt	2009
Mangrove Planting	Mangrove Monitoring	
The tool box guides mangrove rehabilitation and management, including the production of seedlings of different species, planting, maintenance, protection and monitoring. Key Words: Soc Trang, Mangrove Rehabilitation, Management, Monitoring, Nursery		
Awareness survey and assessment on the environment and coastal natural resource management of Soc Trang province	PanNature	2010
ICAM		
This study focuses on the socio-economic characteristics of the study site in Soc Trang province, the awareness and attitude of the local communities and local authorities as well as provincial officials, with regard to coastal resource management.. Key Words: Soc Trang, Coastal Resources Management, ICAM,		
Community livelihood and patterns of natural resources uses in the shrimp-farm impacted Mekong Delta - aquaculture research 2010	Olivier Joffre and Klaus Schmitt	2010
ICAM		
This case study looks at changing livelihood strategies of the coastal population in Soc Trang province in the Mekong Delta, Viet Nam, and their impacts on natural resources. Key Words: Soc Trang, Livelihoods, Shrimp Farm, Mekong Delta, Natural Resources		
Development of a comprehensive mangrove monitoring system in the Mekong Delta, Viet Nam	Dominic Meinardi	2010
Mangrove Monitoring		
This thesis describes two different planting approaches, including site selection, development of a site and planting baseline and finally different monitoring strategies for different planting techniques. It comprises tailored monitoring solutions for the planting techniques used in Soc Trang province. Key Words: Soc Trang, Planting Techniques, Mangrove Monitoring, Site Selection, Mangrove Rehabilitation, Mekong Delta		

Title	Author	Year
Mangrove nursery manual	Hoang Van Thoi and Pham Trong Thinh	2010
Mangrove Planting		
The manual describes the detailed set up of a successful nursery, considering the design, selection of mother trees, techniques for planting in order to produce bare-root seedlings and nursery techniques for different species.		
Key Words: Soc Trang, Mangroves, Nursery, Planting Technique, Manual		
Co-management in Au Tho B Village: A pilot test for the coastal zone of Soc Trang province	Richard Lloyd	2010
Co-Management		
The report describes the project area and details about Au Tho B village, as well as co-management concepts and principles which have underpinned the introduction of co-management in Au Tho B village. It also contains a description of how each of the four steps of the co-management process was undertaken along with the lessons learned.		
Key Words: Soc Trang, Co-management, Au Tho B, Lessons Learned		
Mangrove dynamics in Soc Trang province 1889 – 1965	Olivier Joffre	2010
Mangrove Management		
The report draws on findings from relevant documents, maps and aerial photos of the area dating back to 1889 and is supplemented with information from interviews with local residents. The results of the analysis of the historical material show the dynamic changes in the shape and extent of coastline, the changes in mangrove cover and species composition.		
Key Words: Soc Trang, Mangroves, Development, Coastal Zone		
Vegetation cover in Kien Giang province	Le Phat Quoi	2010
Mangrove Management		
The report describes and classifies the vegetation in Kien Giang Province		
Key Words: Vegetation, Kien Giang, Mangrove		
Biomass and regeneration of mangrove vegetation in Kien Giang	Nick Wilson	2010
Climate Change		
The report includes the feasibility of a REDD+ project in Kien Giang province and an assessment of regeneration needs and potentials.		
Key Words: Kien Giang, CO2, Biomass		
Assessing Mangrove Forest in Kien Giang	Norm Duke	2010
Mangrove Management		
The document is an assessment of the mangrove forest, shoreline condition and feasibility for REDD in Kien Giang province.		
Key Words: Kien Giang, Mangrove, Assessment		
Coastal flora biodiversity study	Vien Ngoc Nam	2010
Mangrove Management		
The report determines suitable species for forest rehabilitation based on an inventory of the biodiversity of the Mangrove forest of Bac Lieu province.		
Key Words: Biodiversity, Species, Bac Lieu, Mangrove		

Title	Author	Year
Guide to regenerate mangrove areas with suitable species-recommendations for Bac Lieu Province	Vien Ngoc Nam	2010
<div style="display: flex; justify-content: space-between;"> Mangrove Management Mangrove Planting </div>		
<p>The guide describes nursery, planting and tending methods for five non-abundant mangrove species in Bac Lieu province.</p> <p>Key Words: Nursery, Planting, Species, Bac Lieu, Mangrove</p>		
Monitoring setup of tidal regime in trial planting sites	Barry Clough	2011
Mangrove Monitoring		
<p>The report describes the development of a benchmark system to assess the hydrological situation in plantation sites and the definition of permanent plots to assess survival and growth rates.</p> <p>Key Words: Monitoring, Hydrology</p>		
Coastal mangrove rehabilitation plan	Barry Clough	2011
<div style="display: flex; justify-content: space-between;"> Mangrove Management Mangrove Monitoring </div>		
<p>The plan prioritizes mangrove rehabilitation sites and recommends suitable mangrove species, planting techniques and includes related cost estimates.</p> <p>Key Words: Rehabilitation, Plan, Bac Lieu, Mangrove</p>		
Monitoring of mangrove rorests	Pham Trong Thinh, Dominic Meinardi and Klaus Schmitt	2011
Mangrove Monitoring		
<p>The monitoring manual covers the planting design, monitoring protocols, monitoring of land use changes and mangrove area, as well as recommendations on data storage and reporting of results.</p> <p>Key Words: Soc Trang, Mangrove Monitoring, Land Use Change, Manual</p>		
Co-management/shared governance of natural resources and protected areas in Viet Nam	Daniel Spelchan, Isabelle A. Nicoll and Nguyen T. P. Hao (eds)	2011
Co-Management		
<p>The papers in these proceedings highlight the application of co-management in different settings in Viet Nam, while emphasizing the need for clear definition, understanding and adoption of terms related to co-management, including closely related concepts of collaborative management, shared governance, community-based conservation, participatory management and community-based management.</p> <p>Key Words: Soc Trang, Co-management, Community Based Conservation, Shared Governance</p>		
Mangroves of Soc Trang 1965 - 2007	Pham Trong Thinh	2011
Mangrove Management		
<p>The study comprises the situation of mangrove development in Soc Trang between 1965 and 2007. It covers the ecological characteristics of the coastal area, describes the ecosystem and the variations in mangrove forests and environmental consequences. Moreover, planting management and protection, as well as measures for protection and development are covered by this report.</p> <p>Key Words: Soc Trang, Mangrove Development, Environmental Management,</p>		

Title	Author	Year
Quantify the CO ₂ absorption capacity of <i>Avicennia marina</i> in coastal areas of Bac Lieu city, Bac Lieu province	Vien Ngoc Nam and Le Hoang Vu	2012
Climate Change		
The study determines the amount of CO ₂ absorbed by <i>Avicennia</i> in the research area in Bac Lieu and to evaluates the environmental cost of <i>Avicennia</i> to provide information for payment of environmental services		
Key Words: CO ₂ , Avicennia, PES, Bac Lieu		
Baseline study coastal erosion	Thorsten Albers	2012
Coastal Protection		
The report contains recommendations for erosion control measures along the coast of Bac Lieu province based on the results of a baseline study that was carried out in December 2011.		
Key Words: Erosion, Coastal Protection, Bac Lieu		
Construction supervision of bamboo fences for erosion control in Bac Lieu province	Thorsten Albers	2012
Coastal Protection		
This report summarizes the technical details and experiences during the construction of T-shaped bamboo breakwaters in Bac Lieu province.		
Key Words: Erosion, Coastal Protection, Bac Lieu		
Shoreline and mangrove resource condition of the mainland coast of Kien Giang	Michael Russel	2012
Mangrove Management	Coastal Protection	
This report summarizes the mangrove resource condition in Kien Giang province as seen from Shoreline Video Assessment and the condition of the gazette reserved protection forest as measured from satellite images.		
Key Words: Kien Giang, Mangrove, Satellite, Shoreline Video Assessment		
Mangroves of the Kien Giang Biosphere Reserve Viet Nam	Norm Duke	2012
Mangrove Management		
The report describes the mangrove species present in the province of Kien Giang.		
Key Words: Mangrove, Biodiversity, Kien Giang		
Mangrove forest and sediment development under four different restoration treatments in Kien Giang	Sophie Delzoppo	2012
Mangrove Management	Mangrove Restoration	
The report compares four different mangrove restoration techniques in Kien Giang province.		
Key Words: Mangrove, Rehabilitation, Restoration, Kien Giang		
Coastal rehabilitation and mangrove restoration using Melaleuca Fences	Chu Van Cuong and Sharon Brown (eds)	2012
Mangrove Planting		
The report summarizes the experiences from Kien Giang province in using Melaleuca fences to reduce the wave power and protect mangrove rehabilitation sites. It includes relevant technical specifications.		
Key Words: Kien Giang, Mangrove, Fence, Melaleuca, Protection		

Title	Author	Year
Experience from integrated coastal zone management in the Philippines - study tour July 2011	Nguyen Anh Dung (ed)	2012
<p>ICAM</p> <p>The document summarizes a wide range of interventions observed by the Soc Trang delegation regarding sustainable management and use of aquatic resources and mangrove forests; environmental awareness raising and management;</p> <p>Key Words: Soc Trang, ICAM, Philippines, Mangrove Management</p>		
Integrated coastal area management (ICAM) - national workshop in Ho Chi Minh City, 24 November 2011	Pham Thuy Duong and Bianca Schlegel	2012
<p>ICAM</p> <p>The report provides an overview of the presentations, discussions and findings of the one-day workshop on Integrated Coastal Area Management (ICAM).</p> <p>Key Words: Soc Trang, ICAM, Conference Proceeding</p>		
Sharing lessons on mangrove restoration	Don Macintosh, Ranjith Mahindapala and Matthew Markopoulos (eds)	2012
<p>Mangrove Management ICAM</p> <p>The document summarizes lessons learned from mangrove planting, protection and management.</p> <p>Key Words: Soc Trang, Mangrove Rehabilitation, ICAM, Mangrove Management</p>		
Cumulative pressures on sustainable livelihoods: coastal adaptation in the Mekong Delta	Timothy F. Smith, Dana Thomsen, Steve Gould, Klaus Schmitt and Bianca Schlegel	2013
<p>Climate Change Natural Resource Use</p> <p>The peer-reviewed article (<i>Sustainability</i> 2013, 5(1)) thematises the viability of proposed adaption pathways in Soc Trang province, an area experiencing cumulative pressures on coastal livelihoods.</p> <p>Key Words: Soc Trang, Coastal livelihoods, Adaption, Climate Change, Mekong Delta</p>		
Site-specific and integrated adaptation to climate change in the coastal mangrove zone of Soc Trang Province, Viet Nam	Klaus Schmitt, Thorsten Albers, Pham Trong Thinh and Dinh Cang San	2013
<p>Climate Change</p> <p>The peer-reviewed article (<i>Journal of Coastal Conservation</i> 2013, 17 (3)) presents site specific and integrated adaptation measures in response to increased intensity and frequency of storms and floods, threatening the protection function of Mangroves.</p> <p>Key Words: Soc Trang, Climate Change Adaption, Mangrove Rehabilitation, Erosion Protection, Co-Management, ICAM</p>		

Title	Author	Year
Integrated coastal area management in Soc Trang province	Timothy F. Smith, Steve Gould and Dana Thomsen	2013
<p>ICAM</p> <p>The report contributes to the implementation of ICAM in Soc Trang province and includes key findings from a relevant literature review, the result of a two day systems workshop and key informant interviews.</p> <p>Key Words: Soc Trang, ICAM, Climate Change, Capacity Building</p>		
Integrated coastal management - session summaries: Soc Trang expert exchange to Australia	Timothy Smith (ed)	2013
<p>ICAM</p> <p>The report summarises the sessions presented at the University of the Sunshine Coast as part of the Integrated Coastal Management (ICM) Soc Trang Expert Exchange. The sessions covered a range of issues and concepts of relevance to ICAM and allowed a comparative discussion of the Australian and Viet Nam experiences.</p> <p>Key Words: Soc Trang, ICAM, Expert Exchange, Australia</p>		
Assessment of the role of women in environmental protection of the coastal zone	Charlotte Huang and Ira Lemm	2013
<p>Coastal Protection</p> <p>The report assesses the knowledge of women about environmental threats and climate change; identifies the potential of women in the environmental protection of the coastal zone; and obstacles that prevent women from actively participating in the environmental protection of the coastal zone.</p> <p>Key Words: Soc Trang, Environmental Protection, Gendering, Women</p>		
Impacts of changing aquatic resource availability on the livelihoods of a coastal zone community in Soc Trang province	Tran Dac Dinh and Trịnh Kieu Nhien	2013
<p>Co-Management</p> <p>The report determines the degree of aquatic exploitation, and possible impacts of aquatic exploitation, on mangrove forests; investigates possible changes in exploitation productivity and the risks related to aquatic exploitation; determines the level of dependency on aquatic resources and the incomes generated from these resources; and, identifies opportunities for sustainable aquatic resource management and exploitation.</p> <p>Key Words: Soc Trang, Coastal Zone, Natural resources; Mangroves, Co-Management</p>		
Saved health, saved wealth: an approach to quantifying the benefits of climate change adaptation	GIZ - Sector Project	2013
<p>Climate Change</p> <p>The report provides a method on how to consistently estimate, monitor and evaluate the actual outcomes of adaptation activities.</p> <p>Key Words: Soc Trang, Health, Wealth, Climate Change Adaptation</p>		

Title	Author	Year
Mangrove planting guideline (in Vietnamese only)	Lisa Steurer and Phan Van Hoang	2013
Mangrove Planting		
The guide outlines how to plant mangrove seedlings including a short overview of the most common species in Bac Lieu province.		
Key Words: Mangrove, Planting		
Shoreline management guidelines: coastal protection in the lower Mekong Delta	Thorsten Albers, Dinh Cang San and Klaus Schmitt	2013
Coastal Protection		
The comprehensive publication explains the processes of shoreline morphodynamics, describes the causes of erosion and flooding, presents coastal protection measures and shoreline management strategies and includes a case study from Soc Trang Province, including field measurements, numerical and physical modelling.		
Key Words: Soc Trang, Shoreline Management, Coastal Protection, Mekong Delta		
Testing plantation of <i>Avicennia marina</i> on accretion areas with the use of bare propagules and covered with nets	Phan Van Hoang	2013
Mangrove Planting		
The report summarizes experiences of <i>Avicennia Marina</i> planting on the mudflat with different techniques: bare propagules and propagules covered with nets.		
Key Words: Avicennia, Propagules, Planting, Mudflat		
Assessing two mangrove rehabilitation techniques in Kien Giang	Stephen Ryan Thornton	2013
Mangrove Planting Mangrove Management		
The research report investigates the use of vegetation and faunal communities as bioindicators to assess two mangrove rehabilitation techniques in Kien Giang, Viet Nam.		
Key Words: Kien Giang, Mangrove, Rehabilitation, Vegetation		
Climate change coastal management – a plan for erosion management and mangrove restoration	Michael Russel	2013
Climate Change Coastal Protection		
The plan outlines the evidence based assessment of the current situation of the Kien Giang coastline and current key pressures on this resource and gives recommendations for action for erosion management, mangrove restoration and livelihood development.		
Key Words: Kien Giang, Plan, Mangrove, Restoration		
Aquaculture and the 70:30 policy in Kien Giang province Viet Nam	Gay Marsden	2013
Natural Resource Use/Livelihood		
The report analyses the 70:30 policy on aquaculture and mangrove forest management in Kien Giang and includes a review of production and sustainability of farms and recommendations.		
Key Words: Kien Giang, Mangrove, Aquaculture		

Title	Author	Year
Site assessment manual	Barry Clough	2014
Site Assessment		
The manual guides appropriate site assessment including visual and quantitative assessment. Key Words: Site Assessment, Mangrove, Rehabilitation		
Shoreline changes in Vinh Trach Dong, Hiep Thanh and Nha Mat Wards, Bac Lieu province Between 2009 and 2014	Barry Clough	2014
Mangrove Monitoring		
The report describes the shorelines changes (erosion and accretion) along the northern coast of Bac Lieu province. Key Words: Erosion, Mangrove, Coastline, Bac Lieu		
Mangrove restoration and rehabilitation- an overview from Bac Lieu province 2011-2014	Lisa Steurer	2014
Mangrove Managment		
The report outlines the current status of the Mangrove forest and summarizes of four years of Mangrove Rehabilitation and Restoration in Bac Lieu province. Key Words: Mangroves, Monitoring, Rehabilitation, Bac Lieu		
Mangrove Restoration on barren land	Barry Clough	2014
Mangrove Planting	Mangrove Restoration	
The report describes the restoration of degraded land and subsequent mangrove rehabilitation including an explanation of the used technique, data analysis and results after three years. Key Words: Degraded Land, Restoration, Rehabilitation, Site Preparation, Mangrove, Soil		

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Annex I

Flow charts

Decision making flow chart for mangrove conservation and planting

Site Assessment

Planting

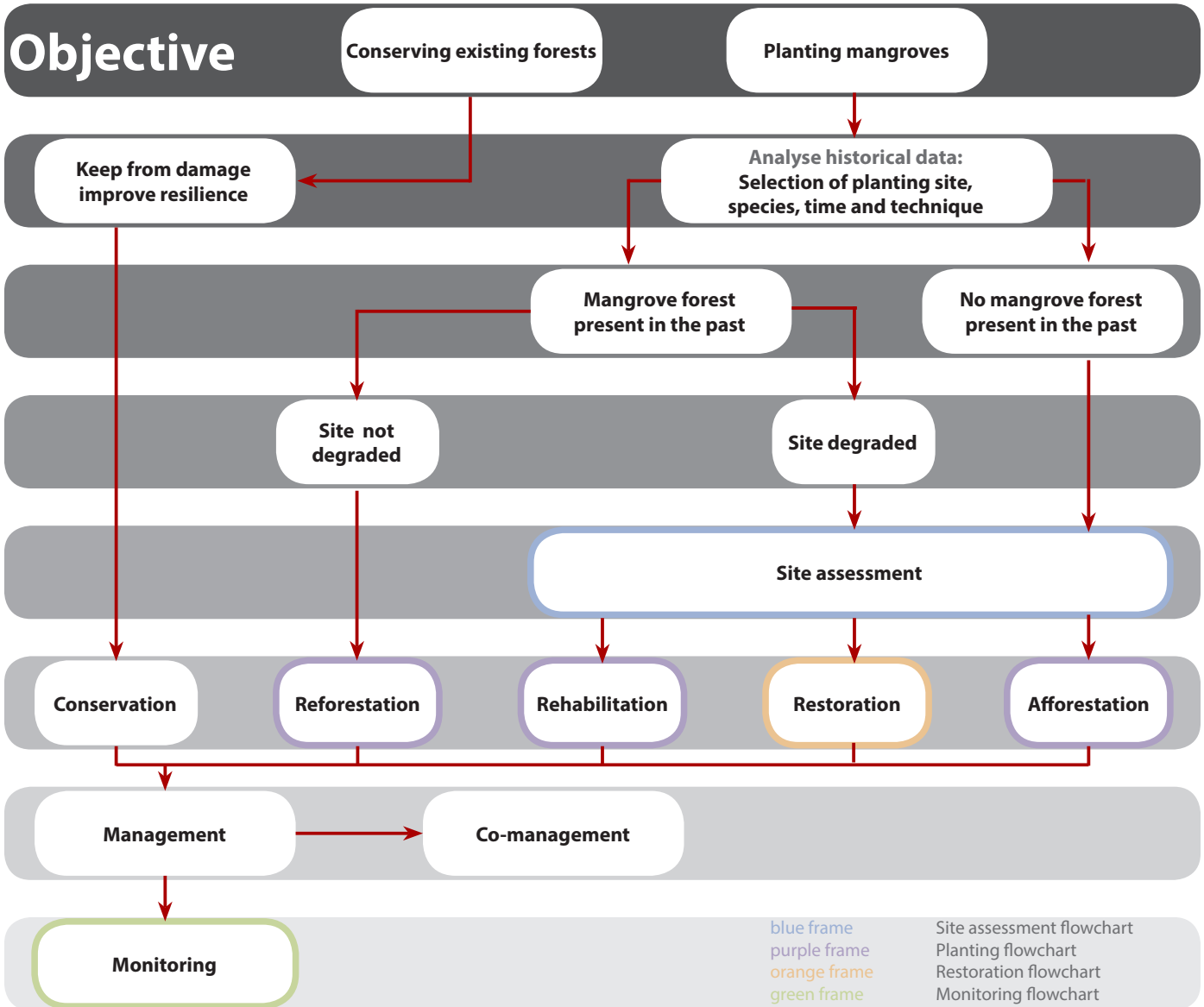
Monitoring

Restoration: Case Study

Decision-making flow chart for mangrove conservation and planting



Published by giz



- To effectively increase mangrove area:**
1. Select a suitable planting site
 2. Select appropriate species
 3. Choose the right planting technique

Flow chart based on: Schmitt K, Duke NC (2014 in print) Chapter 20.2 Mangrove Management, Assessment and Monitoring. In: Pancel L, Köhl M (eds.) *Tropical Forestry Handbook*. 2nd edition, Springer. (Modified by Author) <http://daln.gov.vn/en/icmp-cccep.html>

Conservation
Primary aim of a mangrove management strategy. Maintenance of the health of remaining mangrove forests and reducing loss. Keeping mangrove forests safe from damage and destruction, improving resilience.

Reforestation
Planting trees in areas which were formerly forested and where the site conditions have not been degraded since removal of the mangrove cover.

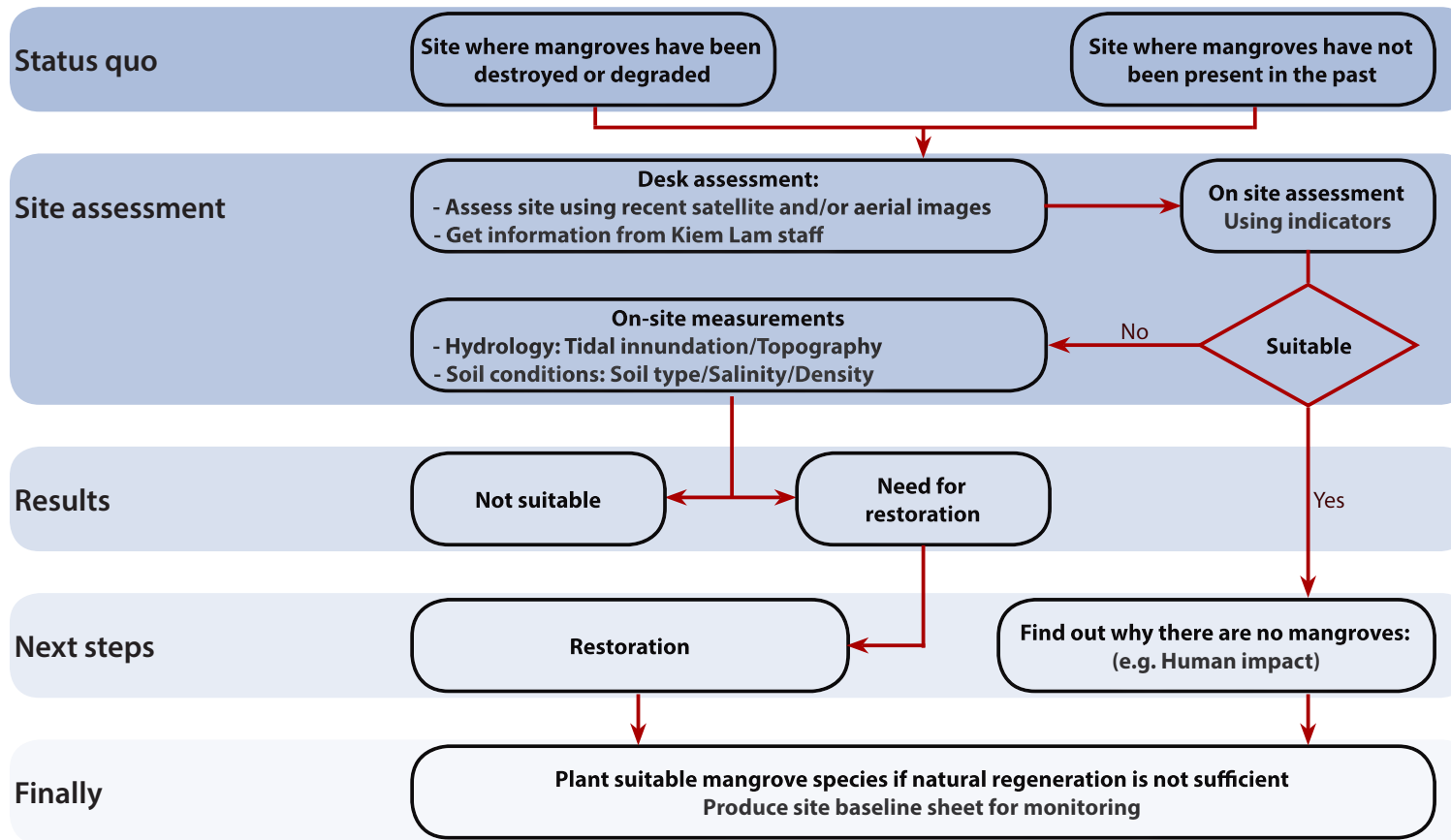
Rehabilitation
Return degraded mangrove land to a fully functional mangrove ecosystem regardless of the original state of the degraded land.

Restoration
Return a site to pre-existing conditions.

Afforestation
Establishing mangrove forest in a site where mangroves have not been present in the past.

Site assessment

In sites where mangroves have been destroyed or degraded, or where mangroves have not been present in the past, a site assessment must be carried out to determine whether or not restoration measures need to be carried out before planting.



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Mangroves grow in intertidal zones, this is the range from the mean sea water level to the highest point of spring tide water level

Indicator

On site inspection in the mangrove belt

<i>Soil texture</i>	<ul style="list-style-type: none"> • Hard/dry • Standing water • Soft and moist
<i>Crab holes</i>	<ul style="list-style-type: none"> • Yes/No
<i>Canopy development</i>	<ul style="list-style-type: none"> • Low • Normal
<i>Forest development</i>	<ul style="list-style-type: none"> • Normal • Poor • Not at all
<i>Root systems</i>	<ul style="list-style-type: none"> • Numerous Pneumatophores • Spongy roots

On site inspection on mud/tidal flats

<i>Presence of Mangroves</i>	<ul style="list-style-type: none"> • Pioneer species • Other species • No trees at all • Natural regeneration
<i>Soil texture</i>	<ul style="list-style-type: none"> • Soft soil • Very soft mud
<i>Surface channels</i>	<ul style="list-style-type: none"> • Yes/No
<i>Currents</i>	<ul style="list-style-type: none"> • Accretion • Erosion

Note: One indicator cannot define the site. All indicator must be considered for the site assessment.

Supporting literature

For further and detailed information, use the following Manuals and reports by ICMP/CCCEP

<http://daln.gov.vn/en/icmp-cccep.html>

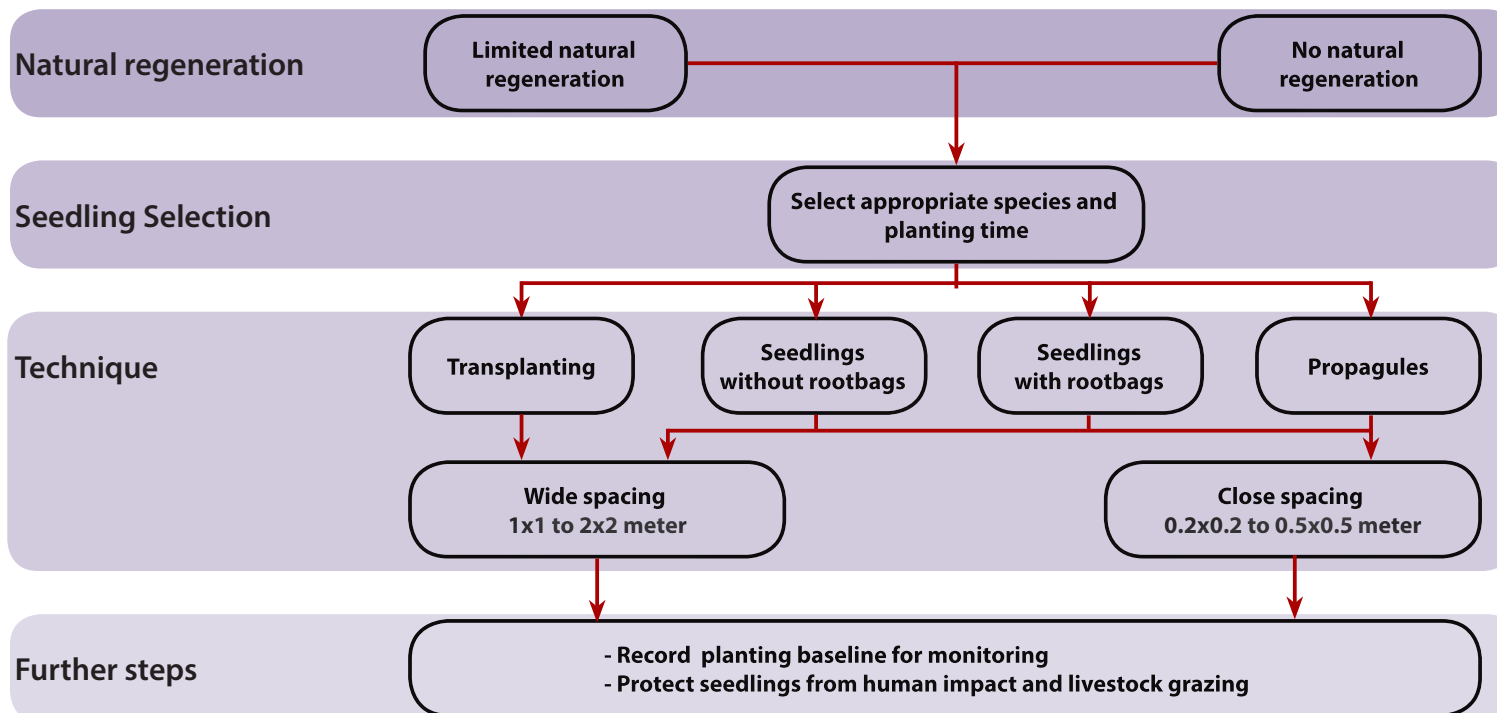
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Planting

Planting is required if natural regeneration is not sufficient. Depending on the objective and the abiotic factors, the right species, planting time and planting technique must be selected.



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Does and Don'ts in Mangrove Planting

1. Do not carry seedling by holding it at the stem but the base of the plant.
2. Remove plastic soil bag carefully.
3. Dig a hole twice as deep and wide as the root ball.
4. Put some loose soil into the hole and place the seedling on top of it. Make sure it is at the right depth: the top of the soil bag should be level with the ground.
5. Fill the remaining space up with loose soil (earlier dug out of the hole). Break up big chunks to fill the space without applying force.
6. Use your hands to compact the soil. Do not use your feet.

Supporting literature

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Seedling selection

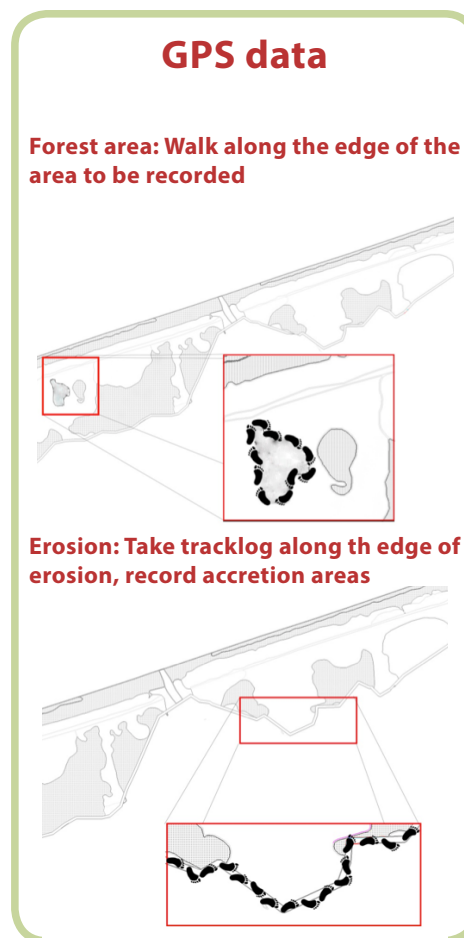
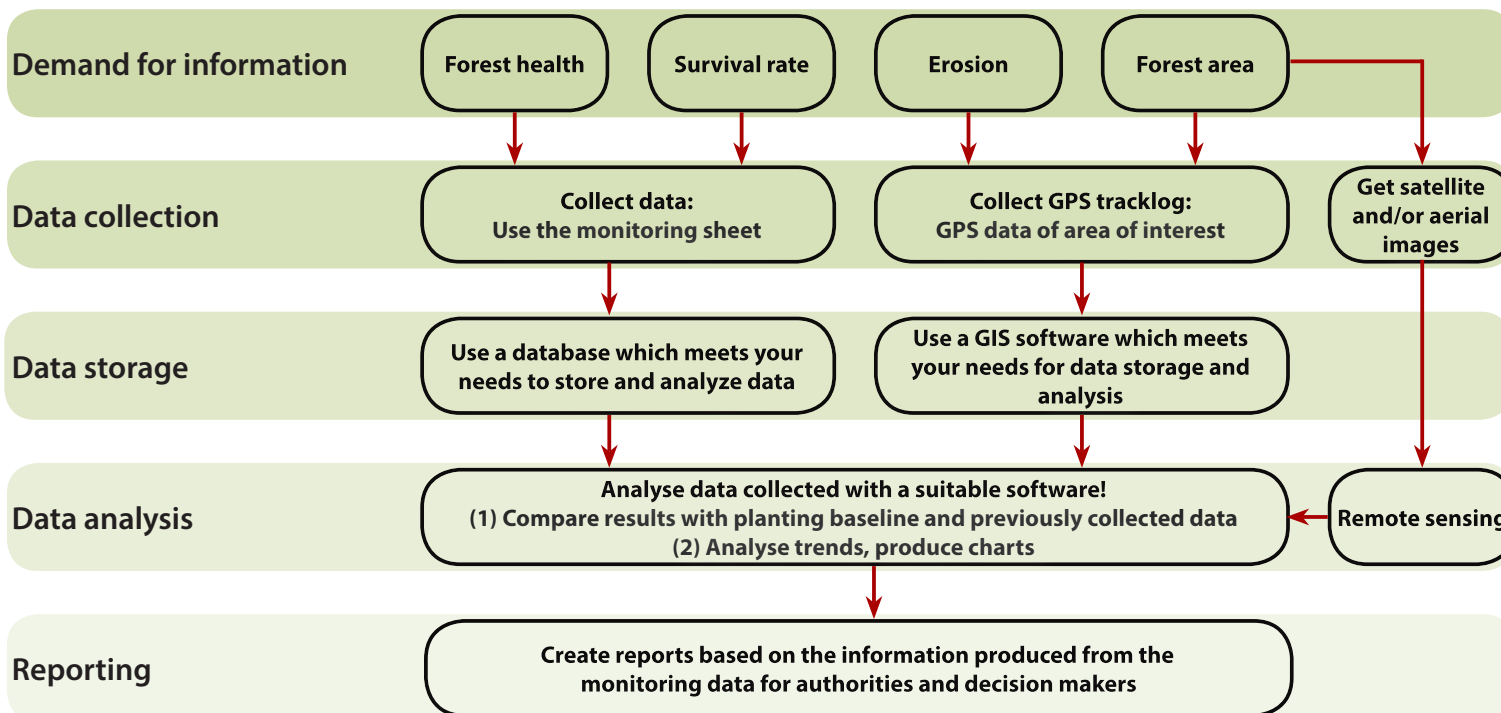
- Use seeds or propagules from the area of planting
- Nurseries can provide good quality seedlings of the desired amount in the time for planting
- A nursery can provide seedlings with root bags if required or bare root seedlings if suitable

Monitoring

Monitoring provides information on forest area and health, survival rate and erosion
It comprises: (1) data collection (2) data storage (3) data analysis (4) reporting



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Supporting literature

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<http://daln.gov.vn/en/icmp-cccep.html>

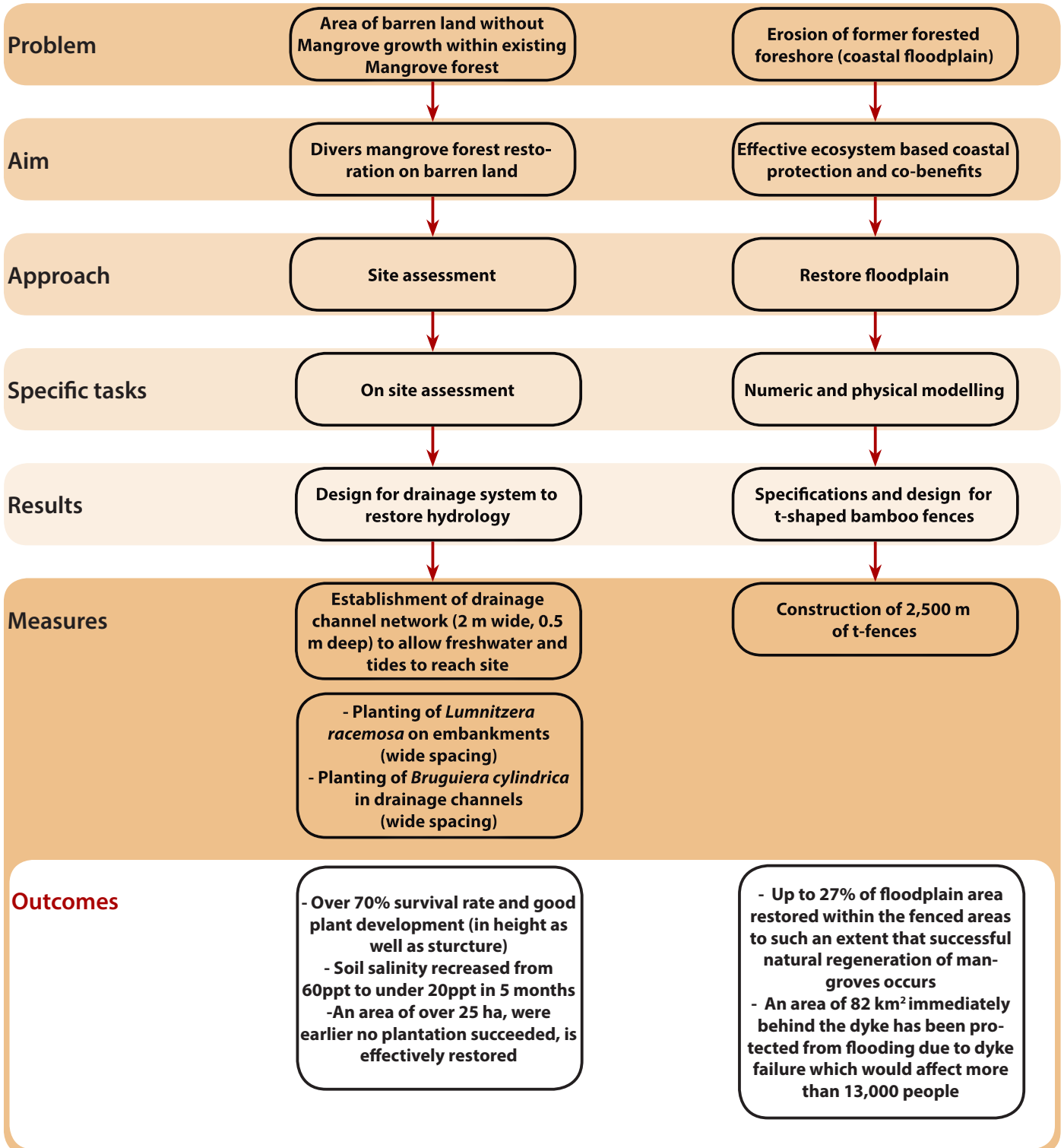
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Restoration

Case studies from the Mekong Delta



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Supporting literature

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- Albers, San and Schmitt 2013, Shoreline Management Guidelines: Coastal Protection in the lower Mekong Delta
- Hoang 2013. Testing Plantation of *Avicennia Marina* on accretion areas with the use of bare propagules and covered with nets
- Macintosh, Mahindapala and Markopoulos (eds) 2012, Sharing Lessons on Mangrove Restoration
- Steurer and Clough 2014, Rehabilitation of Barren Land

Annex II

Monitoring Template

Mangrove monitoring sheet

Date: _____

Code: _____

Name of recorder

Plot number and size

No. _____ Size _____ square meter

Photo reference (field note)

GPS record

48P UTM Waypoint No.

48P UTM Waypoint No.

Factors affecting the growth

- waves accretion barnacles dense growth
 wind erosion pests/diseases human activities

Narrative

Briefly describe remarkable features (continue on back page if space is not sufficient)

Survival rate		Forest health			
No.	Species	Height in cm	Knots/Diameter	Pest (Y/N)	Remarks
5					
10					
15					

Record No. of Knots up to 10, if more, write >10
 If stem is >2.5 cm at 1.3 m height, record diameter in mm

Survival rate			Forest health	
Species	Height in cm	Knots/Diameter	Pest (Y/N)	Remarks

Record No. of Knots up to 10, if more, write >10
 If stem is >2.5 cm at 1.3 m height, record diameter in mm

Imprint

Published by the

Deutsche Gesellschaft für
Internationale Zusammenarbeit (GIZ) GmbH

Registered offices

Bonn and Eschborn, Germany

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As at

September 2014

Photo credits

L. Steurer, D. Meinardi, R. Sorgenfrei, K. Schmitt © GIZ

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GIZ is responsible for the content of this publication.

On behalf of the

Australian Department of Foreign Affairs and Trade (DFAT)

German Federal Ministry for Economic Cooperation and

Development (BMZ)

