



Coastal Risk Reduction

Integrating Natural Defenses into a Sustainable Coastal
Risk Management Framework



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1. Introduction

1.1 Coastal risk

The vulnerability of coastal communities and infrastructure has been starkly exposed in recent years through the devastation caused by numerous coastal storms. Climate change means that we will face higher sea levels and more frequent storms in the future. The social, economic and environmental consequences of these storms, and the repeat nature of many of the impacts, has generated significant scientific and public debate over the sustainability of our current approaches to coastal risk management.

The combination of man-made and natural problems at our coasts requires a considered approach to management. Reactive, local approaches to addressing coastal impacts as they arise is a recipe for increased losses at our coasts. If we take a step back, think about our long-term objectives and look to work with nature where possible, we have the potential to stop our management responses themselves being part of the problem. This thinking is in line with the National Research Council (2014) which, after reviewing current approaches, suggested that a more coordinated, strategic, longer-term vision was needed for the United States (US) coast.

1.2 A new approach

This document sets out guidance for the selection and implementation of nature based solutions within a regional and long-term framework. This document promotes the development of Strategic Coastal Resilience Plans (SCRPs). These plans are intended to reduce the environmental and socio-economic risks of coastal hazards in a sustainable manner.

This document is aimed at communities and organizations responsible for management of coastal zones, their risks and resources, and offers the benefit of a wide range of experience from around the world. The framework proposes that authorities and agencies collaborate to produce plans that cross administrative boundaries, in recognition that nature does not recognize, or reflect, such boundaries.

The approach encourages the use of ecosystem service valuation to ensure that the full range of advantages and disadvantages are considered for the different management options and the multiple benefits of more natural approaches are adequately accounted for. The approach also requires an assessment of conditions over the full coastal process unit, with in-combination impacts

appraised, so as to ensure that recommendations are truly integrated along the shoreline. This is an important move away from the narrow site-specific focus which is often adopted at present. This consideration is particularly important for nature based approaches whose success depends on their integration with natural coastal processes.

This framework has been developed by The Nature Conservancy (TNC) and CH2M, uses existing data sources and tools and develops existing approaches that are commonly used by TNC and CH2M to implement projects.



1.3 Document Structure

The document is structured as follows:

- Chapter 2 The rationale
- Chapter 3 Summary of tasks and activities



About the authors

Since 2005, The Nature Conservancy has worked with government agencies and communities to better prepare for sea-level rise, storm surge, and to understand the role natural habitats can play in reducing our risk from these threats. TNC leads 'The Coastal Resilience network' which supports a community of practitioners around the world applying planning innovations to coastal hazard and adaptation issues.

CH2M has over 25 years' experience from around the world in developing strategic plans for sustainable coastal risk management.

2. Rationale

2.1 Key Requirements

A framework for Strategic Coastal Resilience needs to provide a structured and transparent approach. The key requirements are that it:

- Covers a large coastal area to take account of alongshore connectivity and regional influences on coastal processes.
- Considers a long time period to allow for the consideration of potential future changes to the coastline resultant from both man-made (e.g. development) and natural (e.g. climate change and sea level rise) drivers; anticipating potential future changes in risk, and allowing time for communities to plan for future adaptation.



- Considers the full range of coastal resilience options, including: non-structural, natural, nature-based and structural options, and makes

recommendations for the most appropriate options at different locations over time.

- Promotes the implementation of natural and nature-based solutions where these are appropriate, to realize the multiple benefits they can provide.
- Provides for engagement of the full range of coastal stakeholders in the decision making process including decision-makers, key coastal agencies/ organizations, and community groups.

2.2 Large Spatial Scales

While coastal modeling studies to support the design of storm damage reduction projects may be undertaken with a regional grid, this is not the same as considering management activities in the full coastal context and defining the coherence of management activities along the shoreline. In the US, an appropriate regional coastal process baseline has been established for many areas of the United States through the 'Regional Sediment Management' (RSM) planning efforts. The RSM efforts to date have largely focused on near term existing sediment needs and linking sediment sources to the projects that need sediment for nourishment, etc. Application of this type of regional coastal process understanding to define the linkages between frontages and inform the





definition of integrated management responses, is a key component of the Strategic Coastal Resilience Plan.

Considering coastal processes alongshore, and the interdependencies between frontages, ensures that recommendations in one location do not detrimentally impact our ability to deliver coastal risk management in another. Similarly, this regional view also enables us to consider how future climate change may impact the coast, by considering projected sea level rise and storminess scenarios

to determine their potential impacts on processes. With nature-based solutions this enables us to consider how habitats and features will evolve and ensure we plan to accommodate future change.

2.3 Long-term Approaches

A Strategic Coastal Resilience Plan promotes management approaches for a coastline into the 22nd century. These approaches should achieve long-term objectives without committing to unsustainable practices. It is likely that in some locations, the preferred long-term management approach may differ from present day practices, and in these locations the plan will need to provide a 'route map' for decision makers to move from the present situation towards a potentially different future.

It is therefore appropriate to consider objectives and management options for various timescales; the immediate-term, medium-term and long-term. It is recommended that these should correspond broadly to time periods of 0 to 20 years, 20 to 50 years and 50 to 100 years from today respectively, but these periods should not be regarded as rigid criteria. More importantly is the consideration of how coastal risks and their management might

evolve over time and consider what this might mean for present day practices.

A guiding principle is that the Strategic Coastal Resilience Plan should define a long-term sustainable plan, even though that may change over time. There will always be uncertainty associated with considering the long-term, both in terms of extrapolating information and making predictions regarding future coastal risks, socio-economic factors and other constraints such as funding and natural resources. Consequently, a primary function of the Strategic Coastal Resilience Plan should be to demonstrate that coastal risk management approaches proposed today are not detrimental to delivery of a future resilient coast.



2.4 Coastal Defense Options

In the context of long-term coastal risk management planning, there are a wide range of potential approaches that can be adopted to achieve resilience. These can be divided into three broad categories:

- Natural and nature-based options – working with existing or new/designed features such as wetlands, beaches, dunes, barrier islands, sea grass beds, reefs.
- Non-structural – land planning policies, building codes and emergency response such as early warning and evacuation plans. These options can involve removing risks by avoiding or moving inappropriate development in vulnerable areas or flood proofing buildings to reduce their vulnerability to flood damage.

- Structural options – hard engineered options such as seawalls breakwaters, surge barriers, groynes, levees and sills.



The most appropriate measures will depend on the problem, and on technical, environmental, social and economic restrictions.

There is a growing body of evidence, from both scientific research and experiences during recent storms, that natural habitats and landforms can fulfill a vital function in coastal risk reduction. Intertidal and sub-tidal habitats such as coral reefs, saltmarsh, mangroves and beaches naturally dissipate wave energy, reducing erosive forces, while backshore and upland features such as sand dunes, ridges and forests, provide effective barriers

to storm surge propagation and the consequent flooding. These features also provide a multitude of other benefits including aesthetics, habitat and species conservation and development buffers.

A significant benefit of natural defenses is their in-built ability to 'adapt' to natural change over time. Natural features respond dynamically to both occasional (e.g. storms) and chronic (e.g. sea level rise) events by rebuilding or migrating landwards, maintaining their form, provided sources of sediment are not disrupted. In some instances additional maintenance activities, such as sediment nourishment, may be required. This natural response and adaptation makes these features highly sustainable as a long-term coastal risk management option. Even in locations where built assets are at very high levels of risk, and structural protection such as levees or walls, is deemed necessary, natural defenses in front of these structures can greatly reduce their day-to-day exposure increasing their life and reducing maintenance commitments.

It is commonplace to take an integrated approach to reducing coastal risks and increasing human and ecosystem community resilience through a combination of natural, nature-based, non-structural and structural measures. The term "green



Image courtesy of Ami Vitale

infrastructure" is sometimes used to refer to the integration of natural systems and processes, or engineered systems that mimic natural systems and processes. Some solutions are also referred to as "hybrid solutions" where they involve using structures to augment or encourage the development of habitats.

2.5 Engagement of Stakeholders

It is critical that any plan has the buy-in of those who will be responsible for its implementation and those potentially affected by its recommendations. Engagement with key decision makers and other stakeholders therefore needs to occur throughout the plan.

When considering the engagement of stakeholders it can be helpful to identify the incentive and disincentives for implementing a Resilience plan and nature based solutions. For example this might involve identifying:

- Where policies impede or enable progress.
- Where existing case studies can be used to demonstrate successful outcomes.

- Understanding peoples' perceptions which can be positive or negative. In Vietnam and Philippines, people's perceptions of nature based solutions has been positive and has motivated large scale actions. However, in the US and in many small island developing states, nature based solutions can be viewed as a too risky, not 'solid' enough or a 'poor-persons' solution. In both cases perception can be more important than science in governing successful implementation.

A well planned and implemented stakeholder engagement strategy, that allows for the outcomes of engagement activities to be incorporated into plan formulation and decision making, will greatly increase the likelihood of the final plan recommendations being implemented.





Lessons Learned from Past Natural and Nature-Based Defense Projects

- Economics matter but perception can be paramount. Many early mangrove conservation and restoration efforts were motivated by observations and perceptions from stakeholders and scientists. While economic and ecological data on coastal protection benefits have been increasingly influential, many projects got early motivation from the fact that villagers and local Aid group leaders have seen the loss of mangrove habitats and the concomitant effects of erosion, flooding and loss of livelihoods.
- Subsequent cost:benefit analyses of these actions has shown mangrove restoration to be cost effective for risk reduction.
- Numerous National Adaptation Programmes of Action (NAPAs) for Countries such as the Solomon Islands, Maldives, Dominican Republic and many other Caribbean nations have noted the importance of and prioritized coastal protection by reefs and mangroves.
- Values of coastal protection will be highest where reefs and mangroves are located in front of infrastructure. There can be wide variation in the cost:benefit estimates and the valuation studies. Much of this variation within countries appears to be related to the value of coastal assets behind reefs and mangroves. The greater the value of the assets to be protected the higher the potential values and benefit:cost estimates.
- Mangrove restoration for coastal protection is now a well-established practice. The practice can be done well over hundreds to thousands of hectares of coastline. Many lessons have been learned along the way on how to do this practice well.
- Teaming natural and artificial defenses can be very effective such as mangroves in front of dikes (e.g. Vietnam). No single action will be fully effective in risk reduction. Indeed risk reduction always involves a comprehensive combination of engineering and land-use planning solutions.
- It is not currently common practice to use coral reefs and mangroves for coastal protection. Even when analyses show that they can be used cost effectively, they still may not be chosen because they are comparatively novel practice (e.g. Fiji). Nonetheless a growing number of engineering firms and agencies are incorporating nature based defenses into their analyses and business practices.
- Significant land use and funding decisions are made post disaster and these can support reef and mangrove restoration; the Philippines is the best example of these kinds of activities for reefs and mangroves. Post-disaster funding and re-building also supports activities that can further degrade coastal habitats (e.g. building seawalls and dikes) and it seems likely that these activities may be even more common.
- Coral reef and mangrove restoration are increasingly recognized as contributing cost effectively to coastal risk reduction; this should create better incentives for their restoration and protection. There are a growing number of studies both from models and demonstration projects by scientists, business, agencies, environmental NGOs and aid and development groups. The evidence is quite clear, natural and nature-based defenses can contribute cost effectively to risk reduction in most instances. While this evidence of cost effectiveness should create incentives to include natural and nature-based defenses in policy and practice, this has not happened often.



2.6 Clarity of Decision Making

In order to gain stakeholder support it is vital that the recommendations are demonstrated to be socially, environmentally and economically viable through the Plan analysis and decision making. Key requirements are for the decision-making process to be:

- Robust;
- Transparent; and
- Auditable.

Most important is a robust analysis that supports appropriate management decisions. Transparency requires a clearly defined process which shows how the key decisions are made and how the recommendations are derived from them. The objective for auditability (so stakeholders can review the process for themselves) requires the process to be documented in such a way that recommendations are traceable back to source information and analyses.

2.7 Appropriate Level of Detail

The Strategic Coastal Resilience Plan is to inform high level planning and its presentation should therefore be clear and non-technical. However, to promote sustainable management options a certain amount of detailed analysis will be required to ensure that the options are appropriate and



not undermined by inadequate or incomplete assessment.

This does not necessarily require extensive additional studies; the Strategic Coastal Resilience Plan should seek to maximize the use of existing tools, information, assessments and knowledge.

2.8 Implementable Solutions

The recommendations of a Strategic Coastal Resilience Plan must be realistic and clearly address defined needs in order for the plan to be taken forward to implementation. There are now decades of decisions in support of the conservation and restoration of natural and nature-based solutions for coastal protection, and the lessons from this should be utilized in plan formulation. Box 2

contains some of the key lesson learned in the past from Natural and Nature-Based Defense Projects.

2.9 Relationship with Other Initiatives

Working with and sharing information between Government Agencies (e.g. Federal, State and Local) and other coastal interest groups (e.g. TNC) is important to develop a coordinated approach to managing the shoreline. Strategic Coastal Resilience Plans can support the land use planning/ zoning system in discouraging inappropriate development in areas at risk from flooding, coastal erosion and cliff instability. The plan can also give developers background information about particular sites, so that they are aware of possible problems and the possible mitigation measures that may be necessary.

It is common for a wide range of project, plans and strategies to exist for any stretch of coast. For example, Regional Sediment Management Plans, Coastal Zone Management Plans, storm damage reduction projects, habitat restoration projects, etc. exist for many areas. Although the relationship between these plans and projects can be complicated, they should influence and reinforce each other and provide frameworks for putting the Strategic Coastal Resilience Plan

into practice, including achieving economic, social and environmental objectives. Strategic Coastal Resilience Plans can support other coastal management plans by providing information on the expected coastal changes, coastal risks and the preferred approaches for managing the shoreline. Those responsible for other plans will need to be told about Strategic Coastal Resilience Plans and be appropriately involved in developing them, to identify appropriate actions that contribute to the program of actions.

2.10 The Main Inputs and Outputs

One of the main aims of a Strategic Coastal Resilience Plan is to promote a sustainable risk management approach for the long-term and provide a timescale for managing risks along the coastline into the future. This will be achieved through inputs and outputs.

The main inputs into the Strategic Coastal Resilience Plan are as follows:

- Including up-to-date data and information on the physical, natural and human aspects of the subject coastline.
- Identifying, in general terms, the risks to people and the developed, historic and natural environment in the Plan area.

- Considering stakeholders' objectives, setting policies and considering management requirements.
- Better understanding of coastal processes and movement of sediment.
- Identifying policies that achieve both short-term and long-term objectives without committing to approaches that may be unsustainable in the long-term.
- Identifying the consequences of putting policies into practice, through considering long-term shoreline response (see the glossary) and change.

The main outputs from the Strategic Coastal Resilience Plan are as follows:

- A non-technical explanation which gives background information on developing the plan and discusses sustainable management (see the glossary).
- A high level overview of long-term coastal risks and the recommended management solutions.
- Detailed management statements for those sections of the coast where natural and nature-based solutions are considered in the long-term recommendations, outlining the:
 - Details of the proposed approach, how it may change over time, and how it will be put into practice;
 - Justification for the management approach; and
 - Implications for local objectives (including

identifying and mapping areas of the coast that may remain at risk from flooding and/ or erosion).

- A realistic and affordable action plan for putting the recommendations into practice.
- A record of how objectives have been assessed as part of the option development process.
- Background information used in developing the plan, including the shoreline response assessment and risk assessment.
- Records of how stakeholders have been involved throughout the Plan development.



3. Summary of Tasks and Activities

3.1 Summary of Tasks and Activities

An overview of the recommended approach for producing the Strategic Coastal Resilience Plan is presented here.

1. Identify area, stakeholders and data.
2. Assessing hazards and risks.
3. Assessing alternatives.
4. Implementing the plan.
5. Monitoring success.



4. Identifying Area, Stakeholders and Data

4.1 Identifying Area, Stakeholders and Datas

Typical actions at this stage include:

- Initiate SCRP
 - Agree Steering Group membership
 - Confirm scope and objectives of the SCRP (see Box 3)
 - Confirm study boundaries
 - Identify any outstanding study requirements for the SCRP
 - Agree form of the SCRP
- Define Stakeholder Engagement
 - Define stakeholder engagement strategy
 - Identify stakeholders, status and details
 - Contact stakeholders and inform them of SCRP process and request their inputs on objectives and available data/information
- Data Collation
 - Initiate data collection process and obtain data
 - Data management
 - Initial review of data

Key data here is likely to be:

- Sediment budgets - Regional Sediment Management Plans Regional Sediment Management (RSM) Program - <http://rsm.usace.army.mil/>
- Historical shoreline erosion - USGS - Assessment of Shoreline Change Project - <http://coastal.er.usgs.gov/shoreline-change/>

- Offshore wave buoys, Hurricane tracks, Flood risk mapping, - NOAA Coastal Services Centre - <http://csc.noaa.gov/digitalcoast/dataregistry/#/>

4.2 Assessing Hazards and Risks

4.2.1 Assessing Hazards

Typical actions at this stage include:

- Agree climate change and Sea Level Rise (SLR) scenarios.
- Assess coastal processes and present day behavior.
- Project potential future coastal evolution.
- Assess flooding and erosion hazards.
- Assess existing coastal protection structures and their impacts on potential future evolution.
- Report and map coastal behavior and evolution projections.

There are a number of useful resources here, including:

- Coastal defense App from the TNC.
- Flood and sea level rise App from the TNC.
- Historical Hurricane Tracks - NOAA Coastal Services Centre <http://csc.noaa.gov/digitalcoast/dataregistry/#/>
- National Assessment of Shoreline Change, USGS analysis of historical shoreline changes along open-ocean sandy shores <http://coastal.er.usgs.gov/shoreline-change/>



The objectives of a Strategic Coastal Resilience Plan should:

- *Set out, in general terms, the risks from flooding and erosion to people and the developed, historic and natural environment within the Strategic Coastal Resilience Plan area.*
- *Identify opportunities to maintain and improve the environment by managing the risks from floods and coastal erosion.*
- *Identify the preferred management approaches for managing risks from floods and erosion over the next century.*
- *Identify the consequences of putting the preferred management approaches into practice.*
- *Set out procedures for monitoring how effective these management approaches are.*
- *Inform others so that future land use, planning and development of the shoreline takes account of the risks and the preferred Strategic Coastal Resilience Plan policies.*
- *Discourage inappropriate development in areas where the flood and erosion risks are high.*
- *Follow national nature conservation legislation and biodiversity objectives.*

- Determine the degree of risk to assets, and the benefit derived from them, under the projected future coastal evolution (hazard) scenarios.
- Identify the potential local, regional and national impacts of projected potential losses (qualitative and quantitative), as the basis for justifying future risk management actions.

There are a number of useful resources here, including:

- The Flooding and sea level rise App from the TNC <http://coastalresilience.org/tools/apps>
- Economics data - Various economic productivity reports and data for different areas/scenarios, NOAA Coastal Services Centre, <http://csc.noaa.gov/digitalcoast/dataregistry/#/>
- Natural Environment Designations / protected areas - Marine Habitat data, BOEM/NOAA MarineCadastre viewer <http://csc.noaa.gov/mmcviewer/>
- Historic Environment Records / Designations - Ocean Uses and Planning Areas, BOEM/NOAA MarineCadastre viewer <http://csc.noaa.gov/mmcviewer/>

4.2.2 Assessing Risks

Typical actions at this stage include:

- Stakeholder engagement to understand all interests and objectives for the coastline.
- Identify and review natural and built assets on and near the coast.
- Understand benefits (value) provided by the identified assets; to include heritage, social, amenity, economic, environmental, etc.

4.3 Assessing Alternatives

4.3.1 Assessing Alternative Management options

Typical actions at this stage include:

- Developing a long list of available management options at each site.
- Screening to define a short list of viable management options at each site (considering changes over time).



- Carrying out assessments of implications of options for coastal processes, and natural and built assets.
- Considering adjacent frontages and impacts on coastal processes.
- Modifying management options if necessary.
- Define a draft 'preferred plan' comprising short and long-term options for all frontages.

There are a number of useful resources from the TNC here, including:

- Restoration Explorer App.
- Risk Explorer App.
- Future habitat App. <http://coastalresilience.org/tools/apps>

4.3.2 Consulting with Stakeholders

This occurs throughout the process, but consultation on the proposed plans should involve:

- Confirming consultation strategy and methods.
- Preparing materials.
- Public Consultation.
- Assessing consultation responses

4.4 Implementing the Plan

4.4.1 Developing an Implementation Plan

Typical actions at this stage include:

- Review options to identify where and when implementation actions are expected.
- Develop a prioritized program of actions and an

outline of potential future projects.

- Establish any actions that will be required to resolve uncertainties.
- Establish any actions that may be necessary to deal with the consequences of the plan.

4.4.2 Disseminating and Implementing the Plan

Typical actions at this stage include:

- Make the SCRP accessible
- Publicize SCRP completion.
- Implement action plan program of identified studies

We suggest that an indicative 12 month program to complete the draft SCRP with issue of the final Plan approximately 18 months after commencing its development.

There are a number of key actions to getting buy-in for implementation. Many of these actions need to have occurred throughout the plan development.

4.5 Monitoring Success

Monitoring and measuring success is critical for knowing what is working, how management should be adapted, and for identifying best practices for future management. All too often considerations of measures come last, are underfunded, and end soon after implementation of management plans.

Typical actions at this point should include:

- Identifying the key factors and variables that should be measured to gauge the success of the management actions.
- Considering the ecological, social and economic variables. When possible examine the costs and effectiveness of the measures for meeting management objectives.
- Identifying and using the long-term monitoring or other data sets that may already exist in the management area. Any new data should be incorporated in to them (hopefully to ensure maintenance of the database).
- Ensuring that all information is available open access.
- Ensuring that 5-10% of the budget remains to implement an appropriate monitoring plan.
- Identifying when and by whom the data will be analyzed.

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