Technical Report
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Coastal Vulnerability Assessment for Sea-Level Rise: Evaluation and Selection Methodologies for Implementation

Guidelines for Screening Assessment

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Component 6:
Coastal Vulnerability and Risk Assessment

Introduction

1. Coastal scientists and managers are increasingly being called upon to assess the physical, economic, and societal impacts of sea-level rise due to climate change, and hence investigate appropriate response strategies. This process is broadly termed vulnerability assessment and can usefully be structured into three levels of increasing complexity: screening assessment (SA); vulnerability assessment (VA); and planning assessment (PA). Table 1 shows the requirements for each and the factors to be considered (adapted from Klein and Nicholls, 1998; Nicholls, 1998).

Table 1. Three levels of assessment for coastal zones.

Level of assessment	Requirements			
	Time (months)	Level of Detail	Prior Knowledge	Other Scenarios Considered (in addition to sea-level rise)
Screening Assessment	≤ 3	Low	Low (no previous SA or VA)	None
Vulnerability Assessment	6-12	Medium	Medium (previous SA or VA)	Likely socio-economic changes and other climate change (if possible)
Planning Assessment	Ongoing	High	High	All realistic changes

2. As a first step, a screening assessment should be undertaken using existing data and the judgement of local experts with two objectives: (1) to highlight and then prioritise possible impacts of a one-meter rise in sea level; and (2) to identify gaps in the existing information and data. These results will provide sufficient information for a subsequent, more comprehensive vulnerability assessment.

Screening Assessment

3. The following pages provide an outline of the data and analysis that are necessary to undertake a preliminary screening assessment of the impacts of sea-level rise. This guidance does not claim to be comprehensive, but lists key steps which should be accomplished. It can usefully be divided into four steps A to D.

Step A. Collection of Existing Coastal Data

4. The existing data are often scattered, and compiling all the information described below can require a considerable effort. Further, some of these data will not be available. However, once assembled, a coastal database provides a basis for more informed decisions and helps to identify critical data gaps (Table 2). In addition, this step will assist in the implementation of CPACC's Component 3: *Coastal Inventories of Resources and Uses*, in your country.

This report was prepared by Claudio Volonte, CPACC Technical Coordinator, and Robert Nicholls, CPACC Consultant.

(a) Maps showing what activities are located on the coast, within 6 m, 3 m, and 1 m elevation above mean sea level, such as (a) cities, (b) ports, (c) resort areas and tourist beaches, (d) industrial areas, and (e) agricultural areas.

(b) The best topographic maps, ideally with at least a 3-m contour interval.

(c) Survey maps.

(d) Aerial photographs.

(e) Tide information.

(f) Long-term data on relative sea-level rise, if available.

(g) Evidence of subsidence, if any, including rates and methods used.

(h) Other historical data:
   1) The magnitude of and damage caused by flooding from maps, photographs (aerial or other), and other sources.
   2) Accurate coastal maps from different years to examine coastal changes, such as beach erosion.
   3) Photographs from different years to show coastal changes such as beach erosion or variability.

(i) Population density and other demographic data.

Step B. Assessment of the Possible Impacts of a One-Meter Sea-Level Rise

5. Four impacts of sea-level rise are usually considered in the scientific literature. Their relative importance will vary from site to site, depending on a range of factors.

(a) Increased storm flooding.
   1) Describe what is located in flood-prone areas.
   2) Describe historical floods, including (i) location, magnitude and damage, (ii) the response of the local people, and (iii) the response of government. How have policies towards flooding evolved?

(b) Beach/bluff erosion:
   1) Describe what is located within 300 m of the coast.
   2) Describe beach types.
   3) Describe the various livelihoods of the people living in coastal areas, such as commercial fishers, international-based coastal tourism, or subsistence activities.
   4) Describe any existing problems of beach erosion, including quantitative data. These areas will experience more rapid erosion if sea-level rise is accelerated.
   5) For important beach areas, conduct a Bruun rule analysis (Nicholls, 1998) to assess the potential for shoreline recession given a one-meter rise in sea level. What existing coastal infrastructure might be affected by such recession?

(c) Wetland and mangrove inundation and loss:
   1) Describe the wetland areas, including human activities and resources that depend on the wetlands. For instance, are mangroves being cut and used, or do fisheries depend on wetlands?
   2) Have wetlands or mangroves being reclaimed for other uses, and is this likely to continue?

3) Are these wetlands viewed as a valuable resource for coastal fisheries and hunting or merely thought of as wastelands?

(d) Salt water intrusion:
   1) Is there any existing problem with water supply for drinking purposes?
   2) Does it seem likely that surface and/or subsurface water will be seriously affected by salinization?

6. At this point it is useful to present the information that has been gathered in a matrix format, as shown in Annex 1. Since this is a first, reconnaissance-level assessment, the matrix should be completed at the national level without going into much detail at the local scale. Detailed information, if it exists, can be discussed in the text of a report. Annex 1 presents two actual cases, one for Barbados and the other one for Guyana. Technical staff from both governments following these guidelines prepared both of these cases.

Step C. Implications of Future Development

7. Finally, you should describe how future developments might affect vulnerability to sea-level rise. In many parts of the Caribbean, significant coastal development is expected in the next few decades. Issues to consider include: (1) new (and existing) river dams and their impact on downstream deltas; (2) new coastal settlements; (3) expansion of coastal tourism; and (4) the possibility of transmigration.

Step D. Possible Responses to the Problems Caused by Sea-Level Rise

8. Once the impacts of sea-level rise are identified and their magnitude assessed, what are realistic responses to these problems? Three generic responses - (planned) retreat, accommodate, and protect have been defined (IPCC, 1990) and might usefully be considered in the analysis.

(a) Conduct an informal survey of how other people in positions of influence in the country would respond to the problems of sea-level rise.
(b) Explain property ownership laws in your country. Can the government tell people that they must move back as the water begins to threaten them? Will or can people stay where they are and just build the houses higher for safety and risk reduction?
(c) Describe the history of coastal protection in the country and what this might indicate about future responses to sea-level rise: (a) beach fill; (b) bulkheads; (c) seawalls; (d) groins; and (e) drainage of storm water/sewage runoff.

Table 2. Simplified Geomorphology and Land Use Classification System

I. Coastal Geomorphology
- A. Beaches
  1. Barrier Beach
  2. Strandplain or Headland Beach
  3. Pocket Beach
- B. Wetlands
  1. Estuary
     a. mangrove
     b. marsh (grass)
     c. marsh (scrub shrub)
     d. marsh (forested)
  2. Delta

        a. mangrove
        b. marsh (grass)
        c. marsh (scrub shrub)
        d. marsh (forested)
    3. Backbarrier Areas
        a. mangrove
        b. marsh (grass)
        c. marsh (scrub shrub)
        d. marsh (forested)
    4. Tidal Flats
C. Cliffs (no beach)
    1. Erodible
    2. Rocky
D. Muddy Coast
E. Hardened (Protected) Shoreline

II. Protection (if present)

A. Seawall
B. Bulkhead
C. Breakwater
D. Groins
E. Jetty
F. Protected Harbour
G. Beach Nourishment

III. Land Use

A. Urban/City
B. Residential
C. Industrial
D. Tourist
E. Agricultural (crops - note type if known)
F. Cattle grazing
G. Sheep grazing
H. Orchards
J. Forest
K. Barren
L. Shrub lands
M. Desert
N. Fishing
O. Aquaculture

IV. Inland Geomorphology

A. Flatland
B. Hilly land
C. Mountainous land
D. Lake
E. Wetlands

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Annex 1

Barbados

Screening assessment matrix for impacts of sea-level rise (draft prepared by Yuri Chakalall (Coastal Planner, Coastal Zone Management Unit), Antonio Rowe (Coastal Engineer, Coastal Zone Management Unit) and Rawleston Moore (Environmental Officer, Ministry of Energy, Environment and Natural Resources).

Biophysical Impacts of Sea Level Rise	Socio-Economic Impacts							
	Tourism	Human settlements	Agriculture	Water Supply	Fisheries	Financial Services	Human Health	Others
Inundation	1	1	3	3	2	2	1	N/A
Erosion	1	1	3	2	2	2	2	N/A
Flooding	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Salinization	No Info	No Info	No Info	No Info	No Info	No Info	No Info	No Info
Others?								

1 = Major Impact; 2 = Significant Impact; 3 = Minor Impact

Guyana

Screening assessment matrix for impacts of sea-level rise (draft prepared by Ravita Diaram, Environmental Officer, Environmental Protection Agency, with contributions from: Deborah Ann Montouth, Technical Assistant, Ministry of Housing and Water, Rajendra Rampersaud, Manager, Guyana Water Resources, Pauline Franklin Arjoon, Occupational Health and Safety Officer, GS&WC, Dawn Mason, Fisheries Officer, Fisheries Department, Ram Naresh-Durbeej, Superintendent, Lands and Surveys Division, Taig Kalicharran, Superintendent of Surveys, Transport and Harbors Dept., and Daudi Husbands, GIS Analyst, Natural Resources Management Project).

Biophysical Impacts to sea-level rise	Socio-economic sectors				
	Agriculture	Human Settlements	Tourism	Water Resources	Fisheries
Inundation	Major impact. Inundation will devastate agriculture, a dominant economic activity on the coast.	Major impact. 90 % of housing and population is concentrated in this region, and hence will be severely affected by permanent and more frequent inundation events.	Major impact. Loss of national landmarks, administration buildings, transportation and communication lines. Inundation will also result in losses of beaches.	Medium impact. Inundation will lead to infiltration of saline water into pipelines and contamination of aquifers. This is an important source of drinking water and water for agriculture.	Inundation will cause destruction of landing sites and cooperative buildings. Nursery areas located in mangrove swamps will be damaged and fishing grounds will be shifted.
Salinization	Major impact, since most plants would be unable to survive under such unfavorable soil conditions.	Medium impact. Materials used for building houses will rot at an accelerated rate	Medium impact. Impact on coastal ecosystems.	Major impact. Salinization is likely to occur further upstream of rivers.	Medium impact. Salinization is likely to affect freshwater aquaculture
Erosion	Major impact.	Medium impact. Foundation upon which houses are built can become weak due to rise in water levels.	Impact on coastal ecosystems Beach loss.	Minor impact since pipelines are covered about 1m below ground level.	Minor impact.