



# MANAGING CLIMATE CHANGE HAZARDS IN COASTAL AREAS

THE COASTAL HAZARD WHEEL  
DECISION-SUPPORT SYSTEM



**CTCN**

CLIMATE TECHNOLOGY CENTRE & NETWORK



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# MODULE 1 – The Project & The Consortium

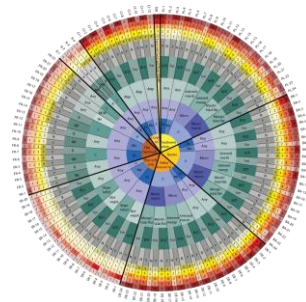
# The context of West Africa and Cameroon



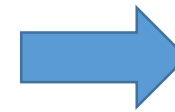
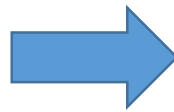
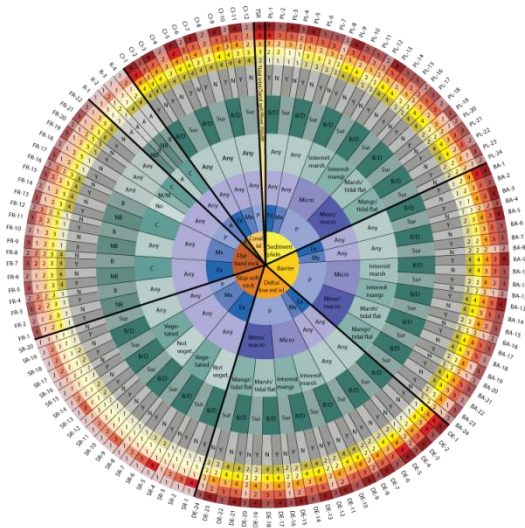
- Increased urbanization of coastal areas
- Climatic uncertainties
- Amplification of the intensity and frequency of coastal risks
- Insufficient data, technical, technological, institutional and financial capacities
- Diversity of evaluation approaches and methodologies



**NEED FOR HARMONIZATION TO SUPPORT DECISION MAKING  
COASTAL HAZARD WHEEL**



## Assessment of Coastal Hazards and Climate Change Adaptation Technologies for the Coastal Region of West Africa and Cameroon Using the Coastal Hazard Wheel (CHW)





## MAIN OBJECTIVE

To develop a standardized methodology based on a common language at the regional level, to collect, manage, share, compare and analyze data on an ongoing basis to support decision-making processes related to sustainable risk assessment and management and building the resilience capacity of the coastal regions of West Africa and Cameroon.

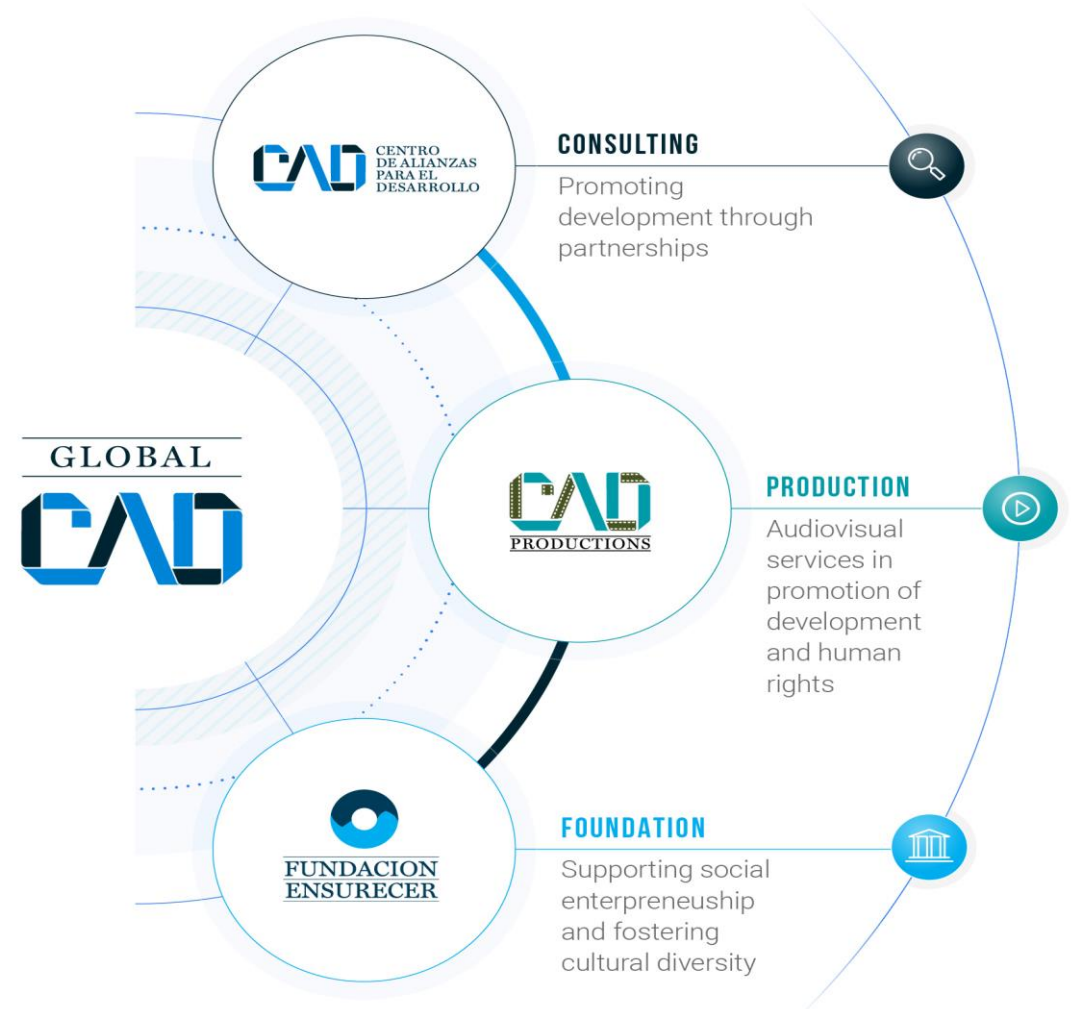
## Specific objectives

- 1) Develop planning and communication documents
- 2) Update the national and MOLOA/ WACOM coordination unit's databases with CHW (including Cameroon's).
- 3) Identify and promote specific adaptation options and technologies most appropriate for coastal risks.

# GlobalCAD – Leader member



The Centre of Partnerships for Development (CAD) is a consultancy company with headquarters in Barcelona, Spain and offices in Berlin, and Mexico, working in different areas linked to human and sustainable development. Through the years, CAD has formed a global network of experts covering a broad range of thematic issues that share the conviction that cross-sector partnerships are key to address today's main development challenges.



# The Consortium members



**WATER, ENVIRONMENT AND BUSINESS FOR DEVELOPMENT (WE&B)** is a consulting company focused on the Water and Environment sectors, offering services in Social and Business Innovation. WE&B has extensive experience and an international team of highly qualified professionals to strive for positive social and economic impact on the lives of those dealing with environmental challenges.



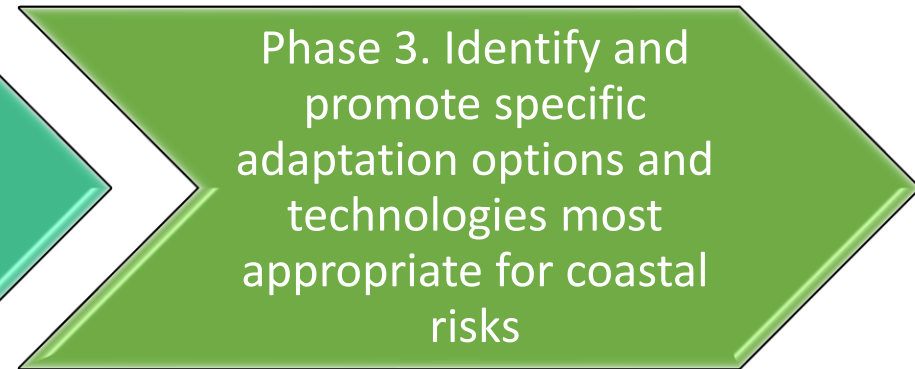
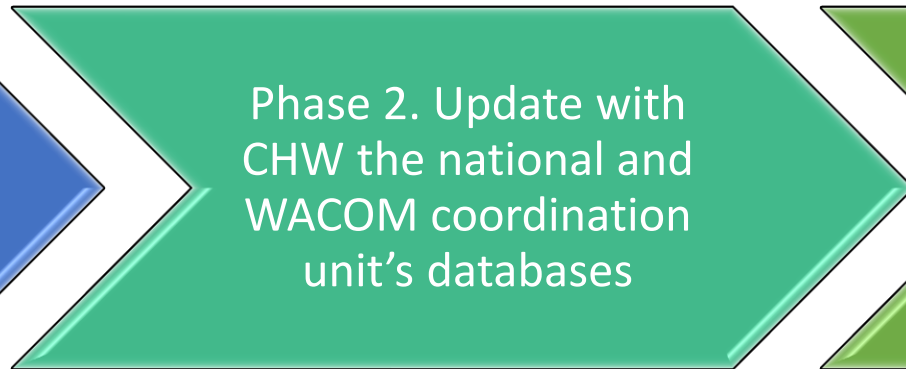
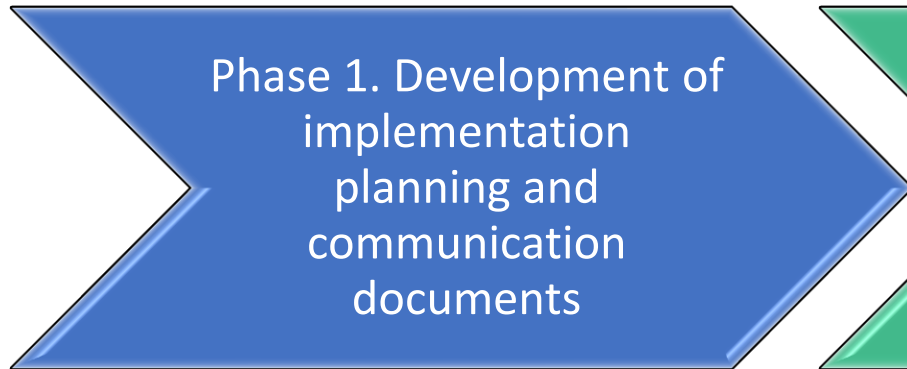
**Meteosim** is a technological consulting company that provides solutions to sectors and industries whose activities are weather, climate and oceanic sensitive, through highly reliable numerical weather forecasts and climate projections.



**The West African Science Service Centre on Climate Change and Adapted Land Use (WASCAL)** is an inter-governmental organization dealing with training, capacity strengthening and research to devise tools and services that will help reduce risks from natural disasters (e.g., droughts, floods) and strengthen the resilience of socio-ecological landscapes across West Africa.



# Project Methodological Phases





## PHASES



## DELIVERABLES

01

**Development of implementation planning and communication documents**

- 1.1 Work plan
- 1.2 Monitoring and evaluation plan (intern)
- 1.3 CTCN impact description (intern)
- 1.4 Closure and data collection report

02

**Update with CHW the national and WACOM coordination unit's databases**

- 2.1 Report of the comprehensive evaluation and analysis of available national and regional data and their integration into the CHW system
- 2.2 Evaluation study on the management of gender issues
- 2.3 Collection and inventory work of available data, pre-processing and preliminary analysis
- 2.4. Report of the training of at least 11 experts
- 2.5. Report on the training of at least 135 experts from the national offices and the regional coordination unit of WACOM and Cameroon
- 2.6. Comments from the technical antenna of validation of the application to the local conditions
- 2.7. Report on the updating of the databases of the nine (09) national databases and WACOM's regional coordination unit
- 2.8. Detailed classification and mapping of coastal hazards of the West African coastline and Cameroon's

03

**Identify and promote specific adaptation options and technologies most appropriate for coastal risks**

- 3.1 Report of the Regional Workshop
- 3.2. At least 05 to 10 adaptation technology options are identified, assessed and considered appropriate for the management of specific risks and recommended for their implementation
- 3.3. A report presenting a series of recommendations on indicators and the process to be followed to continue to use the tool and update the data on a regular basis
- 4. Report of the final regional sharing and capitalization workshop



# MODULE 2 – The Coastal Hazard Wheel – An Introduction



# COASTAL HAZARD WHEEL

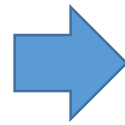
## 1. INTRODUCTION

# General Background: increasing population density in coastal areas



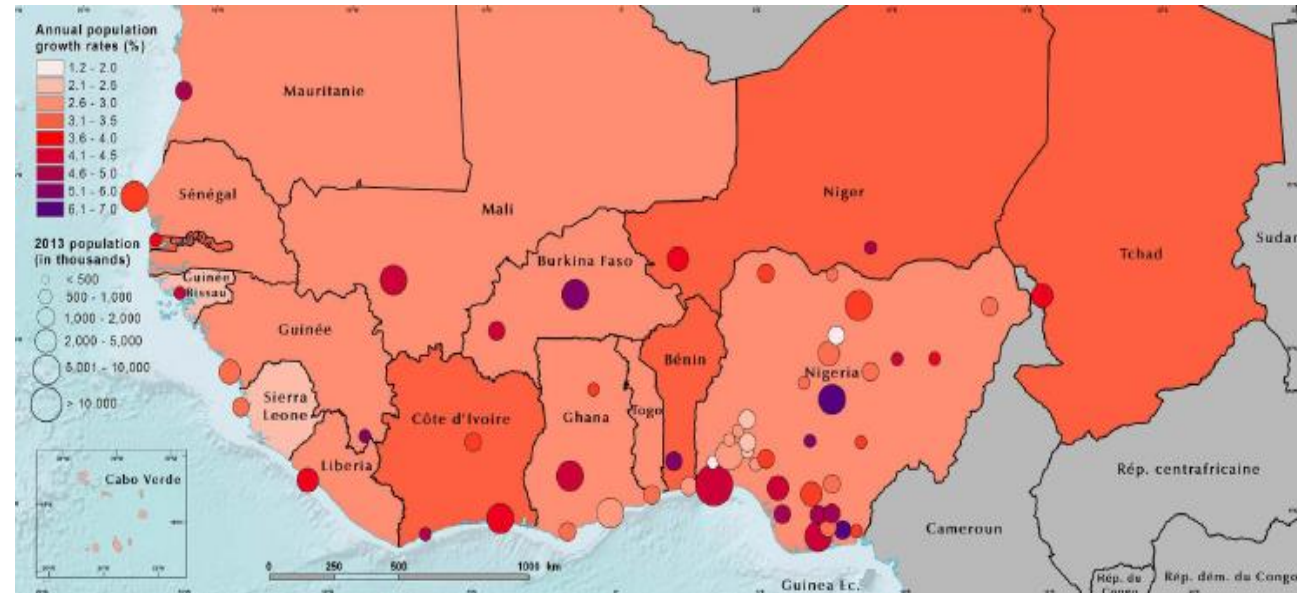
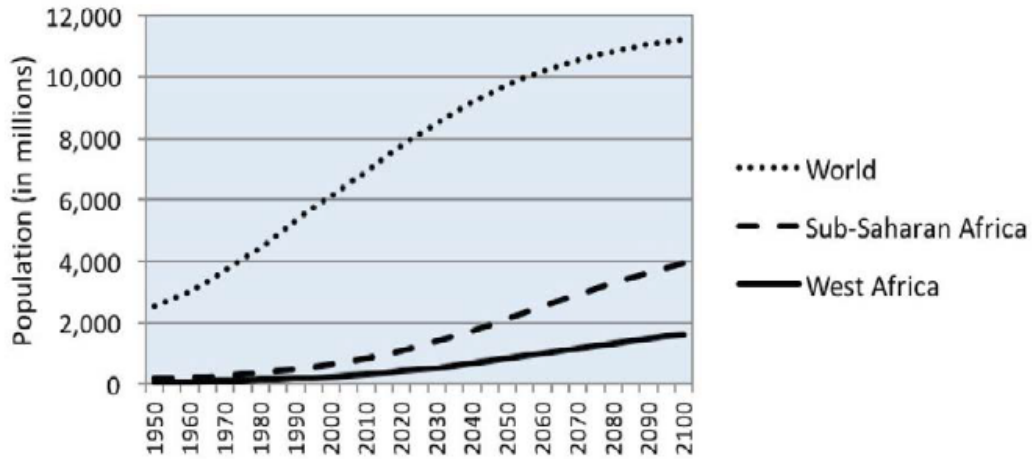
## Coastal population growth:

From 1.2 billion



1.8 – 5.2 billion by the 2080s

Projected population growth from 1950 to 2100



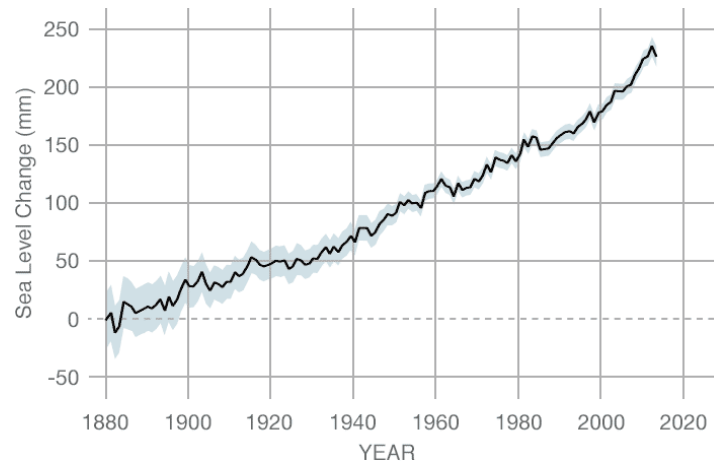
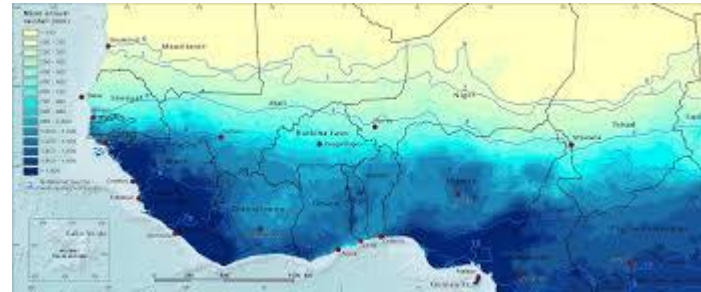
# General Background: climate change as an extra risk factor



## Impact of climate change on the coastal environment



- Ecosystem disruption
- Gradual inundation
- Salt water intrusion
- Erosion
- Flooding



# What is the Coastal Hazard Wheel?



In order to address those challenges, the CHW is an information and decision-support system allowing:

- Multi-hazard-assessments
- Identification of relevant management options for a specific coastline
- Standardized coastal language to communicate coastal information.

# Benefits of the CHW methodology



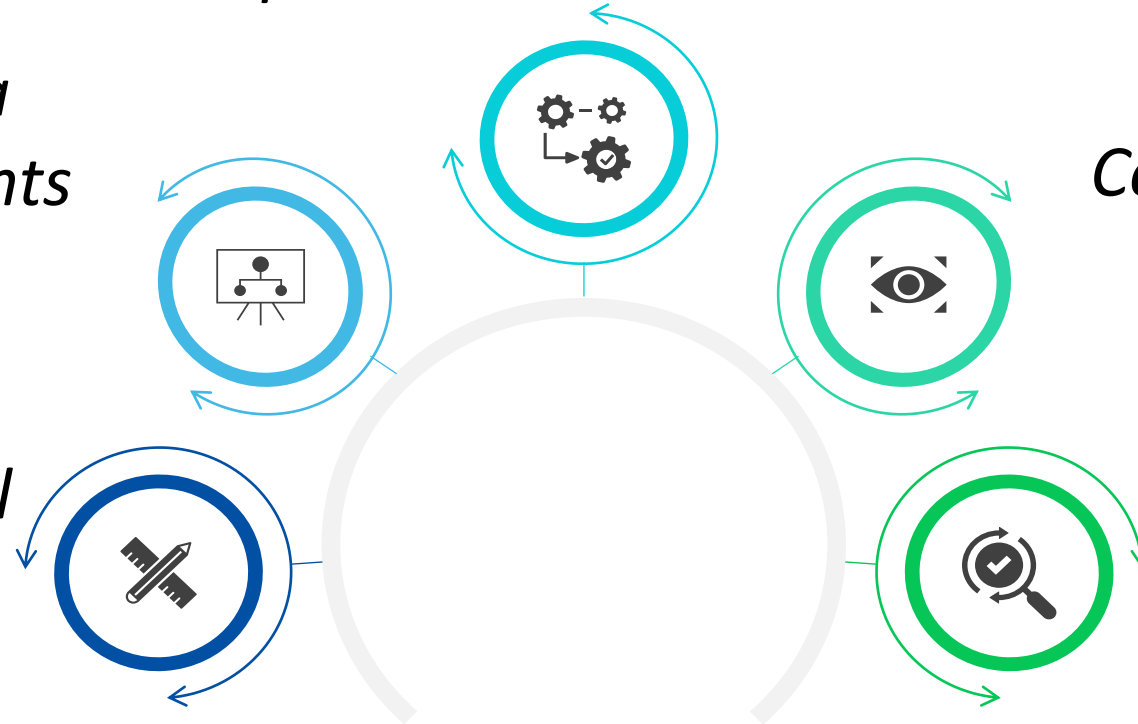
## Open Access Framework

*Low data requirements*

*Coastal decision-making*

*Universal coastal classification system*

*Suitable for developing countries*



## Coastal Hazard Wheel





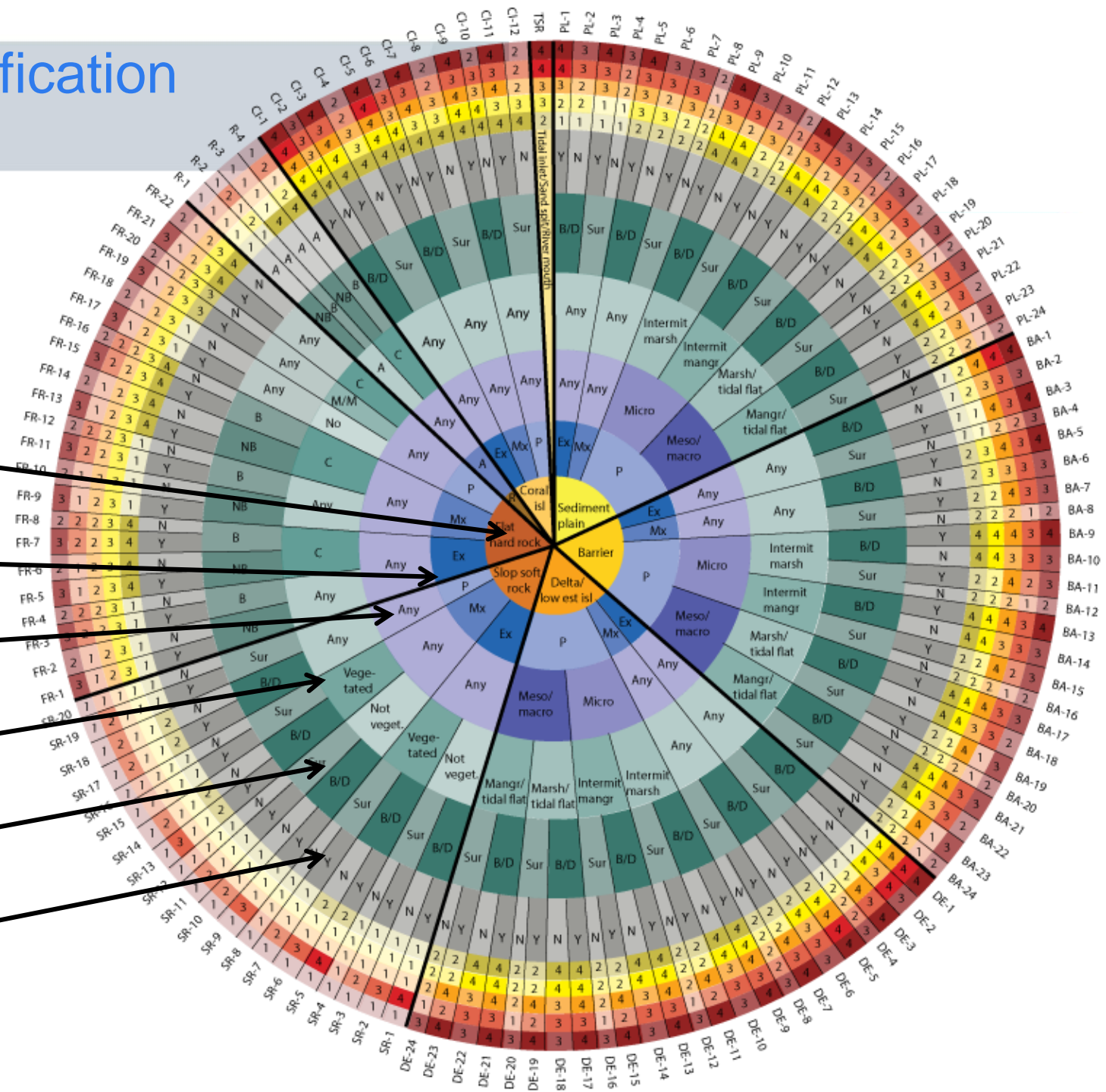
# COASTAL HAZARD WHEEL

## 2. UNIVERSAL COASTAL CLASSIFICATION SYSTEM

# The Universal Coastal Classification System

6 Key bio-geophysical parameters:

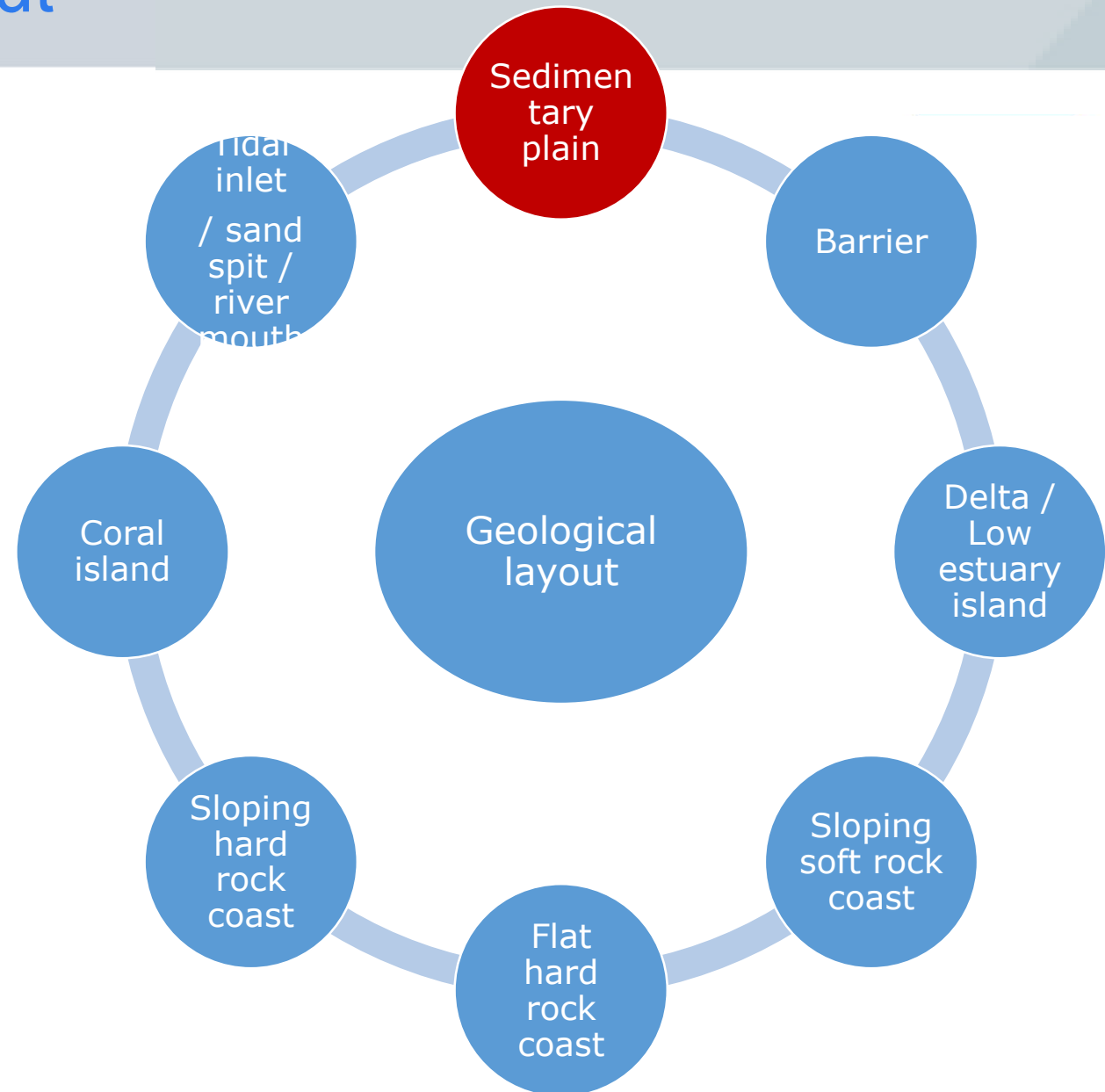
- 1) Geological layout
- 2) Wave exposure
- 3) Tidal range
- 4) Flora and fauna
- 5) Sediment balance
- 6) Storm climate



# Parameter 1: Geological Layout

## **SEDIMENTARY PLAIN**

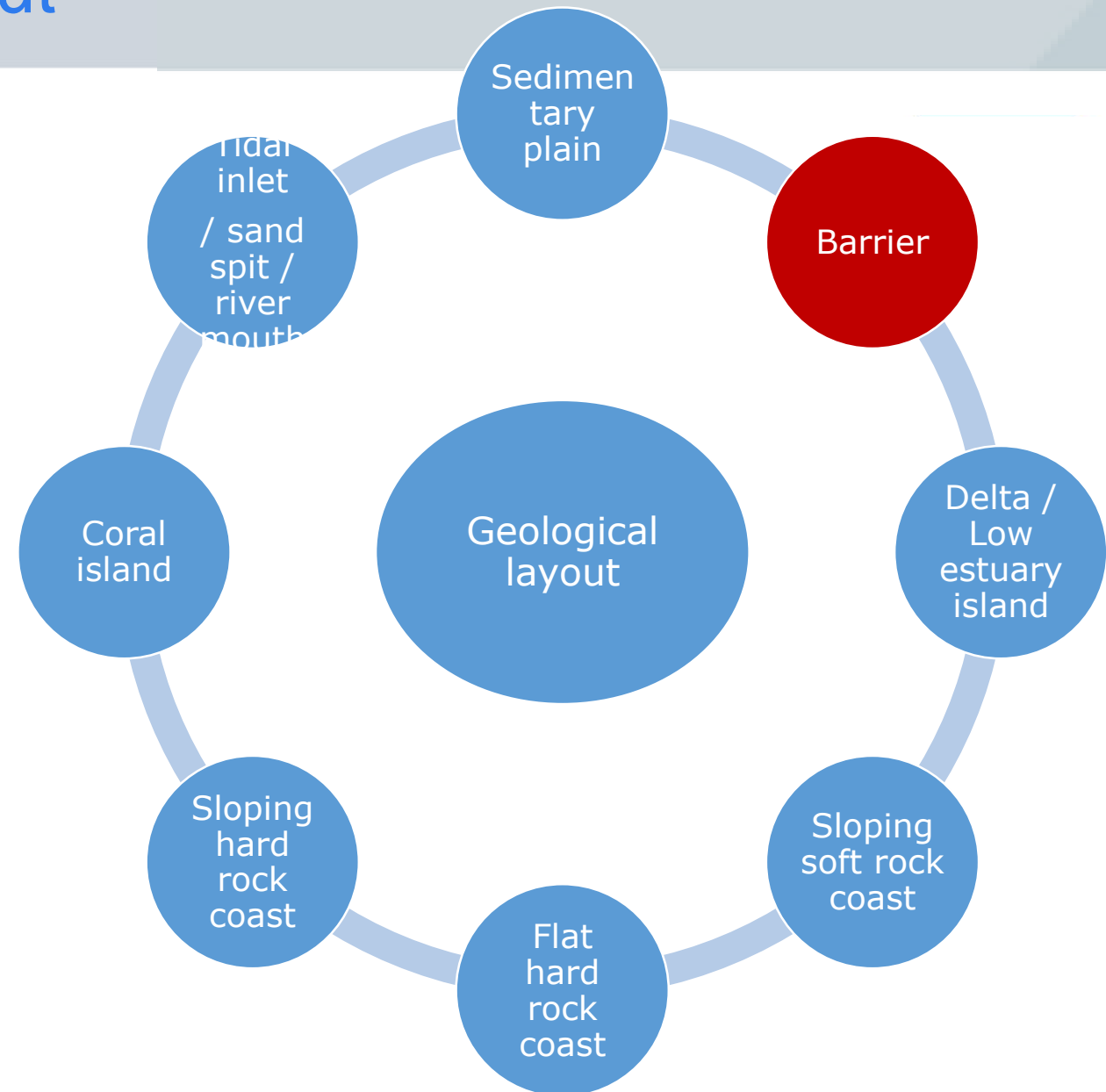
- $H < 6-8m$ , 500m inland
- Composition: clay, silt, sand, till, larger cobbles
- Formation: glacial or fluvial processes



# Parameter 1: Geological Layout

## **BARRIER**

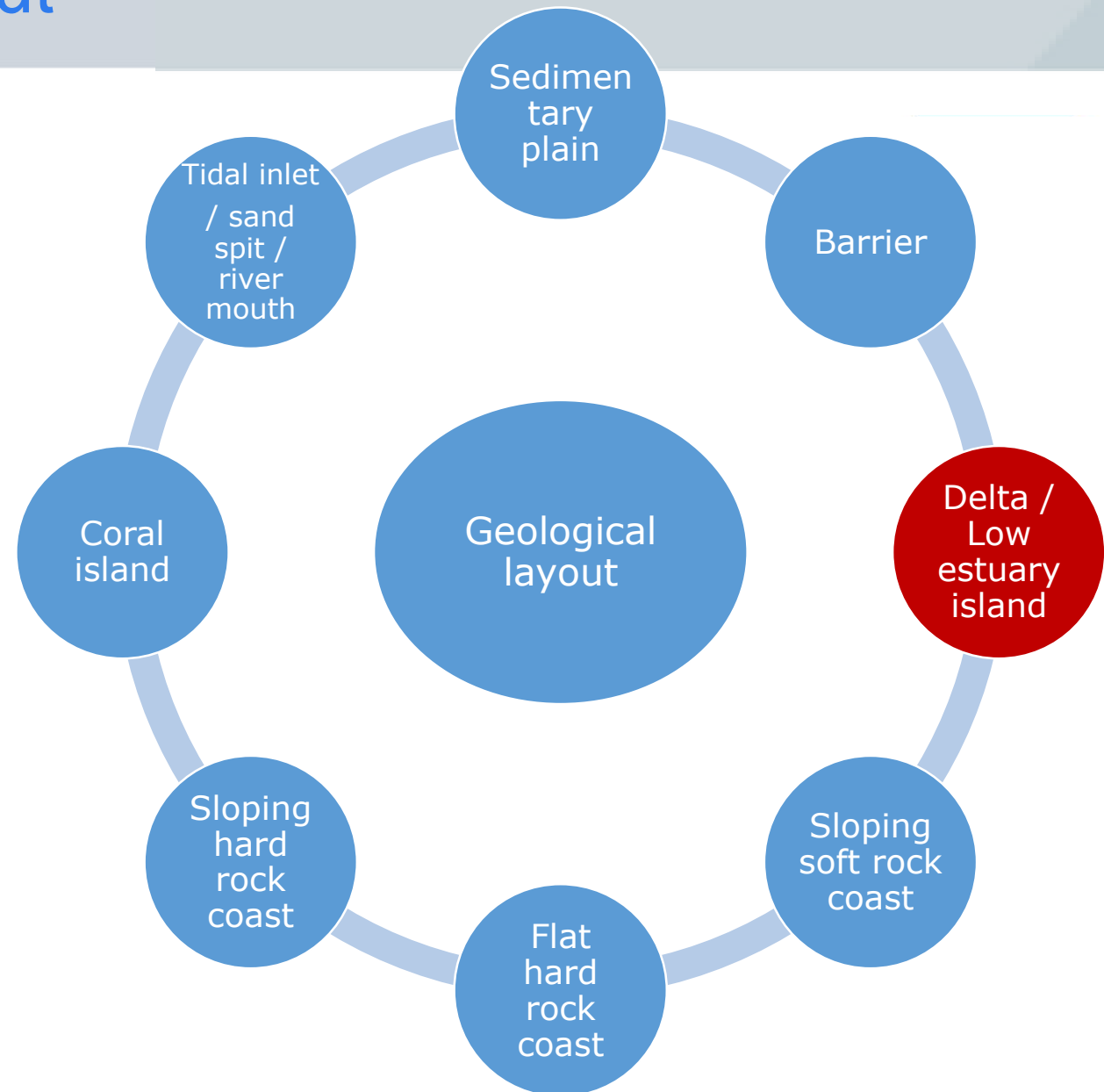
- Shore parallel sedimentary bodies
- Width: 100m – several km
- Length: 100m to >100km



# Parameter 1: Geological Layout

## **DELTA/LOW ESTUARY ISLAND**

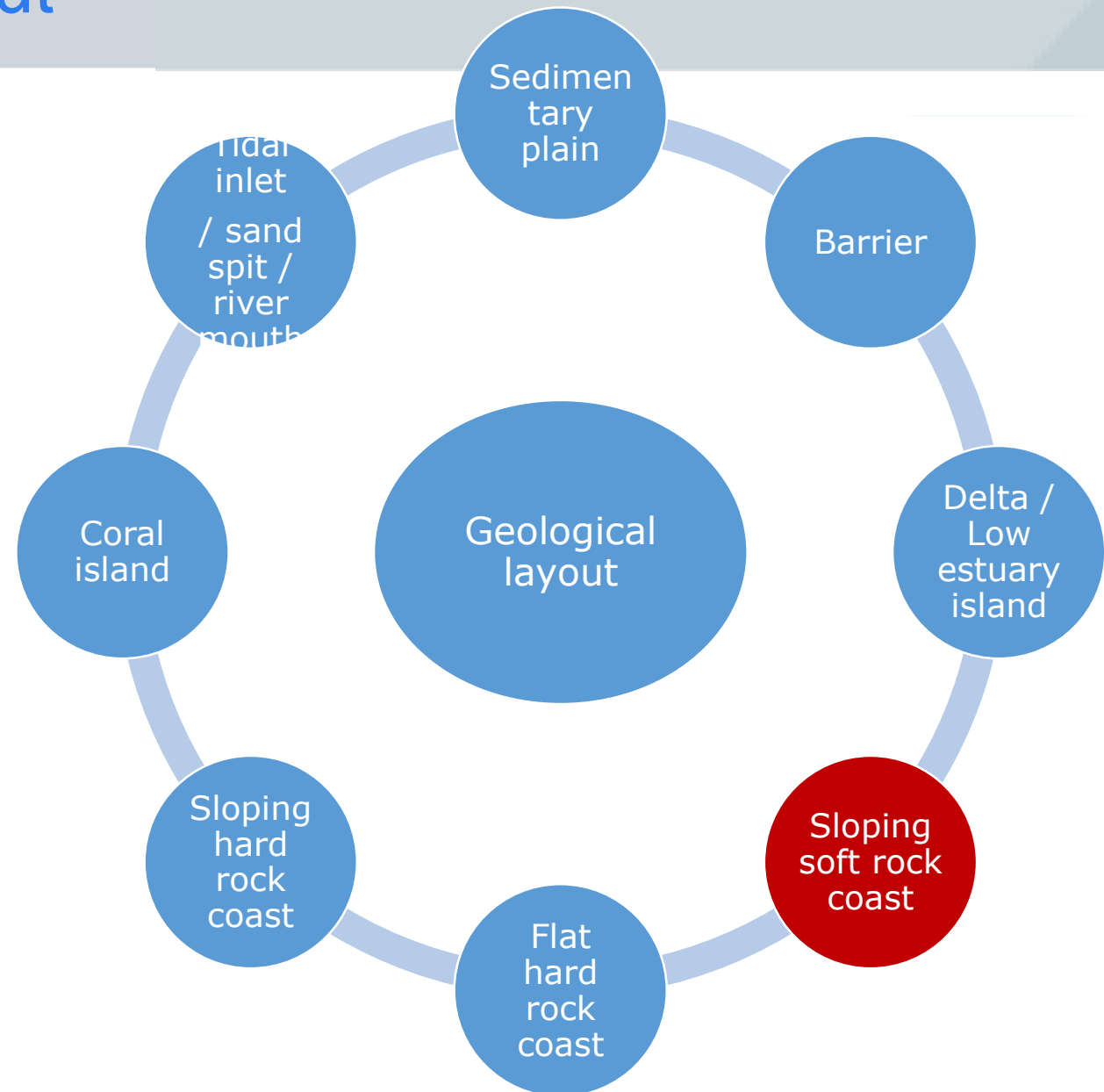
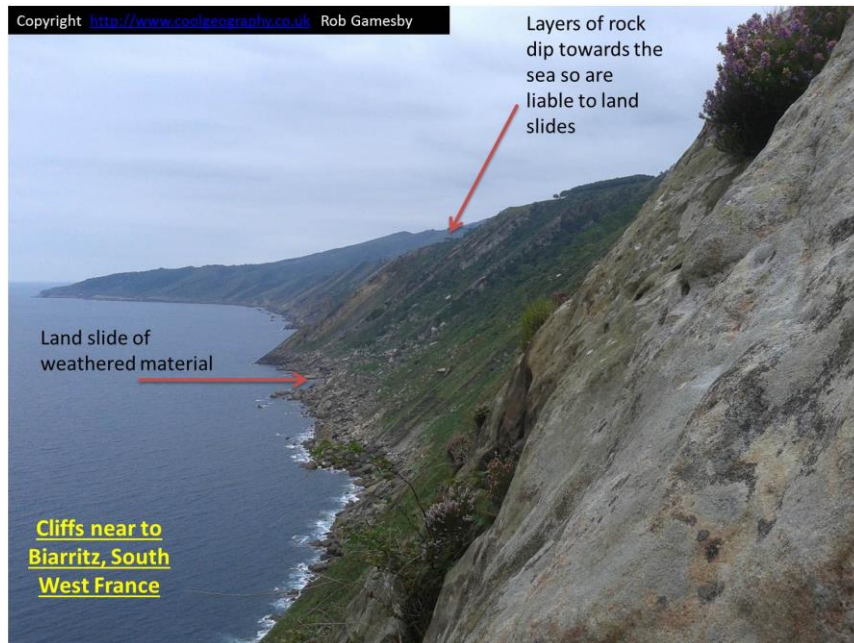
- Fluvial transported sediment deposited in front of a river mouth
- Depends fluvial sediment discharge and coastal waves and currents



# Parameter 1: Geological Layout

## SLOPING SOFT ROCK COAST

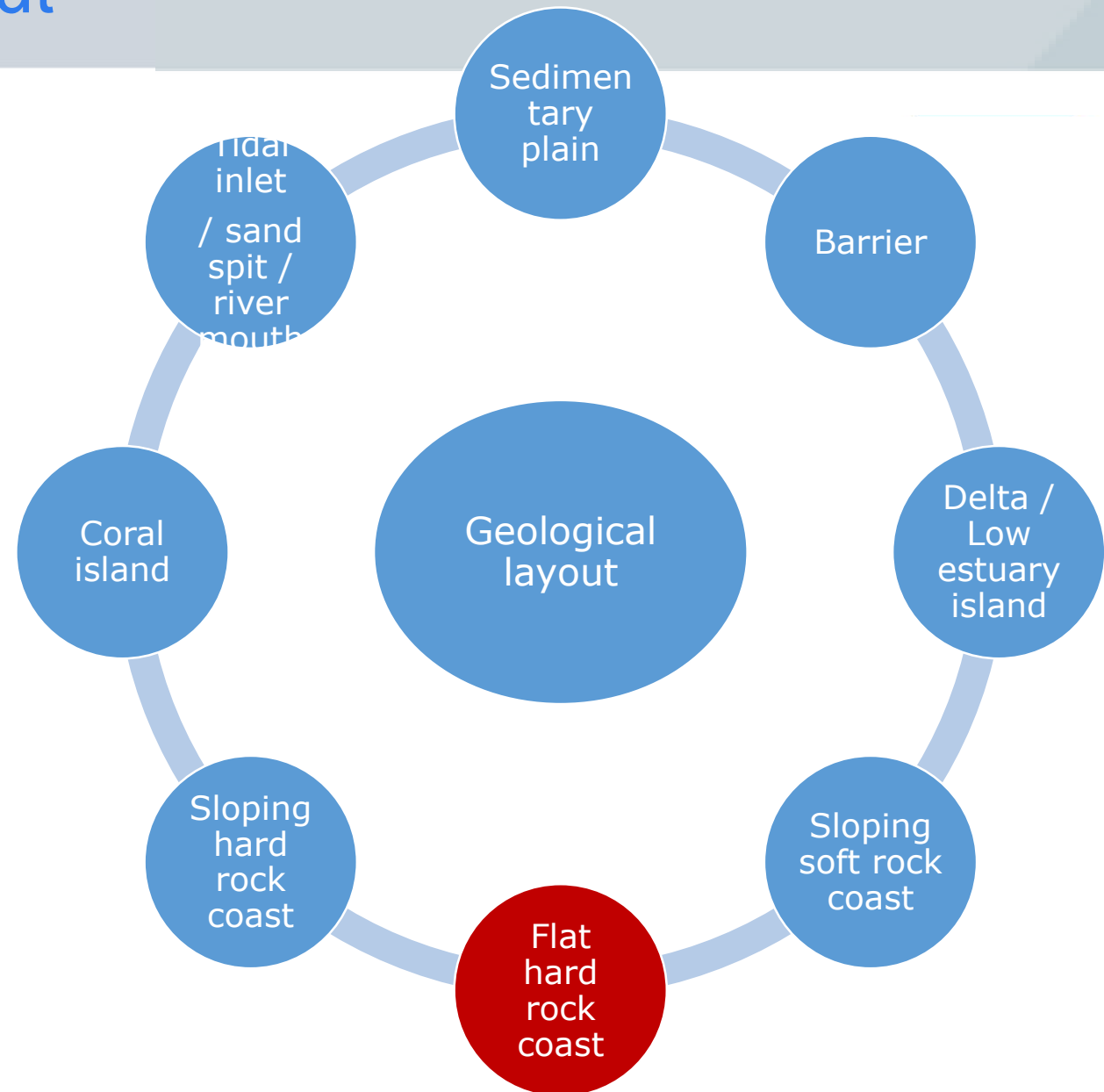
- H > 6-8m, 500m inland
- Composition: chalk, moderately cemented laterite, clay, silt, sand, till, larger cobbles
- Analysis of sediment cementation (push a knife)



# Parameter 1: Geological Layout

## FLAT HARD ROCK COAST

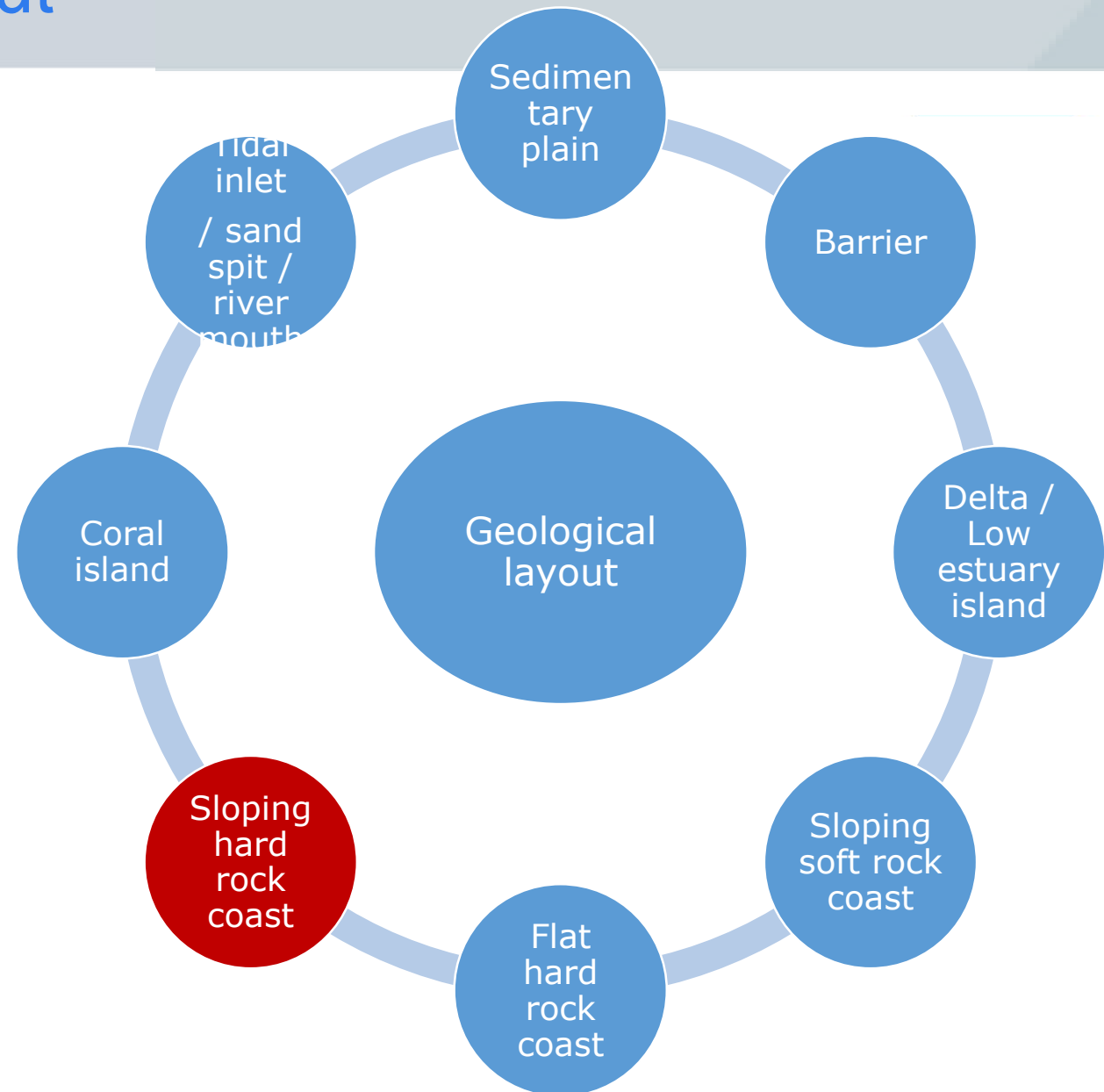
- $H < 6-8\text{m}$ , 500m inland
- Composition: igneous, sedimentary, metamorphic rock



# Parameter 1: Geological Layout

## **SLOPING HARD ROCK COAST**

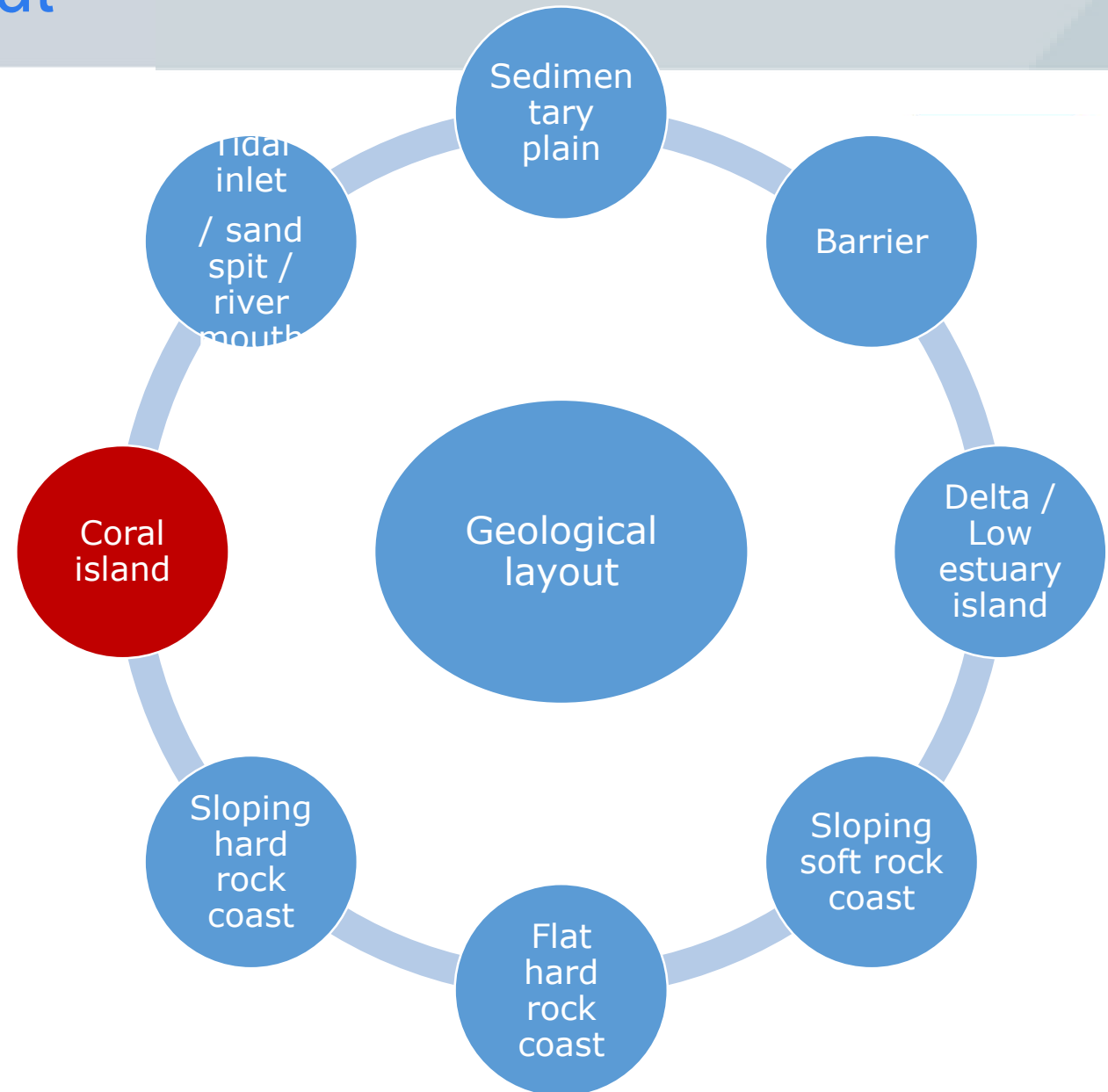
- $H > 6-8m$ , 500m inland
- Composition: igneous, sedimentary, metamorphic rock
- Coastal mountain chains, islands



# Parameter 1: Geological Layout

## **CORAL ISLAND**

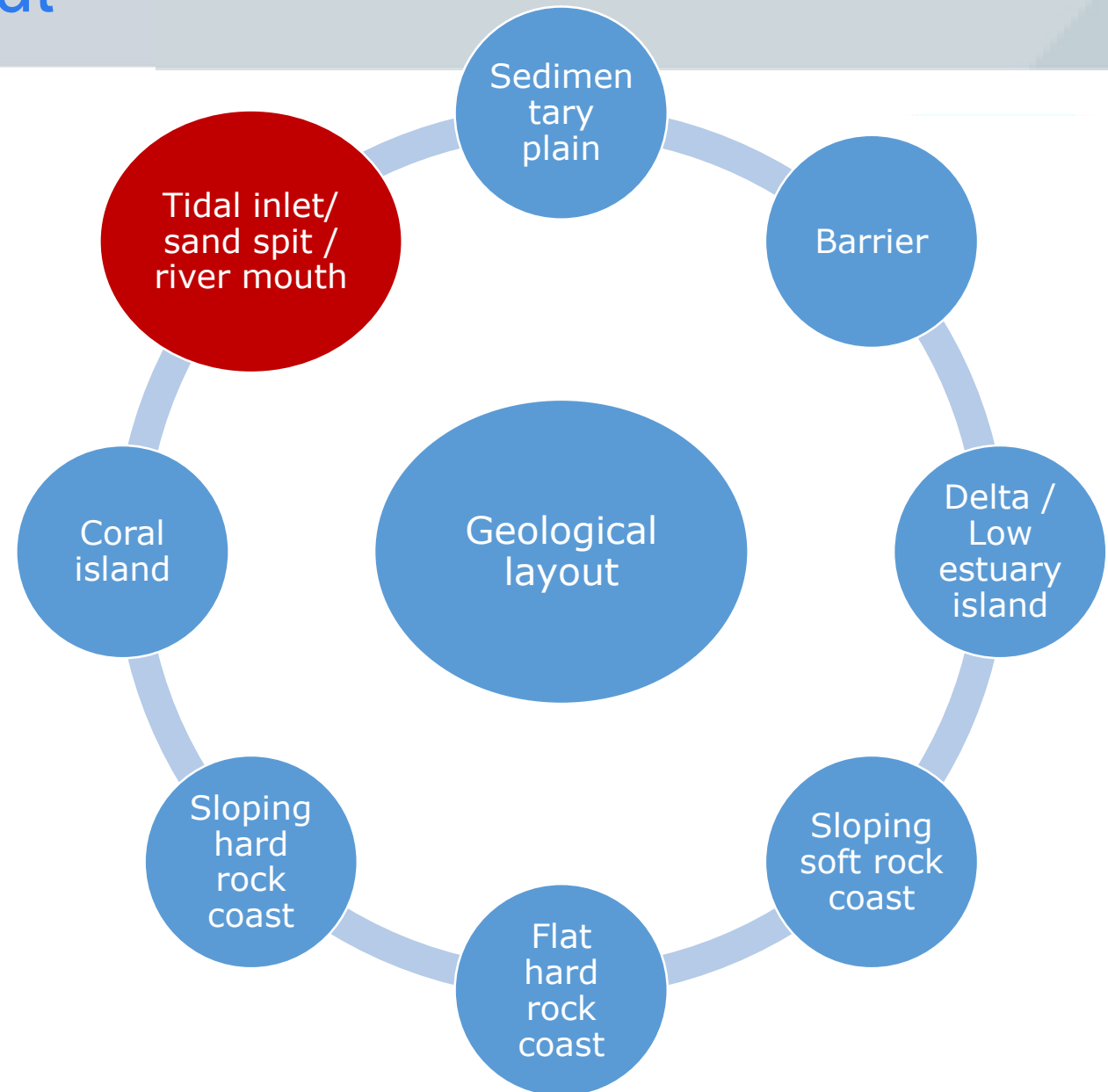
- Low lying coral islands
- Tropical atolls, coral cays



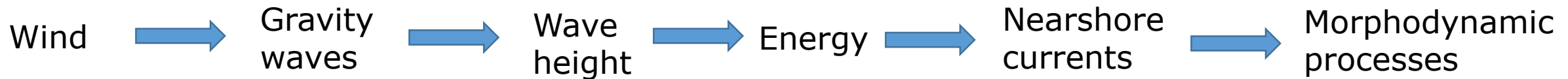
# Parameter 1: Geological Layout

## TIDAL INLET/SAND SPIT/RIVER MOUTH

- Highly morphologically active environments
- Include sides (1km)



# Parameter 2: Wave exposure



**Wave data available**



Hs 12h/yr

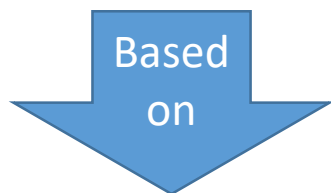
- Hs 12h/yr > 3m → Exposed
- Hs 12h/yr = 1-3m → Moderately exposed
- Hs 12h/yr < 1m → Protected

# Parameter 2: Wave exposure



## Wave data not available

CHW classification



- General wave climate
- Waterbody size
- Specific coastal conditions

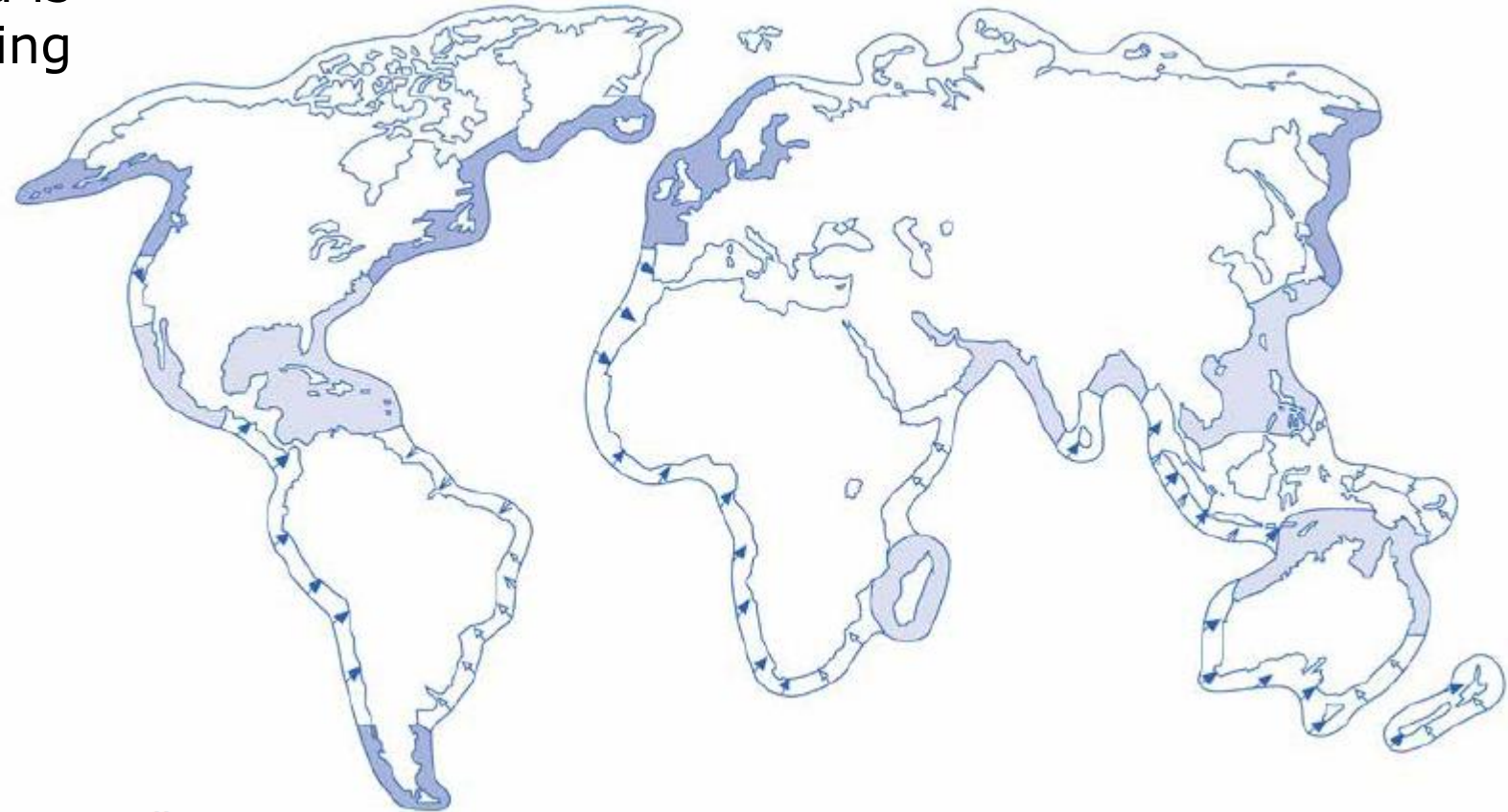
General wave climate	Waterbody size (fetch length)	Specific coastal conditions	CHW classification
Swell wave climate (West coast swell, east coast swell, trade/monsoon influences)	Any	Extreme swell (west coast swell south of 30°S)	Exposed
		Swell	Moderately exposed
		Backbarrier, inner Waters, inner estuary, fjord	Protected
Non-swell wave climate (storm wave, tropical cyclone influences, sheltered área)	> 100 km	Stronger on-shore winds	Exposed
		Weak on-shore winds	Moderately exposed
	10 – 100 km	Stronger on-shore winds	Moderately exposed
		Weak on-shore winds	Protected
< 10 km	Any	Protected	

# Parameter 2: Wave exposure



General wave climate of an area is determined based on the following classification of the coastlines:

- West coast swell,
- East coast swell
- Trade/monsoon influences
- swell wave climates
- non-swell wave climates.



## Wave environments

- |                             |                          |
|-----------------------------|--------------------------|
| Storm wave                  | West coast swell         |
| Tropical cyclone influences | East coast swell         |
| Sheltered area              | Trade/monsoon influences |

# Parameter 3: Tidal Range



CHW classification:

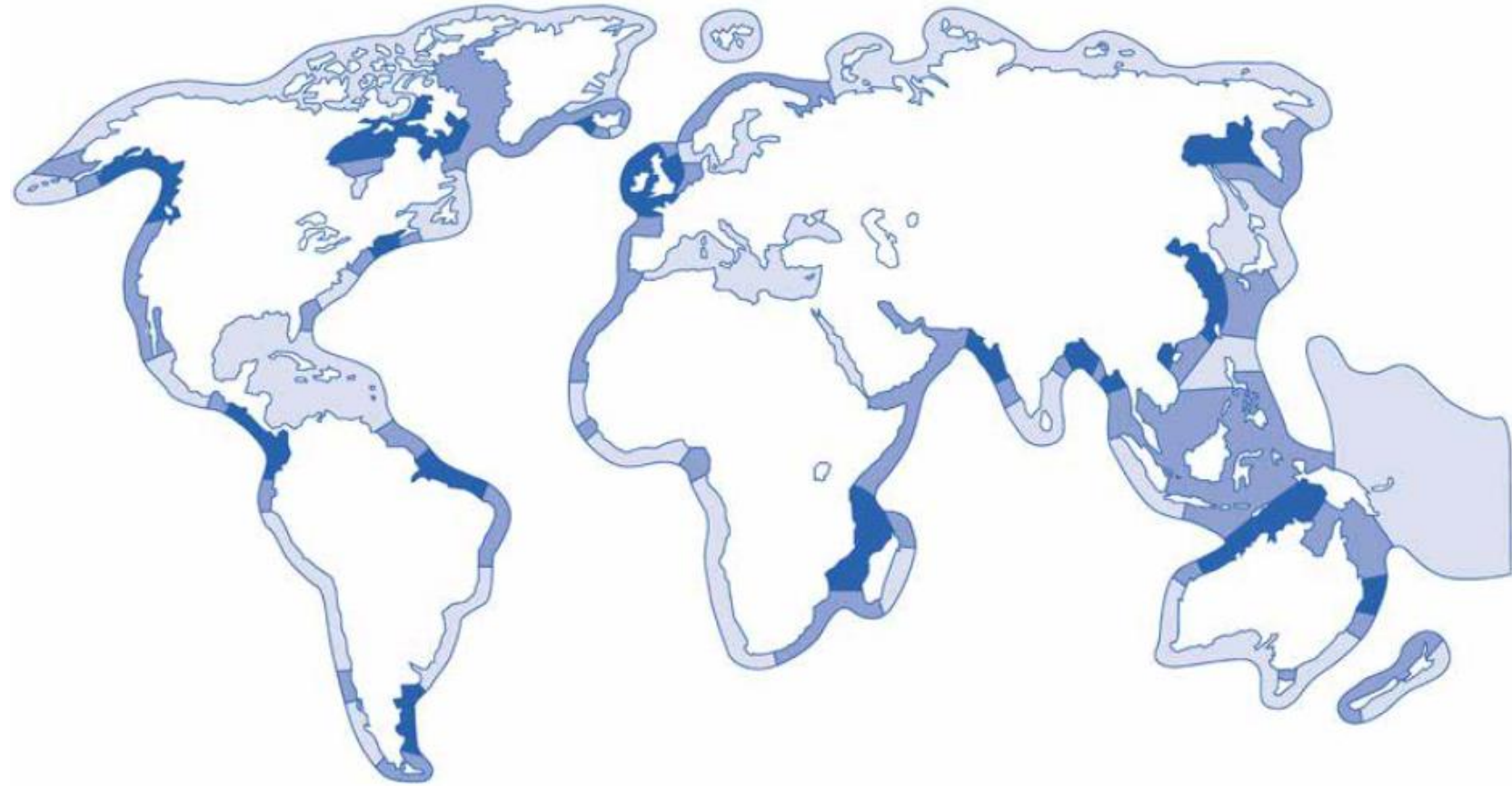
- Microtidal: TR < 2m
- Meso/Macrotidal: TR > 2m

Only influences in:

- Geological Layout
  - Sediment plain
  - Barrier
  - Delta
- Wave exposure
  - Protected



Otherwise this factor does not influence on coast classification



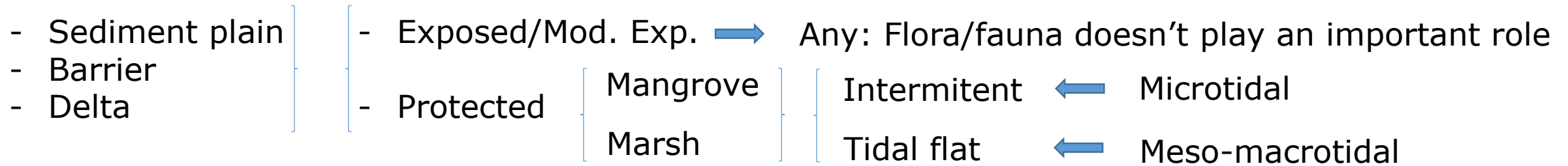
Tide range environments

- < 2 m (micro)
- 2-4 m (meso)
- > 4 m (macro)

# Parameter 4: Flora and fauna



## Depends on geological layout:



**Mangrove**



**Marsh**



# Parameter 4: Flora and fauna



## Depends on geological layout:

- Sloping soft rock
  - Exposed/Mod. Exp.
    - > 25% Surface → Vegetated
    - < 25% Surface → Non vegetated
  - Protected → Any: Flora/fauna doesn't play an important role

- Sloping hard rock
  - Flat hard rock
- Any: Flora/fauna doesn't play an important role
  - Coral

- Particular case → Protected flat hard rock
- Coral
  - Marsh/Mangrove: band of marsh/mangrove vegetation
  - Non vegetated

- Coral islands → Any: Flora/fauna doesn't play an important role

# Parameter 5: Sediment balance

## Depends on geological layout:

- Sediment plain
- Barrier
- Delta/Low estuary
- Sloping soft rock
- Coral island

Balance/Deficit  
Surplus

- Flat hard rock
- Sloping hard rock

Beach  
No beach



# Parameter 6: Storm climate



## Tropical cyclones



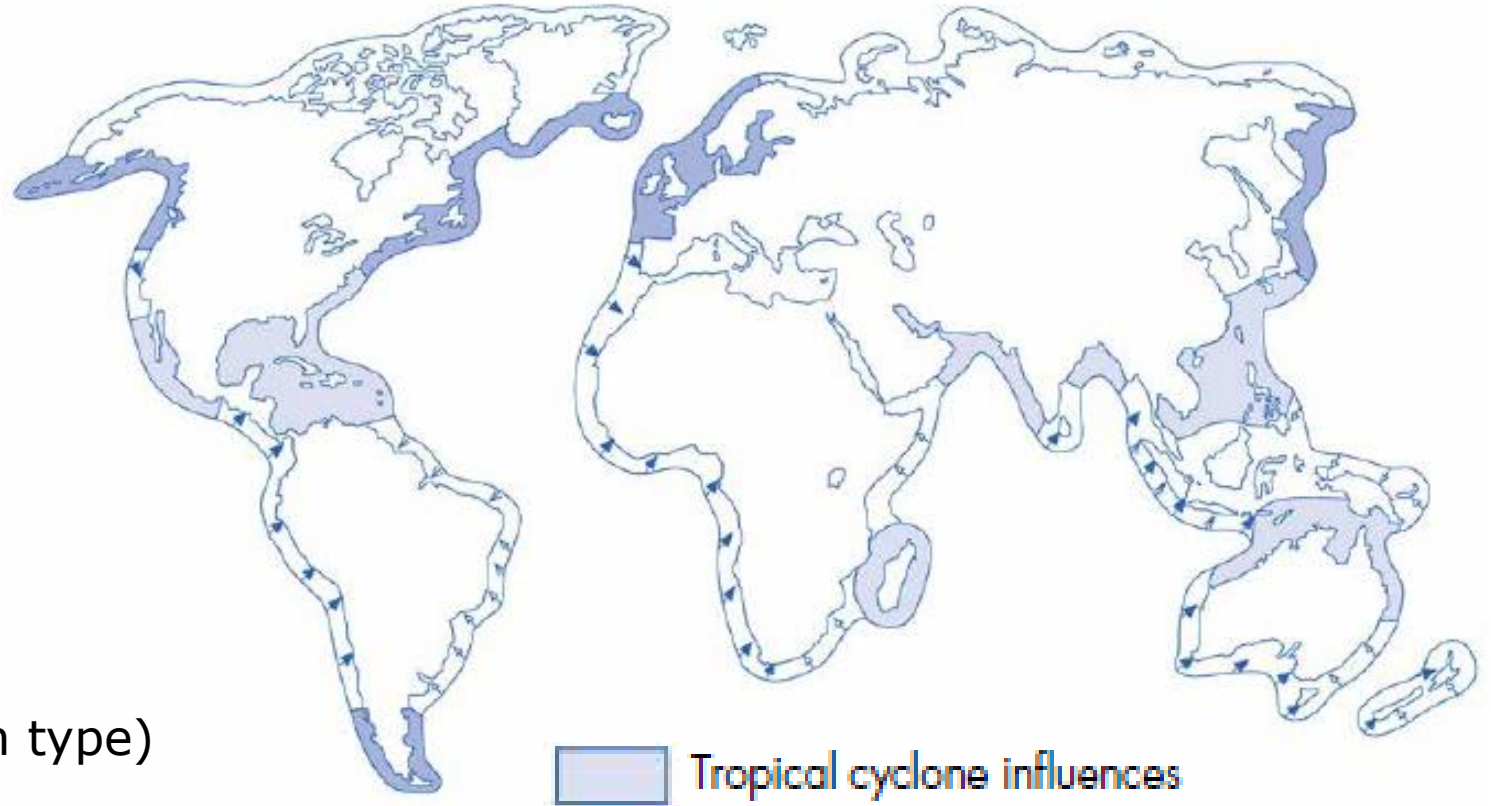
- Wind
- Waves
- Precipitation



Affect coast morphology

Classification

Yes  
No (for each type)





# COASTAL HAZARD WHEEL

## 3. THE HAZARD VALUATION COMPONENT

# The Universal Coastal Classification System

## Risk hazard levels

	Low	Moderate	High	Very high
Ecosystem disruption	1	2	3	4
Gradual inundation	1	2	3	4
Salt water intrusion	1	2	3	4
Erosion	1	2	3	4
Flooding	1	2	3	4

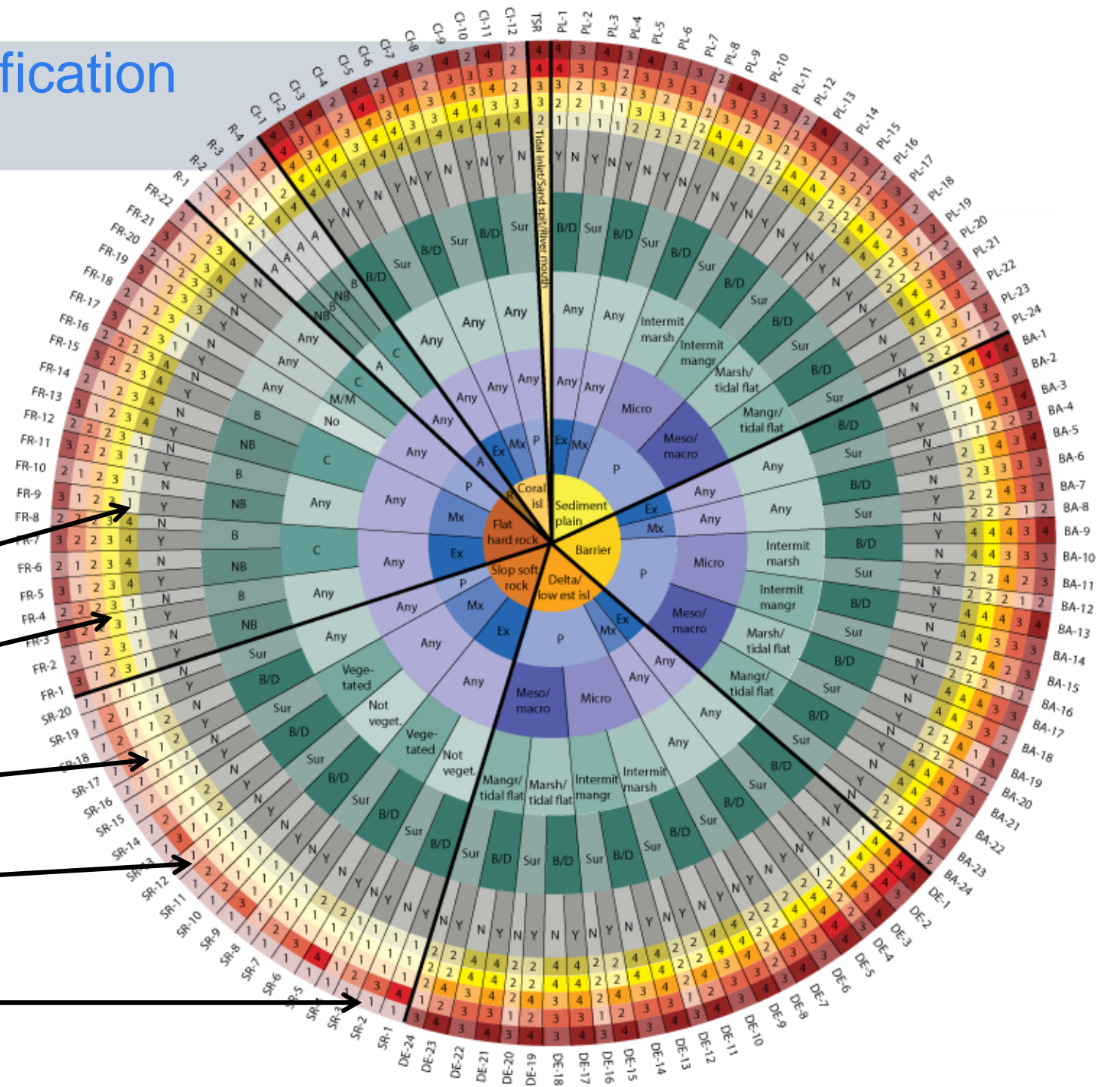
1) Ecosystem disruption

2) Gradual inundation

3) Salt water intrusion

4) Erosion

5) Flooding





# COASTAL HAZARD WHEEL

## 4. APPLICATION FOR LOCAL, REGIONAL, AND NATIONAL MULTI-HAZARD ASSESSMENTS

# Application for multi-hazard assessments



- Can be applied for local, regional and national multi-hazard-assessments
- Can be applied for spot-assessments
- Depending on the data availability and accuracy requirements, coastal multi hazard-assessments can be implemented at any of the following classification/assessment steps:

Step	Data availability & accuracy requirements	Implementation based on	Used for
1	Low	Remote sensing and publicly available data.	Larger sub-regional, regional and national screenings, - initial picture of the hazard presence in a cost-efficient manner
2	Moderate	Additional field verification though remote sensing and public data sources.	Larger sub-regional, regional and national screenings,
3	High	Requires field verification combined with high quality datasets for key classification parameters.	used for coastlines where more comprehensive information is needed



- The manual assessment procedure can be carried out when the preparatory data collection and analysis has been completed. This includes having **created the necessary supporting line features in Google Earth** for **properly evaluating the coastal slope and sediment balance**.
- The assessment is carried out using the CHW and is done through a range of continuous assessments along the coastline with an approximate distance between each **assessment of 200-300 meters**.
- Coastal classification and multi-hazard-assessment to be carried out in ArcGIS, using Esri's ArcGIS Desktop ver. 10.3 (QGIS for open version)



The procedure for carrying out the coastal classification and multi-hazard-assessment in ArcGIS contains the following components:

- 1) Prepare a folder, a file geodatabase and feature classes
- 2) Digitize the coastline
- 3) Split the coastline into segments and assign CHW values
- 4) Symbolize categories
- 5) Save categories as layer files
- 6) Summarize segment lengths by categories

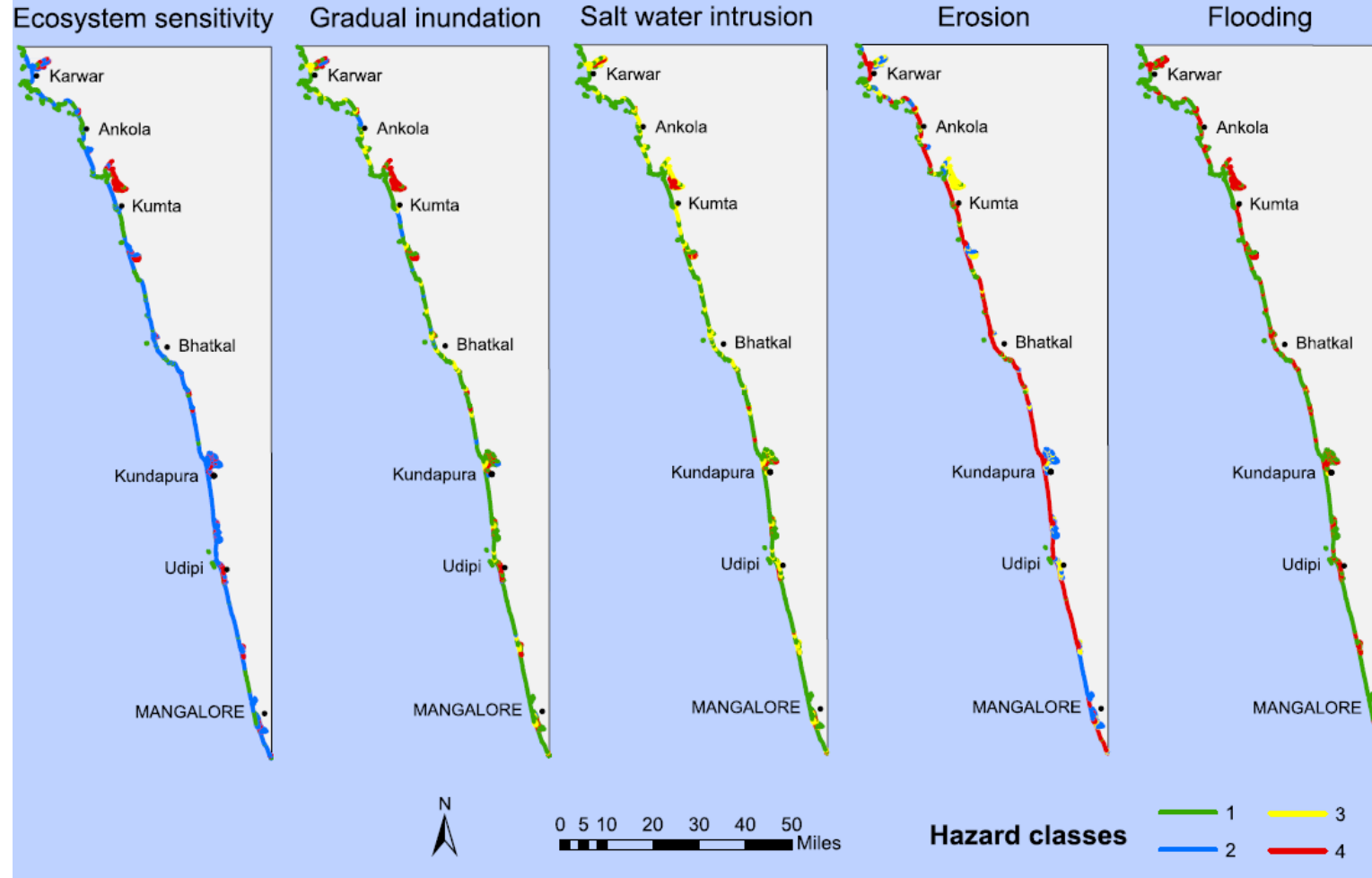


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METEO  
SIM

GLOBAL  
CAD

## Coastal hazard maps for Karnataka



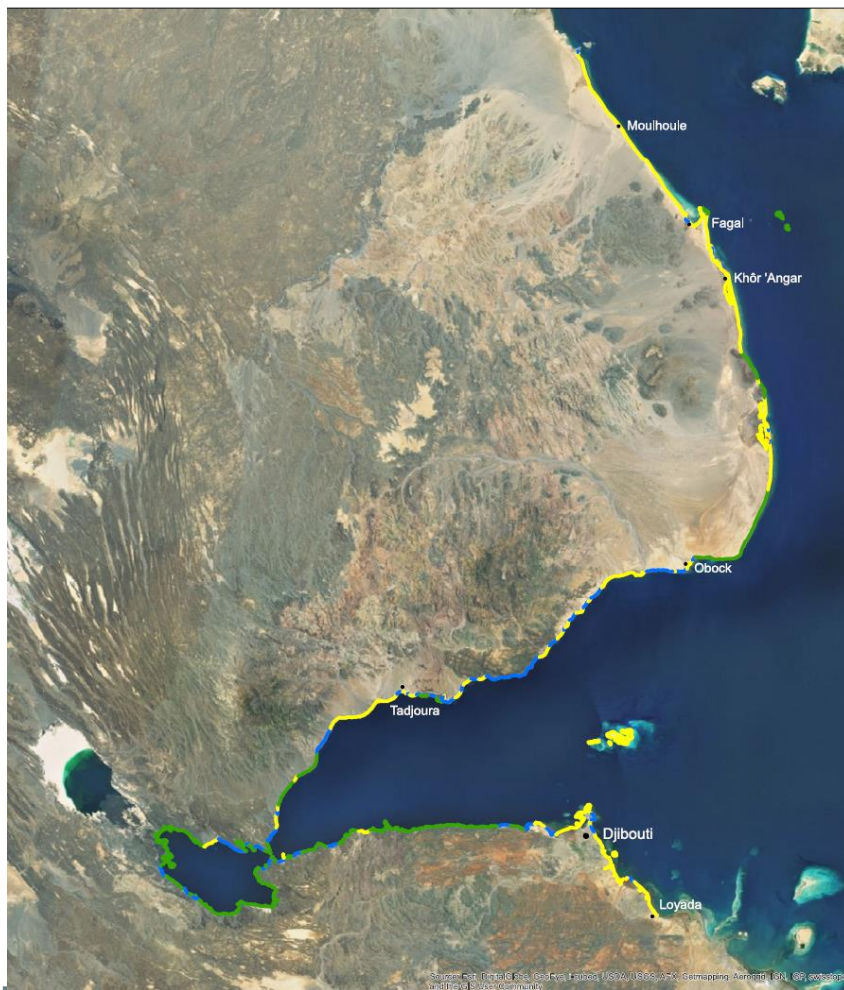
# Application examples



METEO  
SIM

GLOBAL  
CAD

## Gradual Inundation Hazards, Djibouti



Hazard Classes:

- Low (green)
- Moderate (blue)
- High (yellow)
- Very high (red)

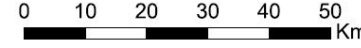


## Ecosystem Disruption Hazards, Djibouti



Hazard Classes:

- Low (green)
- Moderate (blue)
- High (yellow)
- Very high (red)





# COASTAL HAZARD WHEEL

## 5. APPLICATION FOR IDENTIFICATION OF HAZARDS MANAGEMENT OPTIONS



# Hazard management options

- Ecosystem Disruption
- Gradual Inundation
- Salt water Intrusion
- Erosion
- Flooding

	PL/BA/DE-1	PL/BA/DE-2	PL/BA/DE-3	PL/BA/DE-4	PL/BA/DE-5	PL/BA/DE-6	PL/BA/DE-7	PL/BA/DE-8	PL/BA/DE-9	PL/BA/DE-10	PL/BA/DE-11	PL/BA/DE-12	PL/BA/DE-13	PL/BA/DE-14	PL/BA/DE-15	PL/BA/DE-16	PL/BA/DE-17	PL/BA/DE-18	PL/BA/DE-19	PL/BA/DE-20	PL/BA/DE-21	PL/BA/DE-22	PL/BA/DE-23	PL/BA/DE-24		
Breakwaters																										
Groynes																										
Jetties																										
Revetments																										
Sea Walls																										
Dikes																										
Storm surge barriers & closure dams																										
Beach nourishment																										
Dune construction/stabilization																										
Cliff stabilization																										
Wetland restoration										X	X															
Flood warning systems																										
Flood proofing																										
Coastal zoning										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Groundwater management																										
Fluvial sediment management										X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Ecosystem disruption



# MODULE 3 – The Gender Dimension

## Objectives:

- Introduce the gender concept
- Clarify why gender matters in coastal risk management
- Gain an overview on main normative frameworks for gender equality
- Know approaches for integrating gender in coastal risk management



# The Gender Concept



- The term ‘Gender’ refers to the **socially determined roles and responsibilities of men and women and the relationship between them** in any given society.
- It is a concept that is widely misunderstood, often being seen as synonymous with ‘women’ and therefore of concern only to women.
- Gender relationships are dynamic and changeable, and differ from one society to another and even within the same community.

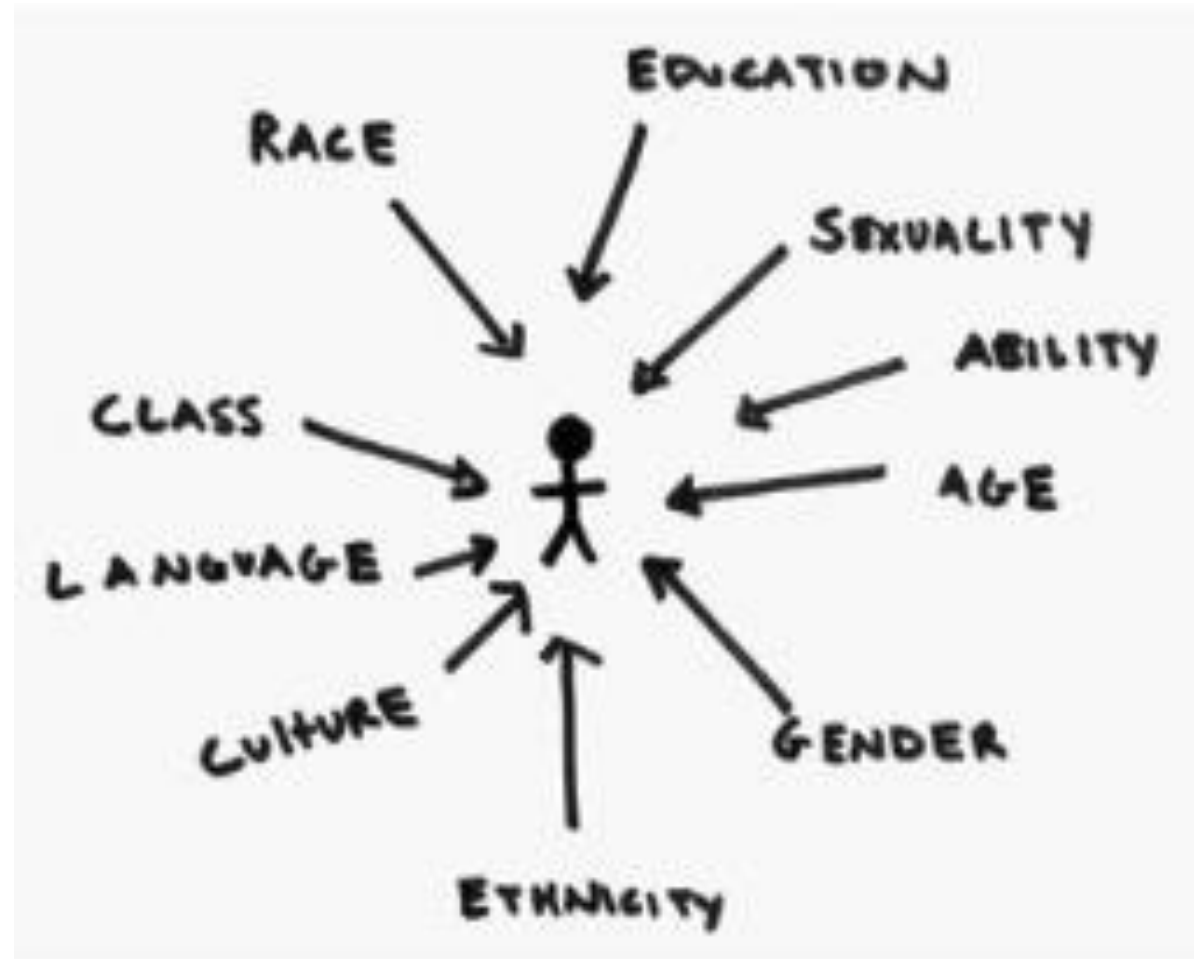


- Refers to the equal rights, responsibilities and opportunities of women and men and girls and boys.
- Equality does not mean that women and men will become the same but that women's and men's rights, responsibilities and opportunities will not depend on whether they are born male or female.

# Intersectionality



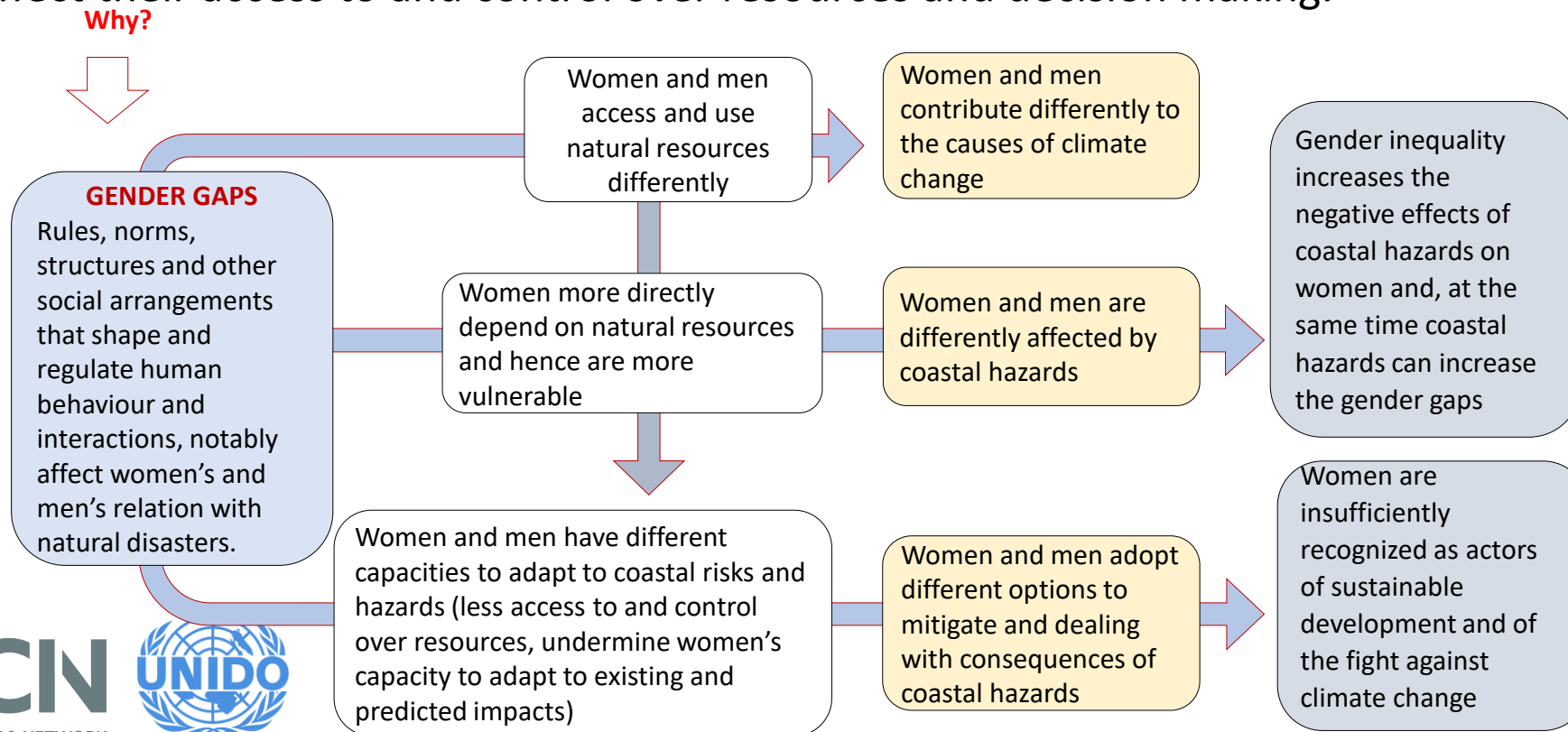
- Gender intersects with other forms of social difference (class, ethnicity, age, etc.) which highlight specific groups of people that experience disadvantage or privilege.



# Why Gender Matters in Coastal Risk Management



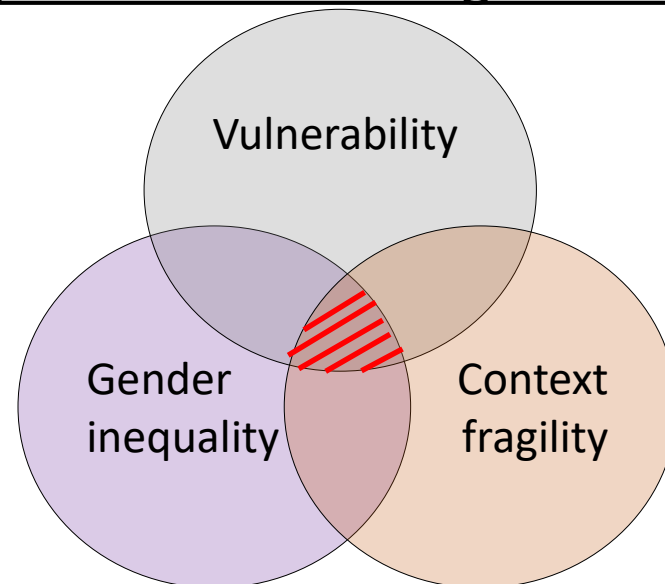
Coastal hazards result in natural environment changes that affect people's livelihood and well-being. In different contexts, coastal hazards impact people differently, but they affect more intensively most vulnerable populations. Women are often amongst the most vulnerable to the impacts of coastal hazards due to cultural and social rules, norms, structures and other social arrangements that shape and regulate their status in society, and that remarkably affect their access to and control over resources and decision making.



# Why Gender Matters in Coastal Risk Management



- The causes and impacts of disasters are not merely the result of ‘natural’ phenomena, but result from decisions made within a social, economic, and political context.
- Gender relations play a major role in structuring this context, and are therefore important to understand that risks and impacts of coastal hazards are different for women and men, that they have different needs, interests and priorities; and also different knowledge, experiences and perspectives dealing with risks and hazards and so both, women and men, must be encouraged in the search of solutions.



# Why Gender Matters in Coastal Risk Management



- Coastal risk management needs to be gender sensitive, incorporating gender perspectives and involving both, women and men as agents of change.
- A gender perspective helps to reveal the roles and contributions of women and shows the need for their full involvement, as well as the obstacles to their participation that must be addressed if equity is to be achieved.



# Engendering policies, programmes and projects



- Governments should incorporate gender perspectives into their national policies, action plans and other measures on sustainable development, climate change and disaster risk reduction, including coastal risk management.





WE & B



- It is a strategy for **making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring and evaluation of any planned action**, including legislation, policies or programs in all political, economic and societal spheres and at all levels, so that women and men benefit equally and inequality is not perpetrated to not harm or exclude women, and help to redress existing gender imbalances.
- The ultimate goal is to achieve gender equality by transforming the balance of power between women and men.
- Gender mainstreaming also implies women's empowerment and men's commitment with the changes that result from an equitable access and use of resources among women and men.

# Main International Normative Frameworks for gender equality



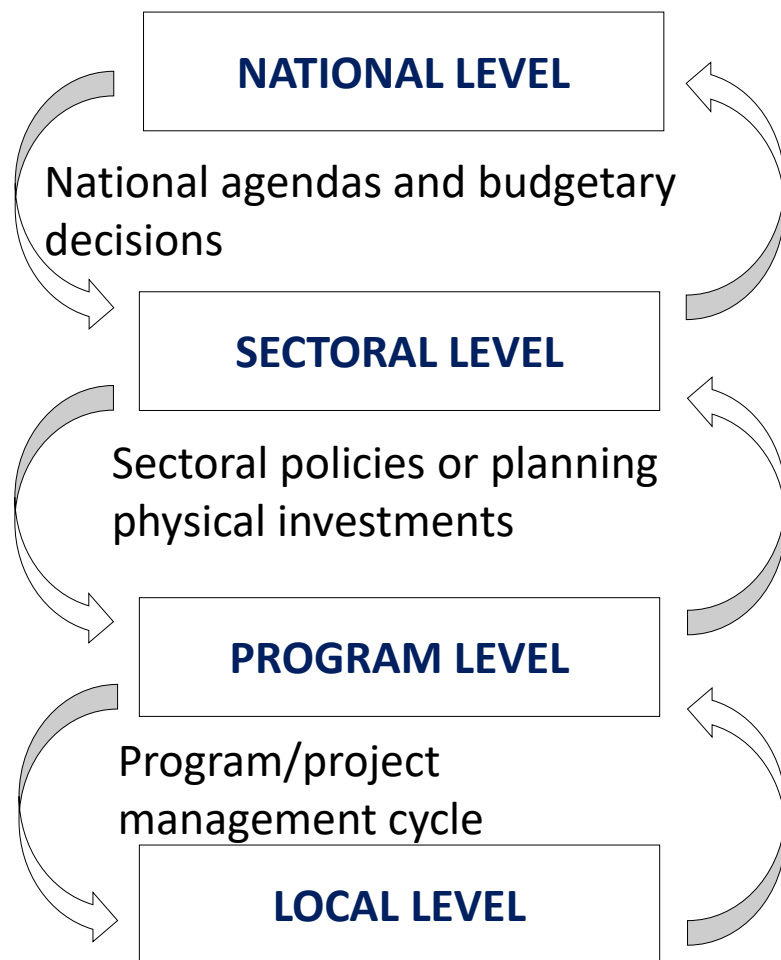
	2017	<i>UNFCCC Gender Action Plan</i>
	2017	UNCCD Gender Action Plan
	2016	Paris Agreement - Lima work program on gender extended to 2019
<b>Beijing +10</b>	2015	<i>2030 Agenda on Sustainable Development (SDGs)</i>
		CDB Gender Plan of Action (2015-2020)
	2015	Sendai Framework for Disaster Risk Reduction 2015-2030
	2014	Lima Work Program on Gender
	2012/ 2013	Commission on the Status of Women (CSW) resolutions 56/2 and 58/2 on gender equality and the empowerment of women in natural disasters
	2008	CDB Gender Plan of Action
	2005	UN World Conference on Disaster Reduction
		Kyoto Protocol (1997) entered into force
	2002	World Summit on Sustainable Development (WSSD)
	2000	Millennium Development Goals (MDGs)
UN Fourth World Conference on Women in Beijing. <b>Beijing Declaration and Platform for Action</b>	1995	
	1992	UN Conference on Environment and Development “ <i>Earth Summit</i> ” (UNCED): - Rio Declaration - Agenda 21 - United Nations Framework Convention on Climate Change (UNFCCC) - Convention on Biological Diversity (CBD) - Convention to Combat Desertification (UNCCD)
<b>Convention on the Elimination of All Forms of Discrimination against Women (CEDAW)</b>	1979	



# From the international to the national level



National Development Plans,  
National Policies for Gender Equality,  
NAPs, etc.



Local planning

## Gender mainstreaming

Mainstreaming gender issues during formulation or planning stages

- A critical examination of how differences in gender roles, activities, needs, opportunities and rights/entitlements affect women, men, girls and boys in certain situations or contexts.
- Gender analysis examines the relationships between females and males, the distribution of decision-making power and their access to and control of resources and the constraints they face relative to each other.
- Gender analysis may be conducted on the basis of qualitative information and methods and/or on the basis of quantitative information provided by gender statistics

A gender analysis should go hand in hand with the assessment of coastal risks/ hazards as a basis for planning adequate responses that ensure equal participation of and benefits for women and men

# Conceptual Frameworks for Integrating Gender in Coastal Risk Management



WE & B



- ❖ **Gender-blind:** Policies/programs recognize no distinction between the sexes; assuming that interests and needs of women and men are the same. These assumptions incorporate biases in favor of existing gender relations and so tend to exclude women.
- ❖ **Gender-balance:** Gender balance is achieved when there are approximately equal numbers of men and women present or participating.
- ❖ **Gender-sensitive:** An approach/strategy that supports policies, programmes, administrative and financial activities, and organizational procedures to: differentiate between the capacities, needs and priorities of women and men; ensure the views and ideas of both women and men are taken into account; consider the implications of decisions on the situation of women relative to men; and take actions to address inequalities or imbalance between women and men.
- ❖ **Gender-responsive:** Entails identifying, reflecting, and implementing needed interventions to address gender gaps and overcome historical gender biases in policies and interventions—contributes to the advancement of gender equality with an idea to ‘do better’; not worsening or perpetuating existing gender realities.
- ❖ **Gender-transformative:** This approach focuses on deconstructing hierarchical gender norms, constructing new concepts of masculinity and femininity and thereby transforming underlying power relations.

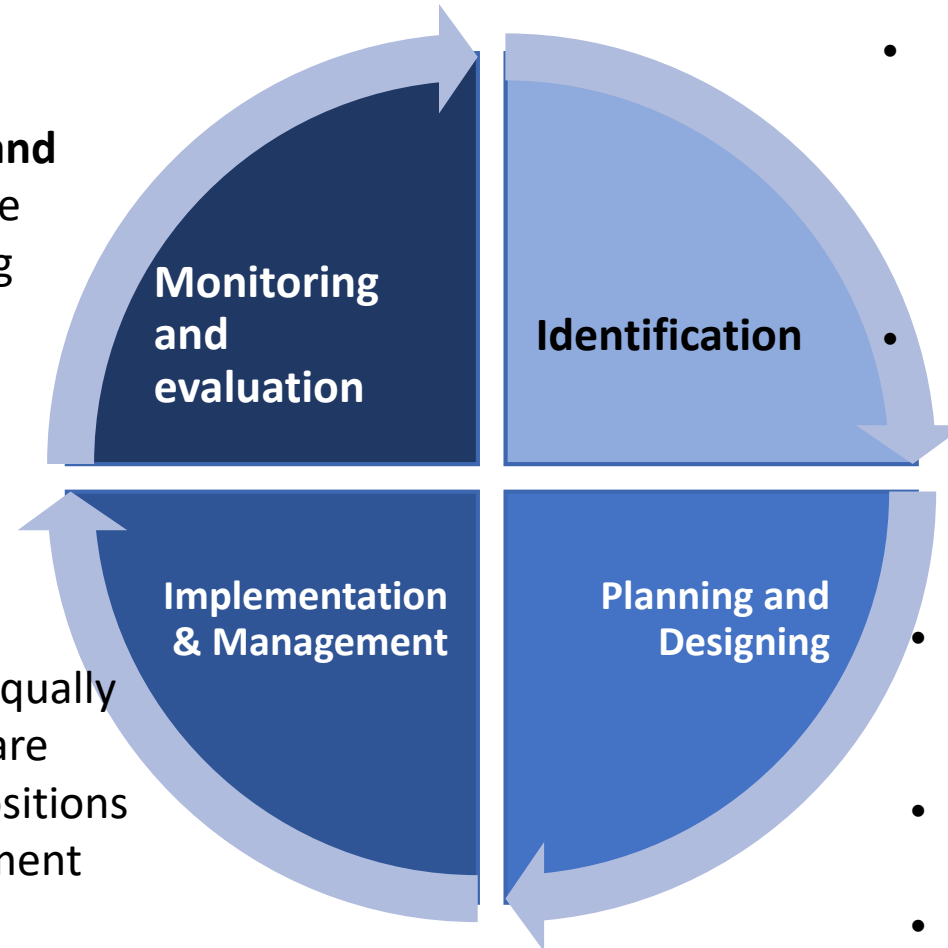
# Project Management Cycle from a gender perspective



WE & B



- **Gender-responsive monitoring and evaluation** (Monitor and evaluate changes in gender relations using gender-sensitive indicators)



- **Risk assessment**
- **Gender Analysis**
- **Gender-responsive stakeholder consultation** (proactively seek out and engage with appropriate women's rights organizations and female community)
- **Gender Impact Assessment** (Assess the different implications of planned interventions for women and men)

- Ensure that women participate equally and actively alongside men and are enabled to take up leadership positions throughout the Project Management

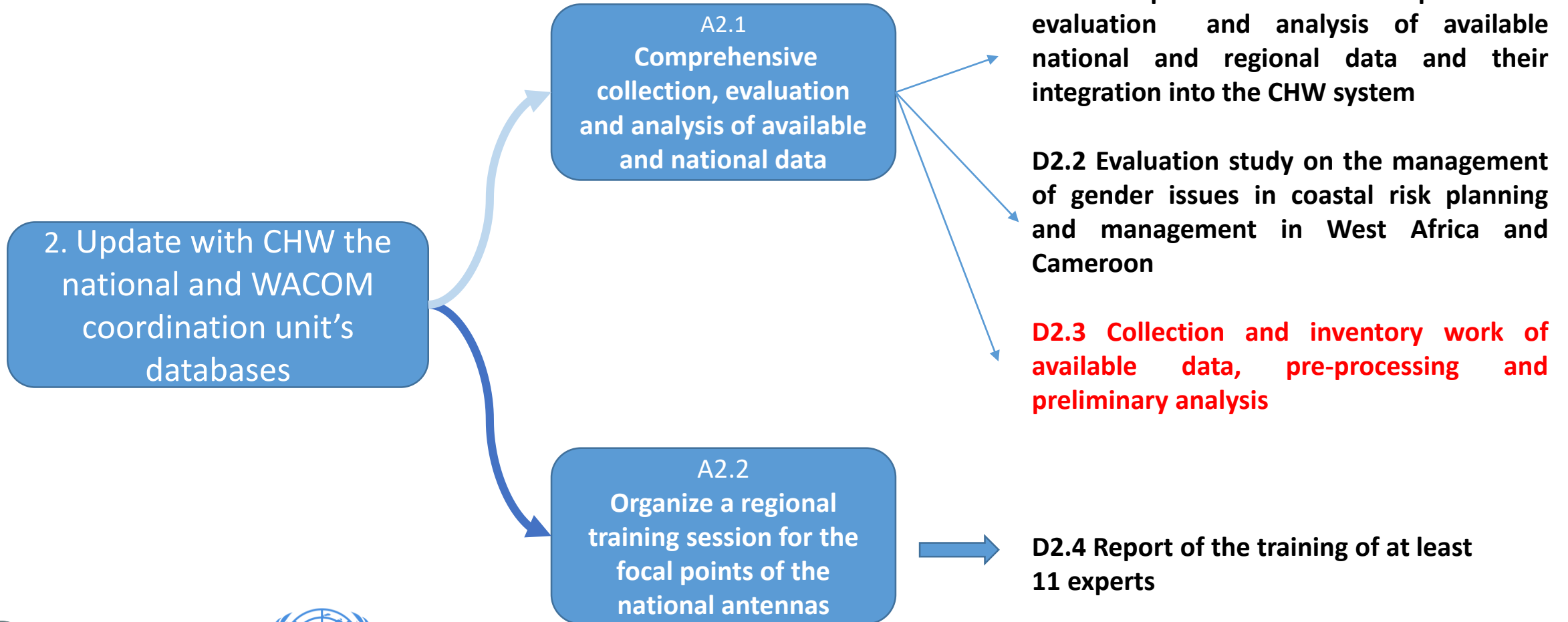
Cycle (PMC)

- **Gender objectives and outcomes** (on gender equality and women's empowerment)
- **Mainstreaming gender in measures/actions** (cross-cutting issue)
- **Gender-Responsive Budgeting**
- **Gender sensitive monitoring and evaluation system design**



# MODULE 4 – In-Depth Regional Analysis

## Phase 2. Update the national and MOLOA/WACOM coordination unit's database



## D2.3 Collection and inventory work of available data, pre-processing and preliminary analysis

### SURVEY

- General Awareness on Coastal risks
- Technical Knowledge on CHW (Geological Layout, Biodiversity, etc)
- Gender Dimension
- Vulnerabilities and next implementation steps

### KEY INTERVIEWS

- Key participants selection
- Preparation of interviews structure based on the survey
- Performing interviews with the selected participants
- Analysing and aggregating data from interviews

### WACOM TRAINING

- Design of the workshop according to information gaps and needs
- Run the online training
- Aggregate and analyze data gathered during the training

# Actual Stage: Data and survey processing phase



## Background information analysis

- Multiple case studies and reports have been identified during the surveys and the key interviews.

## Online Survey

- **14 Online surveys** have been completed by the key identified experts

## Key Interviews

- **5 Key interviews to 10 people** have been realized by country groups



### Background information

- Review available documentation
- Learn from case studies and examples
- Identify risks and opportunities
- Highlight insights & lessons learned



### Online Survey

- Design survey content
- Identify organizations and key experts
- Distribute survey for data collection
- Aggregate and analyze results



### Key Interviews

- Select key participants from survey selection
- Prepare interview structure
- Perform interviews with selected participants
- Aggregate and analyze data from interviews



### Focus Groups

- Organize focus groups formed by selected members
- Design workshop contents according to information needs
- Run workshops with key strategic members
- Aggregate and analyze data from focus groups

## Part 1 General Awareness

- Socioeconomic and Climate Change impact in the country
- Coastal Hazard Wheel Awareness

## Part 2 Technical Information

- Geological Layout
- Wave Exposure
- Tidal Range
- Biodiversity
- Sediment Balance
- Storm Climate

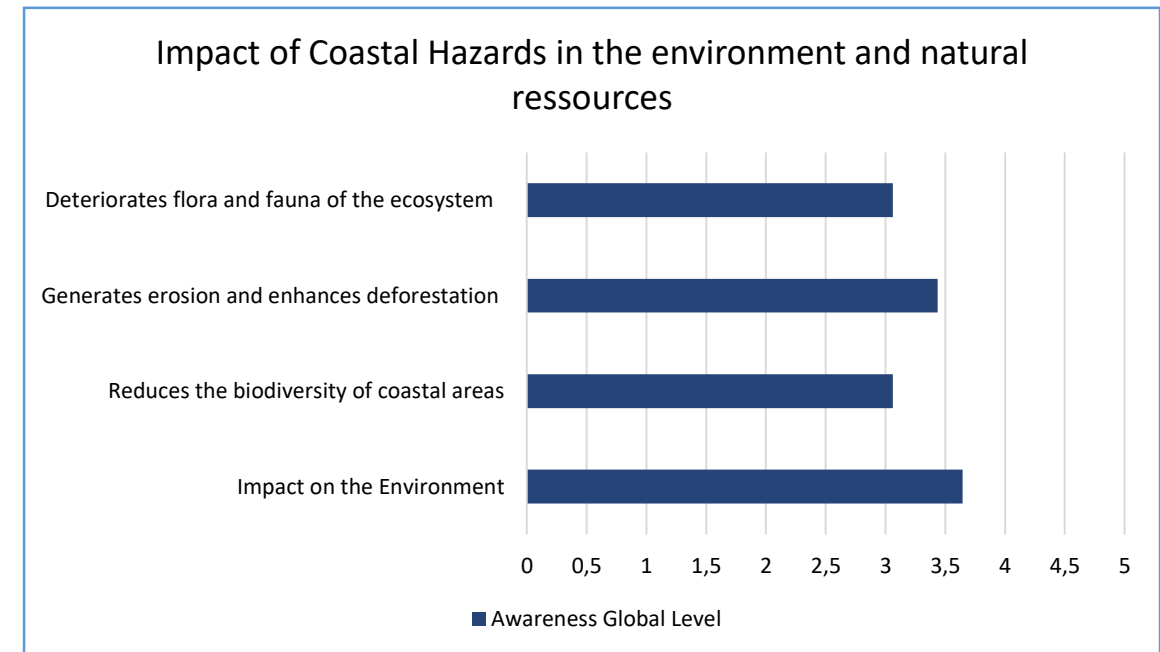
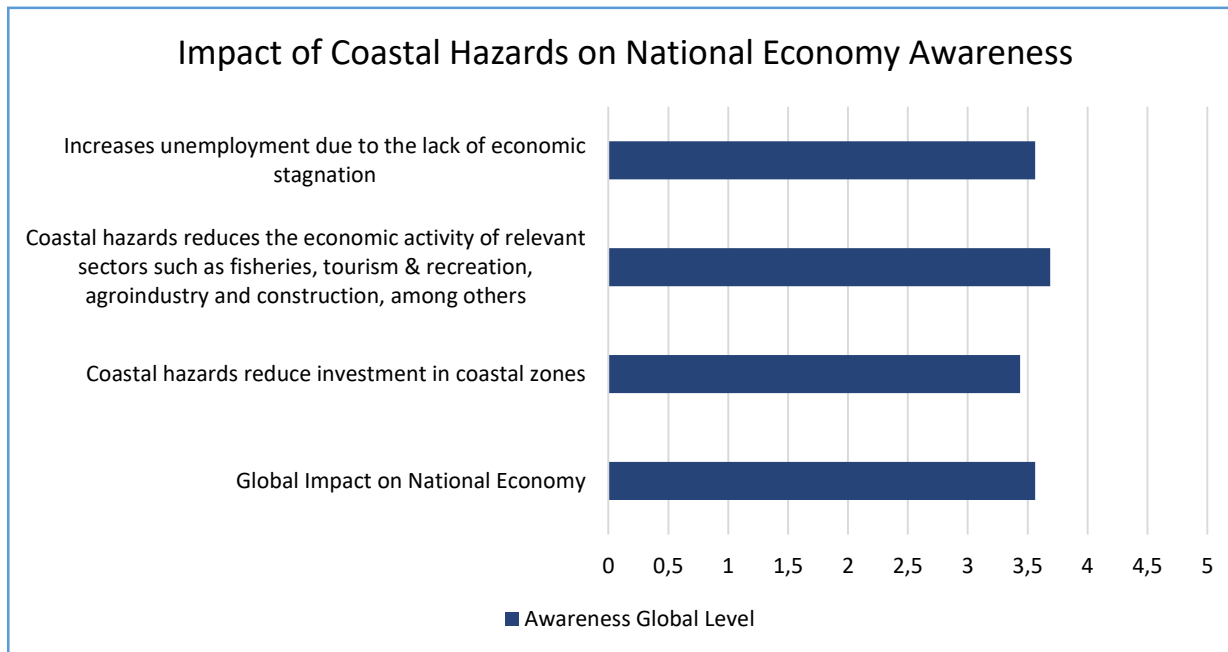
## Other aspects

- Gender
- Others (vulnerabilities)

# General Awareness on coastal hazard impacts



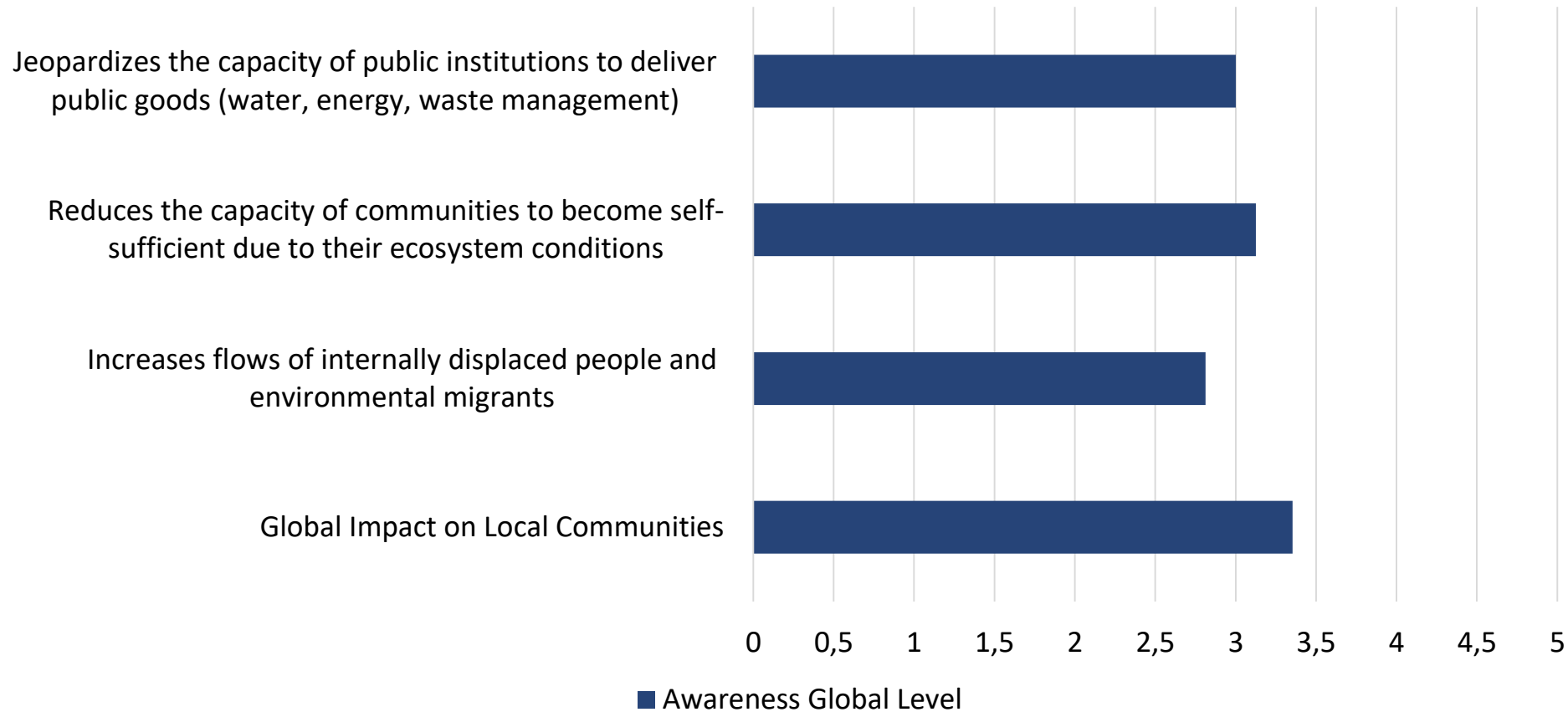
According to the 8 consulted countries, the coastal hazard impacts were the following:



# General Awareness on coastal hazard impacts



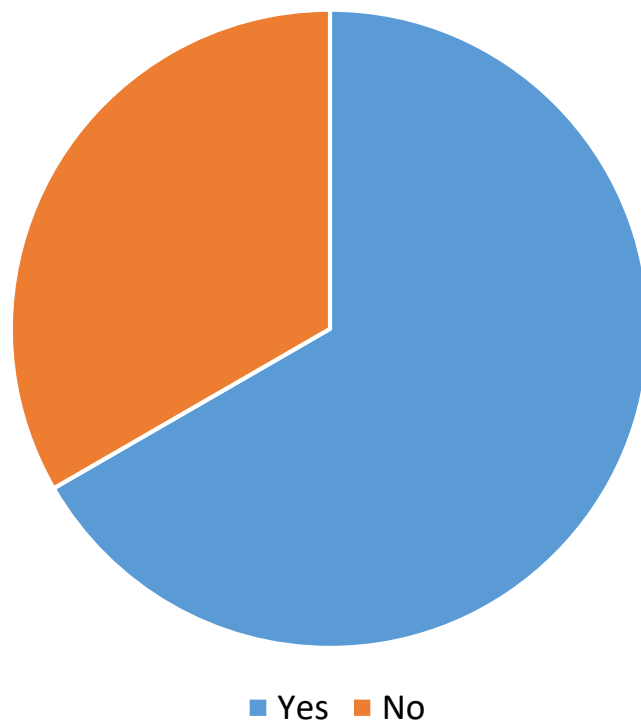
## Impact of Coastal Hazards on local coastal communities



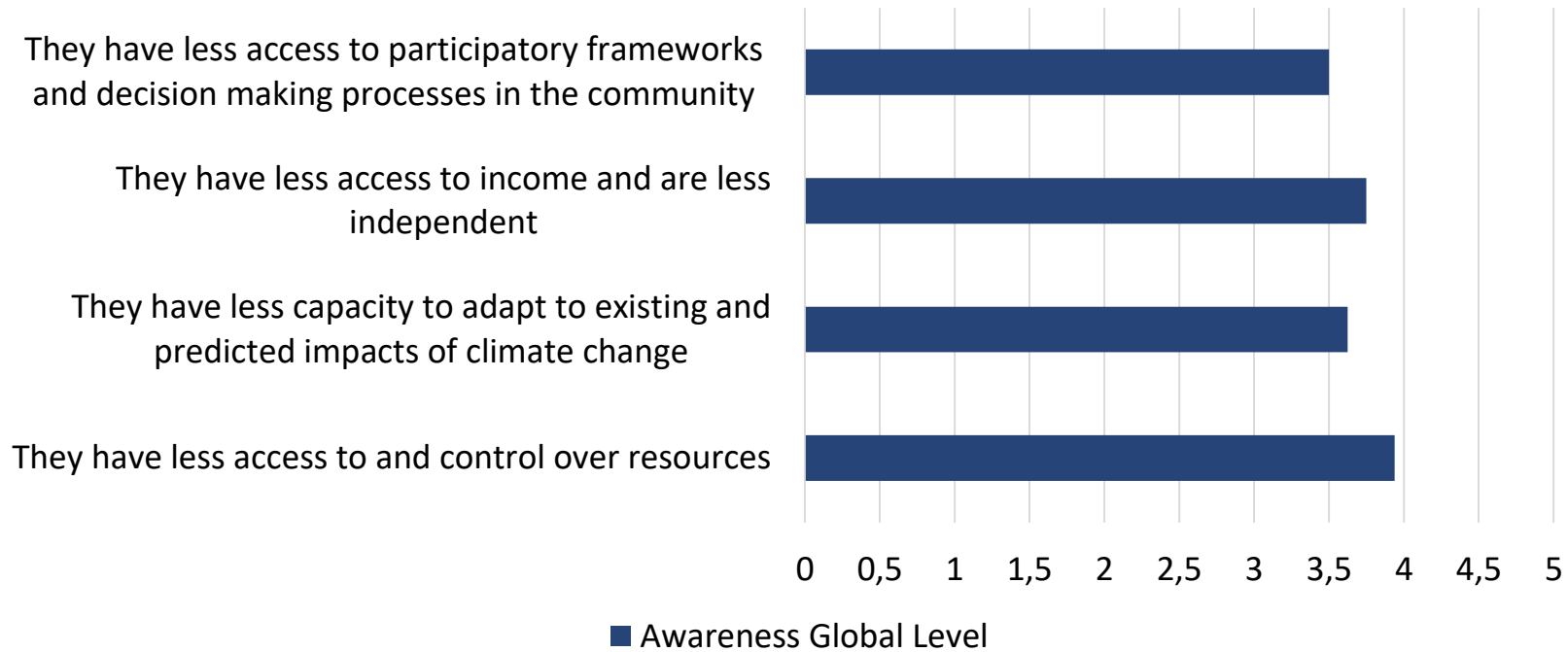
# General Awareness on coastal hazard impacts



Do you think Climate Change and coastal hazards have the same impact on men and women?



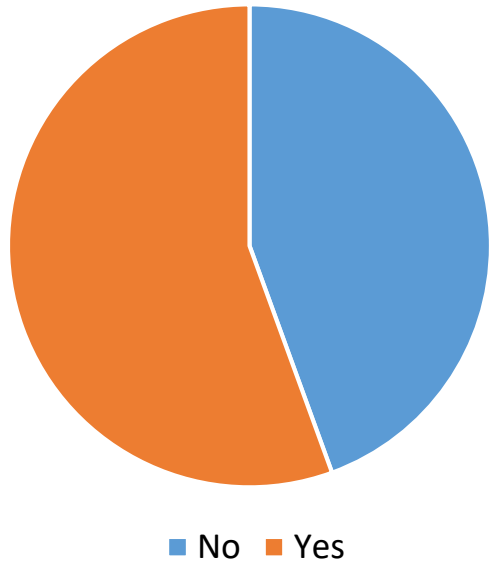
## Reasons why men and women are affected differently by coastal hazards and Climate Change



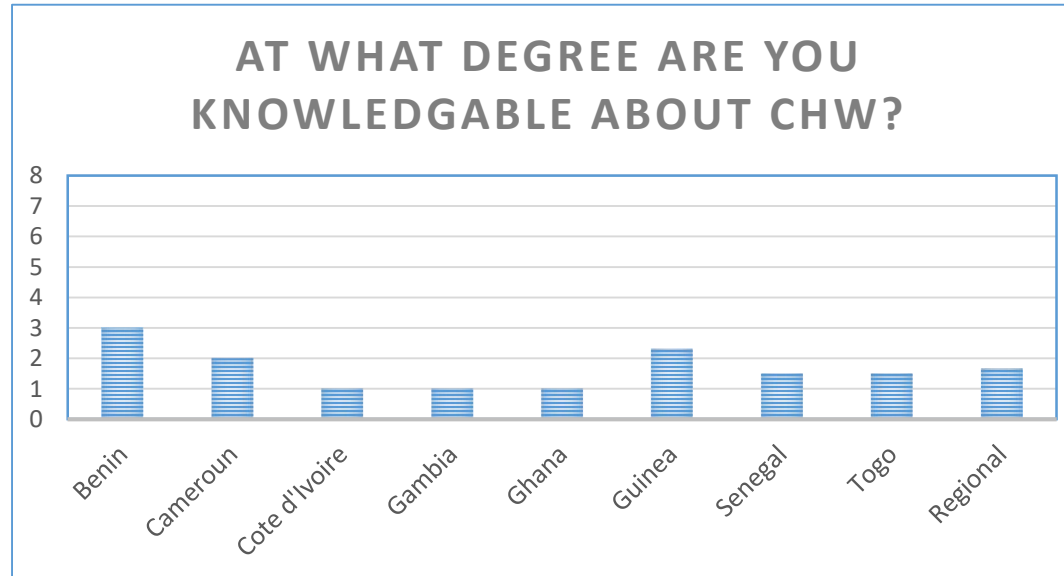
# General Awareness on the CHW tool



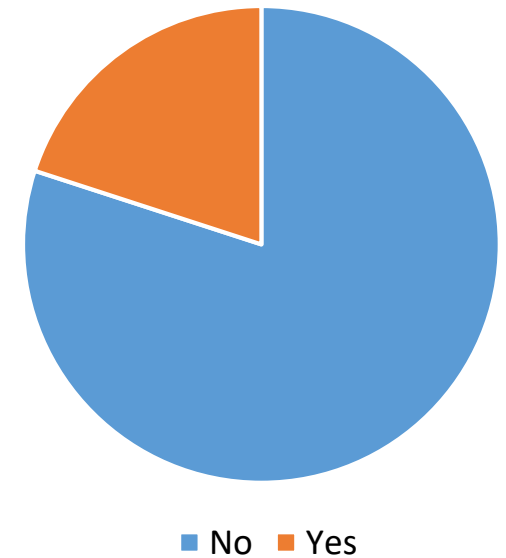
## Have you heard about the Coastal Hazard Wheel (CHW)



## AT WHAT DEGREE ARE YOU KNOWLEDGABLE ABOUT CHW?



## Are you aware about the production of CHW in your country?



# Geological layout - Availability of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Coastal geomorphological classification of the coast	Green	Red	Green	Green	Green	Green	Green	Red
Shoreline database	Green	Green	Green	Green	Green	Green	Green	Red
At national level	Green	Green	Green	Green	Green	Green	Green	Green
At regional level	Green	Green	Green	Green	Green	Green	Green	Green
At global level	Green	Green	Green	Green	Green	Green	Green	Green
Geological map	Green	Green	Green	Green	Green	Green	Green	Green
At national level	Green	Green	Green	Green	Green	Green	Green	Green
At regional level	Green	Green	Green	Green	Green	Green	Green	Green
At global level	Green	Green	Green	Green	Green	Green	Green	Green
Lithological map	Green	Green	Red	Green	Red	Green	Green	Green
At national level	Green	Green	Green	Green	Green	Green	Green	Green
At regional level	Green	Green	Green	Green	Green	Green	Green	Green
At global level	Green	Green	Green	Green	Green	Green	Green	Green
Digital Elevation Model covering the emerged coastal strip	Green	Green	Green	Green	Green	Green	Green	Red
Report or study in relation to coastal geomorphology for your country or region	Green	Green	Green	Green	Green	Green	Green	Green
Orthophotos or a composition of orthophotos taken by plane	Green	Red	Green	Green	Green	Green	Green	Red

# Geological layout - Quality of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Shoreline database available in digital format?	Green	Green	Green	Green	Green	Green	Green	Red
CSV Format								
Shapefile format	Green	Green	Green	Green	Green	Green		
Date of the last update	2018					2018	2019	
Quarterly								
Semi annual								
Annual	Green					Green	Green	
Resolution of the shoreline database (in meters)								
Is that finer than 50 m?	Red	Red	Red	Red	Red	Red		
Geological map available in a digital and georeferenced format?	Green	Red	Red	Green	Green	Green	Green	Red
Lithological map available in a digital and georeferenced format?	Red	Red	Red	Green	Red	Red	Green	Red
Digital Elevation Model available in a digital and georeferenced format?	Green	Red	Green	Green	Green	Green	Green	Red
Date of the last orthophotos taken by plane								
Orthophotos available in a digital and georeferenced format?	Red	Red	Green	Green	Green	Red	Green	Red
Studies/reports about coastal geomorphology available in digital format (PDF)?	Green	Red	Green	Red	Red	Green	Green	Red

# Geological layout - Accessibility of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Shoreline database publicly available	Red	Red	Red	Green	Green	Green	Green	
Electronic open version				Green			Green	
Electronic version upon request			Green	Green	Green	Green	Green	
Printed version on public information centres				Green				
Printed copies upon request				Green	Green	Green		
Not publicly available	Green					Green		
Knows the institution/s responsible for the production of the shoreline database or related information	Green	Red	Green	Green	Green	Green	Green	Red

## Availability of data

- Strengths:
  - Most important data (geomorphology, geology, shoreline, DEM) are available for most of countries of the region.
  - Existing data have a national coverage.
  - Previous studies (and corresponding reports) related to coastal morphology are available in all countries.
- Weaknesses
  - Main gap for relevant data ([geomorphology](#), shoreline, DEM, [aerial photographs](#)) is found at Togo and [Cameroun](#).

## Quality of data

- Strengths :
  - Base data (shoreline) to apply CHW is available in nearly all countries in digital format.
  - Existing DEM and aerial photos are mostly in digital format.
- Weaknesses
  - Geological/lithological data are frequently in non-digital version.
  - Some reported existing aerial photos (Benin, Guinea) and DEM (Cameroun) are not directly usable –non digital -.
  - Some existing studies are only available in paper format, limiting their “usability” (transfer and analysis).

## Accessibility to data

- Strengths :
  - Relevant data is publicly available and/or upon request in many countries (Gambia, Ghana, Guinea, Senegal).
  - Responsible institutions gathering and analyzing relevant data are known for most of countries.
- Weaknesses
  - Shoreline data in Benin and Cameroun are not publicly available.
  - No responsible institutions gathering and analyzing relevant data have been identified for Cameroun and Togo.



## Readiness

- Overall, nearly all the countries of the region have the required basic data regarding the Geological layout to implement the CHW.
- Togo still requires to compile additional data.
- Benin, Gambia, Ghana, Guinea and Senegal have the information in right format to be operative.
- Cameroun, Cote d'Ivoire needs to convert some data to digital format to be operative.



## Actions required

1. At regional level, to compile existing data to implement the CHW.
2. For countries with data in paper, to convert it to digital format.
3. For Togo, to fill data gaps from global databases including GoogleEarth.

# Wave exposure - Availability of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Wave information coming from buoys	Green	Red	Red	Green	Green	Red	Red	Red
Wave information from reanalysis data	Red	Red	Red	Green	Green	Red	Red	Red

# Wave exposure - Quality of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Number of buoys and location	Red	Red	Red	Green	Red	Red	Red	Red
Measured Wave Parameters	Red	Red	Red	Green	Red	Red	Red	Red
Lengths of wave registers and gaps	Red	Red	Red	Red	Red	Red	Red	Red
Horizontal resolution of wave hindcast	Red	Red	Red	Red	Red	Red	Red	Red
Time resolution of wave time series	Red	Red	Red	Red	Red	Red	Red	Red
Responsible institution for managing wave records	Green	Red	Red	Green	Green	Red	Red	Red

# Wave exposure - Accessibility of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Open access to wave time series	Red	Red	Red	Green	Green	Red	Red	Red
Wave time series available in a digital numerical format	Red	Red	Red	Green	Green	Red	Red	Red



## Availability of data

### ■ Strengths:

- Benin, Gambia and Ghana have access to a wave buoy network with multiple wave buoys.
- Gambia and Ghana have also a wave reanalysis at national scale.

### ■ Weaknesses:

- The rest of the countries have no wave measurements available.

## Quality of data

### ■ Strengths:

- Benin, Gambia and Ghana have a public institution on behalf of managing wave measurements.
- Multiple buoy datasets are available in Gambia and Ghana.
- Significant Wave Height, Wave Period and Wave direction are registered in the buoys of Gambia and Ghana.

### ■ Weaknesses:

- Data length and locations of buoys are unknown by the Consortium.
- Data files for Ghana and Gambia are still not available for the Consortium, so data quality cannot be assessed.

## Accessibility to data

- Strengths :
  - Wave buoy data for Ghana and Gambia should not be difficult to access, as the responsible institution is identified.
- Weaknesses:
  - Buoy data and wave reanalysis for Ghana and Gambia are still not accessible by the Consortium.

## Readiness

- Overall, the countries of the region still have work to do in order to apply CHW concerning Wave Exposure.
- Gambia and Ghana have useful data to be applied for the CHW classification concerning Wave Exposure. However, this datasets are still no available, so their quality has not been assessed yet.
- The rest of the countries don't have wave measurements / reanalysis at national level.



## Actions required

1. For those countries with no wave data, the Consortium recommend to work with the open access wave reanalysis at global scale (i.e. ERA5 from Copernicus). Alternatively, the Consortium can make available own generated wave hindcasts at global scale. Quality in both datasets is guaranteed.
2. For Gambia and Ghana, wave buoys and wave reanalysis are available, so they should be provided to the Consortium and, then, quality should be assessed.

# Tidal range - Availability of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Tidal records in harbours	Green	Red	Red	Green	Green	Green	Red	Red
Tidal data from satellite missions	Green	Red	Red	Green	Red	Red	Red	Red

# Tidal range - Quality of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Multiple locations with tidal data along the coast	Red	Red	Red	Green	Red	Green	Red	Red
Responsible institution for managing tidal records	Red	Green	Red	Green	Green	Green	Green	Red

# Tidal range - Accessibility of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Public Access to tidal data	Red	Red	Red	Green	Red	Green	Red	Red
Tidal records available in digital numerical format	Red	Red	Red	Green	Red	Green	Red	Red

## Availability of data

### ■ Strengths:

- Gambia and Guinea have access to a tidal data from harbours.
- Cameroun, Gambia, Ghana, Guinea and Senegal have been working with tidal data from satellite missions.

### ■ Weaknesses:

- Benin, Cote d'Ivoire and Togo have no experience in treating with tidal data.

## Quality of data

- Strengths:
  - Benin, Gambia and Ghana have a public institution on behalf of managing tidal data.
- Weaknesses:
  - Tidal data for Guinea and Gambia is still not available for the Consortium, so data quality cannot be assessed.

## Accessibility to data

- Strengths :
  - Tidal data for Guinea and Gambia are public access and accessible in digital numerical format.
  - The responsible institutions of the data are identified.
- Weaknesses:
  - Tidal data for Guinea and Gambia is still not accessible by the Consortium.



## Readiness

- Overall, most of the countries don't have the proper databases to apply CHW concerning Tidal Range.
- Gambia and Guinea have useful data to be applied for the CHW classification concerning Tidal Range. However, this datasets are still not available, so their quality has not been assessed yet.



## Actions required

1. For those countries with no/scarce tidal data, the Consortium recommend to work with the open access tidal data from satellite missions (e.g. OTIS Tidal Solutions).
2. Tidal range can be estimated from the existing databases
3. For Gambia and Guinea, tidal datasets are available, so they should be provided to the Consortium and, then, quality should be assessed.

# Biodiversity - Availability of data



	Benin	Cameroon	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Flora and fauna database cover with satellite images by Google Earth	Red	Red	Red	Green	Red	Green	Red	Red
Phytoplankton dynamics + chlorophyll-a	Red	Red	White	White	White	Red	White	White
Invasive species	Red	Green	Green	Green	Green	Red	White	White
Threatened species	Red	Green	White	Green	Green	Green	White	White
Total catch by species and quota	Red	Red	White	Red	Green	Red	White	White
Source to measure latitude of assessment area	Red	Green	White	Green	White	Green	White	White
Marine and coastal protected areas	Green	Green	White	Green	Red	Green	White	White
Database updated with other sources	Green	Red	White	Red	Red	Green	White	White
At national level	Green	Red	White	White	White	Green	White	White
At regional level	White	Red	White	White	White	White	White	White
At global level	White	Red	White	White	White	White	White	White
Local institution responsible for shoreline database	Green	Red	White	Green	Red	Green	Green	White

# Biodiversity - Quality of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Knowledge of last update of the biodiversity database								
Frequency of update currently been used for the database								
Knows of the institution/s responsible for reviewing and supervising the quality of the database updates								

# Biodiversity - Accessibility of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Database publicly available								
Electronic open version								
Electronic version upon request								
Printed version on public information centres								
Printed copies upon request								
Not publicly available								



## Readiness

- In the region Biodiversity data is mixed:
  - Only 2 national databases exist of Biodiversity data
  - Rich information on Biodiversity in reports (e.g. Cameroon)
  - Only 2 countries with Google Earth aerial photos of coastal areas showing biodiversity.
- The general lack of aerial photographs or satellite images of coastal flora in the region inhibits the application of the CHW methodology concerning flora and fauna classification
- Guinea and Gambia are shining examples of biodiversity information for CHW application (Databases, Google Earth Images, Open Access)

# Biodiversity – Status and main actions required for CHW implementation



## Actions required

### Regional Level

1. We recommend the countries to revise Google Earth images for the entire coastal area in order to identify zones with enough quality for identification of mangrove and marsh areas (ideal for CHW classification)
2. Countries should work on identifying vegetated and non-vegetated areas along the coast – using these satellite images
3. Countries should identify areas of coral reef coverage
4. Côte d'Ivoire, Senegal and Togo surveys outcomes provide little information on biodiversity data so there is a need to revise the availability and accessibility of information

## Actions required – National Agencies

For Biodiversity Classification of the CHW we recommend the national agencies responsible for biodiversity data to be supported in obtaining Google Earth images of the entire coastline. This relates specifically to the following countries:

- Benin
- Cameroon
- Côte d'Ivoire
- Ghana
- Senegal
- Togo

# Sediment balance - Availability of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Studies / reports on coastal erosion	Green	Green	Green	Green	Green	Green	Green	Green
Availability of historical ortophotos	Green	Green	Green	Green	Green	Green	Green	Red
Availability of digital historical shorelines	Green	Red	White	Green	Green	Green	Red	Red
Inventory of anthropogenic actions to fight coastal erosion	Green	Red	Red	Green	Red	Green	Green	Green
Local institution responsible for the production and management of the shoreline database	Red	Red	Red	Green	Green	Green	Green	Green

# Sediment balance - Quality of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Orthophotos in digital and georeferenced format								
Available dates of historical ortophotos		1980 -2015	various – non regular		2005	2018		
Format of digital historical shorelines	shapefile				shapefile			
Available dates of historical shorelines					1974			

# Sediment balance - Accessibility of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Are the historical shorelines publicly available?	Red	Red	Yellow	Green	Red	Green	Yellow	
Electronic open version				Green		Green		
Electronic version upon request	Green			Green	Green	Green	Green	
Printed version on public information centres				Green		Green		
Printed copies upon request	Green			Green		Green	Green	
Not publicly available								

## Availability of data

### ■ Strengths:

- Previous studies/reports on coastal erosion exist for all countries.
- Historical orthophotos exist for nearly all countries.
- Historical shoreline data exist for most of the countries.
- Inventory of coastal protection measures exist for many countries.

### ■ Weaknesses

- Main gap for relevant data (orthophotos, [shorelines](#)) is found at Togo, [Cameroun](#) and [Senegal](#).

## Quality of data

- Strengths :
  - When existing, orthophotos are in digital format and georeferenced.
  - Good time coverage of orthophotos in Cameroun.
- Weaknesses
  - Time coverage of historical orthophotos and shorelines is not well known or identified for most of the countries.
  - When reported, time coverage is, in most of the cases, short to properly characterize long-term coastal evolution.



## Accessibility to data

- Strengths :
  - Relevant existing data (shorelines) is available request in many countries (Benin, Gambia, Ghana, Guinea, Senegal).
  - Responsible institutions producing shoreline data are known for most of countries.
- Weaknesses
  - Shoreline data in Cameroun is not publicly available.
  - No responsible institutions gathering and analyzing relevant data have been identified for Benin, Cameroun and Cote d'Ivoire.

## Readiness

- Overall, all the countries of the region have background information on coastal erosion to help in characterizing sediment balance.
- Nearly all the countries have data (orthophotos and shorelines) in right format to compute the sediment balance component of CHW.
- Cameroun, Senegal and Togo lack of historical shoreline information to characterize sediment balance.



## Actions required

1. At regional level, to compile existing data to implement the CHW.
2. For countries without data (Togo) to fill data gaps by using global database (GoogleEarth).
3. To assess coastline evolution trends along their coasts.

# Storm climate - Availability of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Database reporting storm intensity and damage	Red	Red	Red	Green	Red	Red	Green	Red
Reports on storm characteristics	Red	Red	Red	Green	Green	Red	Green	Red
Institution of storm monitoring	Red	Red	Red	Green	Green	Red	Green	Red

# Storm climate - Quality of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Storm database Level:								
National	Red	Red	Red	Green	Red	Red	Green	Red
Regional	Red	Red	Red	White	Red	Red	Green	Red
Local	Red	Red	Red	White	Red	Red	White	Red
Length of storm database	Red	Red	Red	Red	Red	Red	Green	Red

# Storm climate - Accessibility of data



	Benin	Cameroun	Cote d'Ivoire	Gambia	Ghana	Guinea	Senegal	Togo
Open Access of Storm database	Red	Red	Red	Green	Red	Red	Red	Red
Digital numerical format	Red	Red	Red	Green	Red	Red	Red	Red

## Availability of data

### ■ Strengths:

- Gambia and Senegal have a storm database available describing the intensity and damages of historical storms. Ghana has some reports describing some historical storms.

### ■ Weaknesses:

- The rest of the countries have no database/reports describing historical storms.

## Quality of data

- Strengths:
  - Benin, Gambia and Ghana have a public institution on behalf of storm monitoring.
  - Storm databases are available at national level and for multiple storms
- Weaknesses:
  - Storm data is still not available for the Consortium, so data quality cannot be assessed.

## Accessibility to data

- Strengths :
  - Storm database for Gambia is public access and accessible in digital numerical format.
  - The responsible institutions of the data are identified.
- Weaknesses:
  - Storm data for Guinea and Gambia is still not accessible by the Consortium.



## Readiness

- Overall, most of the countries still have to collect information about the historical storms and their impacts.
- Only Gambia has a storm database and storm reports. However, this dataset has not been provided to the Consortium yet. So, its quality has not been assessed.



## Actions required

1. Africa is not affected by Tropical Cyclones, strictly defined by CHW. However, Storm climate in this case can be useful to determine the impact of extreme events in terms of wind, waves and precipitation.
2. Meteorological information can be collected and processed from meteorological reanalysis (ERA5 from Copernicus). Estimation of extreme climatology must be assessed at national level for each country.



# MODULE 5 – The Path Forward

# Action Points – What is needed



## Geological Layout

- At regional level, to compile existing data to implement the CHW.
- For countries with data in paper, to convert it to digital format.
- For Togo, to fill data gaps from global databases including GoogleEarth.

## Wave Exposure

- For those countries with no wave data, the Consortium recommend to work with the open access wave reanalysis at global scale (i.e. ERA5 from Copernicus). Alternatively, the Consortium can make available own generated wave hindcasts at global scale. Quality in both datasets is guaranteed.
- For Gambia and Ghana, wave buoys and wave reanalysis are available, so they should be provided to the Consortium and, then, quality should be assessed.

## Tidal Range

- For those countries with no/scarce tidal data, the Consortium recommend to work with the open access tidal data from satellite missions (e.g. OTIS Tidal Solutions).
- Tidal range can be estimated from the existing databases
- For Gambia and Guinea, tidal datasets are available, so they should be provided to the Consortium and, then, quality should be assessed.

# Action Points – What is needed



## **Biodiversity**

We recommend the countries to revise Google Earth images for the entire coastal area in order to identify zones with enough quality for identification of mangrove and marsh areas (ideal for CHW classification)

Countries should work on identifying vegetated and non-vegetated areas along the coast – using these satellite images

Countries should identify areas of coral reef coverage

Côte d'Ivoire, Senegal and Togo surveys outcomes provide little information on biodiversity data so there is a need to revise the availability and accessibility of information

For Biodiversity Classification of the CHW we recommend the national agencies responsible for biodiversity data to be supported in obtaining Google Earth images of the entire coastline. This relates specifically to the following countries: Benin, Togo, Ghana, Senegal, Cameroon, Cote d'Ivoire

## **Sediment Balance**

At regional level, to compile existing data to implement the CHW.

For countries without data (Togo) to fill data gaps by using global database (GoogleEarth).

To assess coastline evolution trends along their coasts.

## **Storm Climate**

Africa is not affected by Tropical Cyclones, strictly defined by CHW. However, Storm climate in this case can be useful to determine the impact of extreme events in terms of wind, waves and precipitation.

Meteorological information can be collected and processed from meteorological reanalysis (ERA5 from Copernicus). Estimation of extreme climatology must be assessed at national level for each country.