These lecture materials are for the Marine Coastal and Delta Sustainability for Southeast Asia (MARE) (Project No. 610327-EPP-1-2019-1-DE-EPPKA2-CBHE-JP).

This project has been funded with support from the European Commission. This publication reflects the views only of the authors, and the Commission cannot be made responsible for any use which may be made from the information contained herein.

Co-funded by the Erasmus+ Programme of the European Union

VEB4213 Ocean and Coastal Engineering

Ts. Dr. HM Teh

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energising futures

TRAINER PROFILE

Ts. Dr. Teh Hee Min

- Senior Lecturer, Department of Civil & Environmental Engineering, Universiti Teknologi PETRONAS
- B.Eng. (Civil), UTM
- M.Eng. (Coastal & Maritime), UTM
- PhD (Coastal Structures), University of Edinburgh
- Areas of Interest:
  Coastal hydrodynamics, wave hydrodynamics, marine renewable energy, physical modelling

Course Synopsis

Coastal environments are complex regions which are diverse in function and form. They are constantly subjected to environmental pressure due to human interventions and exploitation as well as climate change impacts. A good level of coastal engineering knowledge is required to contribute to resolving the various conflicting interests between the coastal environment and human use of the coastal environment. This short course outlines the fundamental principles of coastal engineering and the governing rules in assessing the coastal environments. The course gives an overview of several topics including wave theory, wave transformation, tides, nearshore currents, sediment transport, coastal morphology.

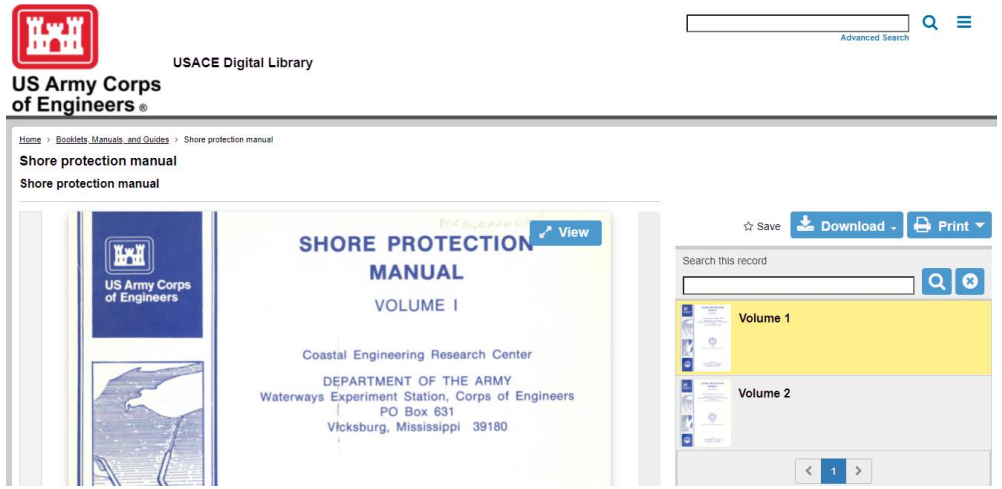
Course Learning Outcomes

Upon completion of this course, students should be able to:

1. Evaluate the properties of offshore and near shore waves and establish design wave specification.
2. Assess currents and tidal processes.
3. Formulate sediment budget and perform shoreline evolution analysis.

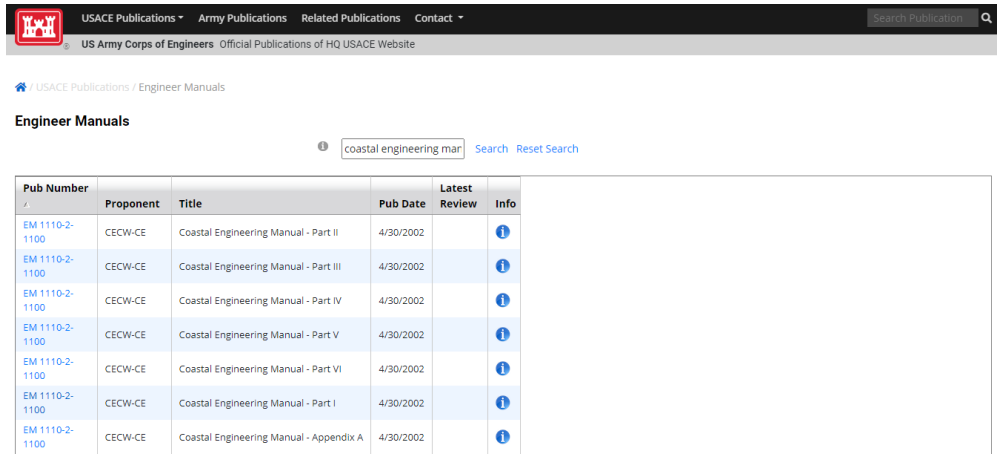
Learning Objectives

Main References



SHORE PROTECTION MANUAL

https://usace.contentdm.oclc.org/digital/collection/p16021coll11/id/1934/



COASTAL ENGINEERING MANUAL

https://www.publications.usace.army.mil/USACE-Publications/Engineer-Manuals/u43544q/636F617374616C20656E67696E656572696E67206D616E75616C/

Student Attendance

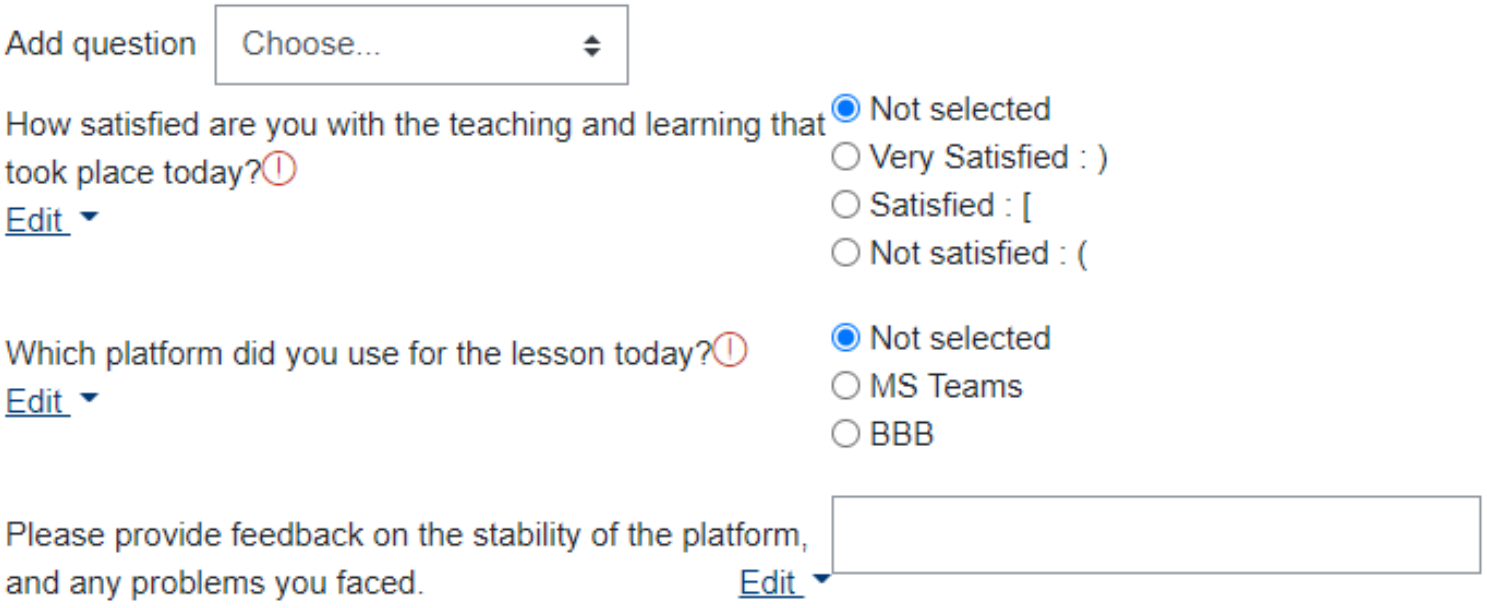
Microsoft PowerApps

MANDATORY

How satisfied are you with the teaching and learning that took place today?

MANDATORY

1- Very Satisfied
2- Satisfied
3- Not satisfied



Topic 1
Introduction to Coastal Environment

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Course Learning Outcomes

Upon completion of this course, students should be able to:

1. Evaluate the properties of offshore and near shore waves and establish design wave specification.
2. Assess currents and tidal processes.
3. Formulate sediment budget and perform shoreline evolution analysis.

Learning Objectives

Lesson Outcomes

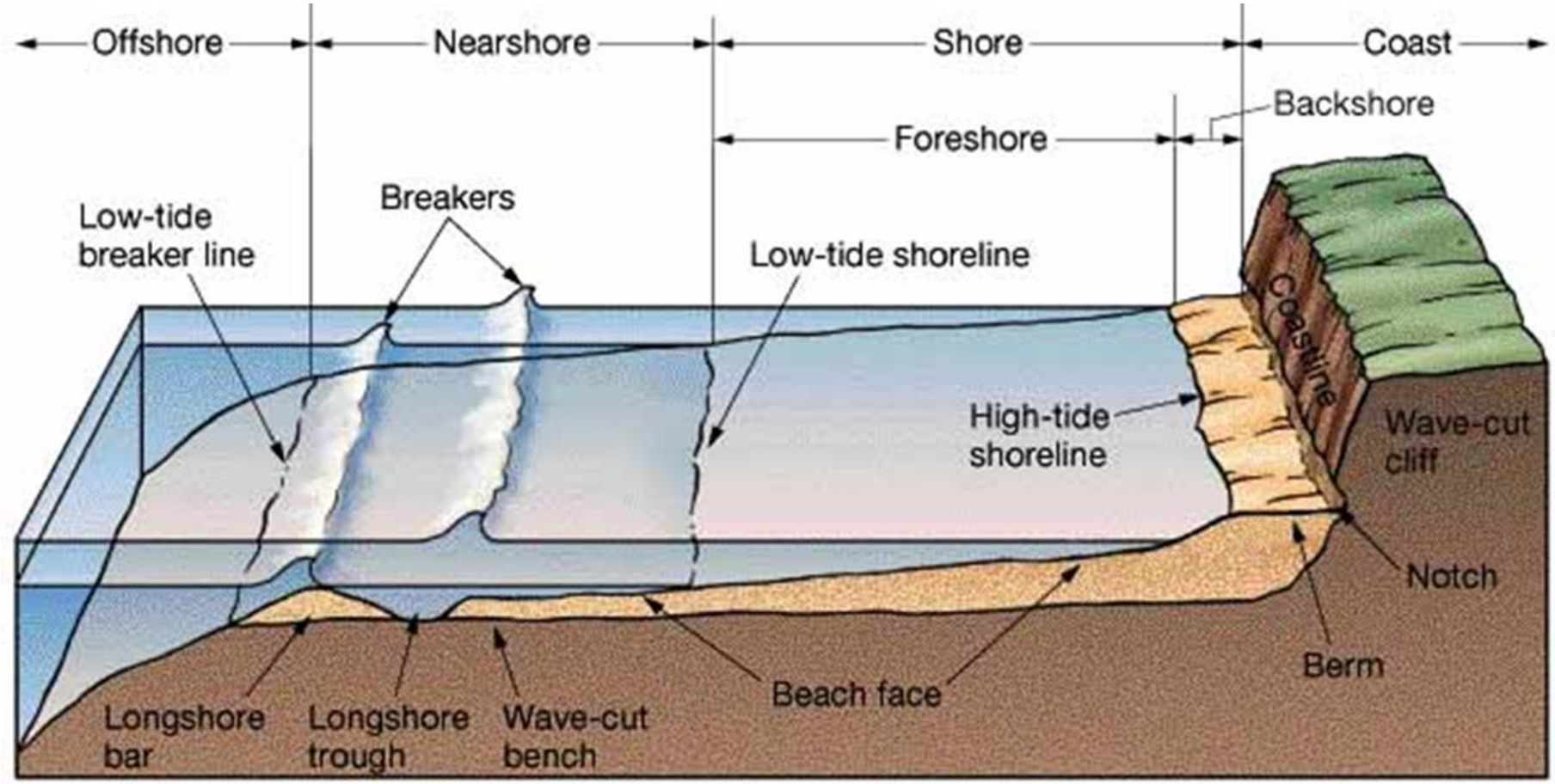
Upon completion of this lesson, students should be able

- to identify and describe the ocean and coastal components.
- to classify the type of coasts based on the sediment particle size.
- to characterize the coastal formations.

Learning Objectives

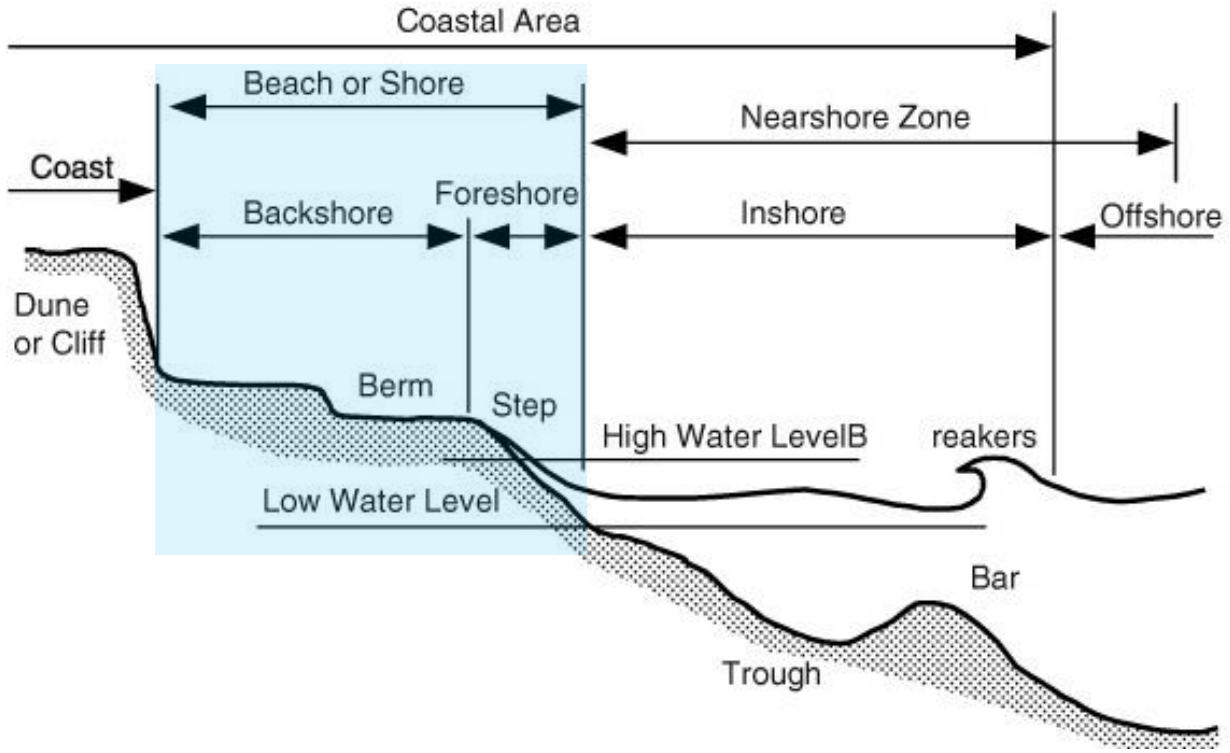
Describe the coast

TYPICAL BEACH PROFILE



(Source: https://slideplayer.com/slide/12996920/)

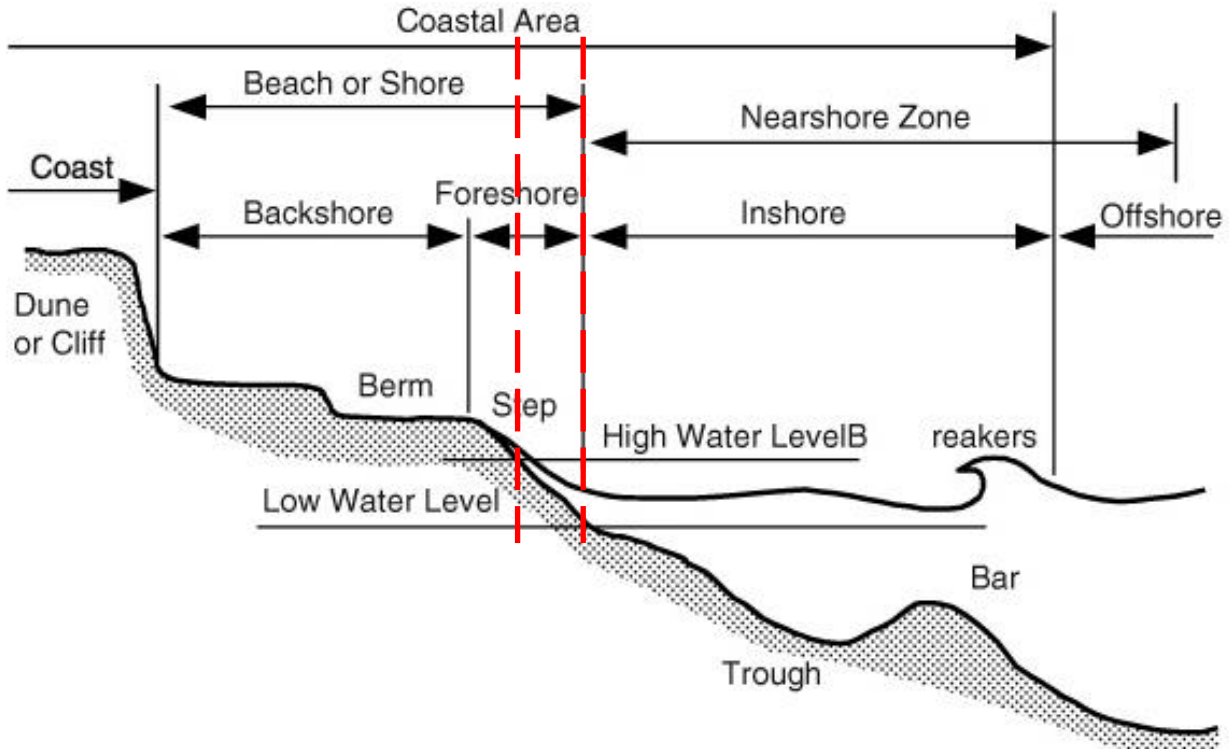
Beach/Shore



(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

The narrow strips of land in immediate contact with the sea, including the zone between high and low water lines.

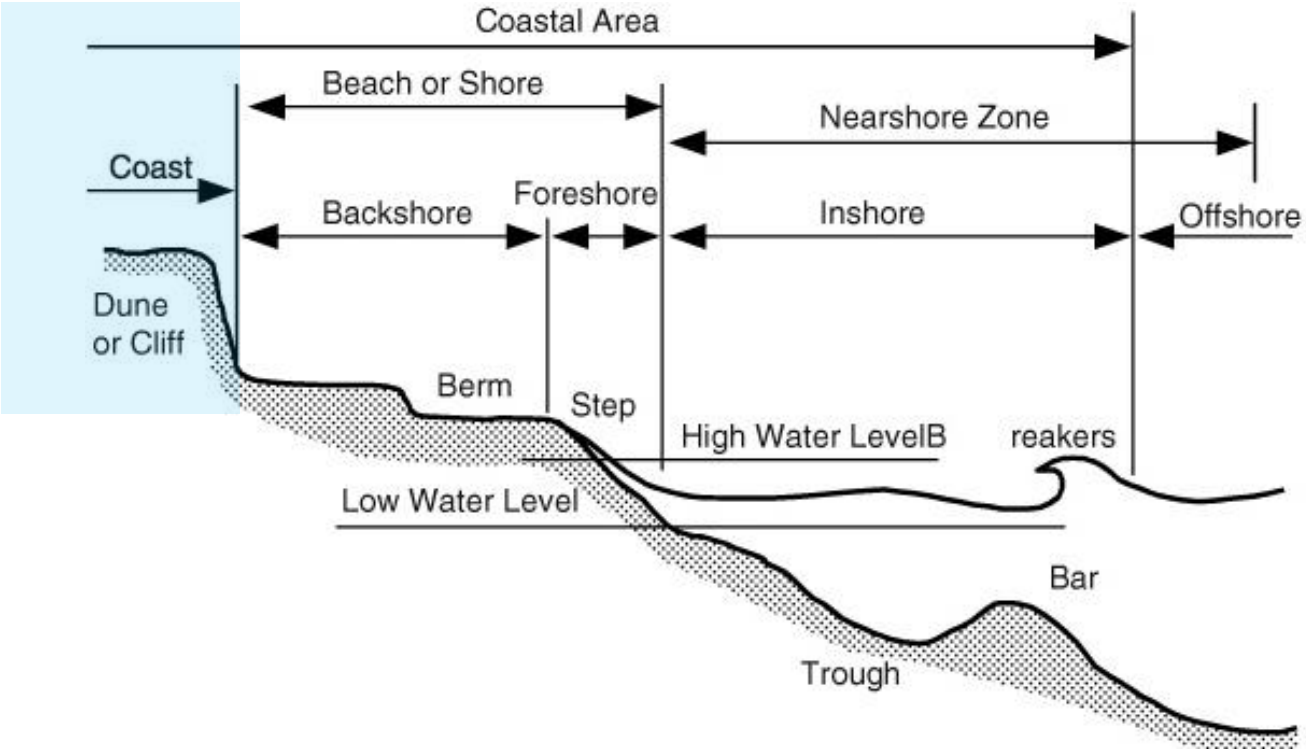
SHORELINE



(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

The intersection of a specified plane of water (e.g., mean high water) with the beach/shore.

Coast

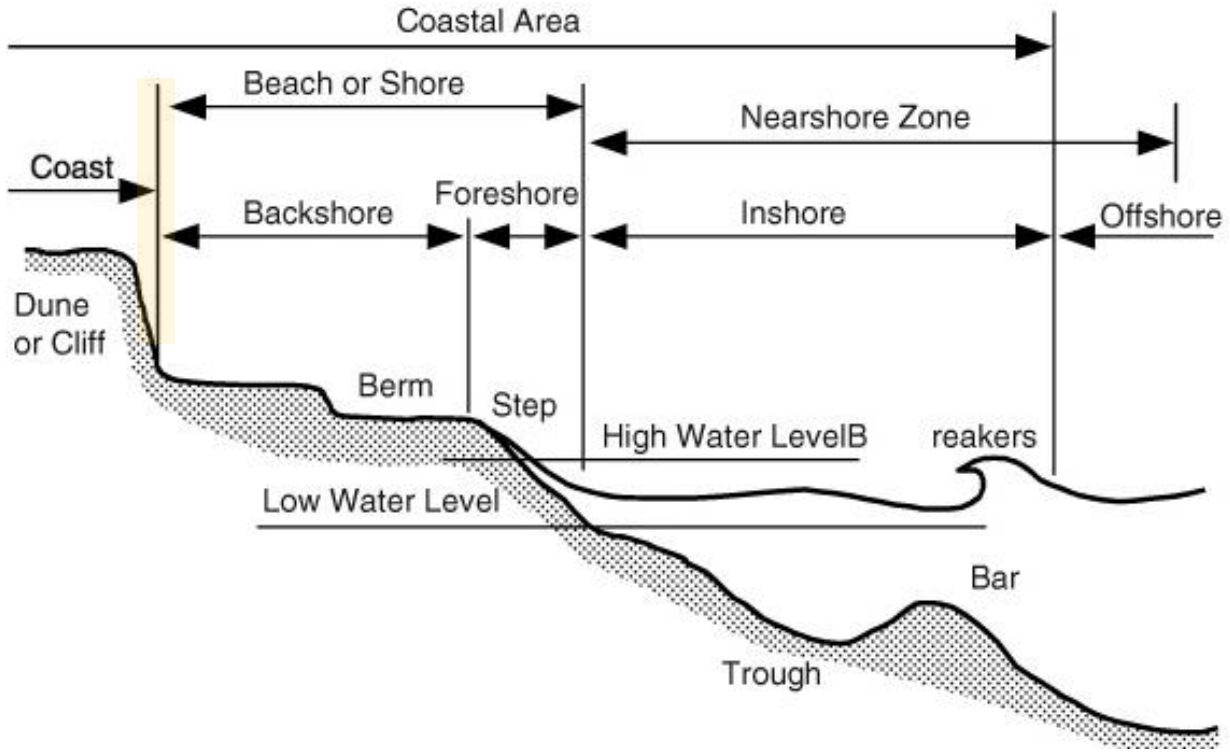


(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

A strip of land of indefinite width (may be several kilometres) that extends from the beach/shore inland to the first major change in terrain features.

The Economic Planning Unit (EPU): The inner landward limit is 5 km from the shoreline. However, if the area is lined with mangrove/nipah swamps, then the coast extends 5 km from the landward side of the swamps.

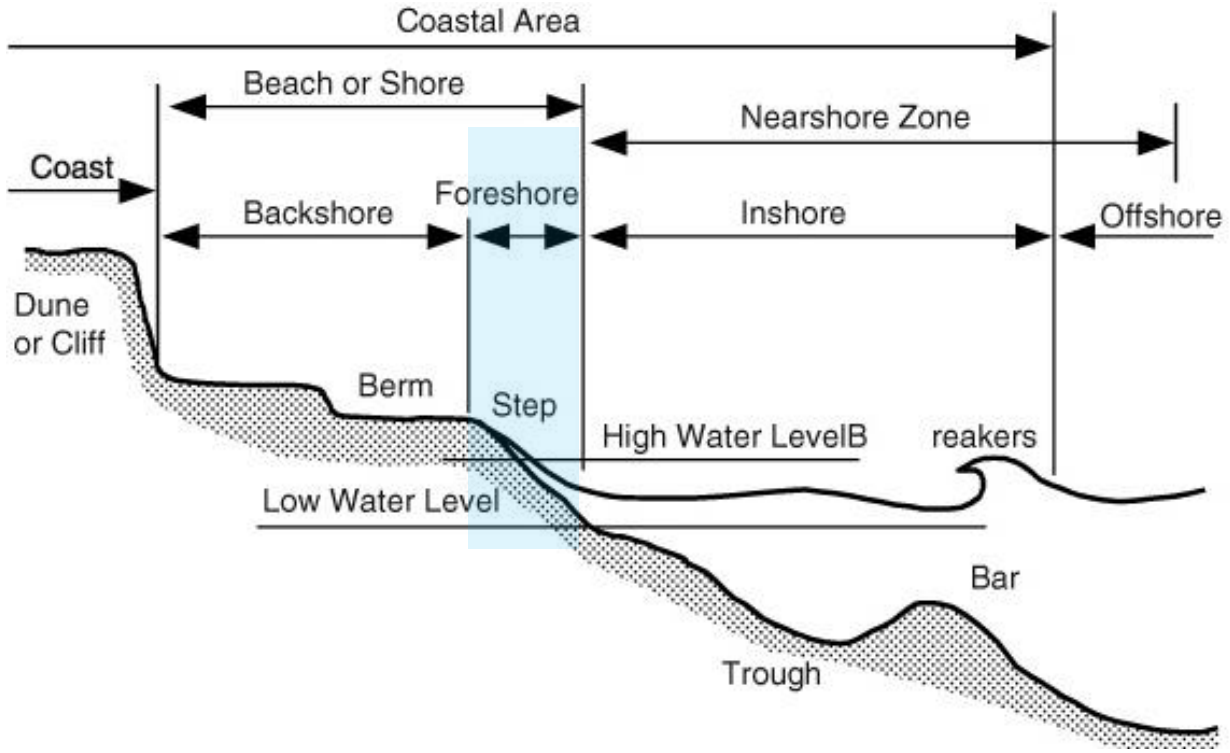
Coastline



(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

The line that forms the boundary between the coast and the shore.

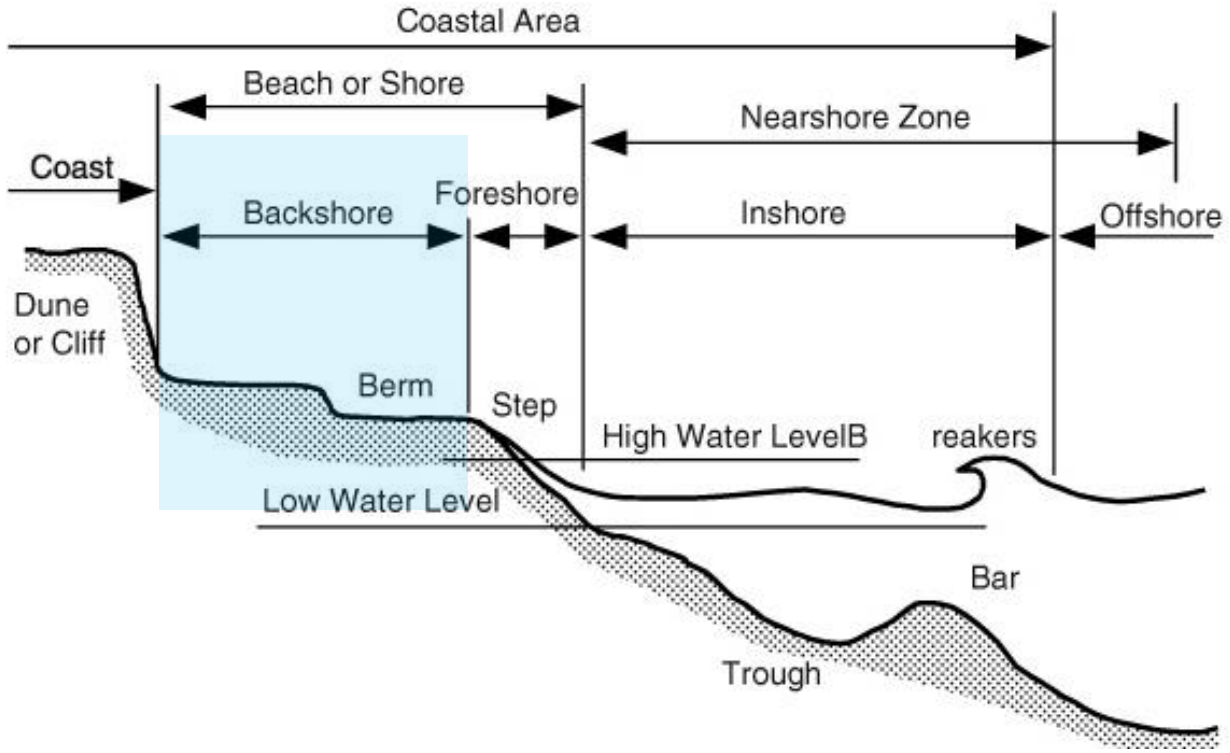
FORESHORE



(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

The part of the shore, lying between the crest of the seaward berm and the ordinary low-water mark.

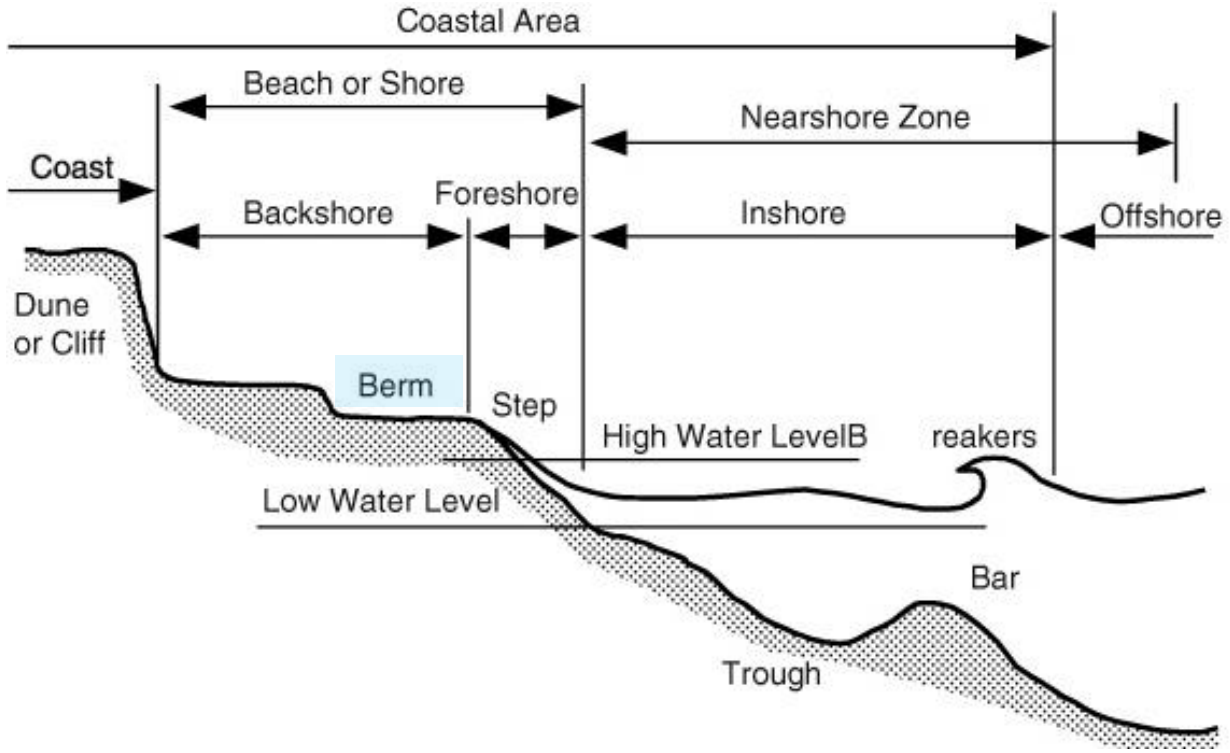
Backshore



(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

The zone of the shore/beach lying between the foreshore and the coastline comprising the berm(s) and acted upon by waves only during severe storms, especially when combine with exceptionally high water.

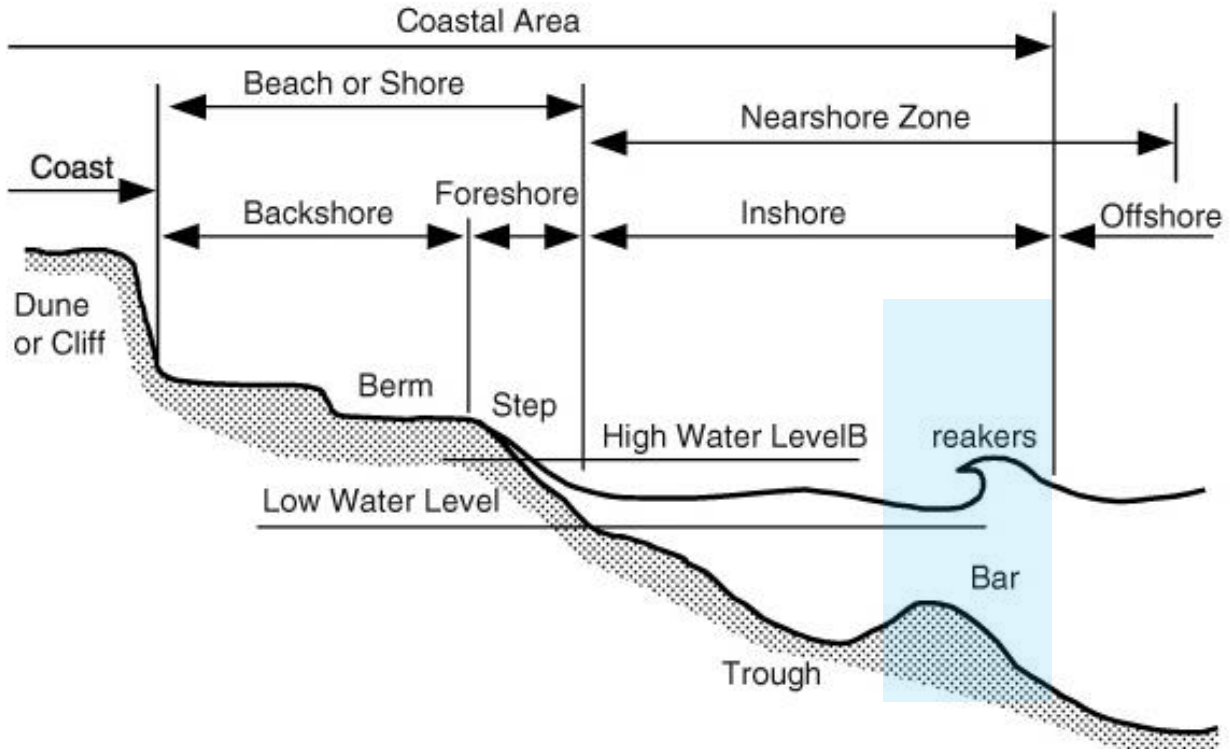
Berm



(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

A nearly horizontal part of the beach or backshore formed by wave and wind action.

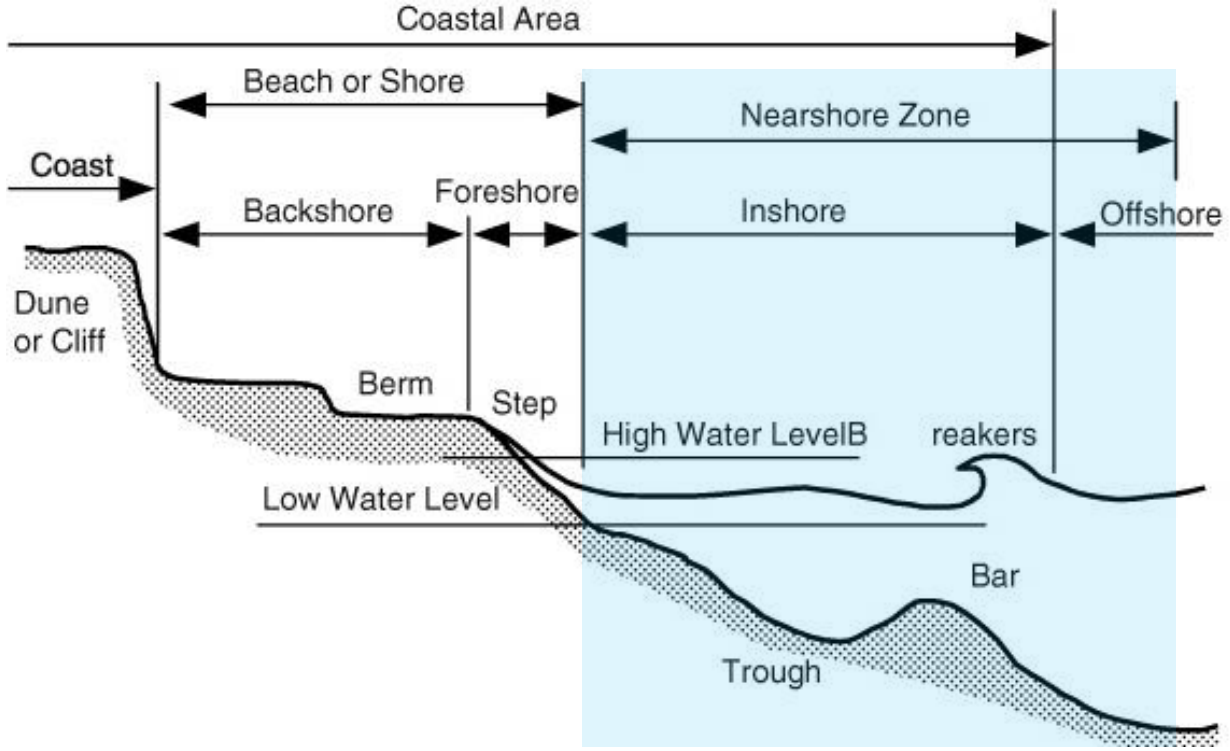
Breaker Zone



(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

The zone within which waves approaching the coastline commence breaking, typically in water depths of between 5 and 10 meters.

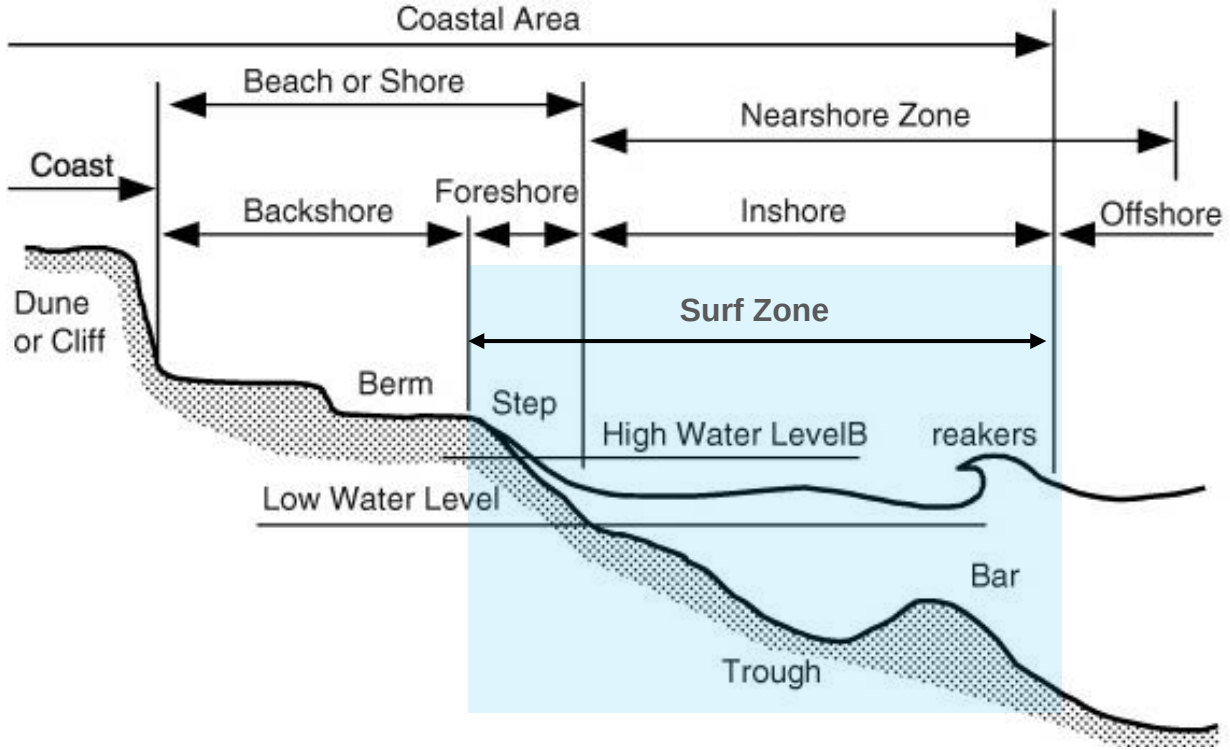
NEARSHORE



(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

An indefinite zone extending seaward from the shoreline well beyond the breaker zone.

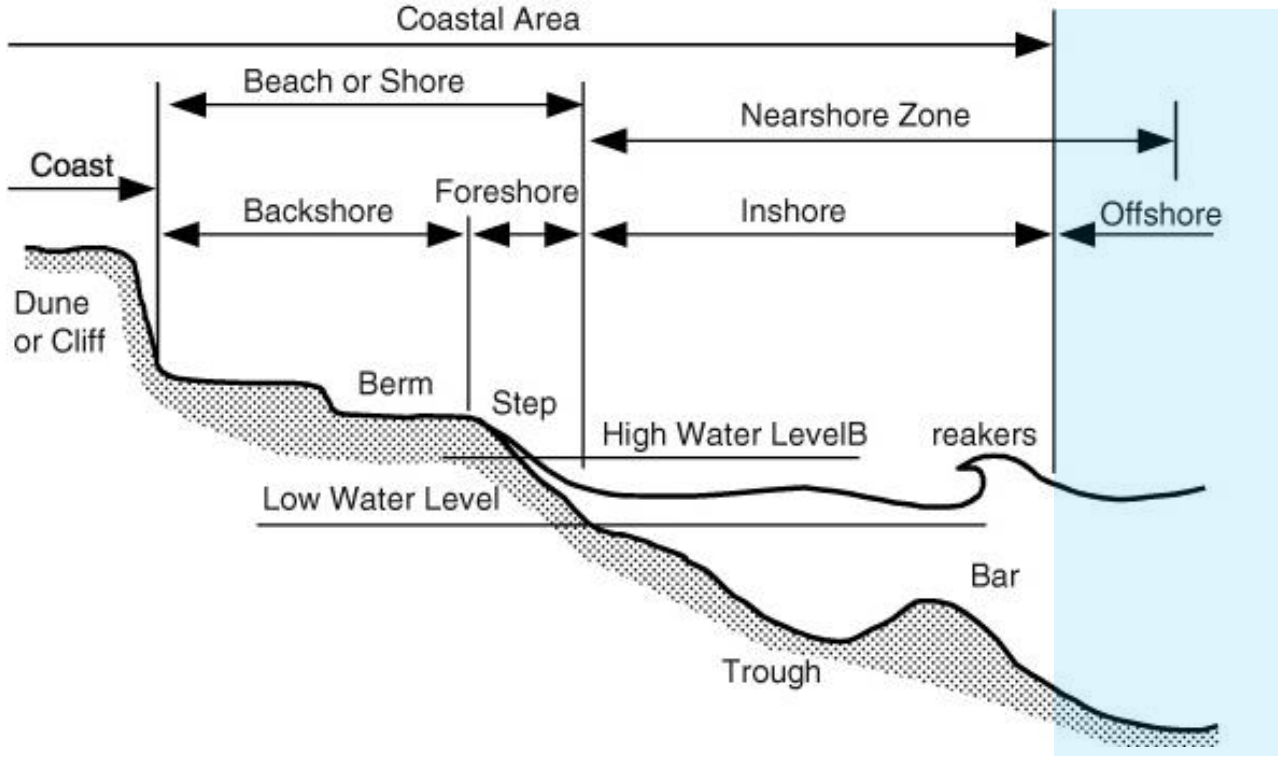
Surf Zone



(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

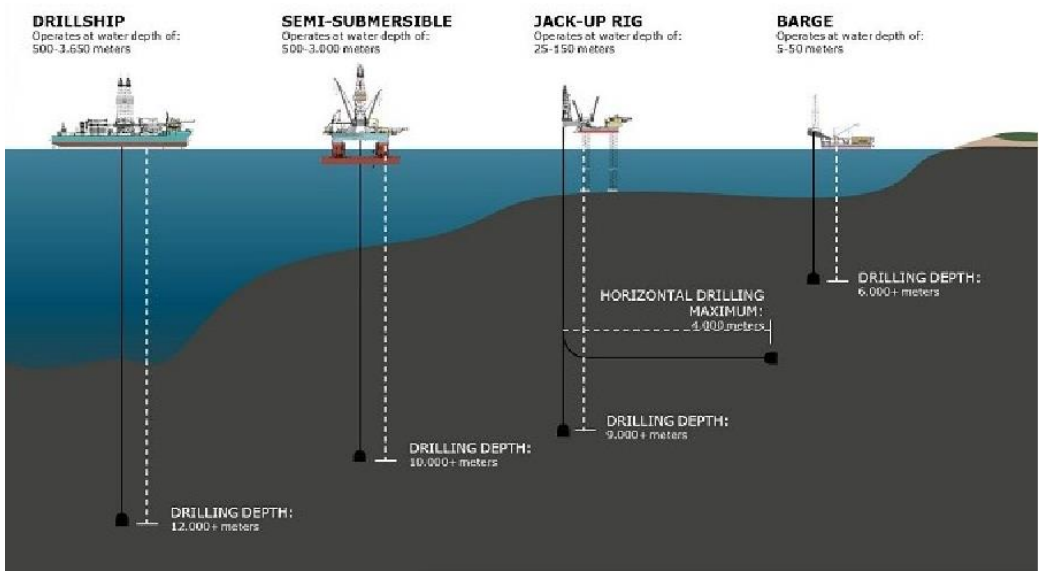
The area between the outermost breaker and the limit of wave uprush (the rush of water up onto the beach).

OFFSHORE

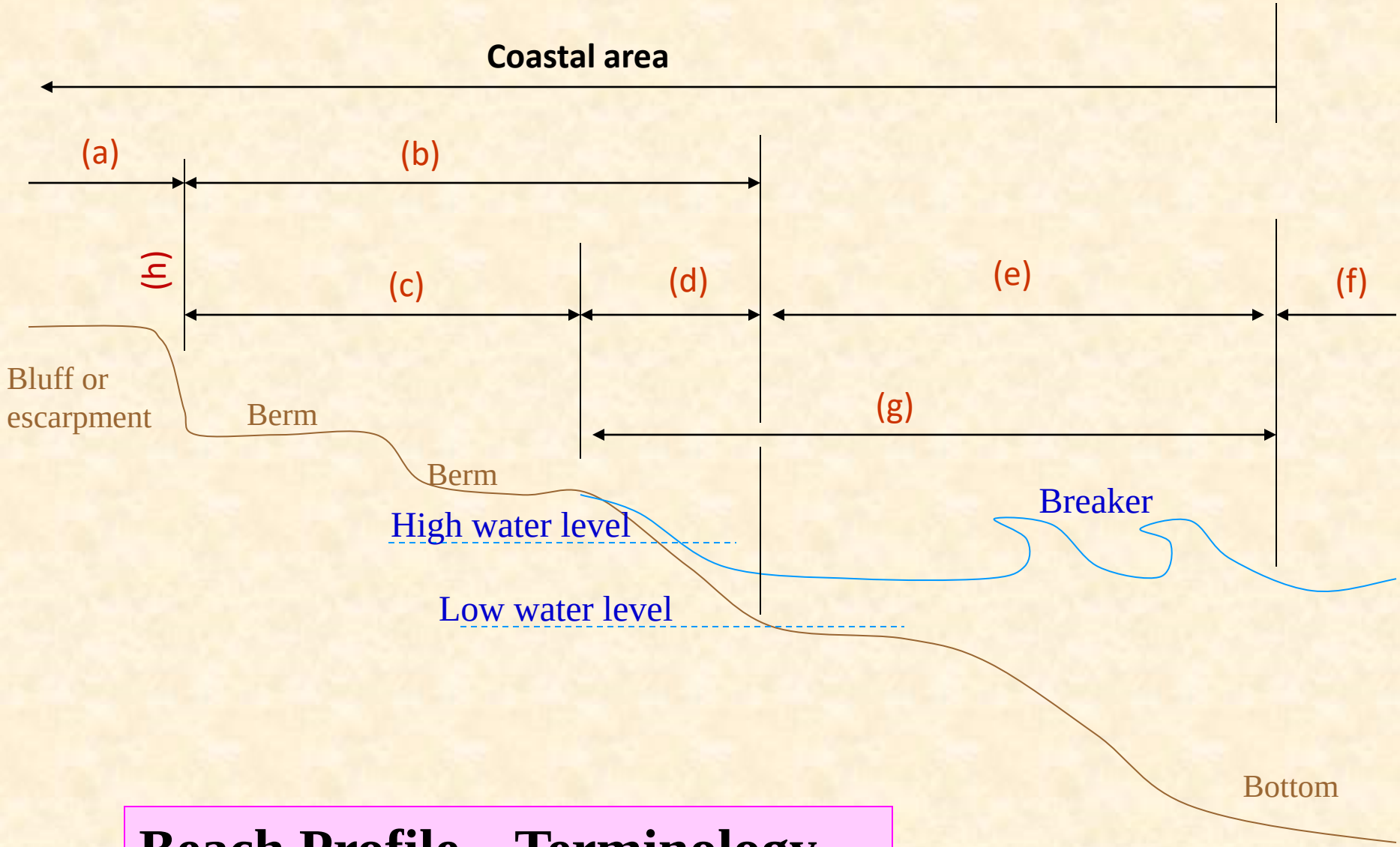


(Source: https://link.springer.com/referenceworkentry/10.1007%2F1-4020-3880-1_37)

The comparatively flat zone of variable width extending from the breaker zone to the seaward edge of the Continental Shelf.

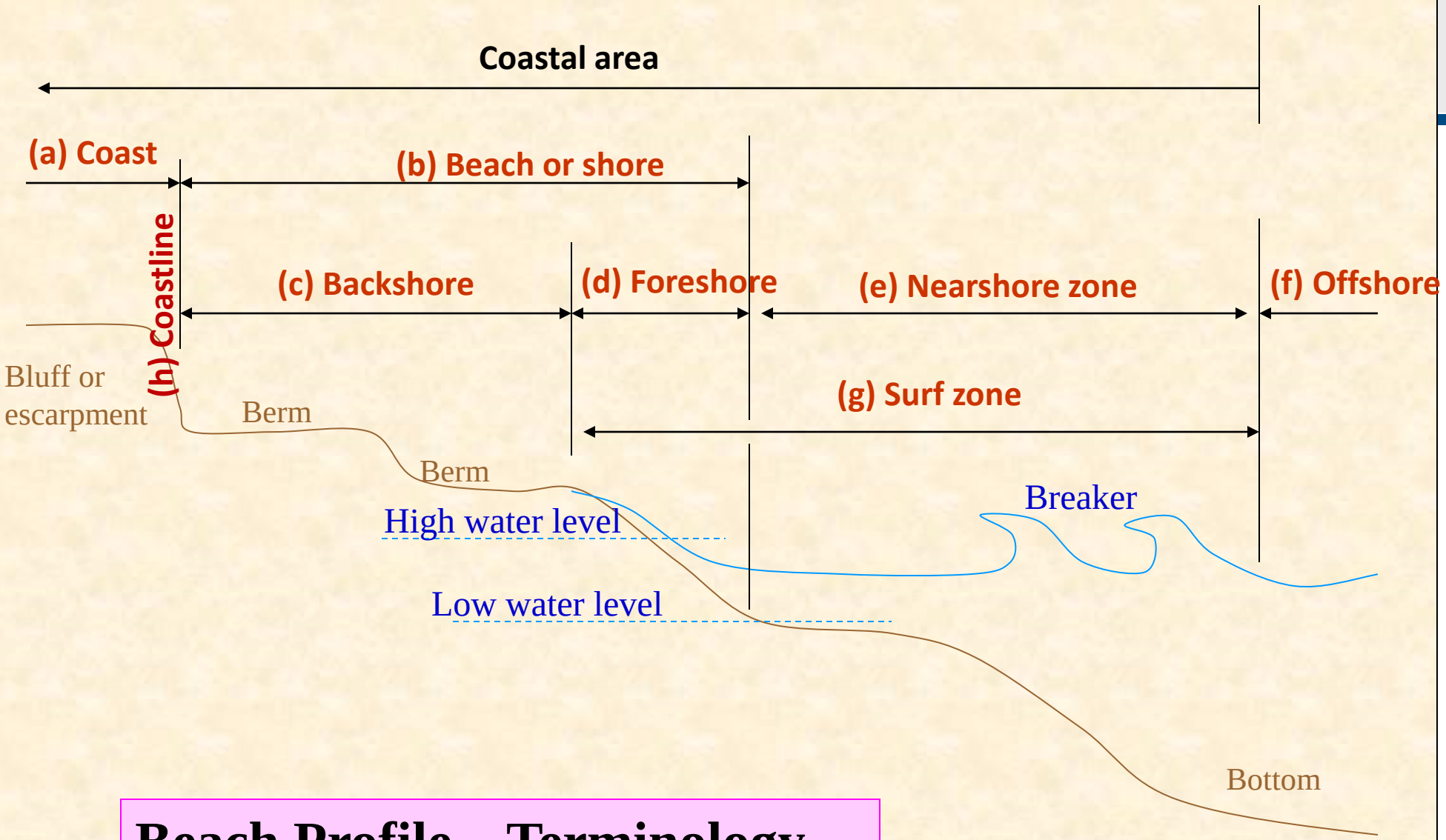


https://www.semanticscholar.org/paper/Technical-problems-of-mud-pumps-on-ultra-deepwater-Bejger-Piasecki/fdd0bdc2485361f20e3215a9aabb5c26f0ee5fc6



Beach Profile – Terminology

- Surf zone
- Offshore
- Coast
- Nearshore
- Foreshore
- Backshore
- Shore
- Coastline



Beach Profile – Terminology

Lesson Outcomes

Upon completion of this course, students should be able:

- to classify the type of coasts based on the sediment particle size.
- to characterize the coastal formations.

Learning Objectives

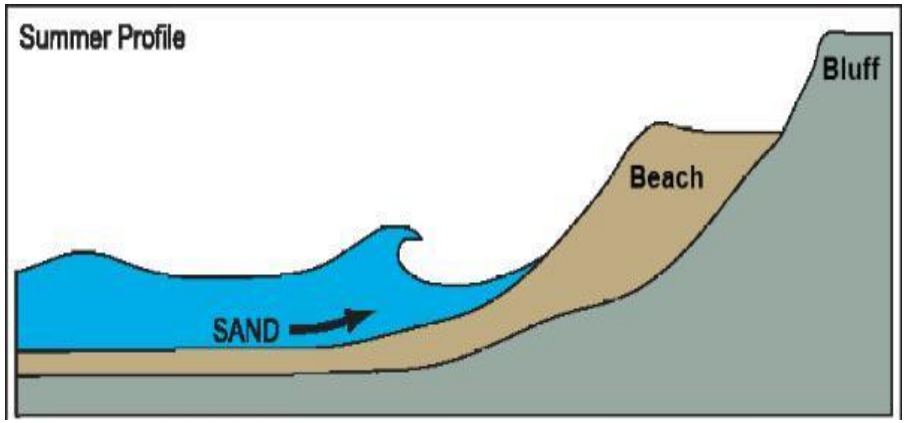
Coastal Profile

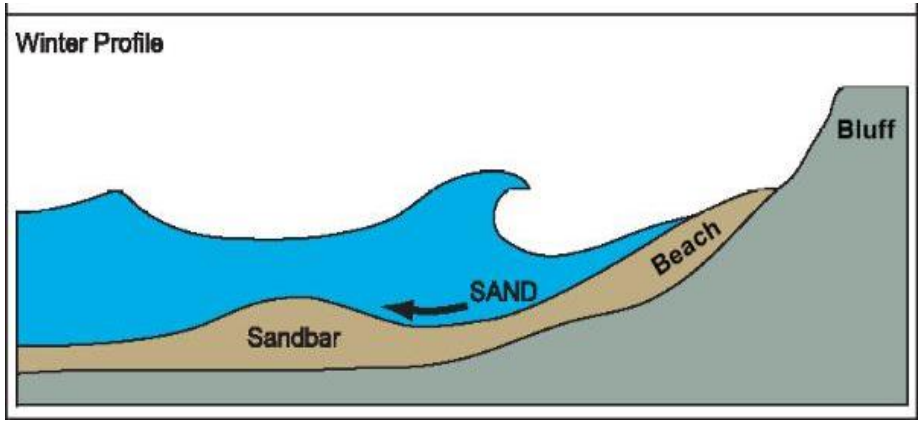
Adapted from the source:
http://www.kustopkracht.nl/over-kust-op-kracht/fotos/artist-impression.html

- Where ocean and land meet, some kinds of natural coast form.

- The profile of a particular coast depends on:
  - ➢ local characteristics of the land
  - ➢ the sediment
  - ➢ local wave and current characteristics

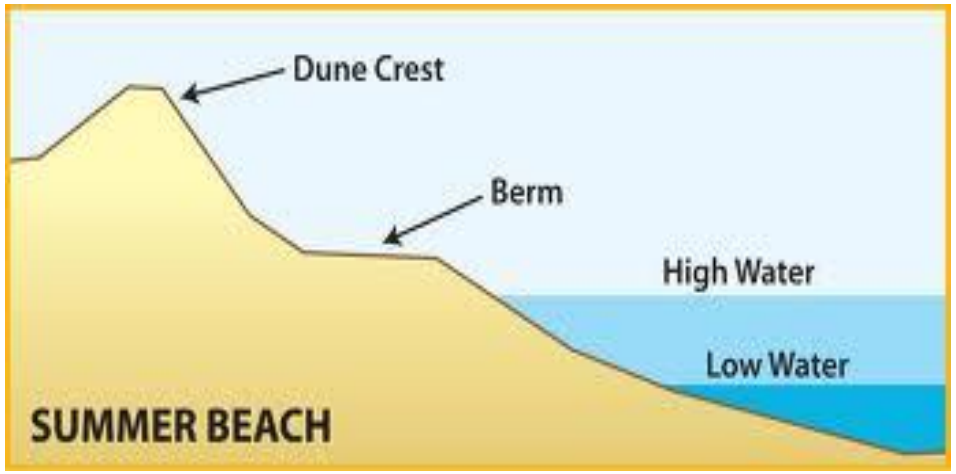
Beach Profile





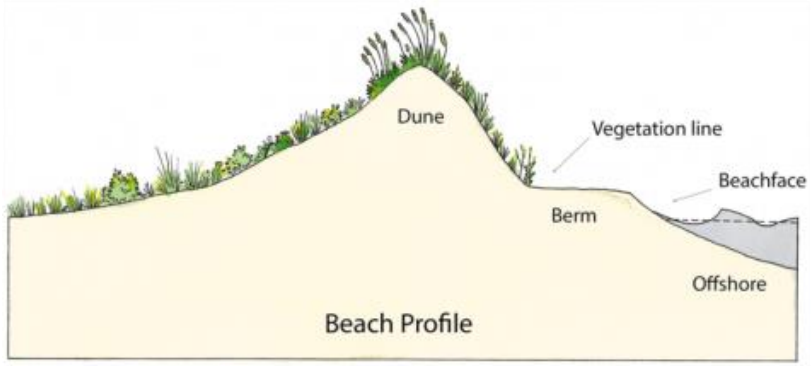
- A beach will develop if sufficient sediment is available.
- The form of a beach depends on wave and current characteristics, and sediment characteristics.
- In regions where the weather conditions are strongly dependent on the season, different profiles for the summer and the winter beach occur.

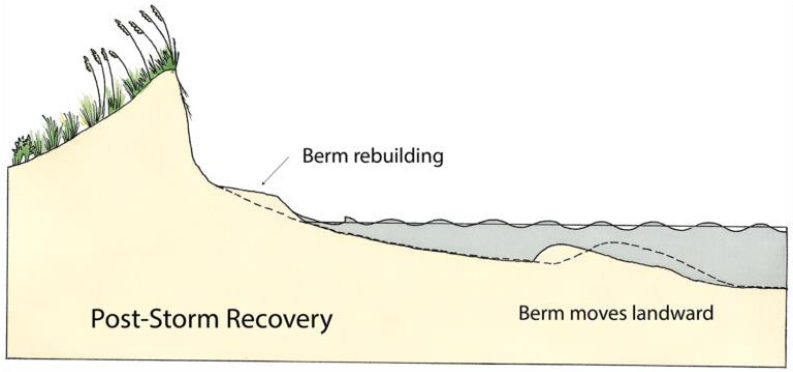
Beach Sediment

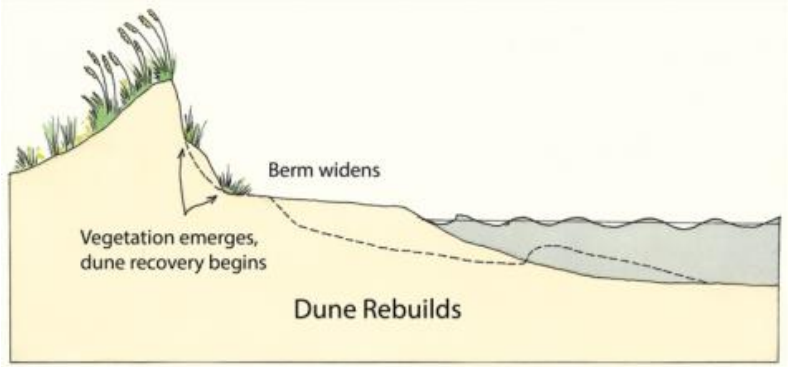


- Courser sediments will result in steeper beaches.
- At the point of maximum wave uprush, a berm is formed.
- The geometry of the berms and their number is related to the size and frequency of water level changes caused by tide and wind.

DUNES







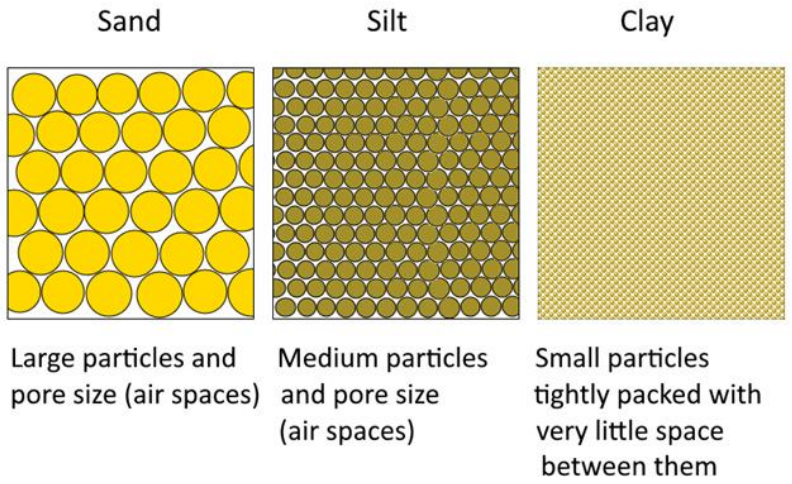
A beach profile consists of a sand dune, vegetation line, berm, backshore and foreshore.

The berm can take months, perhaps years, to rebuild after a storm.

The berm widens naturally after a storm.

(Source: https://dredgewire.com/coastal-erosion-specialist-on-surf-citys-300000-beach-push-emotional-benefit-but-little-improvement/)

Classification of Beach Materials



Sediments are classified from course to fine as:

- Pebbles and gravel (> 2 mm)
- Sand (0.06 – 2 mm)
- Silt (0.004 – 0.06 mm)
- Clay (< 0.004 mm)

(Source: https://dengarden.com/gardening/How-to-Determine-Your-Soil-Type-For-Planting-Success; https://deepgreenpermaculture.com/2020/07/23/three-simple-soil-tests-to-determine-what-type-of-soil-you-have/)

Beach Classification

- Sandy beach
- Shingle beach
- Rocky beach
- Muddy beach

Sandy Beach

- Sand at the beach, which originates mostly from inland rock formations, is eroded and transported by rivers and coastal currents.
- Coasts with fine sands can result in very gently sloping beaches, with slopes as low as 1:100 or even flatter.

Shingle Beach

- A steeper beach profile (with a slope of 1:10 – 1:2) with offshore steps occurs.

Rocky Beach

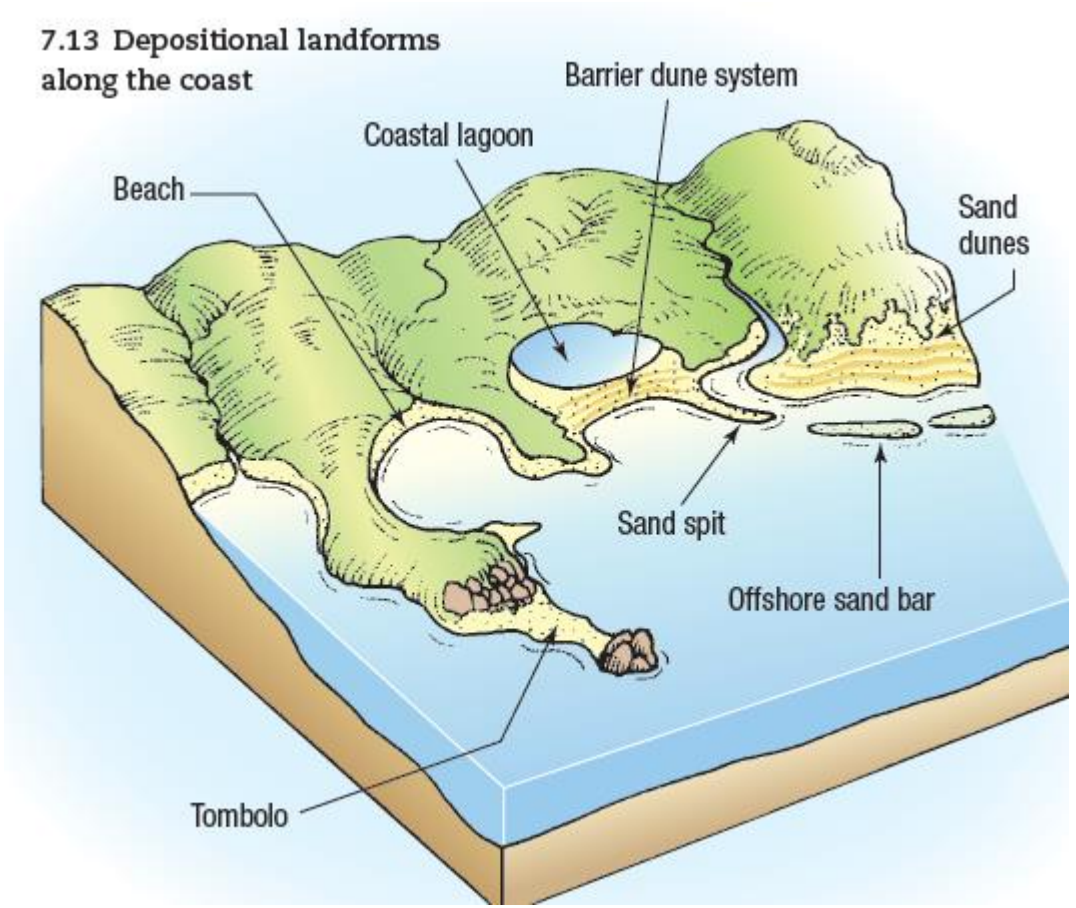
- If the land consists of high solid rocky material, the coast will be dominated by cliffs instead of dunes.
- Whether or not a beach will be presented at the foot of the cliff depends on the local wave and current characteristics, as well as on the amount of available sediments either formed by erosion of the cliffs or brought by currents.

Muddy Beach

- Very fine sediments such as silt and clay are normally kept in suspension near the coast.
- Mud coasts only occur if large amounts of fine particles are present or if the coast is protected from wave action.
- The coastal profiles of mud coasts are very flat; slopes < 1/1000 or even flatter. Hence, the foreshore area, which is alternatively wet and dry, is very wide.

Coastal Formations

1. Estuary
2. Tidal inlet
3. Delta
4. Barrier Island
5. Spit
6. Tombolo
7. Pocket Beach

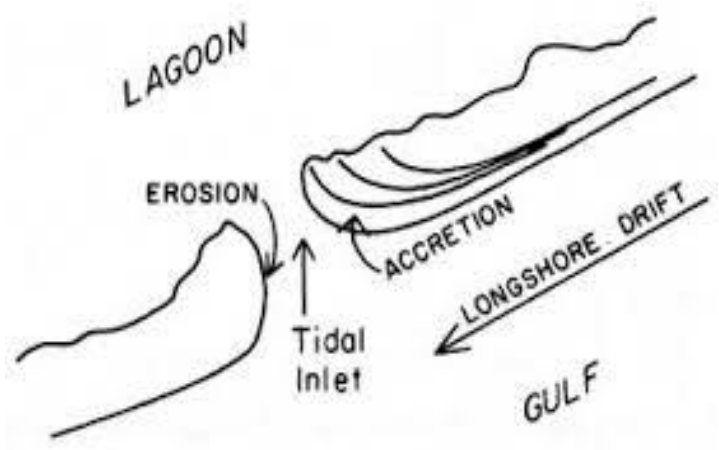


http://cavsgeographyclass.blogspot.com/2011/02/year-10-73-geographical-processes.html

Estuary

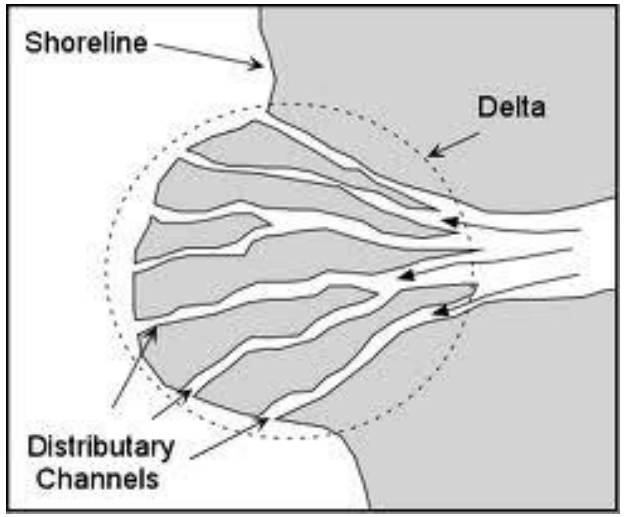
- Estuaries are those parts of rivers where the tide of the sea has an effect.
- An estuary forms the transition from river to sea.
- The saline sea water mixes with the fresh river water (brackish water).
- Estuaries are home to unique plant and animal communities that have adapted to brackish water.

Tidal Inlet



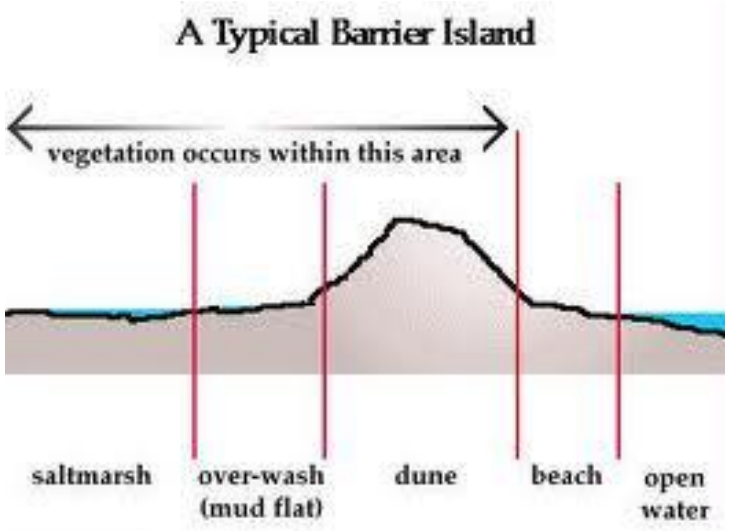
- A tidal inlet is an opening in the shoreline through which water penetrates the land.
- The tide transports sea water into a marsh behind the dunes or through a string of barrier islands into a lagoon.
- A tidal inlet is a short, narrow passage connecting two larger and wider bodies of water.
- In contrast to an estuary, no discharge of river water is present.
- During flood, landward transport of sea water takes place which is reversed during the ebb.

Delta



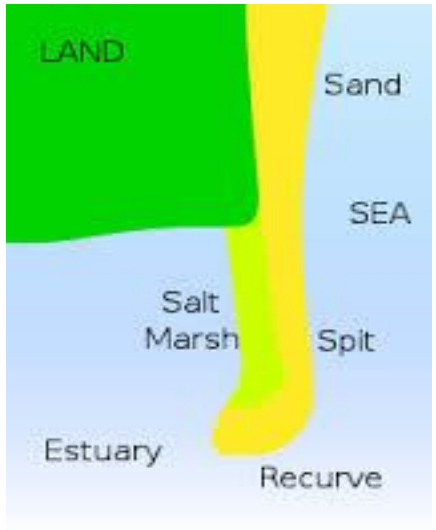
- River deltas are formed when the supply of sediments to the coast by a river is faster than they are dispersed by waves, tides and the associated currents.
- They are the result of depositional and erosional processes under the influence of currents, waves and tides.
- Because of their different morphologies, often a distinction is made between river-dominated deltas, wave-dominated deltas and tide-dominated deltas.

Barrier Island



- Barrier islands are long, narrow, offshore deposits of sand or sediments that parallel the coastline.
- They are subject to change during storms and other action, but absorb energy and protect the coastlines and create areas of protected waters where wetlands may flourish.
- A barrier island may extend uninterrupted for over a hundred kilometers, excepting the tidal inlets that separate the islands.
- The amount of vegetation on the barrier has a large impact on the height and evolution of the island

Spit/ sandspit



- A narrow coastal land formation which points as a tongue into the sea.
- It is formed by a wave-driven current that transports sediment along a shore (alongshore current). Due to this longshore transport, the coast will be extended in the longshore direction where the shore abruptly ends.
- They often are complexly curved, with a characteristic recurved head (hook); this probably results from the refraction of waves around the spit's end.

HEADLAND

- A headland is a point of land usually high and often with a sheer drop, that extends into a body of water.
- A headland of considerable size often is called a cape.
- Headlands are characterised by high, breaking waves, rocky shores, intense erosion, and steep sea cliff.
- Headlands consist of bands of stronger (more resistant) rocks (i.e., limestone, granite) forming a headland, or peninsula.

Bay

- A bay is a recessed, coastal body of water that directly connects to a larger main body of water, such as an ocean, a lake, or even another bay.
- A large bay is usually called a gulf, sea, sound, or bight.
- A cove is a small, circular bay with a narrow entrance.
- Headlands and bays are often found on the same coastline.

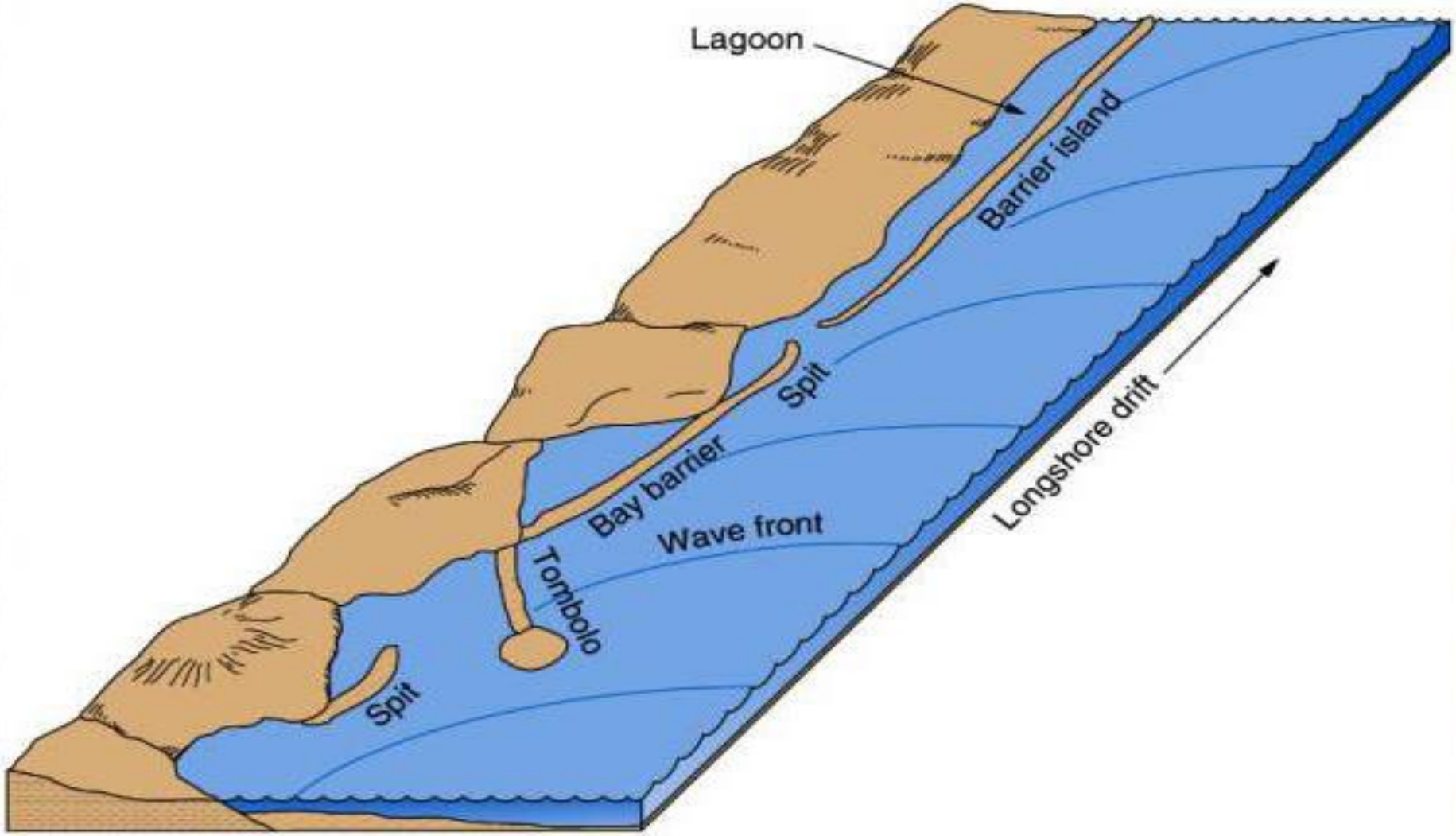
Tombolo

- An obstacle in front of a coast (e.g. a rock formation, an offshore breakwater, or a shipwreck) can result in a tombolo.
- A tombolo is a spit connecting an island to the mainland.
- Due to reduced transport capacity in shadow zone between the obstacle and the coast, a neck-like shoal will develop.

Pocket Beach

- A pocket beach is usually a small beach that is isolated between two headlands.
- Between two protruding rock formations, an often relatively small amount of sediment can be confined. The sediment form a beach that is aligned to the dominant wave crest direction.
- There is typically very little or no exchange of sediment between the pocket beach and adjacent shorelines.

Typical Coastal Formations



Ocean Environmental Forces

Coastal Challenges

- Coastal erosion
- Climate change & sea level rise
- Storm surge
- Tsunami
- Seawater contamination

How Coastal Erosion Works?

Climate change

Climate change effects on the key physical processes acting on coasts

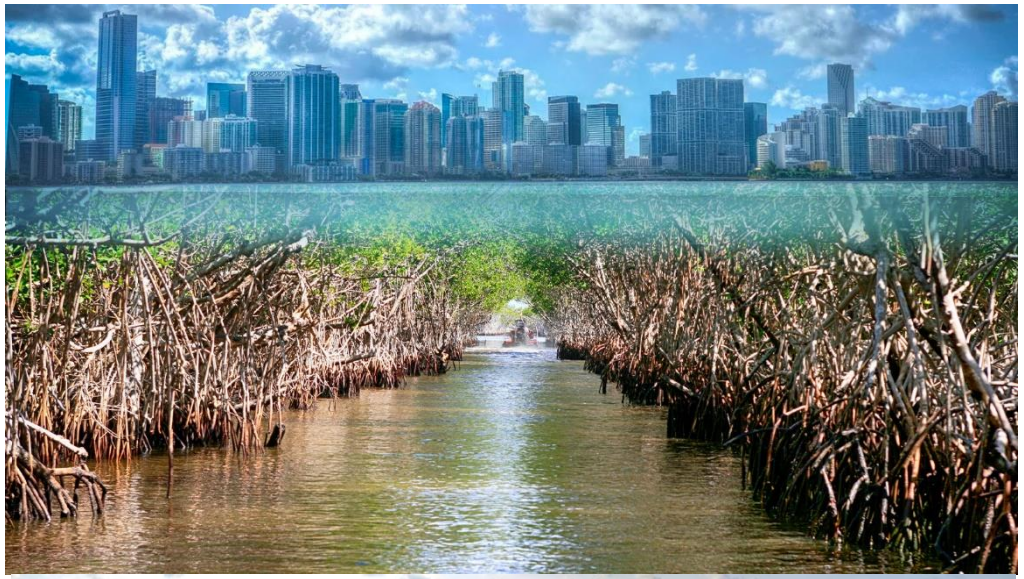
Symbol	Parameter
	sea level rise
	changes in storm intensity and frequency
	changes in storm surge
	changes in mean wave conditions
	changes in river flow

[Source: Ranasinghe, 2016]

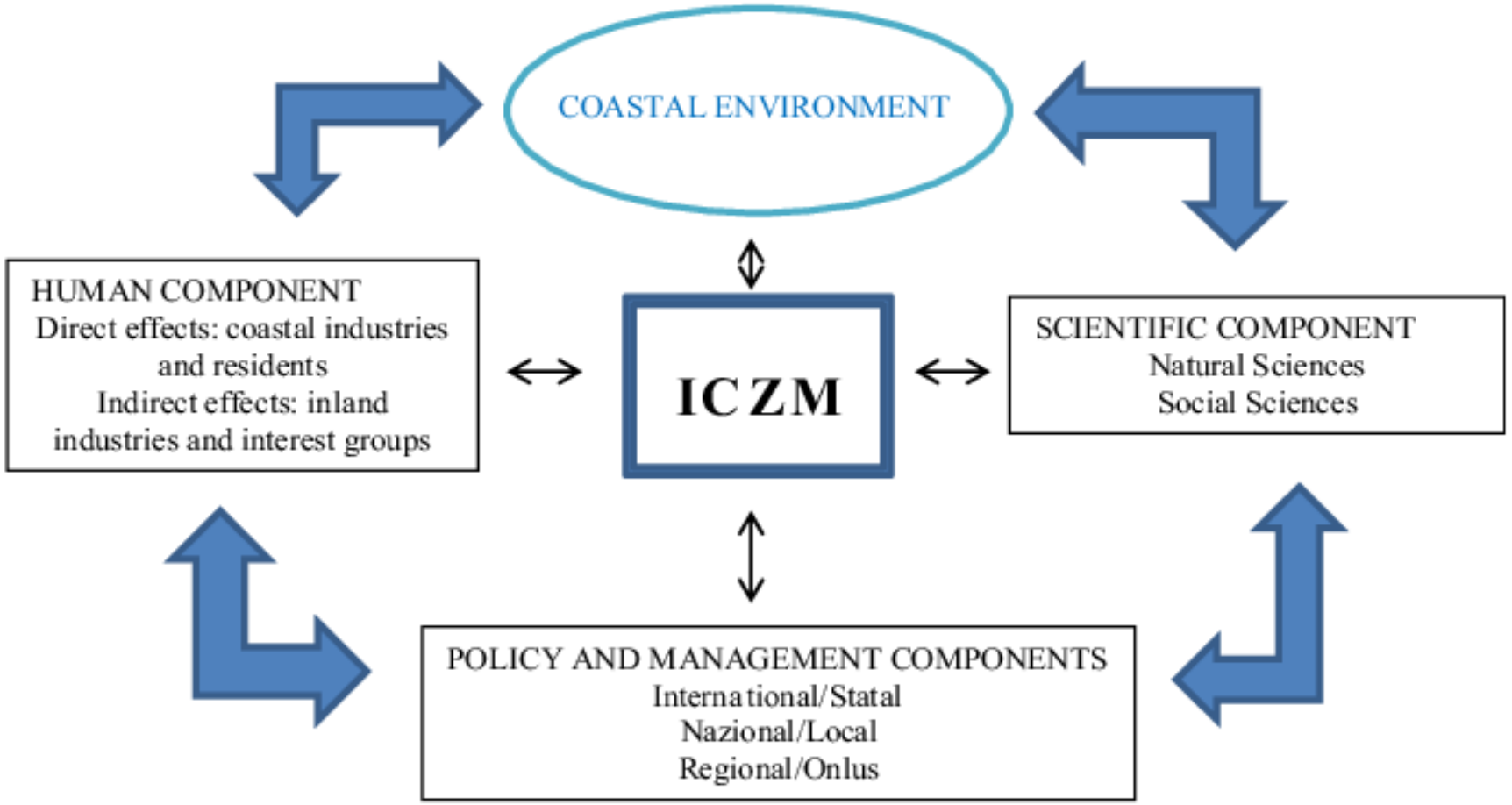
Climate Change in the Pacific: COASTS

Coastal Sustainability

(Source: http://140.112.64.54:88/en/TCG04/%C3%A2cs/vdsd)



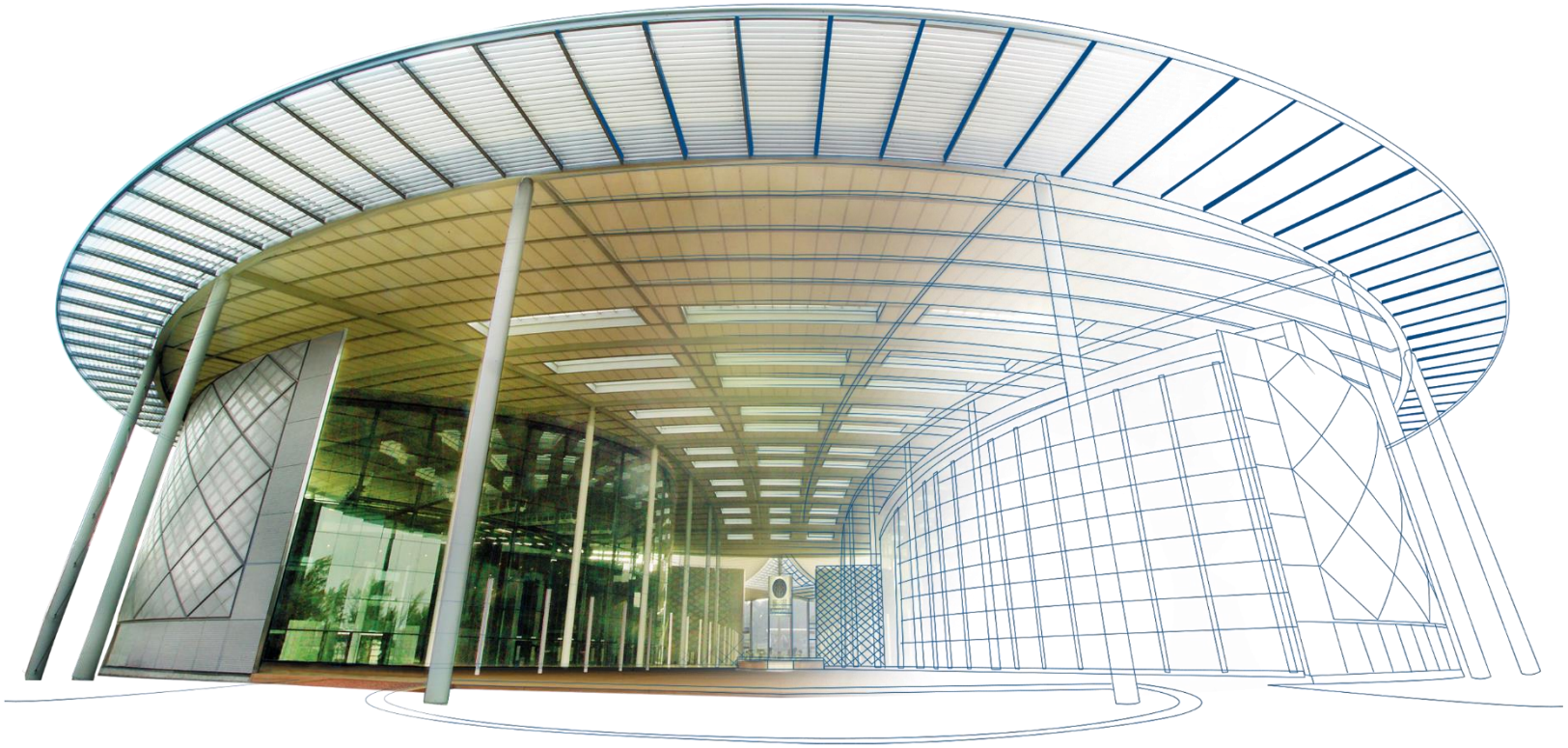
Coastal Sustainability



(Source: https://www.semanticscholar.org/paper/Marine-and-river-environments%3A-A-pattern-of-Coastal-Cantasano-Pellicone/82e62cb92d4cd2b7cd0fc523210516925ebf5ba8)

KIND REMINDER

1. Student attendance using MS PowerApps
2. T&L satisfaction poll



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