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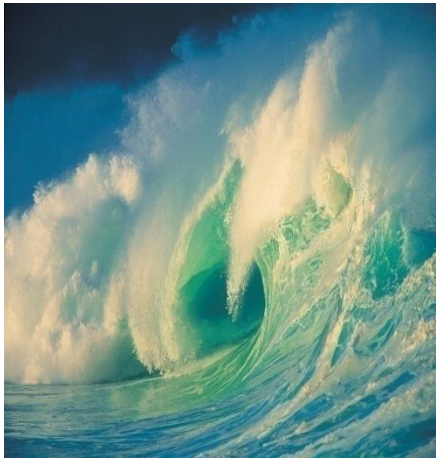
Co-funded by the Erasmus+ Programme of the European Union

Overview

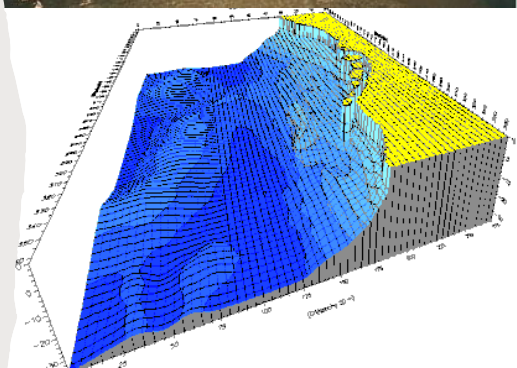


Course Learning Outcomes

CLO1 Assess the influencing environmental factors and related coastal processes, and analyze causes of coastal erosion/sedimentation

CLO2 Develop skills and knowledge for the planning and management of coastal zone in respecting the principles of sustainability

CLO3 Evaluate application of different coastal stabilization schemes and the governing factors for their selection and impacts



Coastal Planning & Management

General Overview

- Overview of Coastal Engineering
- Basic Glossary and Terminology
- Intro to coastal processes
- Impact of development to coastal processes

Introduction

The term **“Coastal Engineer”** as indicated by O’Brien in First Conference on Coastal Engineering at Long Beach, California in 1950 is:

“It (Coastal Engineering) is not a new or separate branch of engineering and there is no implication intended that a new breed of engineer or society is in making. Coastal Engineering is primarily a branch of Civil Engineering which leans heavily on the sciences of oceanography, meteorology, fluid mechanics, electronics, structural mechanics and others.” Among others, there are geology, geomorphology, mathematics and statistics, computer science, soil mechanics and material science.

Introduction

Malacca

- Settlements started in coastal areas, especially at river mouths where shelter, easy access & food source were available.
- In later part of 19th & early 20th century, further development took place in coastal areas & hinterland with increased trading activities & population.
- Many coastal settlements, especially at estuaries developed further as state capitals & urban centers.

- Total length of coastline in Malaysia is 4,809 km;
- 1,972 km in Peninsula Malaysia & 2,837 km in East Malaysia

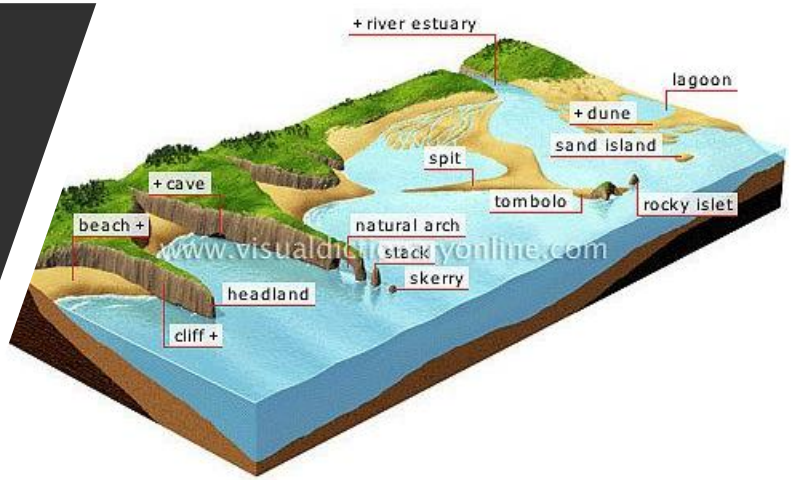
Location	Coastline Composition (%)	
	Sandy Beach	Mudflats
P. M'sia: West Coast	72	15
P. M'sia: East Coast	91	8
Sarawak	76	24
Sabah	54	39

Introduction (con't)

- To improve living standard of rural population, vast areas of mangrove swamps on Peninsular Malaysia's west coast were cleared for agricultural & aqua-cultural development in the 1960s & 1970s.
- For the past two decades, land reclamation projects had shifted focus to housing, urban, resort, hotel & industrial development.
- Concurrently, sandy beaches had also been widely developed for hotels & tourist resorts.
- Until today, land reclamation projects are being continually proposed & implemented.

Coastal Zone & Processes

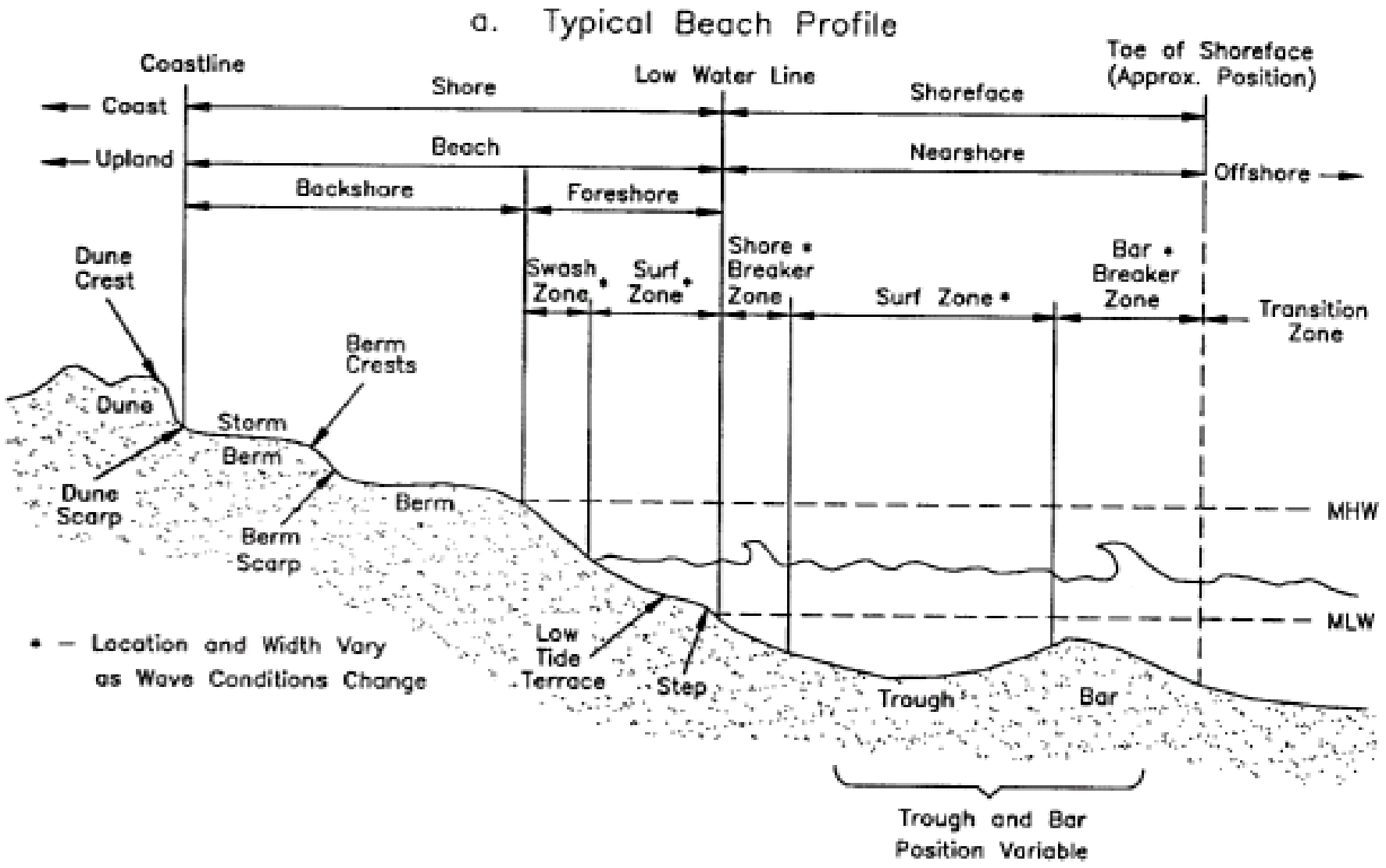
- 70% of the Earth is covered by water, and along coastlines, this water exerts tremendous forces on the coasts causing erosion, transport and deposition (Coastal morpho-dynamics).
- All coasts are subject to inputs of energy and materials which interact within the geological framework to produce coastal landforms.
- Coastal landforms are generally at ‘dynamic equilibrium’.



Shoreline

- The shoreline is the interface between land & sea.
- A natural shoreline can accrete or erode depending on prevailing environmental forces.
- A stable coastline is where its mean position remains unchanged over a period of time i.e. in a state of dynamic equilibrium.

Coastal Zone



Definition of terms & features describing the coastal zone (CEM 2002)

Coastal Nomenclature

- **Offshore:** Water depths > 1/2 wavelength of incoming waves ($d/L > 0.5$). Wave-induced sediment movement is limited.
- **Nearshore:** Wave transformations and virtually all sediment movement occurs.
- **Breaker zone:** Breaking waves occur.
- **Surf zone:** Broken waves travel up the shore; sediment is transported onshore, offshore and alongshore.
- **Swash zone:** Landward area covered by uprushing water from breaking wave, and the water recedes as backwash.
- **Backshore:** Lies above level of wave action (swash zone).


Rocky beach

Boulder beach

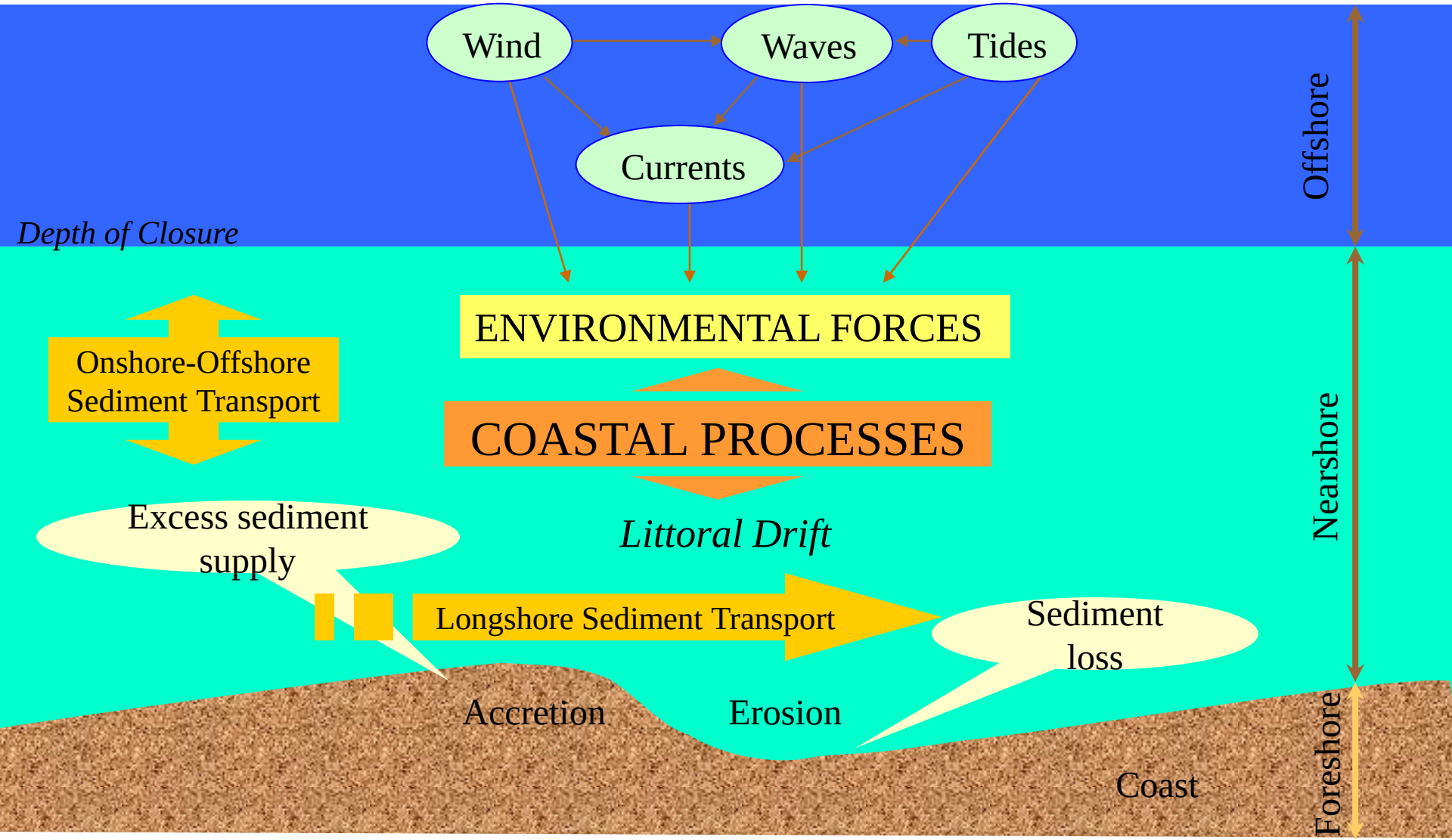

Shingle beach


Sandy beach


Muddy beach

Coastal Processes

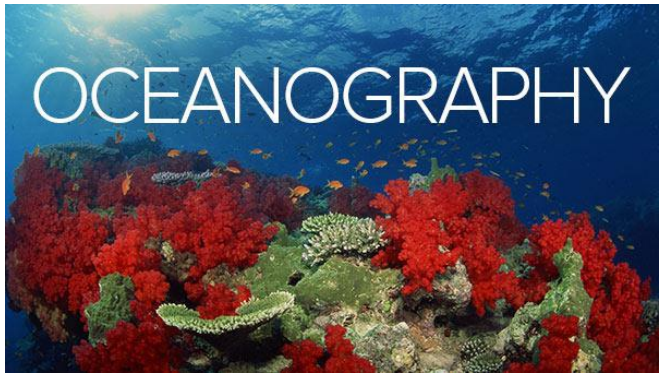
Coastal Environment



Coastal processes

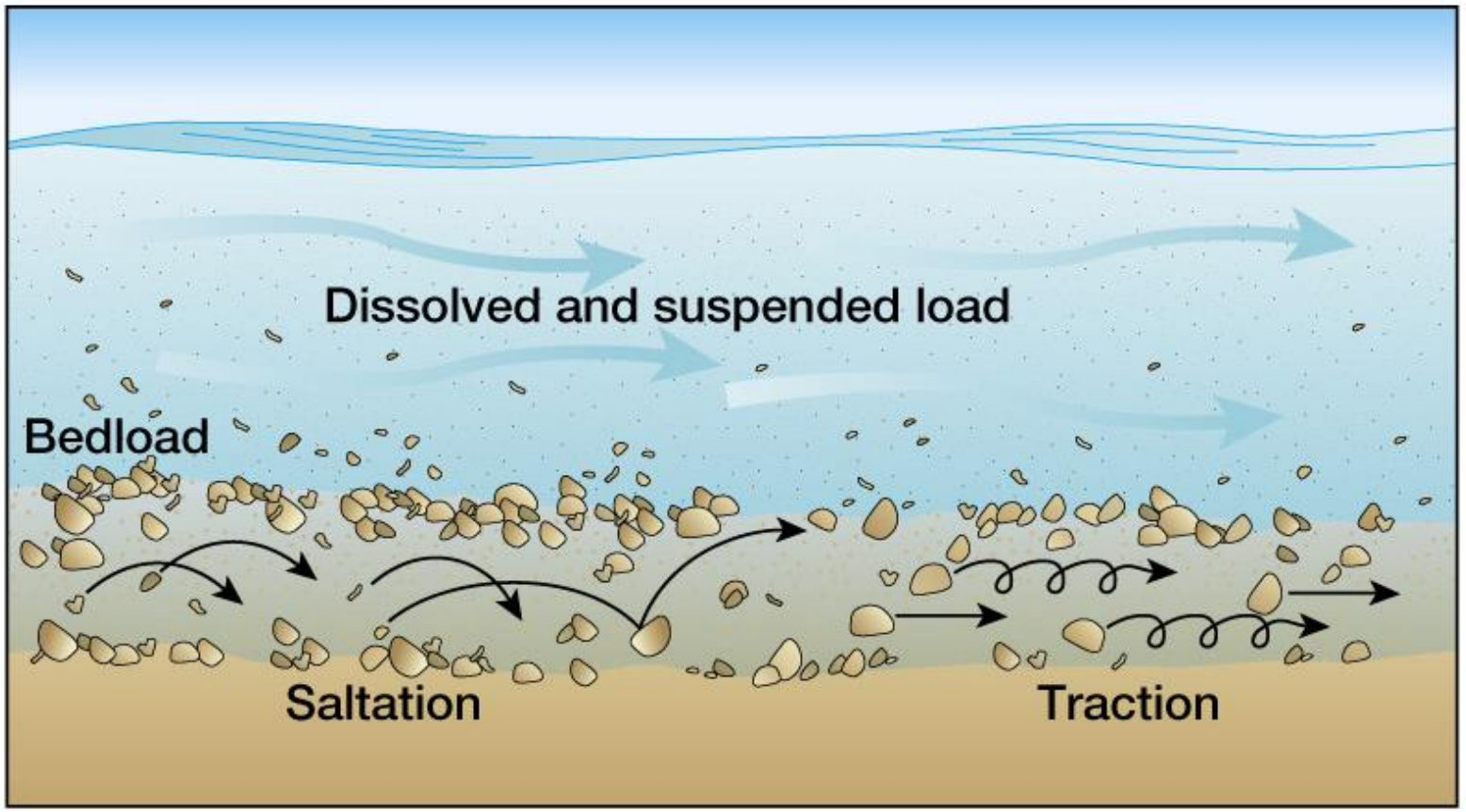
Physical processes, i.e. tides, waves, winds & currents continuously shape the coastline, wearing it down (erosion) in some places & building it up (accretion) in others

Coastal processes



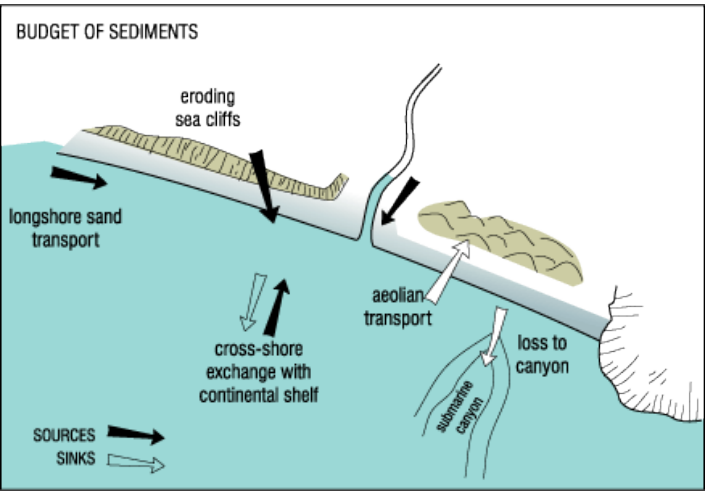
- Oceanography, geology, ecology & morphology are strongly interrelated in the coastal zone.
- Physical, chemical & biological processes influence configuration of the coast.

Coastal Processes



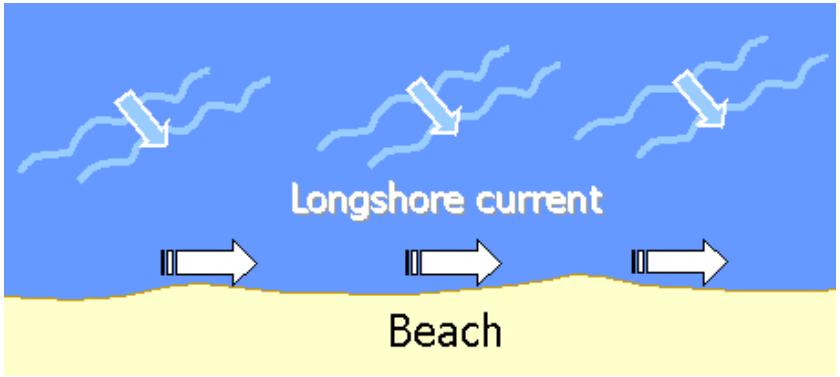
- Diverse and complex natural processes change coasts physically, at scales that range from microscopic (grains of sand) to global (changes in sea level).

Natural Processes



- Coastal lands and sediments are constantly in motion.
- **Alongshore sediment transports:** Breaking waves move sand along the coast, eroding sand in one area and depositing it on an adjacent beach.
- Rivers carry sediment to the coast and build deltas into the open water
- Storms cause deep erosion in one area and leave thick overwash deposits in another.

Longshore Sediment Transport



Schematic of Longshore Transport

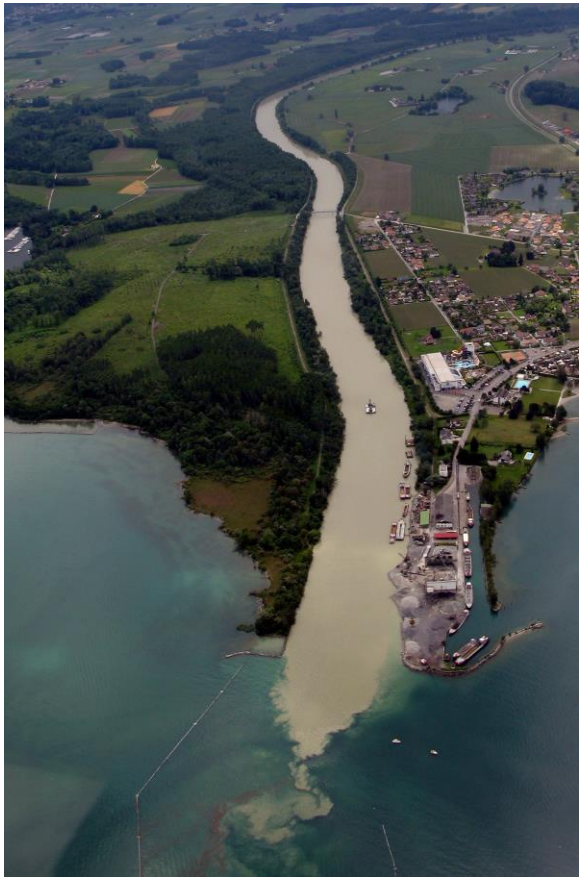
Sediments are transported alongshore by waves breaking at an angle to the shore.

Kerteh, Terengganu

If sediment carrying capacity of longshore current generated by waves exceeds quantity of sediments naturally supplied to the beach, **beach erosion** occurs.

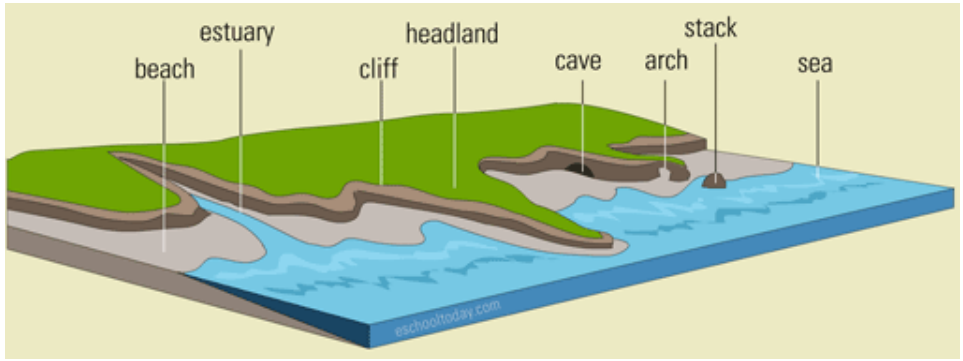
Variability in Sediment Supply to the Littoral zone

Changes in world weather pattern can cause drought resulting in reduction of floods on rivers, limiting sediment supply to the coastal zone.



Muda Dam, Kedah (2003)

Coastal Processes



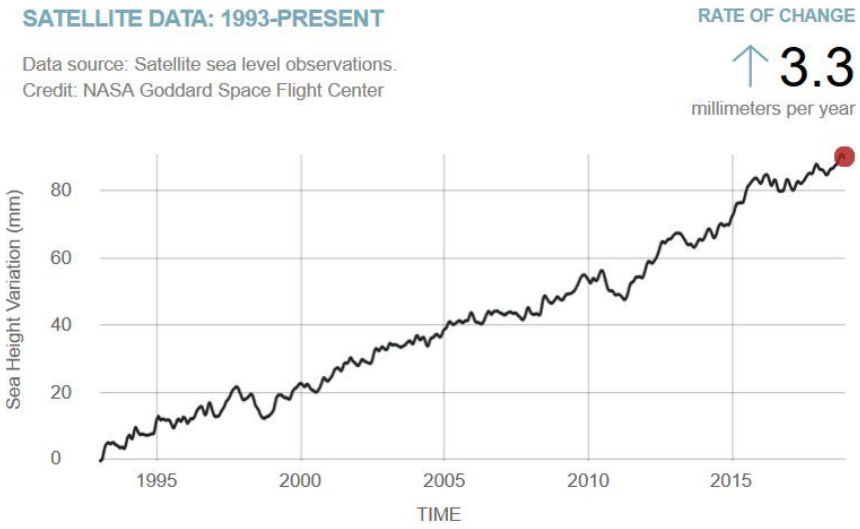
Regional and local characteristics of coasts control the differing interactions and relative importance of these natural processes.

Wave & Surge Overwash

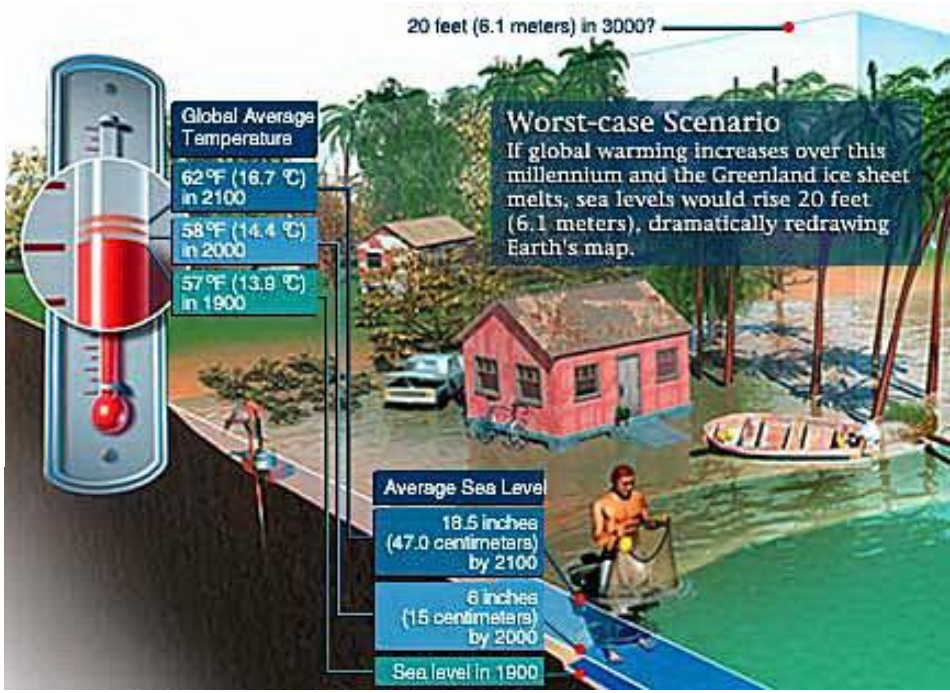
Waves & overflowing water erode the beach, transport & deposit the material shoreward of the beach

Pre- & post Hurricane Ivan conditions in Alabama, USA (2005)

Sea Level Rise



https://www.google.com/maps/place/Mal%C3%A9,+Maldives/@3.8224143,73.4381053,37127m/data=!3m1!1e3!4m5!3m4!1s0x3b3f7e5607d1f5e5:0x8ad8e99b5a051299!8m2!3d4.1754959!4d73.5093474

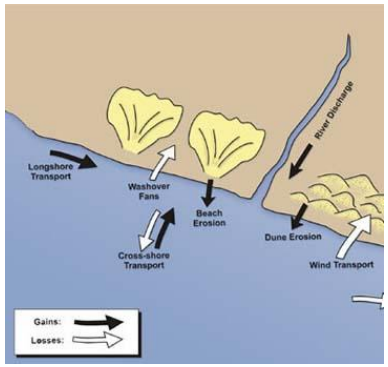


Global Warming Affects Sea Level Rise

Long term rise in sea level exists resulting in a slow, long-term recession of the shoreline partly due to direct flooding & partly as a result of land profile adjustment to higher water level.

Coastal Threats & the Impacts

Impact of Development



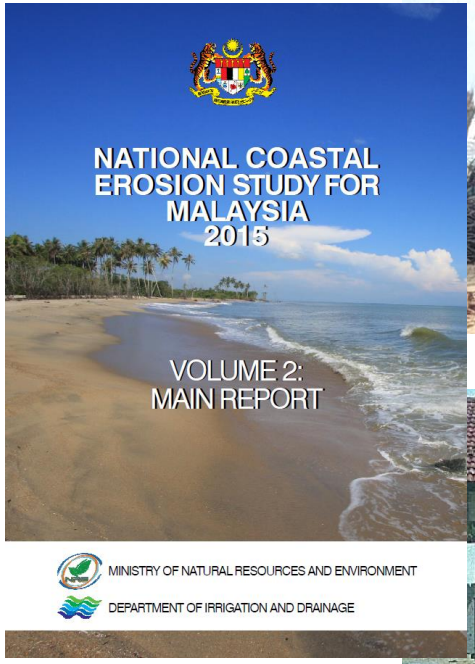
Changes in overall coastal processes

Imbalance in sediment transport patterns

Erosion & Sedimentation

Coastal Erosion

A **National Coastal Erosion Study (NCES)** was commissioned in 2015 in response to increasingly serious problems of coastal erosion threatening properties & livelihood of coastal communities.



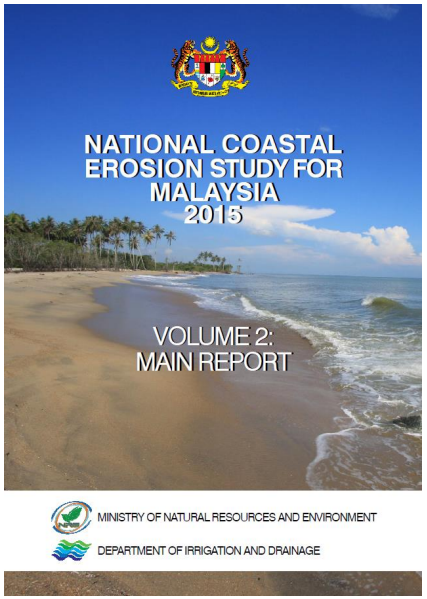
Pantai Sabak (1986)

Pantai Sabak (1999)

Pantai Sabak (1987)

Pantai Sabak (2003)

Coastal Erosion



Coastal erosion sites are classified into:

- **Category 1 – Critical Erosion**:

Fast retreating coastline at the rate of more than 4 m/year with generally fairly dense human settlement, with some commercial/industrial activities being served by significant public infrastructure and facilities

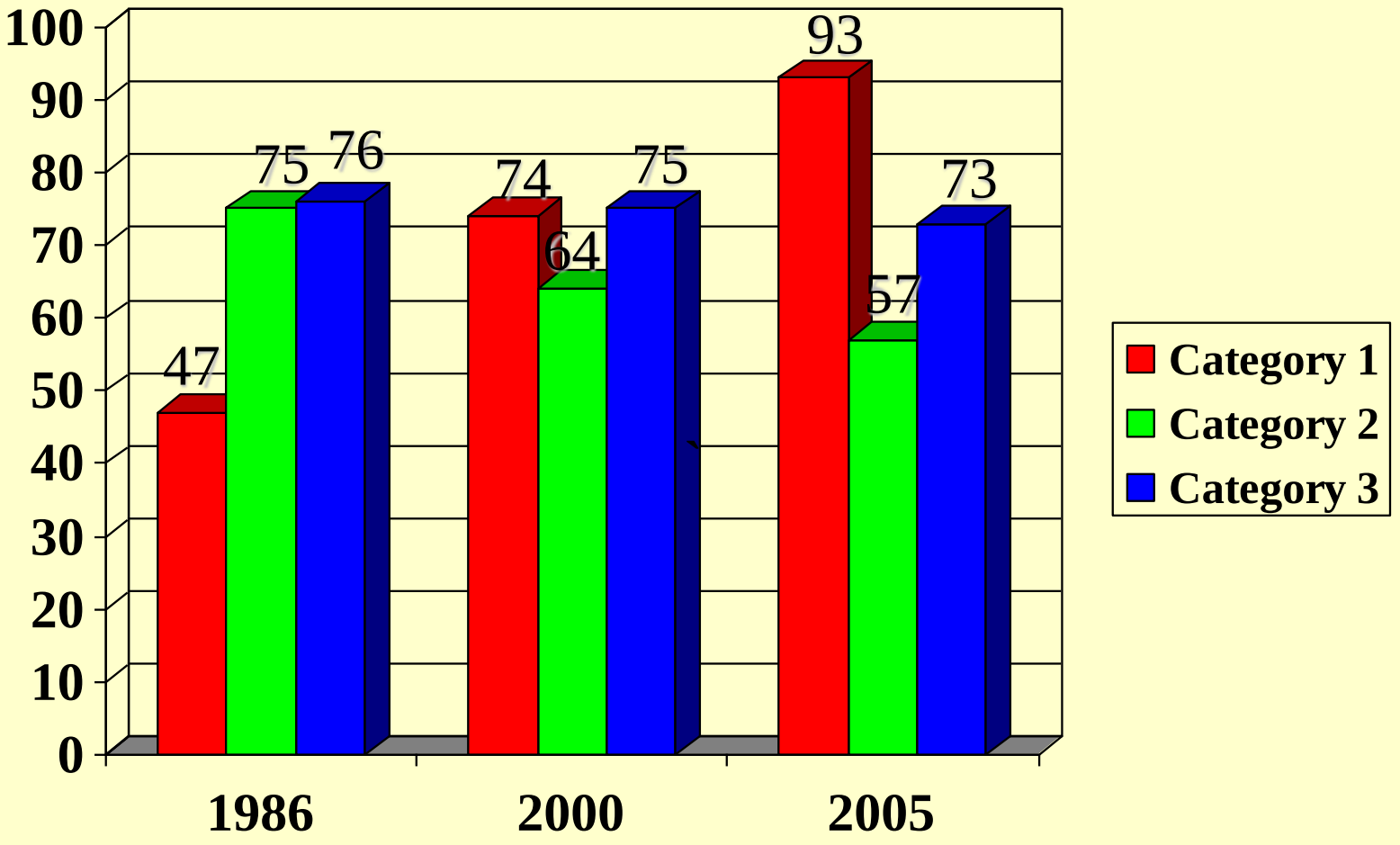
- **Category 2 – Significant Erosion**:

Retreating coastline at the rate of between more than 1 m/year but less than 4 m/year with generally sparsely-populated area, with some agricultural activities being served by relatively minor public infrastructure and facilities

- **Category 3 – Acceptable Erosion**:

Slowly retreating coastline of less than 1 m/year with generally no human settlement and minimal agricultural activities, and not served by public infrastructure and facilities.

Coastal Erosion



Source: JPS

The Basic

Erosion is a process, not a problem.

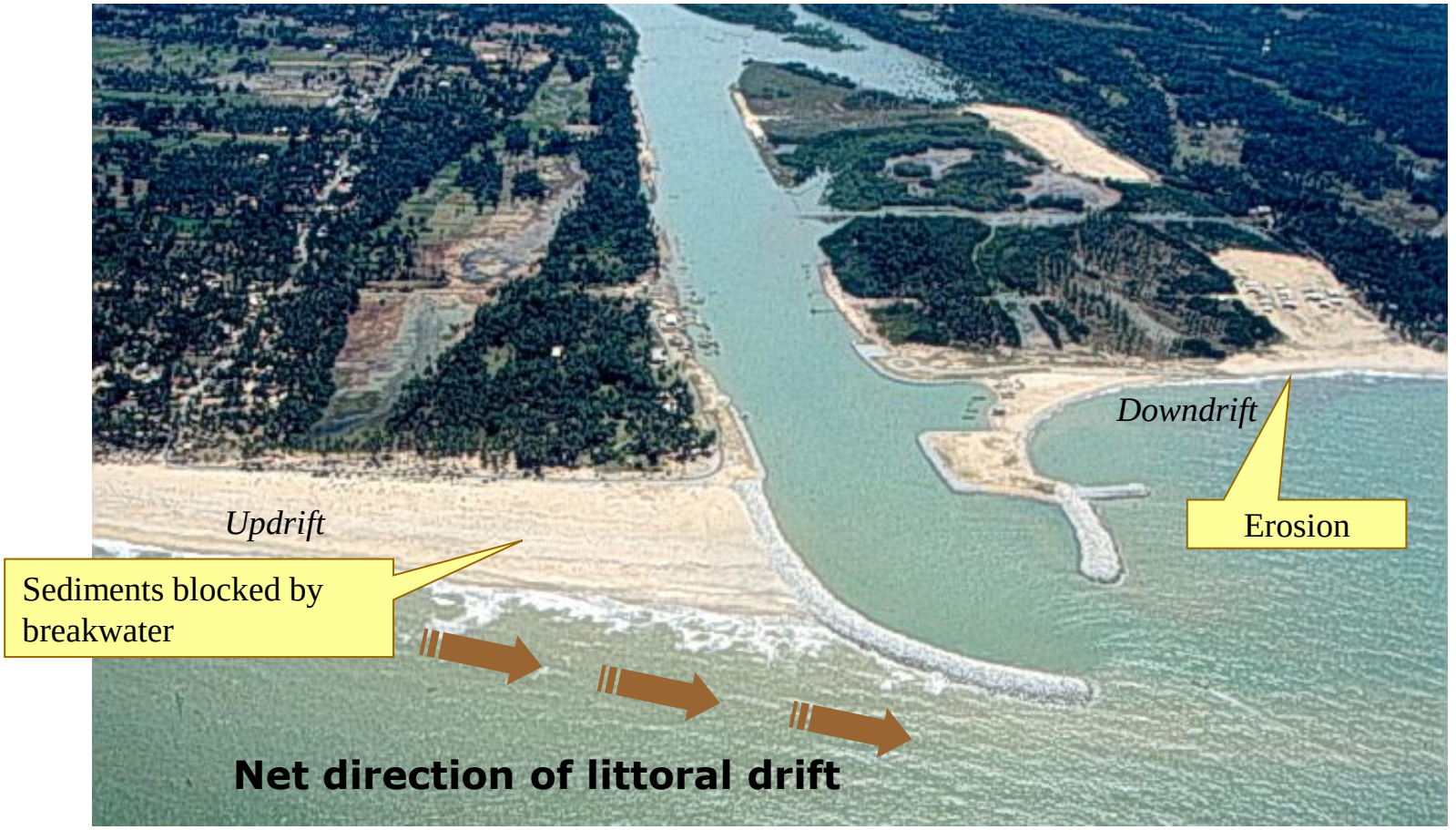
- **Beaches are natural and dynamic.**
- **The problem occurs when there is a static structure built on a dynamic, moving beach or the erosion has reached the static structures.**

Human Activities

- Human activities may affect sources of new sediment to the coast and the movement of sediment within the coastal environment.
- People's activities are often conducted without an adequate understanding of coastal geology and processes. As a result, they can lead to unforeseen degradation of coasts.
- **Even human actions intended to save or improve the coast may inadvertently increase erosion.**

Shore Connected Breakwaters

Even human actions intended to save or improve the coast may inadvertently increase erosion.



Sg. Pengkalan Datu River Mouth, Kelantan

Training walls at the river mouth improves navigation but alters shoreline processes - Interruption of material in transport.

Coastal Development

Development encroaching coastal areas

Coastal Development

Agriculture & Aquaculture

Mangroves

Prawn Farming

Mangrove Clearing

Clearing of mangroves to allow for aquaculture?

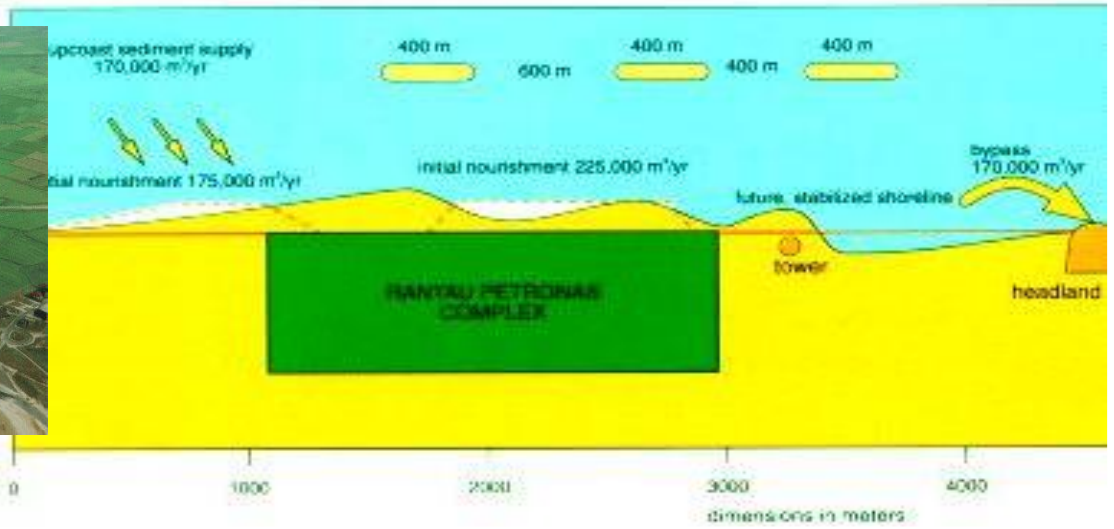
Land Reclamation

Coastal Development

Offshore sand mining and dredging

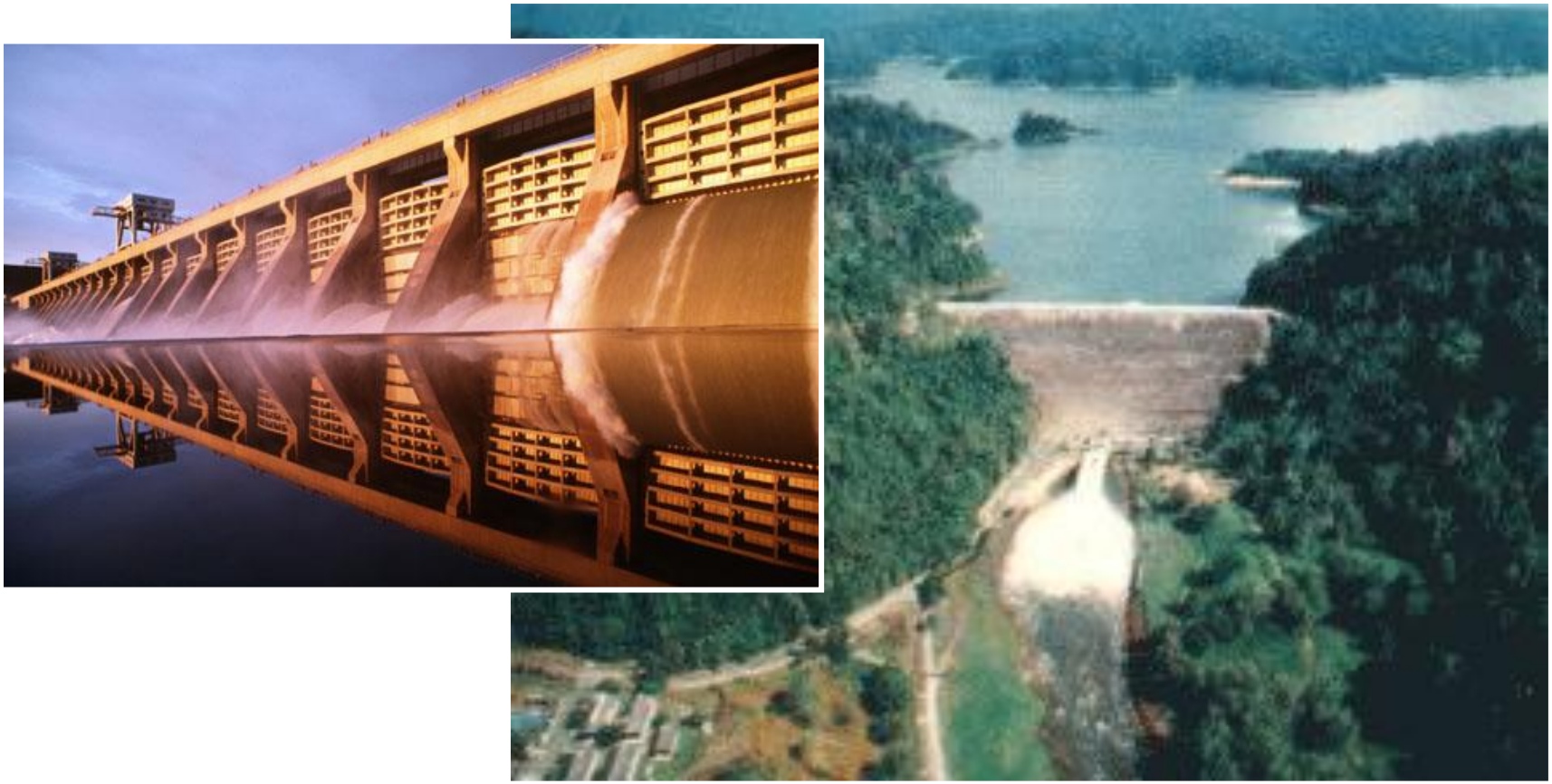
Coastal Defense & Protection Structures

Principal lay-out Nourishment and sediment supply



Upstream Development

Dams and barrages

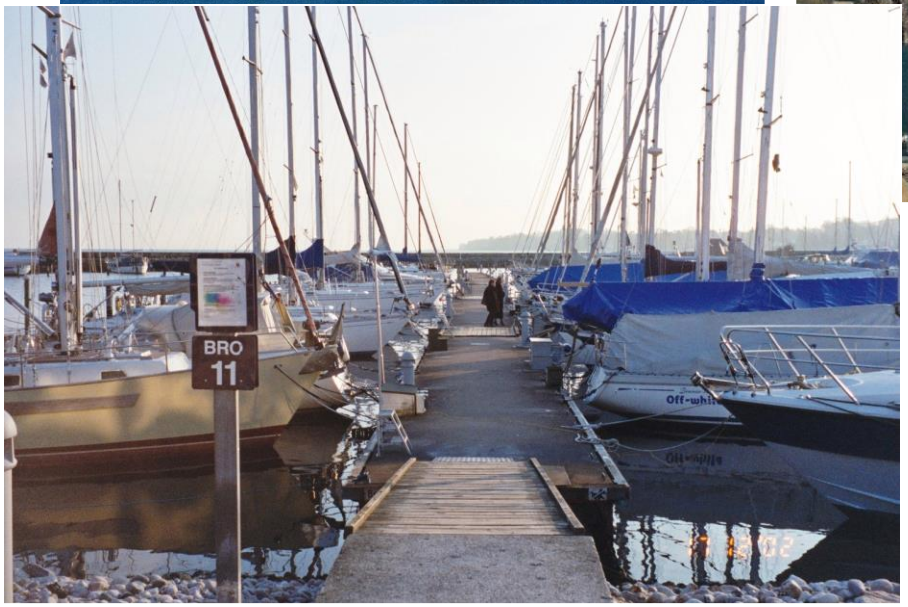


Upstream Development

River sand mining

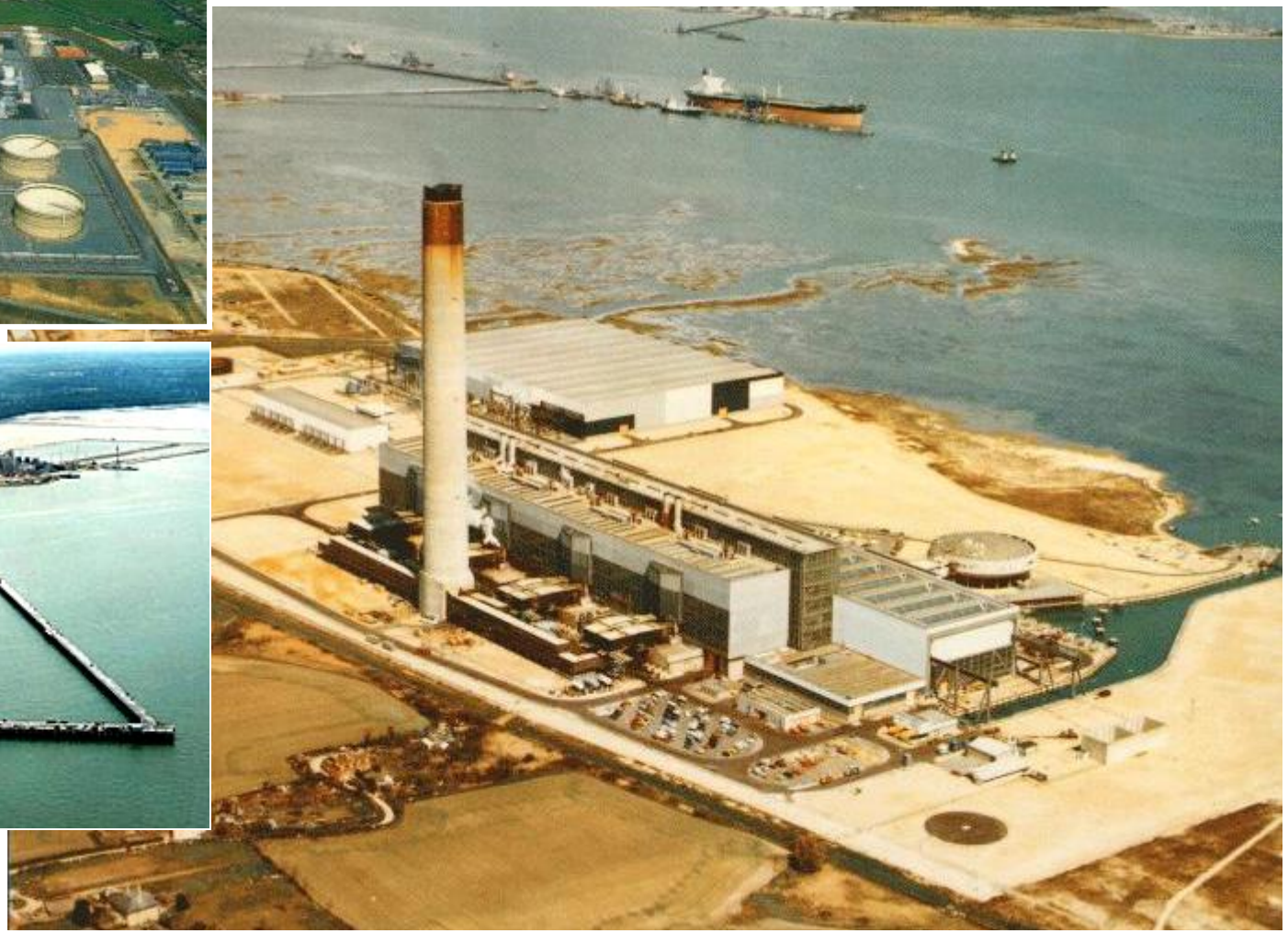
Coastal Development

Marina, Port & Harbour



Coastal Development

Power plant



Risky Development

Example of development too close to coastline – suffered from serious erosion

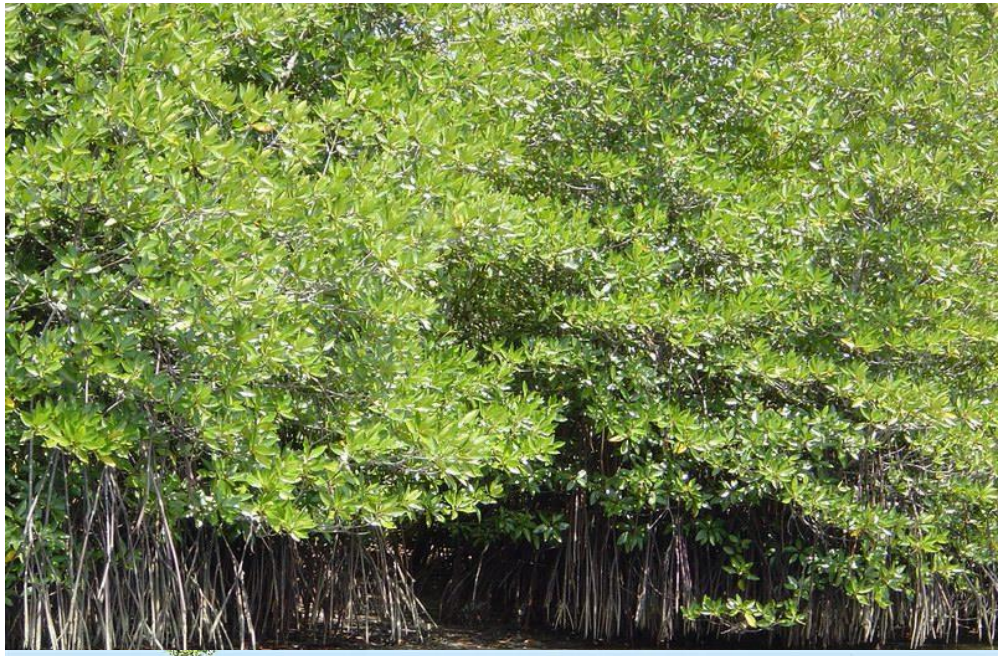
- Setback required

Land subsidence

Removal of natural resources (e.g. oil, gas & groundwater) underlying the coastal zone may cause beach subsidence (similar effect as sea level rise).

Drilling for Oil fronting Mississippi River Mouth, Louisiana, USA

Loss of Mangroves



Coastal and marine ecosystems such as mangroves, sea grass and coral reefs are productive ecosystems in the world.

Important for:

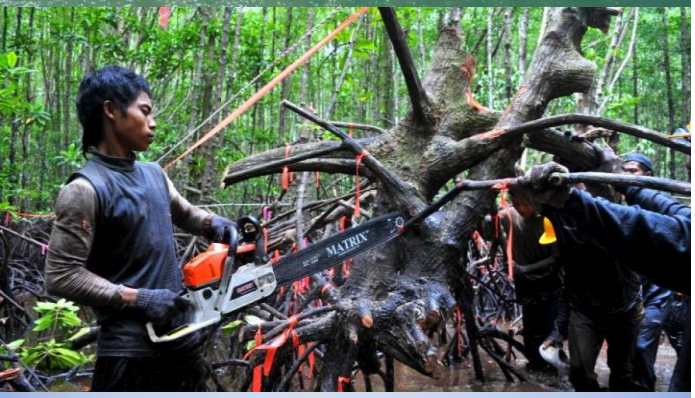
- Fisheries
- Natural protection for waves

Loss of Corals

Past…

Future…?

Present…



Impact of Development

Major impacts of coastal development:

- Changes in coastal processes resulting in erosion or accretion
- Loss of mangrove and corals
- Lost of fishing ground
- Change in socio-economic pattern
- Resettlement of population
- Degradation of water quality
- Loss of historical sites and artifacts

From Complex to Even More Intricate

- Natural processes can affect coastal dynamics.
- Taken individually, each natural process of coastal transport is complex: taken collectively, they create an extraordinarily complex system that attempts to achieve a dynamic balance.
- Human activities add another layer of complexity to the natural processes of coastal lands and materials. These activities may have direct or indirect effects on our changing coasts.

Re-cap of today's lecture

- Overview of Coastal Engineering
- Basic Glossary and Terminology
- Intro to coastal processes
- Impact of development to coastal processes

Available References

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- Shore Protection Manual (1984). U.S. Army Corps of Engineers.
- Manual on the Use of Rock in Coastal and Shoreline Engineering (1991). CIRIA Pub No 83.

Post-Lesson
Reflect on the Learning

- What are the new thing you learn today?
- What is unclear or confusing?
- Does the information you learned today connect to something else you've learned in the past?

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PowerApps

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