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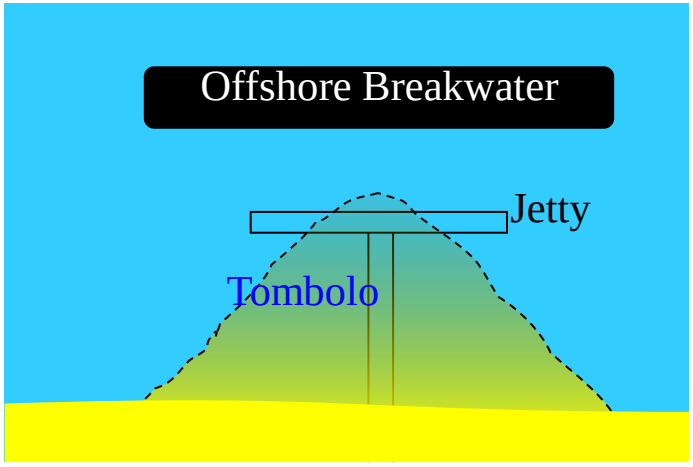
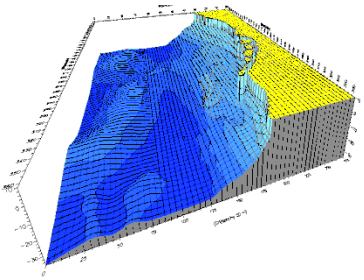
Coastal Structure Applications & Impacts



Overall Learning Outcomes



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

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

3. **Evaluate application of different coastal stabilization schemes and the governing factors for their selection and impacts**

PO1	Acquire and apply engineering fundamentals to complex civil engineering problems
PO2	Identify, formulate and solve complex civil engineering problems using creativity and innovativeness

Coastal Planning & Management

Applications and Impact

- Important understanding of sediment transport
- Impacts of natural factors and human interferences to coastal processes
- Applications of various mitigation strategies
- Coastal vulnerability in Malaysia
- Examples and case studies

Recalling – Basic Perspective

Erosion is a process, not a problem.

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

Sediment Transport

- Sediment is lifted from bed when bed critical shear stress values are exceeded.
- Each sediment grain size is moved by a certain critical velocity along the bed.
- Grain size influences fall velocity (Stoke's Law); larger grains require greater velocities to move.
- Mud particles can remain in suspension for a long time

Poll 1

The bedload will continue staying at the seabed until the bed critical shear stress is ____ by the action of current flow that present.

a. altered
b. lowered
c. interrupted
d. exceeded

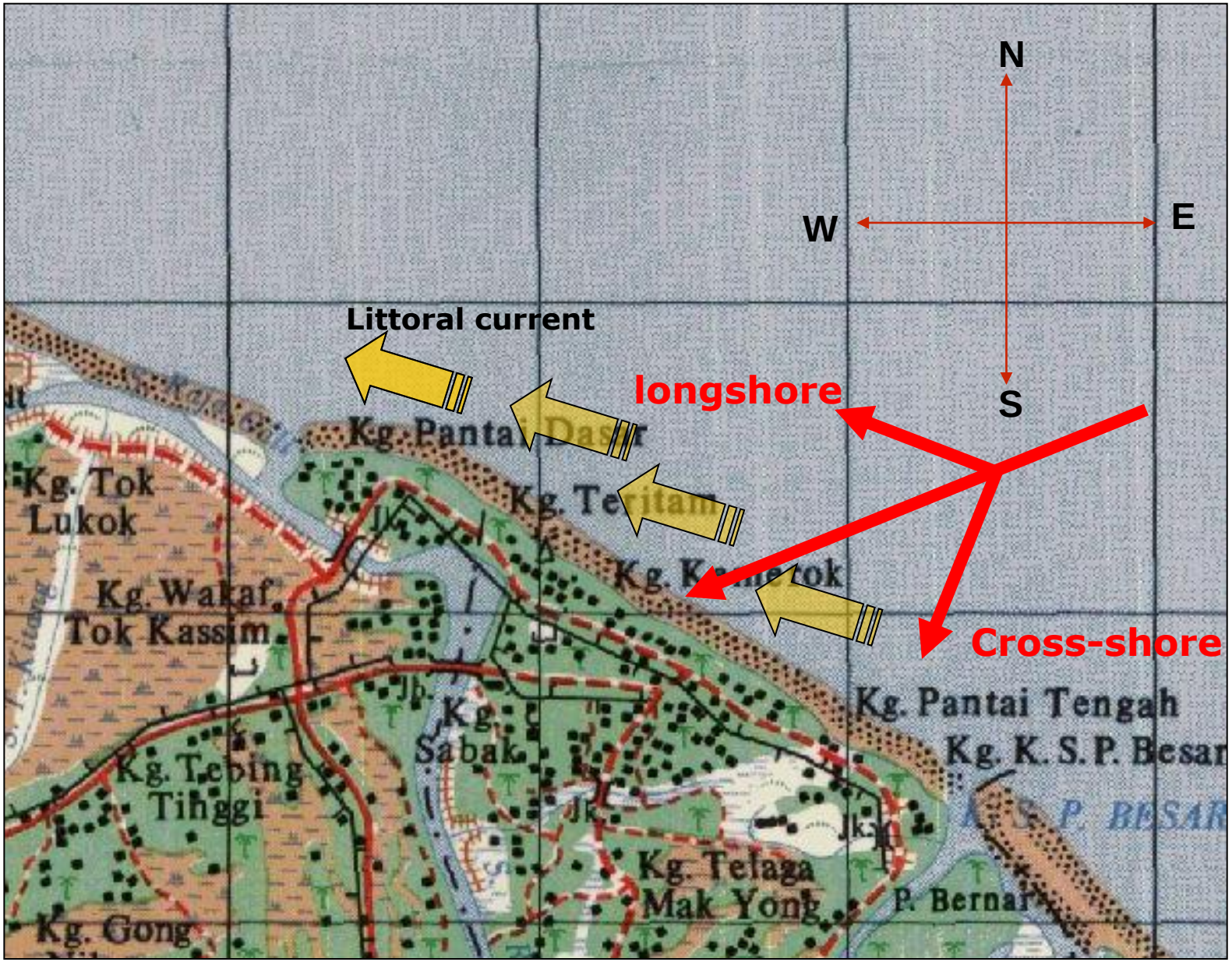
Poll 2

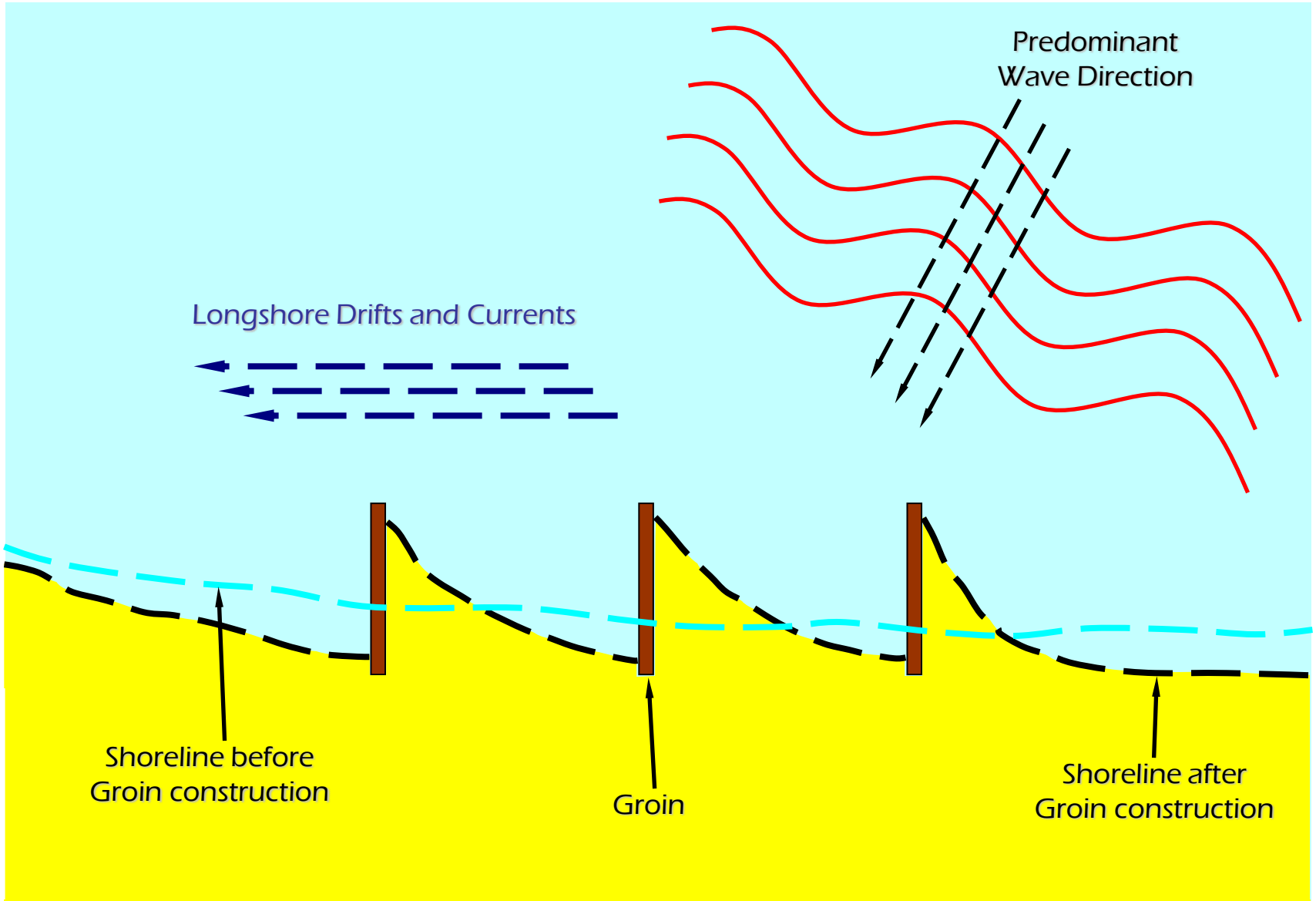
The sediment will settle on the bed if the current flow is ____than the sediment fall velocity.

a. more

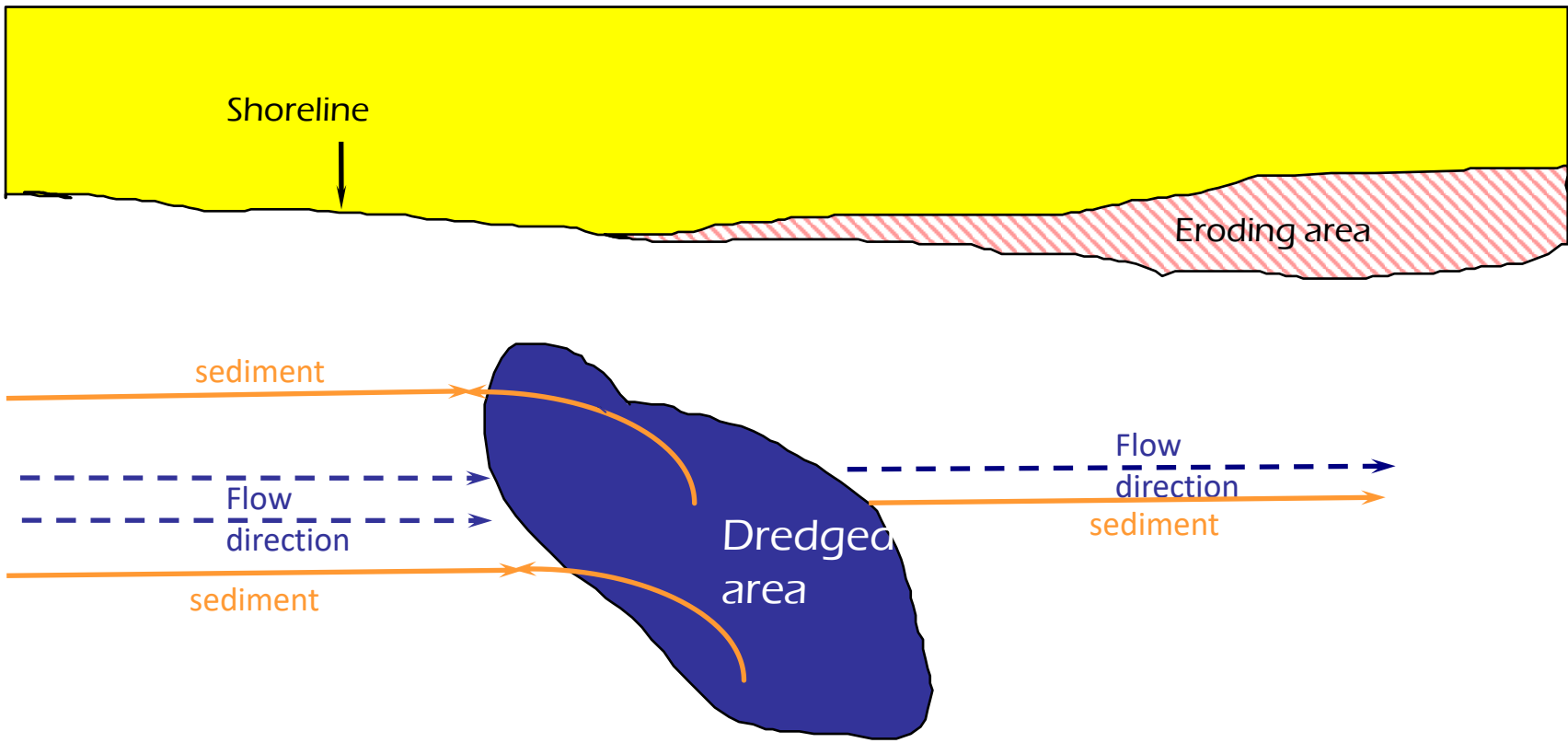
b. less

Littoral Current



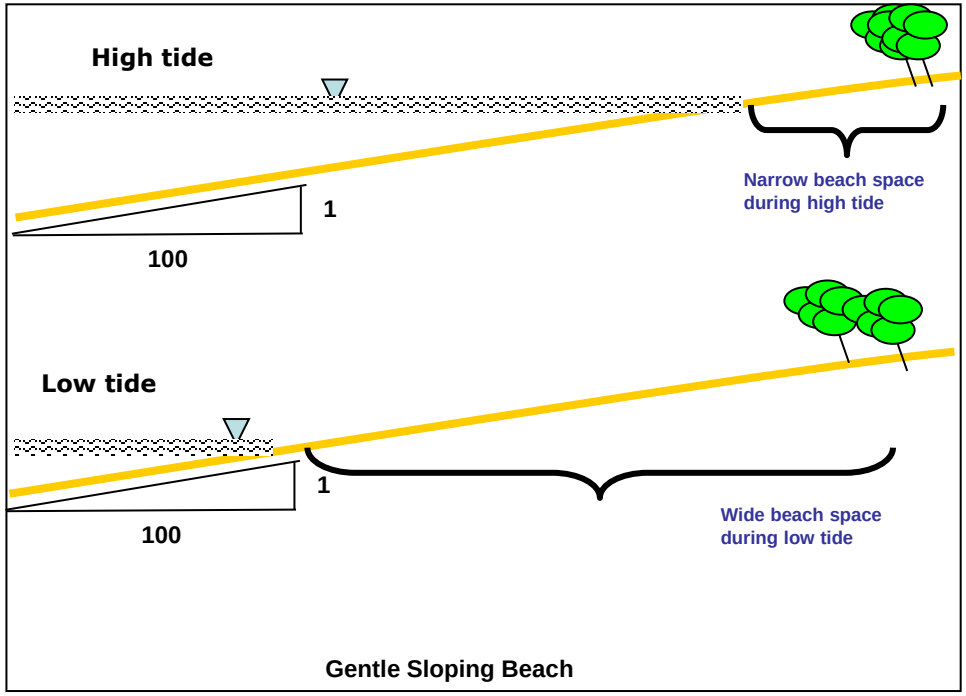


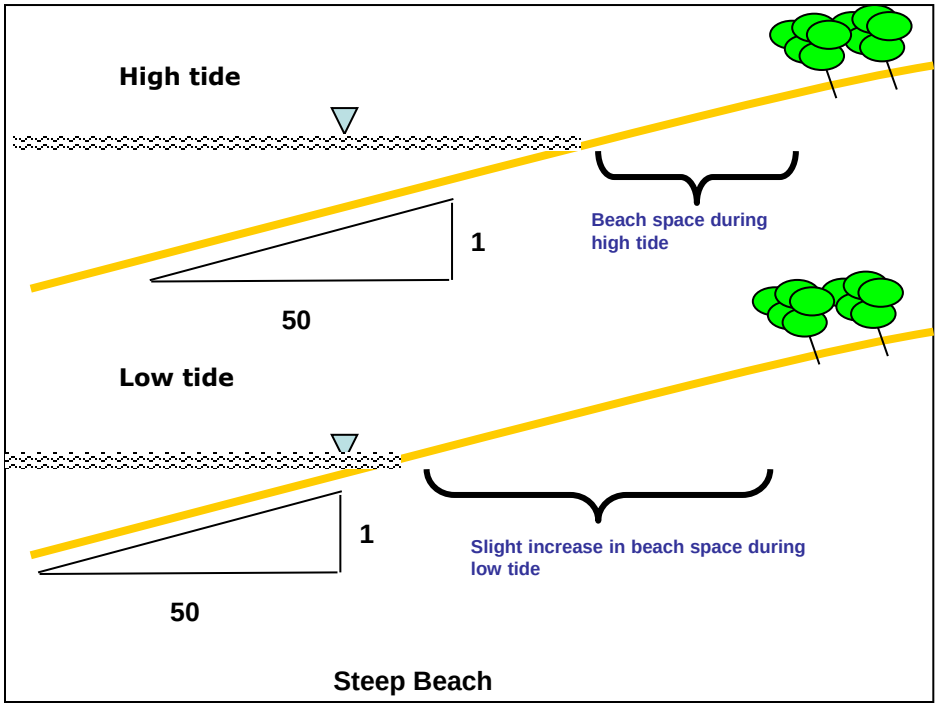
Construction Of Groynes Along Shore To Control Erosion May Produce Unwanted Changes If Longshore Drift And Current Is Not Be Considered



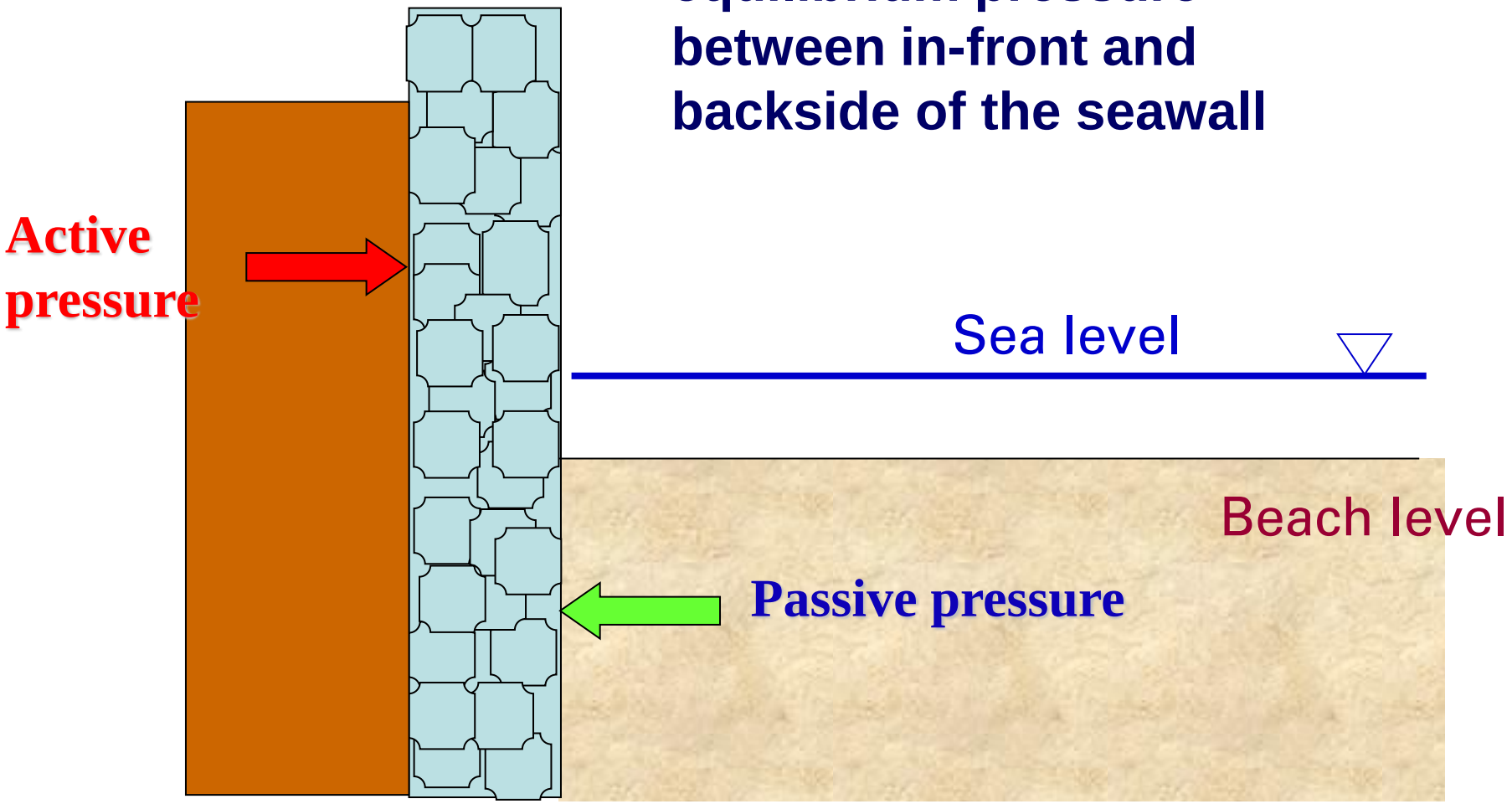
Sediment movement settled at the dredged area

Characteristics of Beaches – effect of slope



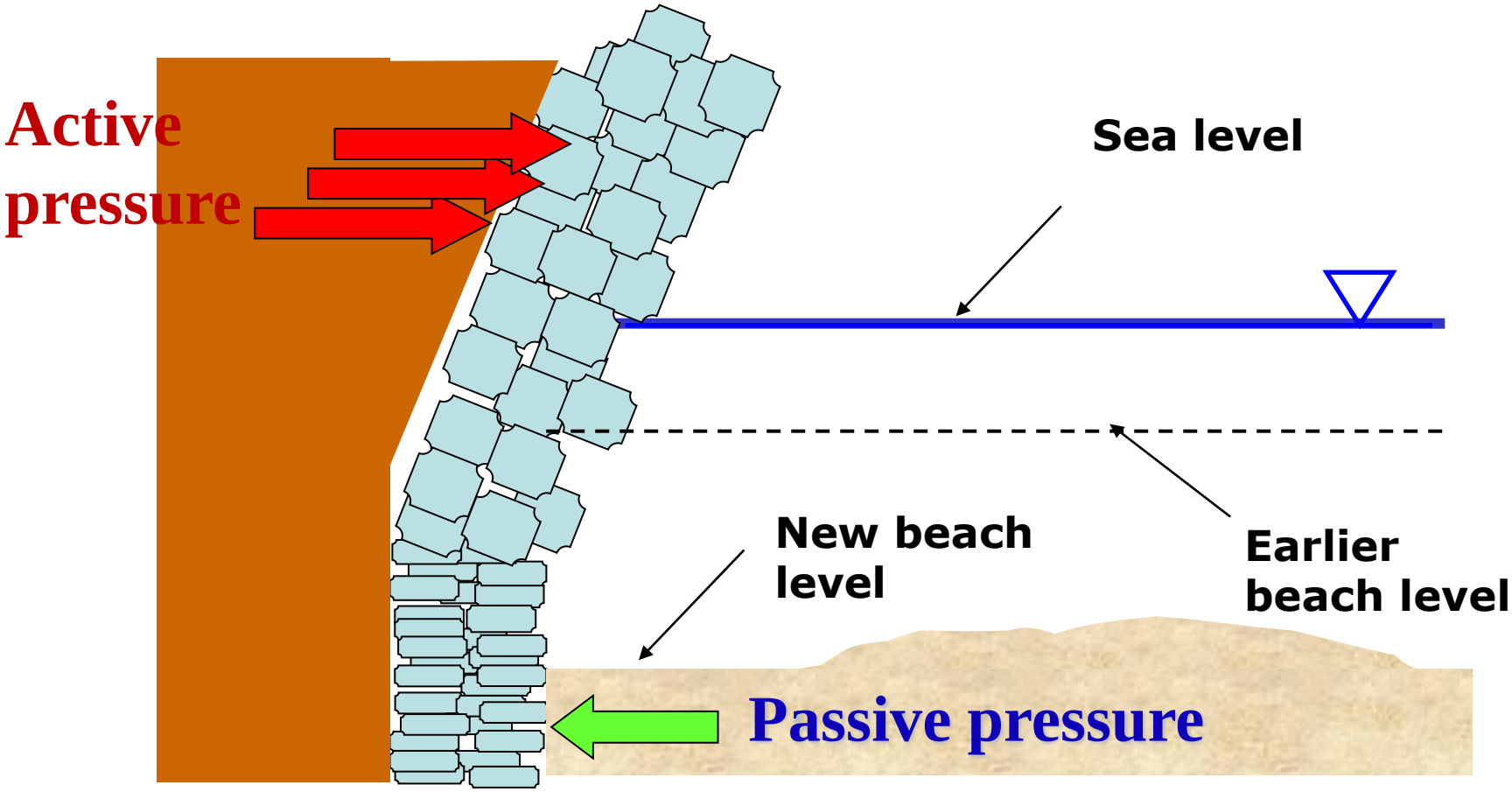


Stability depends on the equilibrium pressure between in-front and backside of the seawall



Active pressure = Passive pressure

Active pressure >>> Passive pressure



Poll 3

Groyne series is built to distribute the shoreline in locations where alongshore transport activities are active.

True/False

Coastal Protection

- Hard protection
  - Prevent retreat of shoreline
  - Prevent loss of sediments or trap sediments
  - Wave attenuation, wave energy dissipation
  - e.g. Seawalls, revetments, breakwaters

- Soft protection/eco-engineering
  - Wave attenuation, wave energy dissipation
  - e.g. beach nourishment, mangrove replanting, artificial seagrass
  - Recent innovations


toe
slope

Interlocking concrete slab system

Backshore improvement


crest
slope
Flex-slab revetment

Sine Slab Revetment

SAUH Revetment

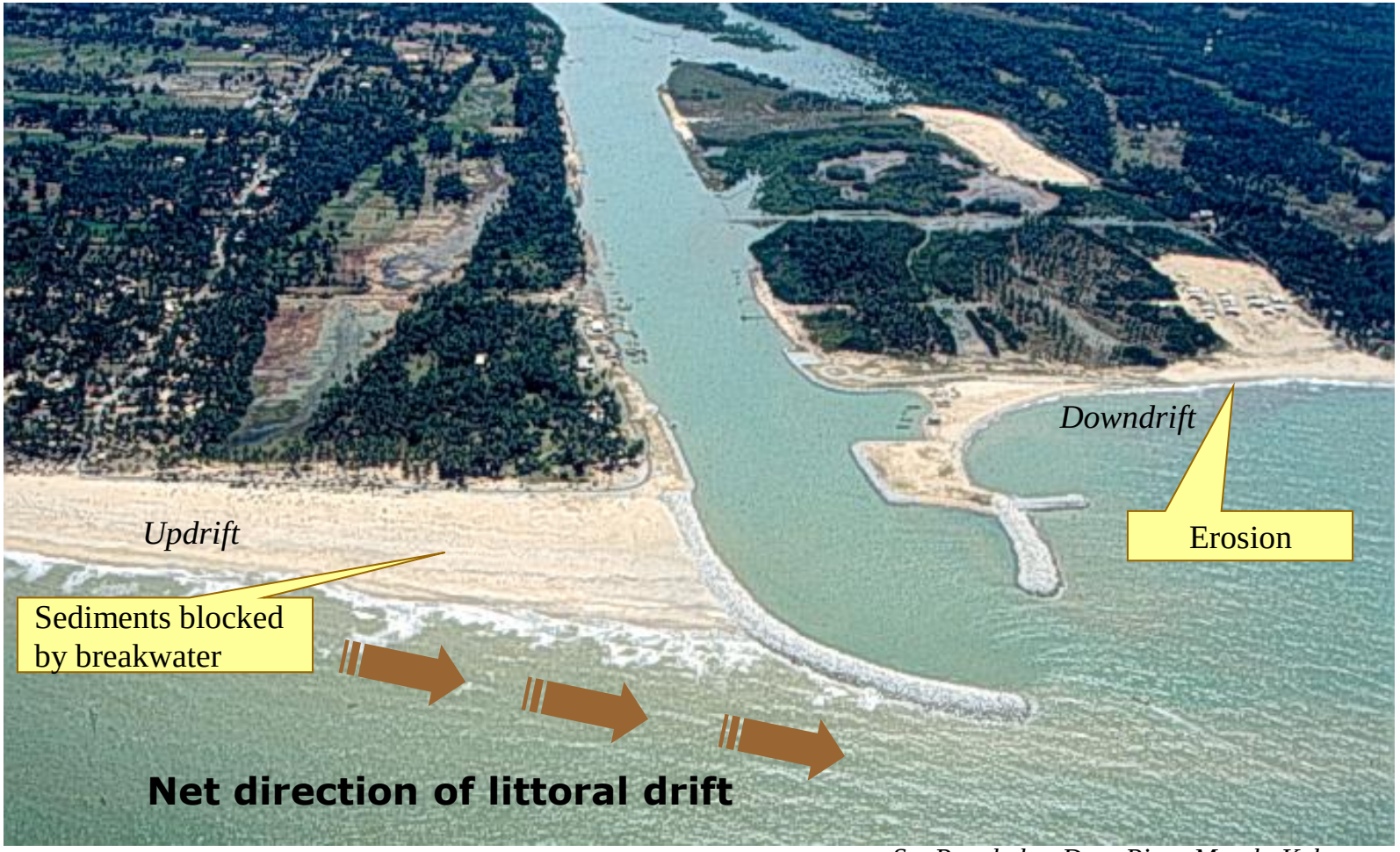
Groyne

Groyne systems

Shore Connected Breakwaters

- **Interruption of material in transport**

Breakwaters at river mouth improves navigation but alters shoreline processes



Sg. Pengkalan Datu River Mouth, Kelantan

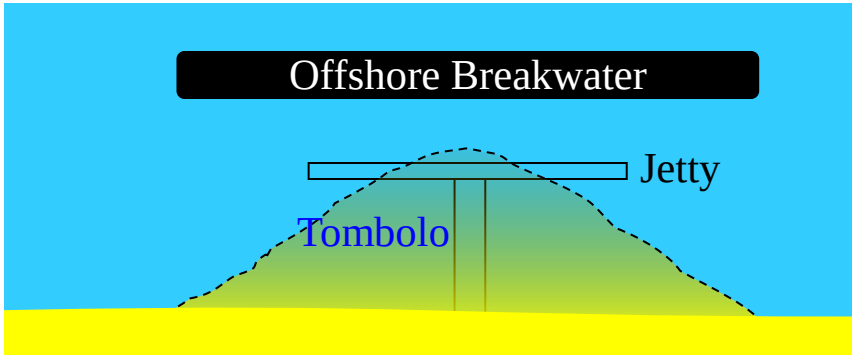

Area of less
wave energy
Area of less
wave energy
Nearshore Breakwaters

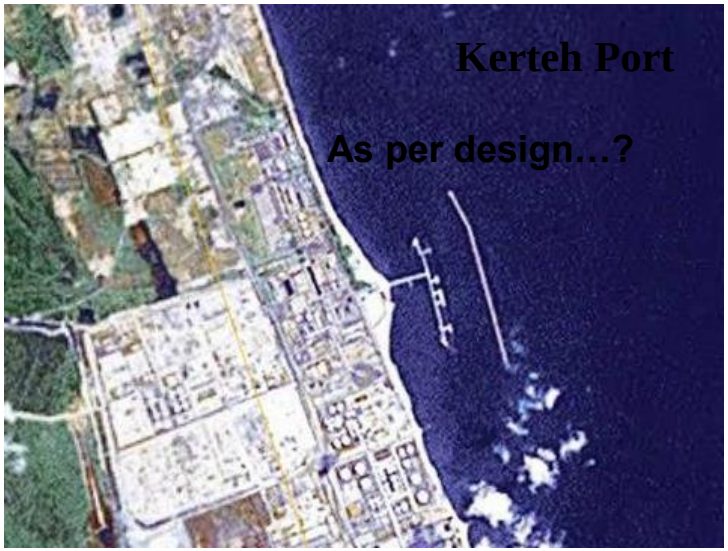
(Island) Detached Breakwater


Beach Breakwaters

Geo-tube Breakwater

Offshore Breakwater





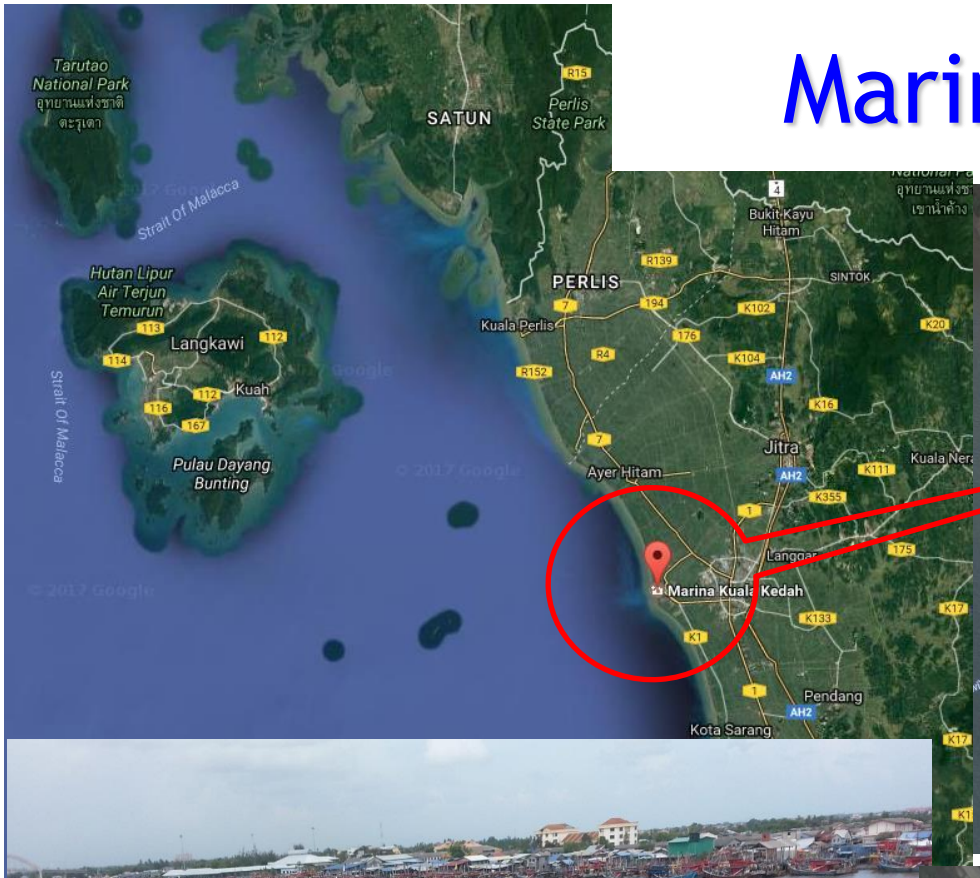
Examples of application and impact:
Offshore Breakwater

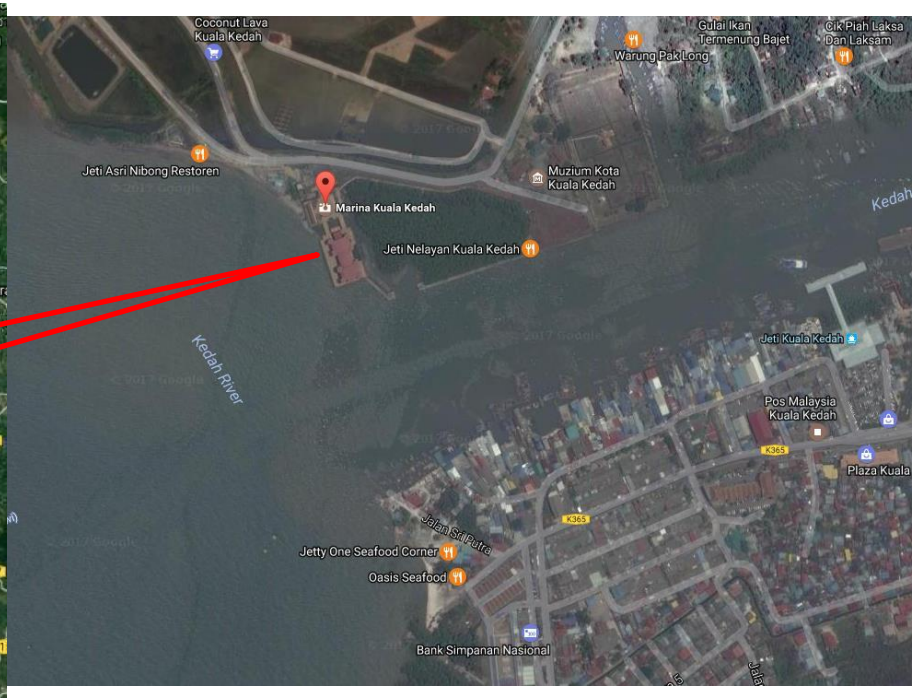
Merang – recent condition

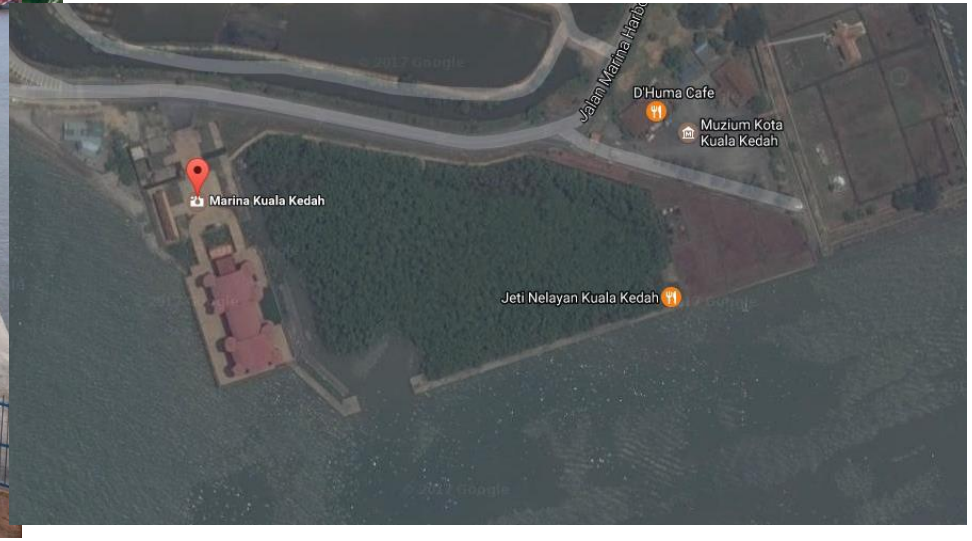
Merang – recent condition

Beach Nourishment – widening beach using imported sand; needs periodic replenishment

Marina, Kuala Kedah







Poll 4

Beach nourishment is a permanent solution to coastal erosion problems.

True/False

COASTAL VULNERABILITY IN MALAYSIA

Impact of sea level rise

1. Increasing flood-frequency probabilities and enhancement of extreme flood-level risks
2. Erosion and sediment deficits
3. Gradual inundation of low-lying areas and wetlands
4. Rising water tables
5. Saltwater intrusion
6. Biological effects

COASTAL VULNERABILITY IN MALAYSIA

Impact of sea level rise in Malaysia

- Some minor inundation along coastal areas in Peninsular Malaysia
- The highest SLR occurs in the northeast and northwest regions of Peninsular Malaysia
- The low elevation areas and rivermouth in the southwest and north coast of Sarawak are very vulnerable to SLR
- Vulnerable areas in Sabah are smaller than in Sarawak due to higher coastal elevation in Sabah

National Coastal Vulnerability Index (NCVI)

- NCVI study is required to identify coastal area exposed to the effect of sea level rise.
- The result of the study will be used to prepare Coastal Vulnerability Index with level of exposure to coastal area so that any development in these areas can be avoided.
- It will be the basis to implement protection measure caused by sea level rise.
- The index will provide an indicator as to how vulnerable the coastline is to the impacts of accelerated sea level rise.

National Coastal Vulnerability Index (NCVI)

Vulnerability to impacts encompasses:

- biogeophysical
- economic
- institutional factor
- socio-cultural factor

COASTAL VULNERABILITY IN MALAYSIA

National Coastal Vulnerability Index (NCVI) Study

Objective of the study

- To formulate a national coastal vulnerability index (CVI) and to test /apply in two pilot sites mentioned above and to determine the necessary long-term adaptation/mitigation measures

Poll 5

NCVI is required to _____

A. identify the coastal erosion hotspots in Malaysia
B. estimate the wave energy distribution along the Malaysian coast.
C. determine the flood-prone areas in Malaysia.
D. identify coastal areas exposed to the effect of sea level rise.

Poll 6

The objective of NCVI are to:

i. To formulate a national coastal vulnerability index
ii. To determine the necessary long-term adaptation and mitigation measures.
iii. To overcome the coastal erosion problems

A. i and ii
B. ii and iii
C. i and iii
D. All of the above

National Coastal Vulnerability Index (NCVI) Study

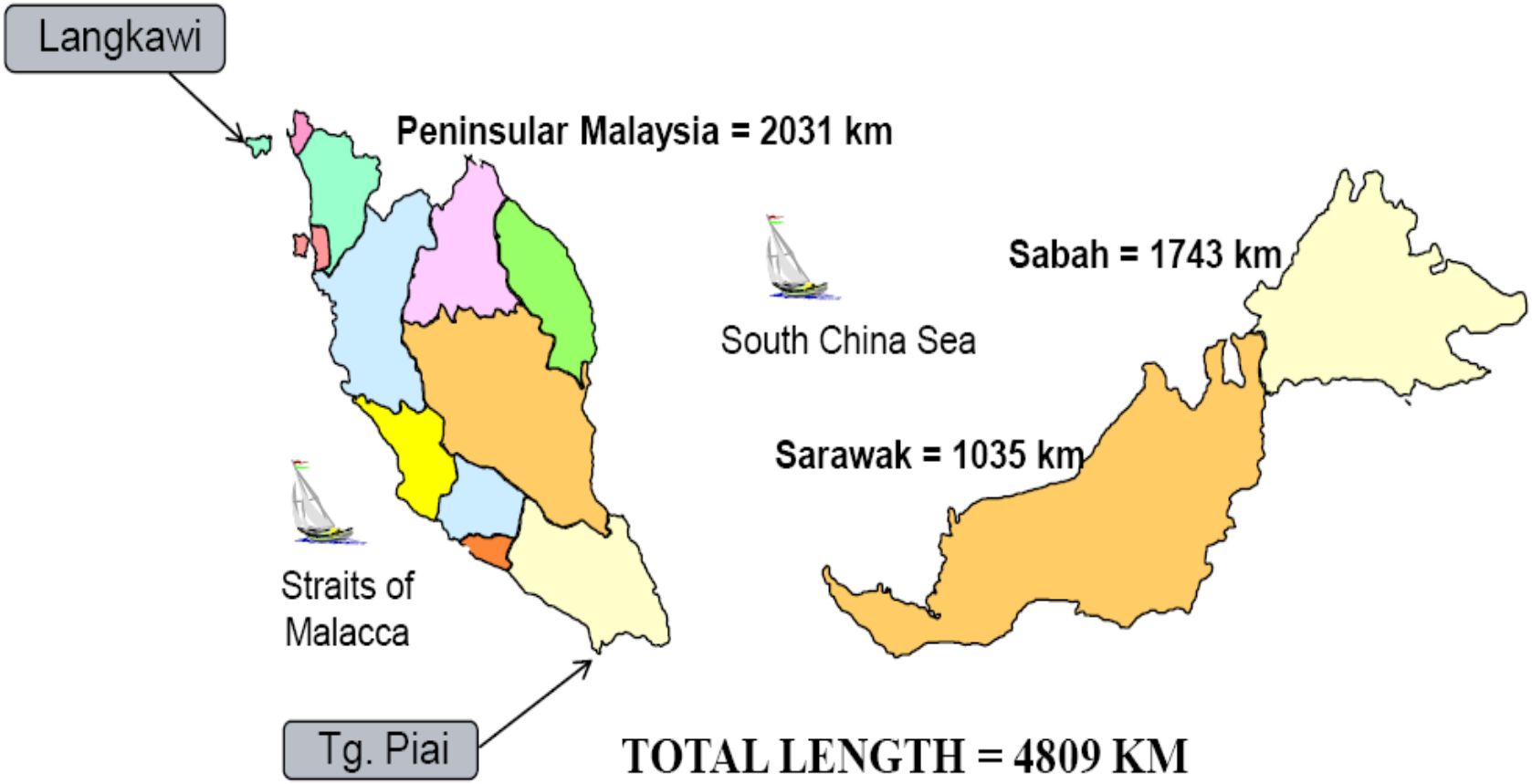
- The study was done at two pilot sites in 2007

Site 1 : coastal stretch from Tanjung Piai to Sungai Pulai Estuary, Johor

Site 2 : western shoreline of Pulau Langkawi to Tanjung Malai, Langkawi, Kedah

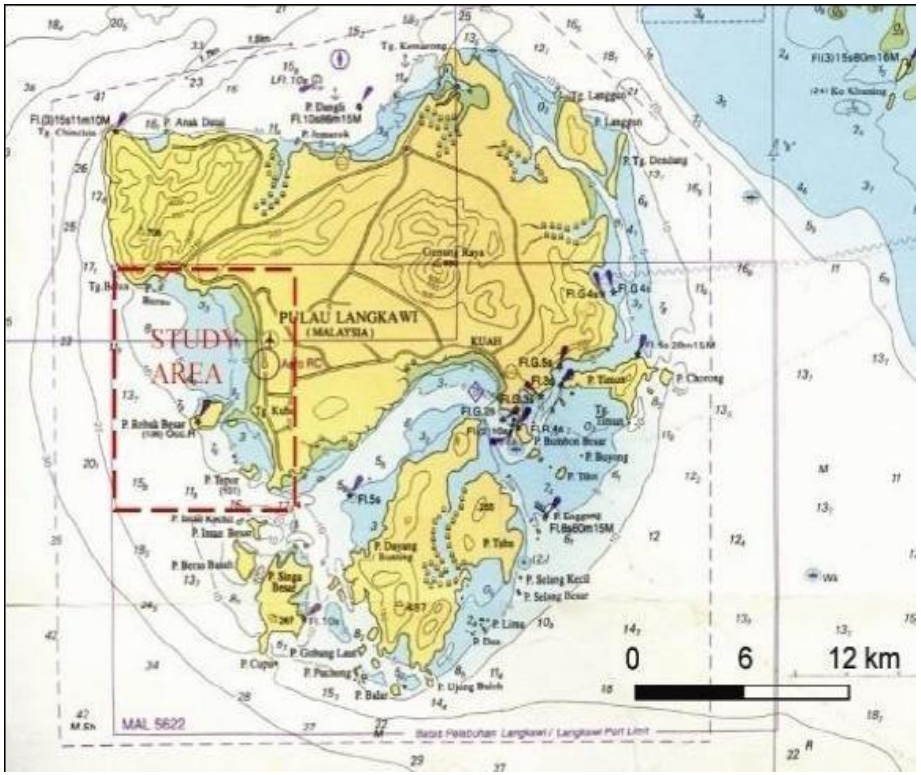
- These two sites have widely varying characteristics

COASTAL VULNERABILITY IN MALAYSIA



NCVI Study

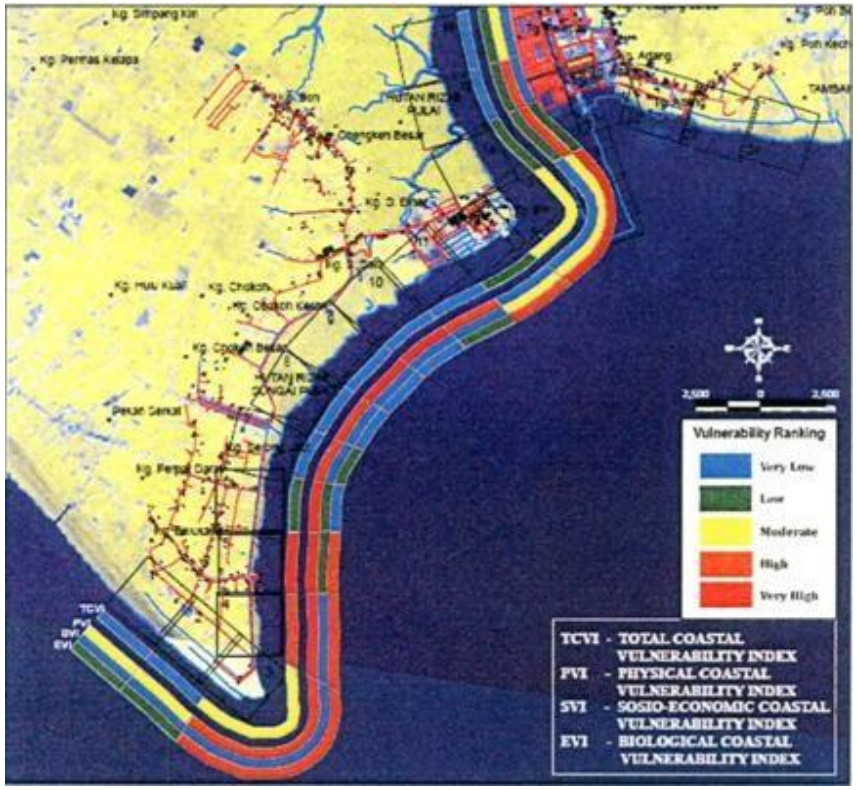
Pilot site 1 : Tanjung Piai – Sg Pulai estuary

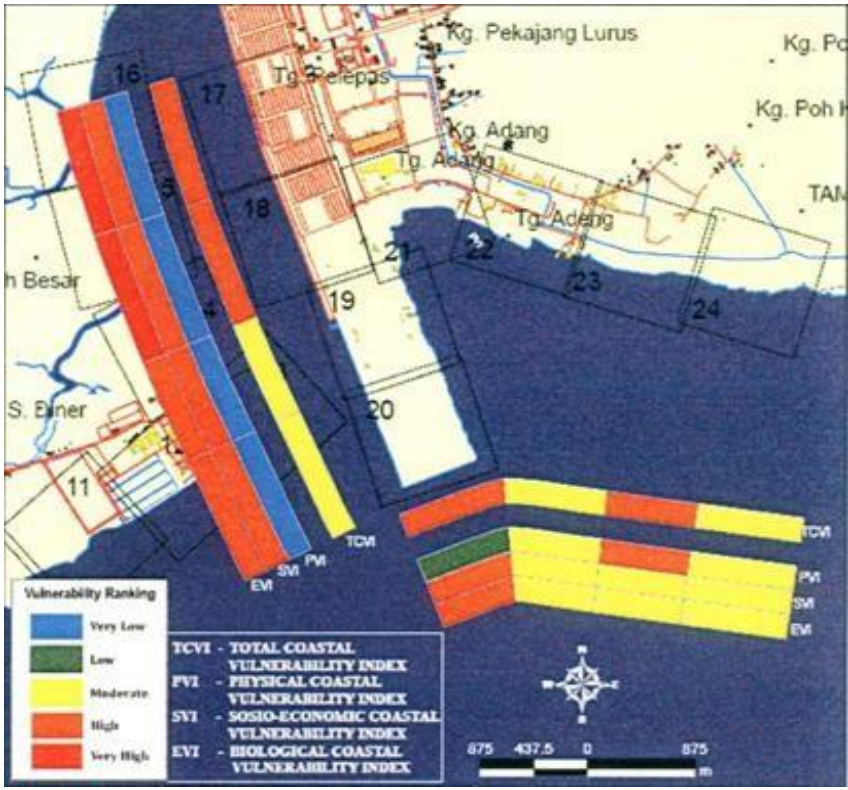


Pilot site 2 : West coast of Langkawi

NCVI Study

Output of the study

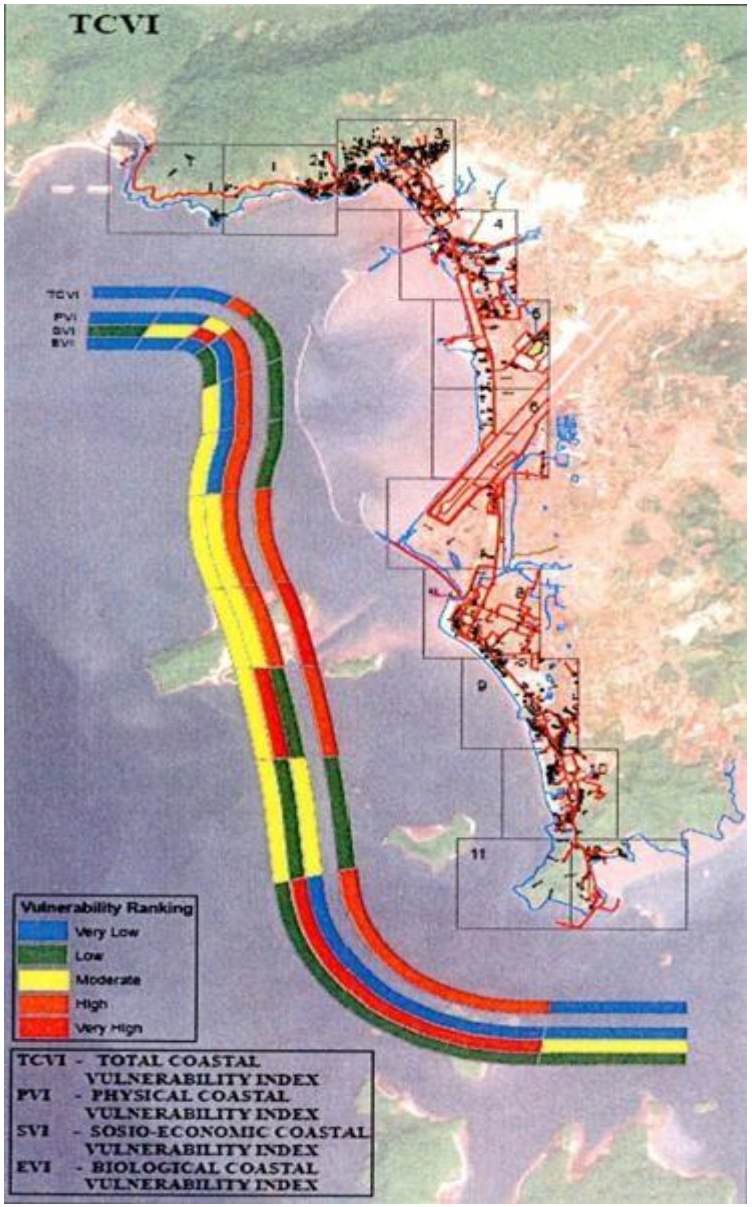




CVI for Site 1 : Tanjung Piai – Sg Pulai estuary

NCVI Study

Output of the study



CVI for Pilot site 2 : west coast of Langkawi

COASTAL VULNERABILITY IN MALAYSIA

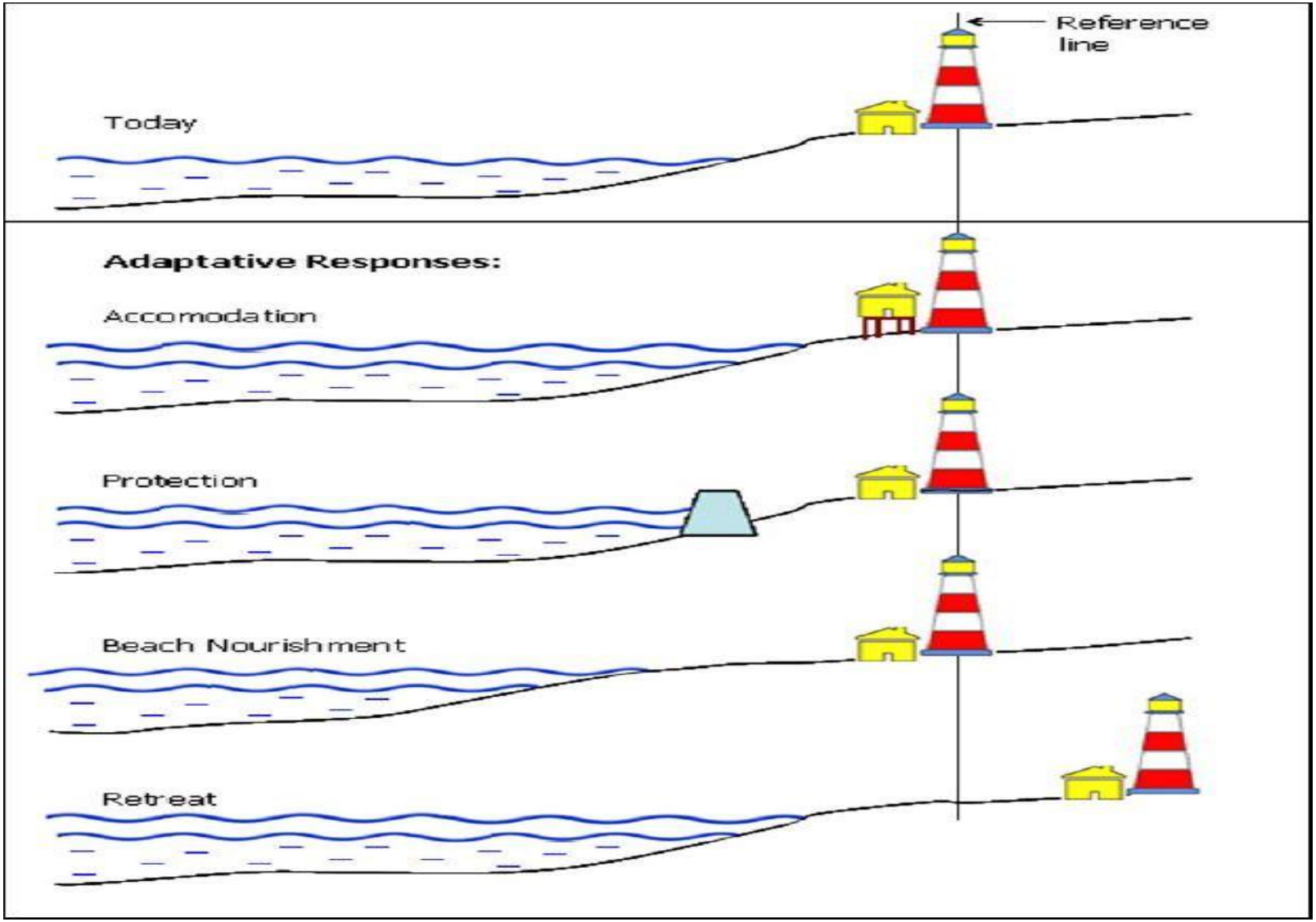
- Based on a 20-year tidal record at the two pilot sites, the rate of the local or relative sea level rise at both sites may be considered to be smaller than the average global-low rate of 2 – 3 mm/year:

  SLR at Tg Piai = 0.2 – 1.3 mm/yr

  SLR at Langkawi = 0.5 – 1.0 mm/yr

- The increase in flood levels at both sites for the local SLR scenario is not significantly high.
- Impact of SLR will become significant if global high level of 10 mm/year were to take place

COASTAL VULNERABILITY IN MALAYSIA



COASTAL VULNERABILITY IN MALAYSIA

Adaptive measures proposed for both sites :

- Natural mangrove regeneration
- Soft engineering shore protection complemented with mangrove replanting
- Combination of soft and hard engineering shore protection
- Raising the level of coastal bunds and river levees
- Installation of tidal gates at drainage outlets

Protecting the Shoreline: *Recommended Procedures*

- **Project evaluation**
  - Define problem and final objective
  - Identify wider implications:
    - work within ISMP
    - consider impacts on adjacent beaches
  - Mitigative measures

- Develop **Appraise Options**
  - Consider environmental implications of the site
  - Informal environmental assessment

Coastal Defense Options

- **Do Nothing**
  - Take no action to maintain or improve existing defences
- **Risk Management**
  - Improve warning systems
- **Sustain**
  - Maintain current standard of defences
  - Restore or repair
- **Change**
  - Reconstruct
  - Upgrade defences at existing position
  - Construct defence at advance position
  - Construct defence at retreat position
  - Tiered defence; maintain existing defence while creating new defence at retreat position

Choosing the Preferred Options

- Eliminate options with major environmental impacts
- Rank remaining options based on
  - benefit-cost ratio
  - environmental assessment
  - Project appraisal is an iterative process
- Design
  - Proceed when preferred option selected
  - Include Environmental Management Plan in construction specs

Post Project Appraisal

- Evaluate results of periodical monitoring
- Mitigation measures if results not favourable
- Compile data and information for records and future reference

Poll 7

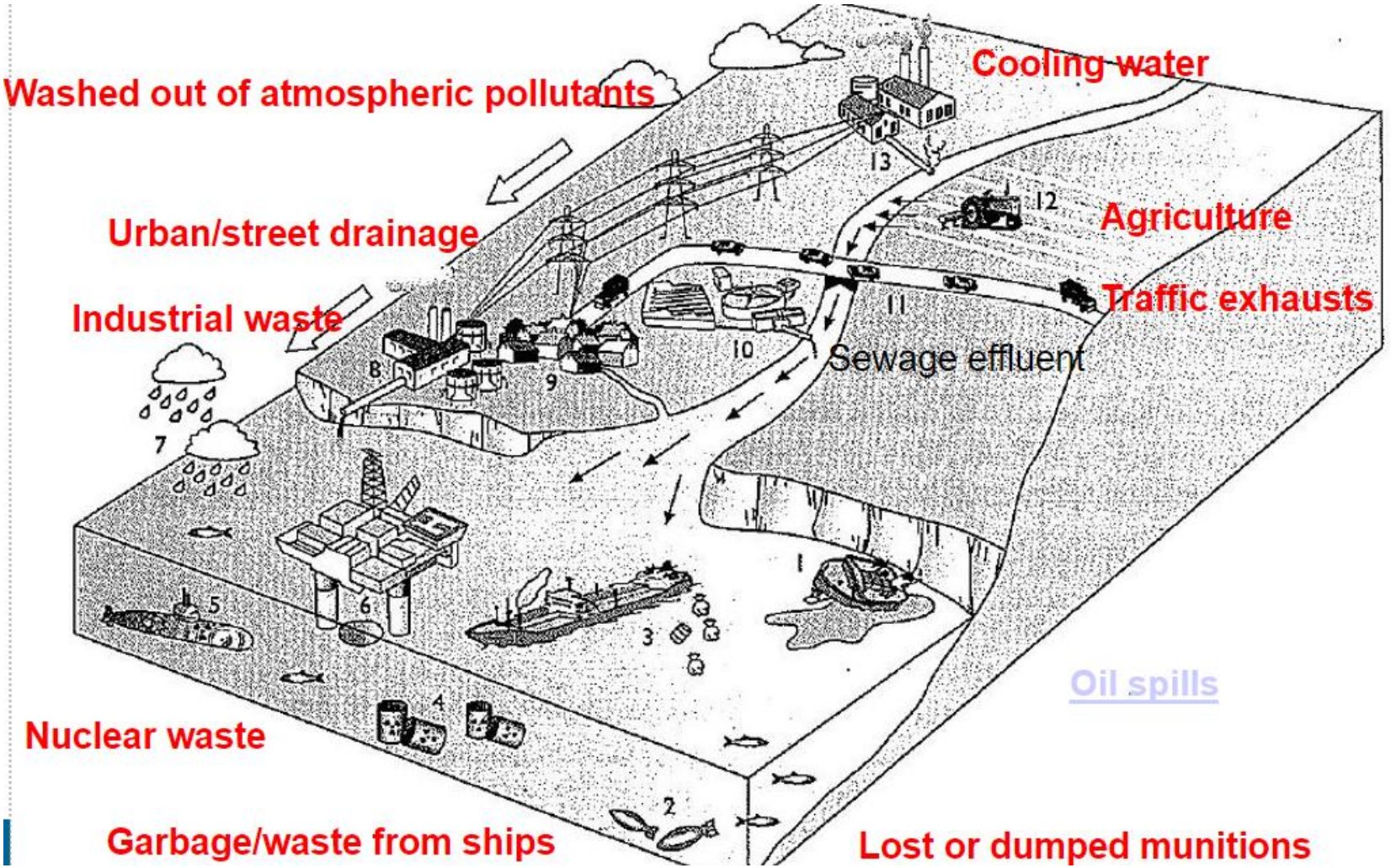
Below are the coastal defense options EXCEPT

a. Do nothing
b. Sustain
c. Change
d. Cost Management

Marine Pollution

• Pollution is defined as the process of introducing harmful or poisonous substances into the natural environment.
• Marine pollution is therefore defined as the introduction of toxic materials such as plastic, oil, chemicals, agricultural waste, and industrial waste into the marine waters.
•There can be several causes of ocean pollution, but the leading causes include sewage, toxic chemicals from industries, nuclear waste, thermal pollution, plastics, acid rain, and oil spillage.

Pollution of marine environment



Marine Pollution

Marine Pollution

Sewage

Sewage is defined as the wastewater and its component excrements that are transported in the sewer system. Sewage is mostly comprised of the human waste from toilet flushing, dirty water from bathing and even animal waste.

Industrial Chemicals

Another major pollutant is the chemicals from industries and from the fertilizers and other farm products that are carried by run-off water into the ocean waters. Many industries dump their waste materials and chemicals into the ocean waters. These chemicals pollute the ocean by altering the pH level of the waters. Most aquatic plants and animals cannot survive in adverse pH levels.

Marine Pollution

Nuclear Waste

Another major ocean pollutant is the nuclear waste, which is mostly produced from industrial, medical, and also scientific procedures that use radioactive material. The common industries that produce nuclear waste include power stations, the military, and the reprocessing plants.

Thermal Pollution

Thermal pollution is the lowering of water quality by any method that tends to change the water temperature. Thermal pollution occurs when power plants and manufacturing companies release hot water into the water streams and oceans and thus causing a change in temperature by raising the temperatures higher. The sudden change in temperature causes reduction in the oxygen supply. Aquatic plants and other organisms that are adapted to a certain temperature range get killed abruptly by the sudden change in temperature by a process known as thermal shock.

Marine Pollution

Oil Spills

Oil spillage is another primary cause of ocean pollution in that the oil forms a layer on the water preventing oxygen circulation. Lack of oxygen in the ocean waters results in the destruction of marine life over a long period. Therefore, it is necessary to prevent these pollutants from entering the oceans to protect the marine animals and plants.

Plastics

Plastic pollution mainly involves the accumulation plastic in the ocean waters and thus causing adverse effects on marine organisms. Marine organisms are affected by the plastics through direct ingestion of the plastic wastes and also through exposure to chemicals that are within the plastics.

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Measures / Strategies

Among the DOE guidelines for possible mitigation measures/strategies to reduce or prevent adverse impacts on water quality for sand mining / dredging activities:

1. Selection of sand mining methods as to minimize the disturbance to seabed morphology and dispersion of suspended sediments to adjacent areas

2. Oil and grease – no discharges of oily seawater from sea vehicles engine room directly to the sea

3. Heavy metals – analysis of sand source to determine the presence of any toxic constituents