# CURRENTS

# Currents

- What are currents?

  - “Rivers” of circulating water

- Causes
  - Wind
  - Rotating Earth
  - Density Changes

# OCEAN CURRENTS

**-Currents related to the density distribution in the sea**

Suspended sediment

Temperature variations

**-Currents caused by surface waves**

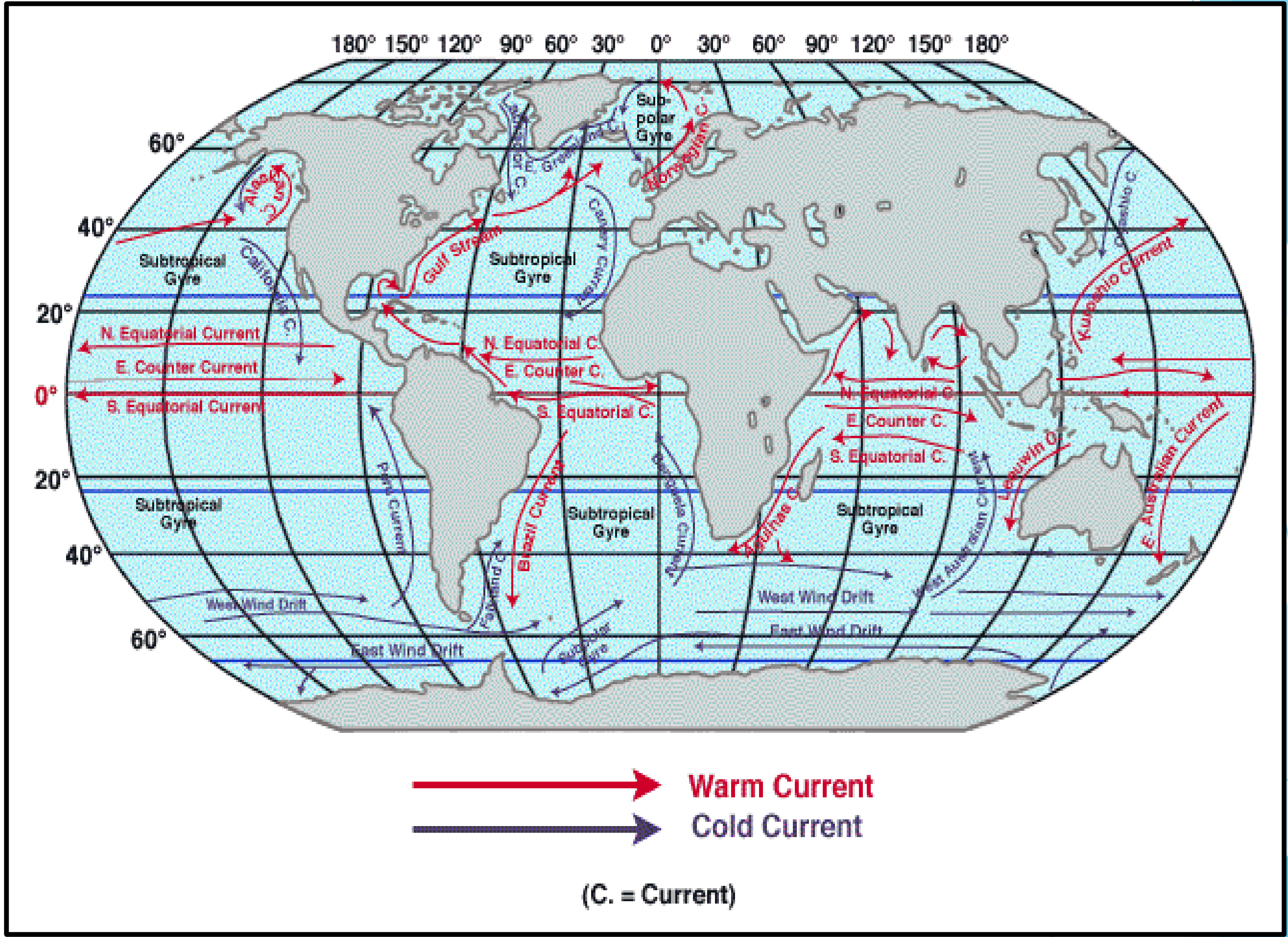
Deep: Mass transport (Offshore, open orbits, wave drift)

Shallow: Onshore, longshore, rip currents

**-Currents caused by wind stress**

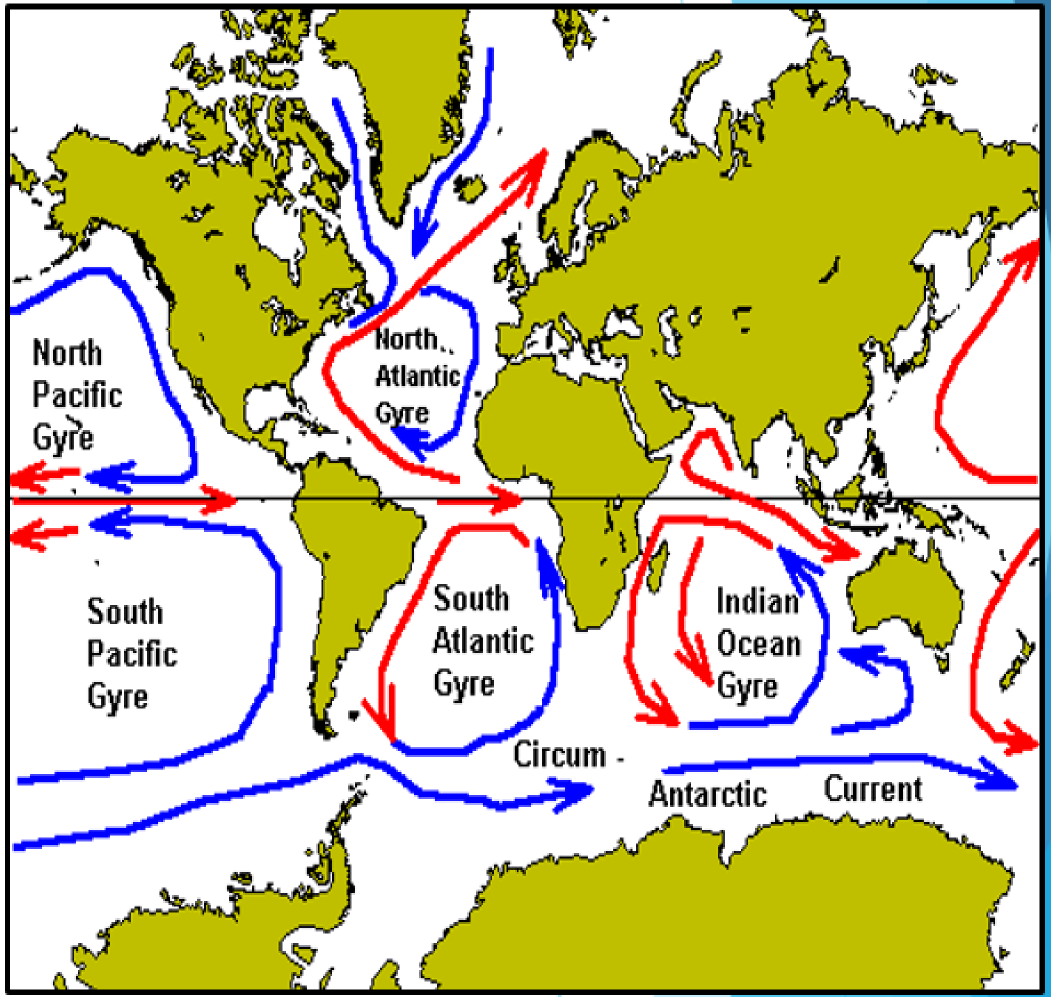
-**Tidal currents**

**-Local Currents** (in the nearshore ares where water from rivers and nearly enclosed ways is discharged into the ocean with considerable momentum)


180° 150° 120° 90° 60° 30° 0° 30° 60° 90° 120° 150° 180°
60°
40°
20°
0°
20°
40°
60°
Subtropical Gyre
Subtropical Gyre
Subtropical Gyre
Subtropical Gyre
Subtropical Gyre
Sub-polar Gyre
N. Equatorial Current
E. Counter Current
S. Equatorial Current
N. Equatorial C.
E. Counter C.
S. Equatorial C.
N. Equatorial C.
E. Counter C.
S. Equatorial C.
Gulf Stream
Norwegian C.
Canary Current
California C.
Kuroshio Current
Peru Current
Brazil Current
Benguela Current
Agulhas C.
Leeuwin C.
E. Australian Current
West Australian Current
West Wind Drift
West Wind Drift
East Wind Drift
East Wind Drift
Warm Current
Cold Current
(C. = Current)

# Surface Ocean Currents

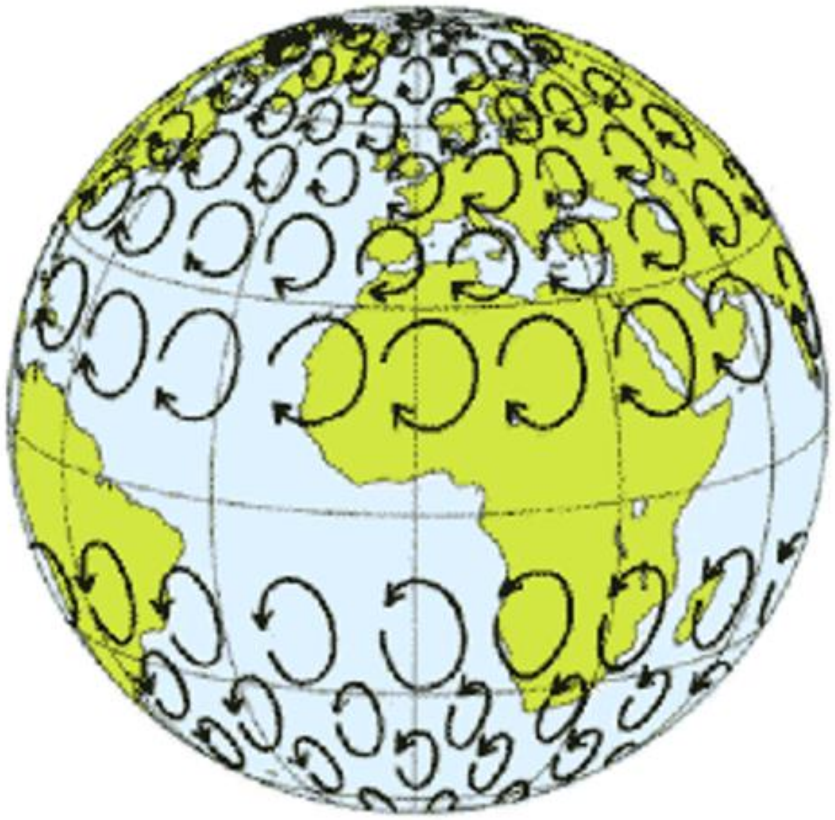
- Broad, slow drifts; never cross equator
- Wind generated; circular patterns



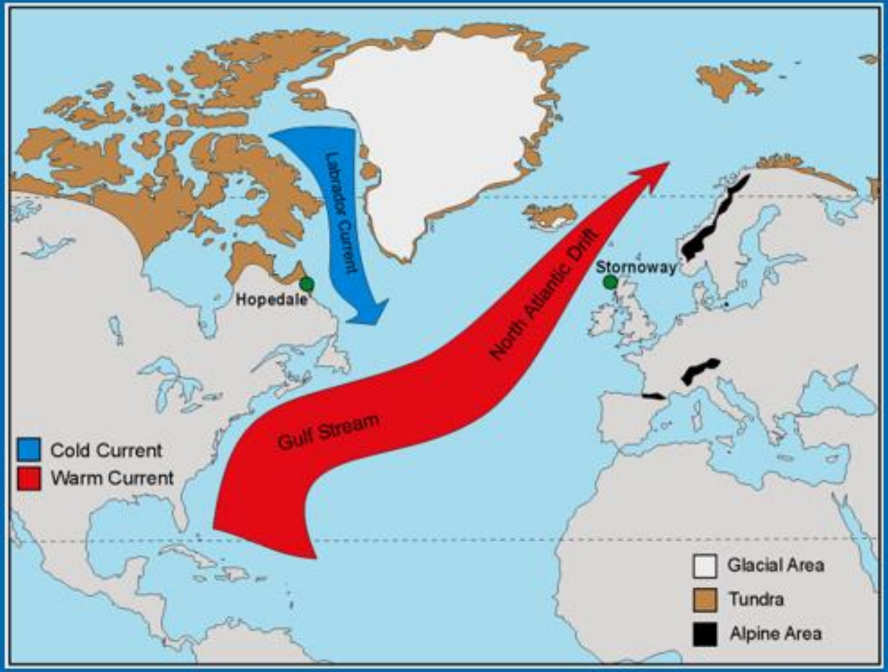
# Coriolis Effect

- N. Hemis – clockwise; Right

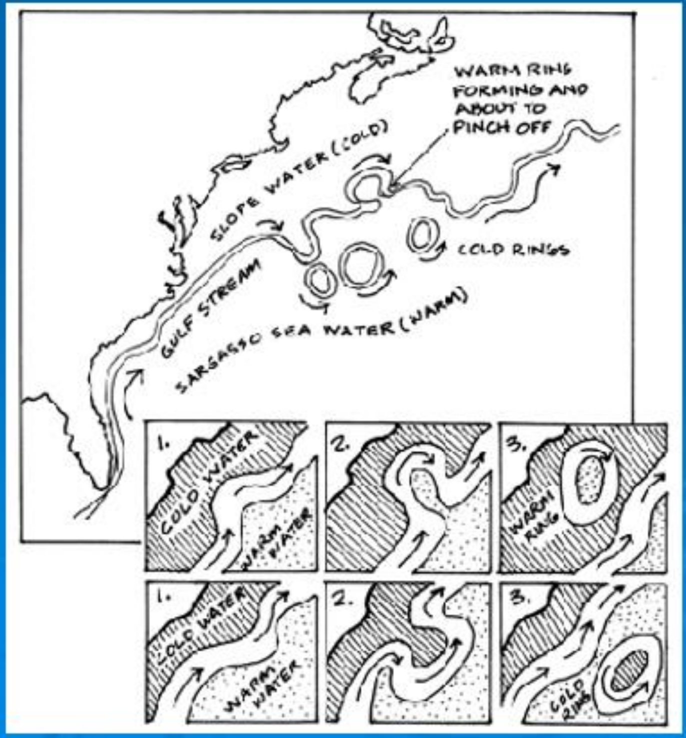
- S. Hemis – counterclockwise; Left



- Gulf Stream
  - N. Atlantic
  - Brings warm water from equator north along east coast of N. A.




-Sometimes form <u>eddies</u> – circulating water that pinches off from the current

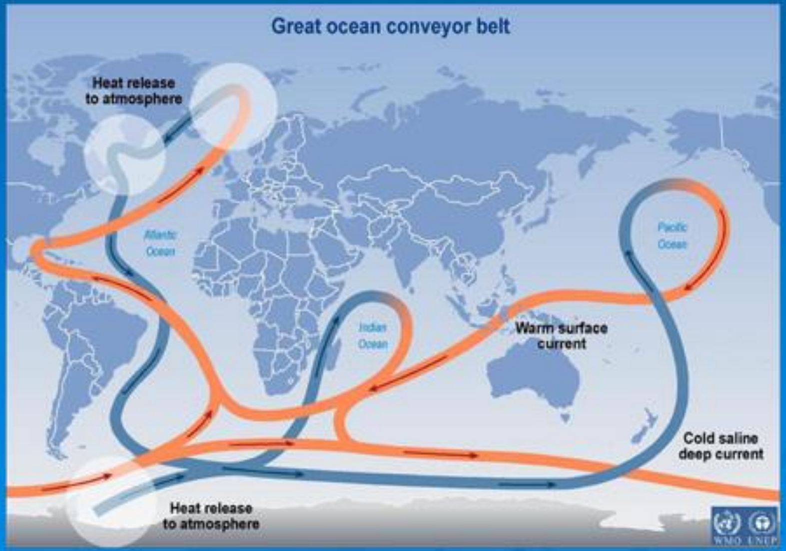


# IMPORTANCE OF SURF. CURRENTS

MIGRATION


NAVIGATION

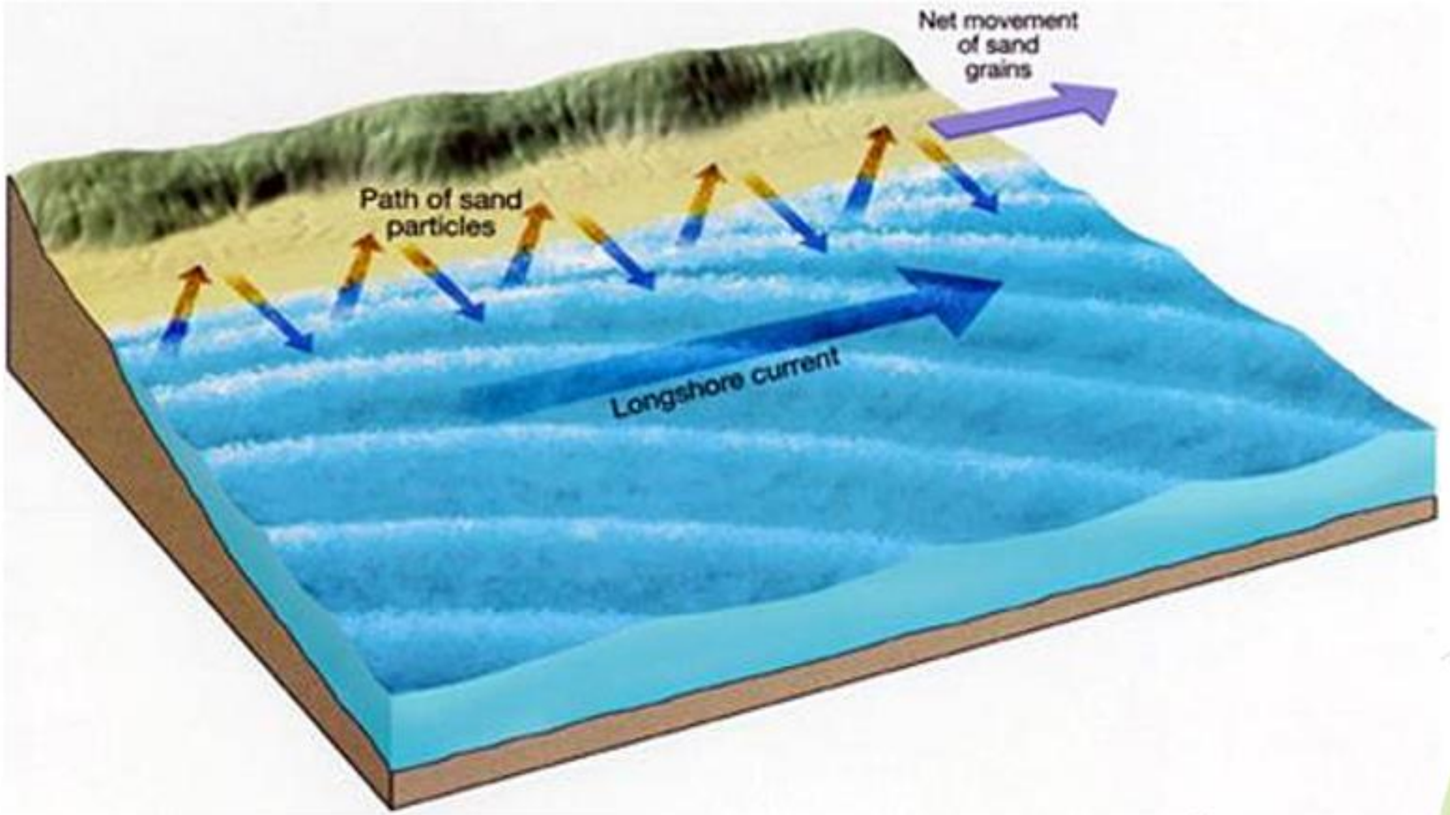
WEATHER

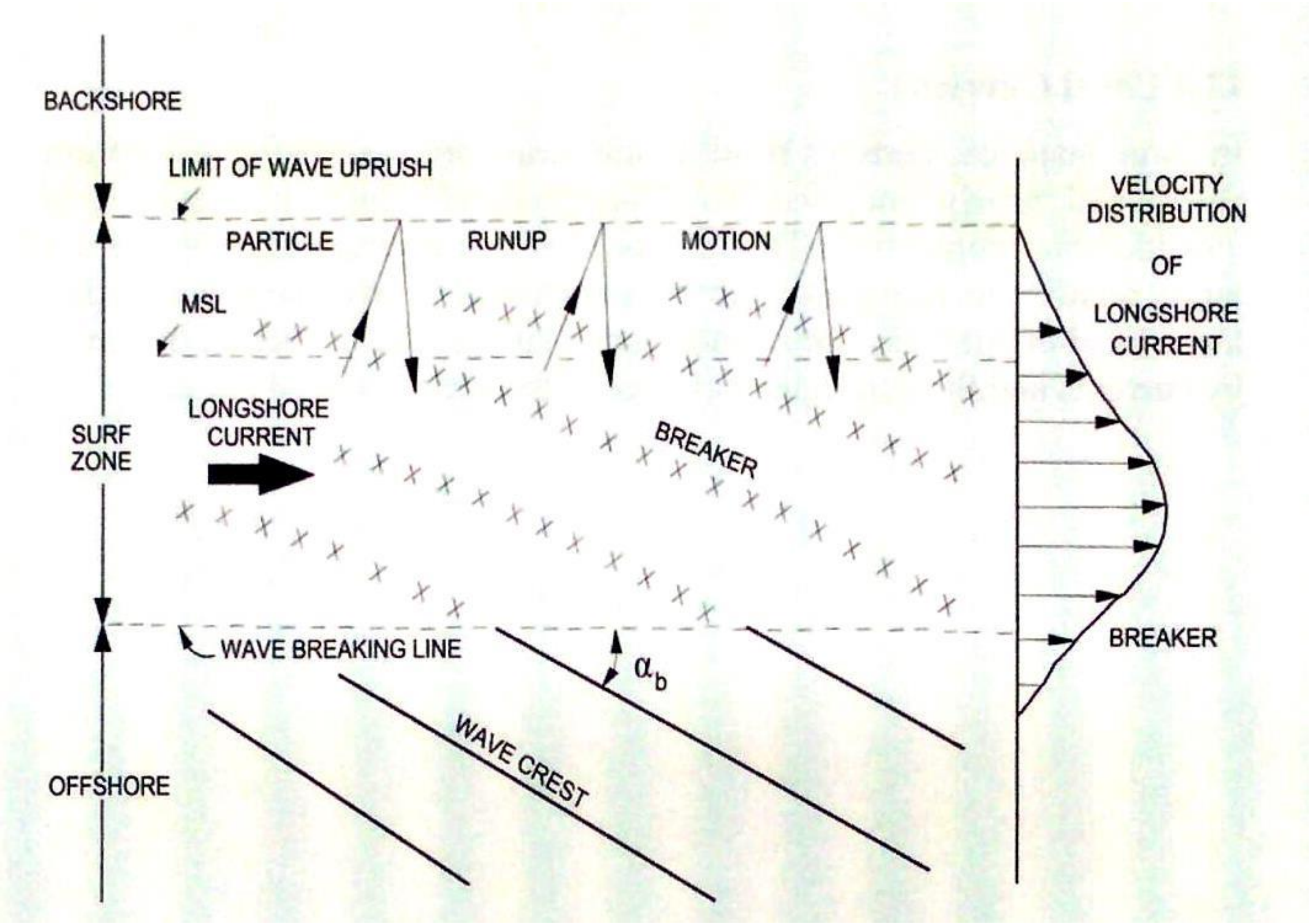


# Localized Surface Currents

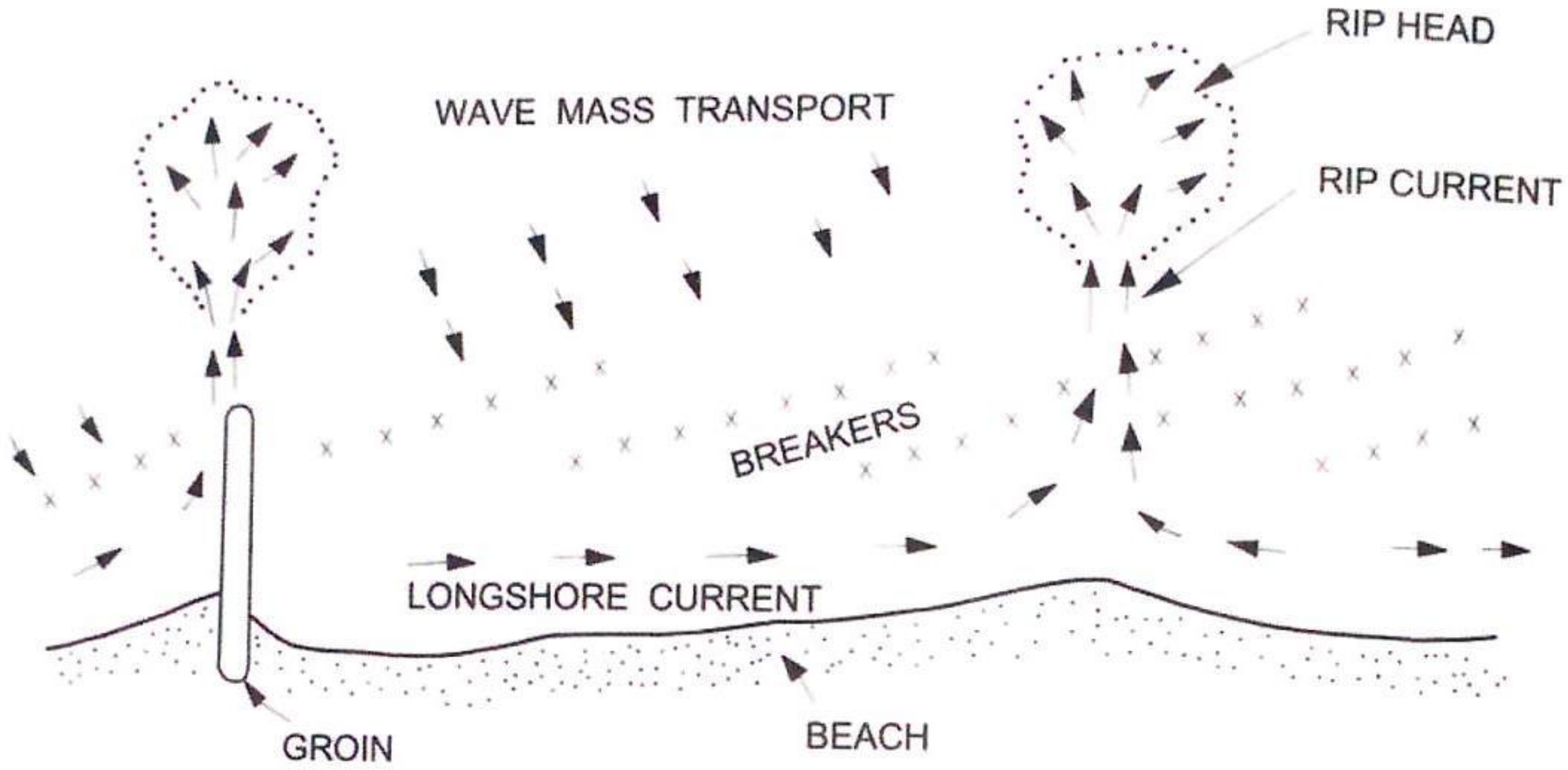
## Longshore Current.

- Flows parallel to shore; move sediment
- Between the breakerline and shoreline
- A typical velocity of about 0.30m/s





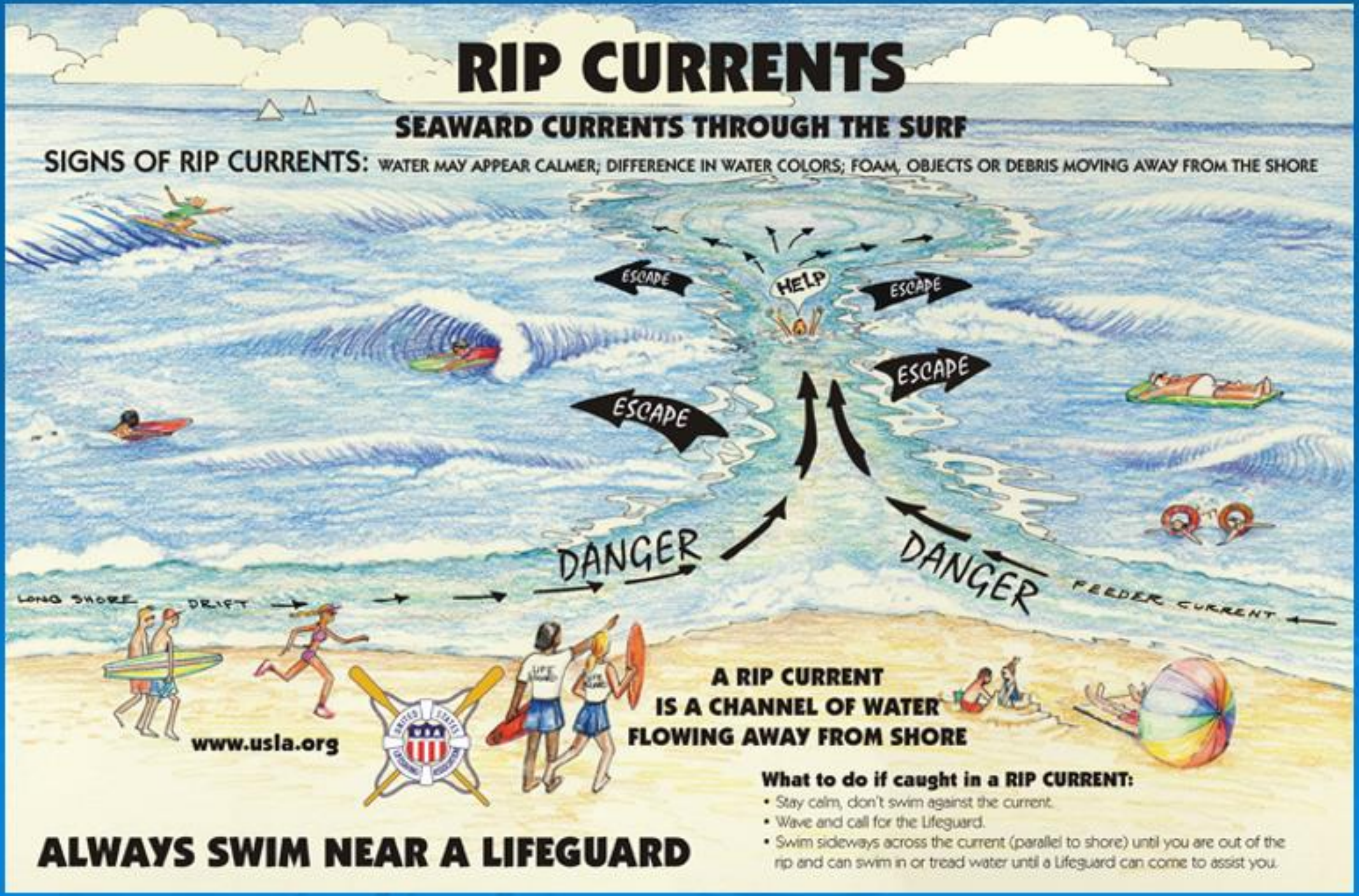
BACKSHORE
LIMIT OF WAVE UPRUSH
PARTICLE
RUNUP
MOTION
MSL
VELOCITY DISTRIBUTION OF LONGSHORE CURRENT
SURF ZONE
LONGSHORE CURRENT
BREAKER
WAVE BREAKING LINE
$\alpha_b$
BREAKER
WAVE CREST
OFFSHORE

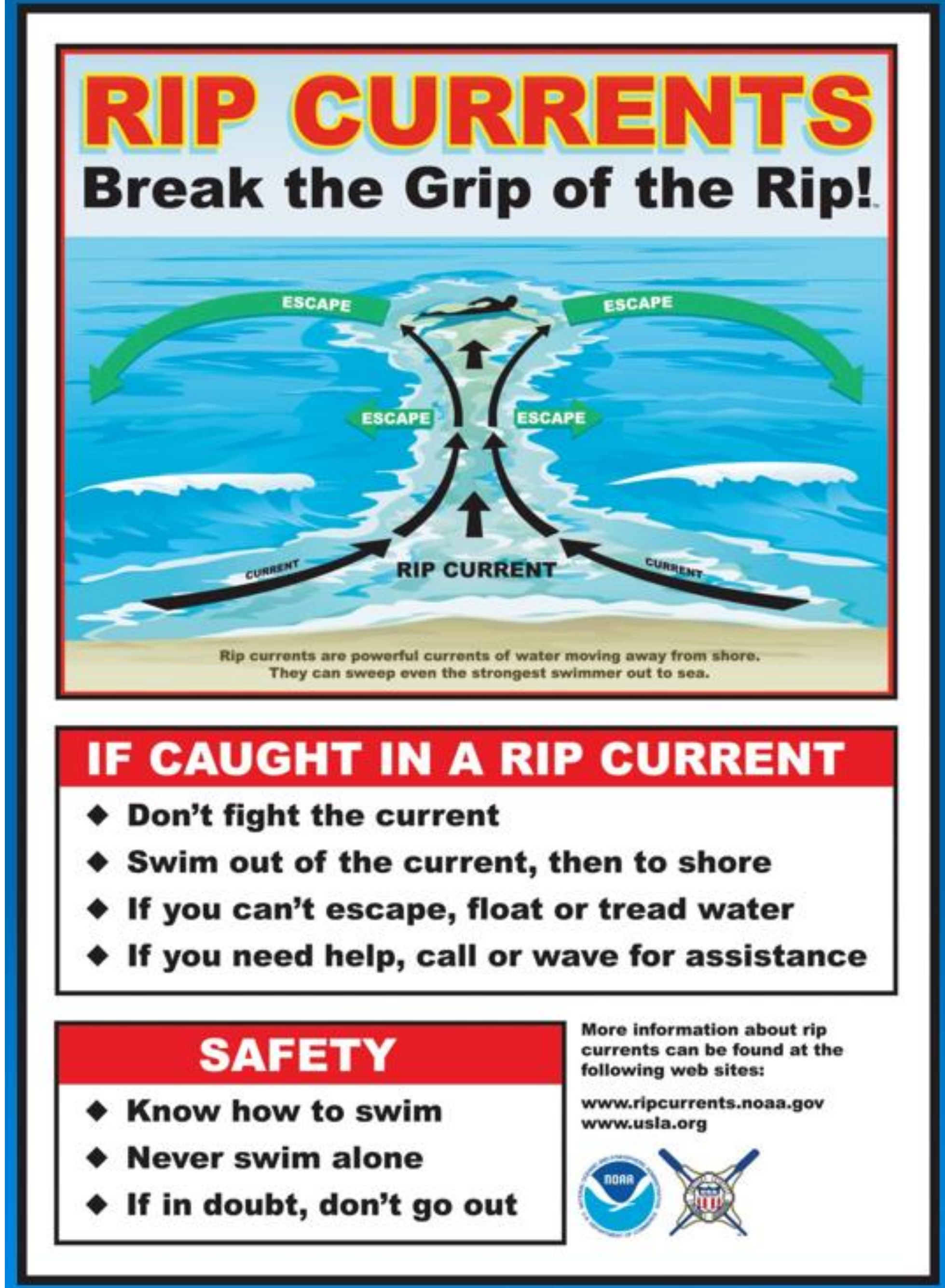


RIP HEAD
WAVE MASS TRANSPORT
RIP CURRENT
BREAKERS
LONGSHORE CURRENT
GROIN
BEACH

# RIP CURRENT

- Caused by converging longshore currents
- Between offshore and the surf zone
- Very dangerous ; Red Flag
- DO NOT fight rip current; swim parallel to shore to get out of channel
- Exceed 2.2m/s



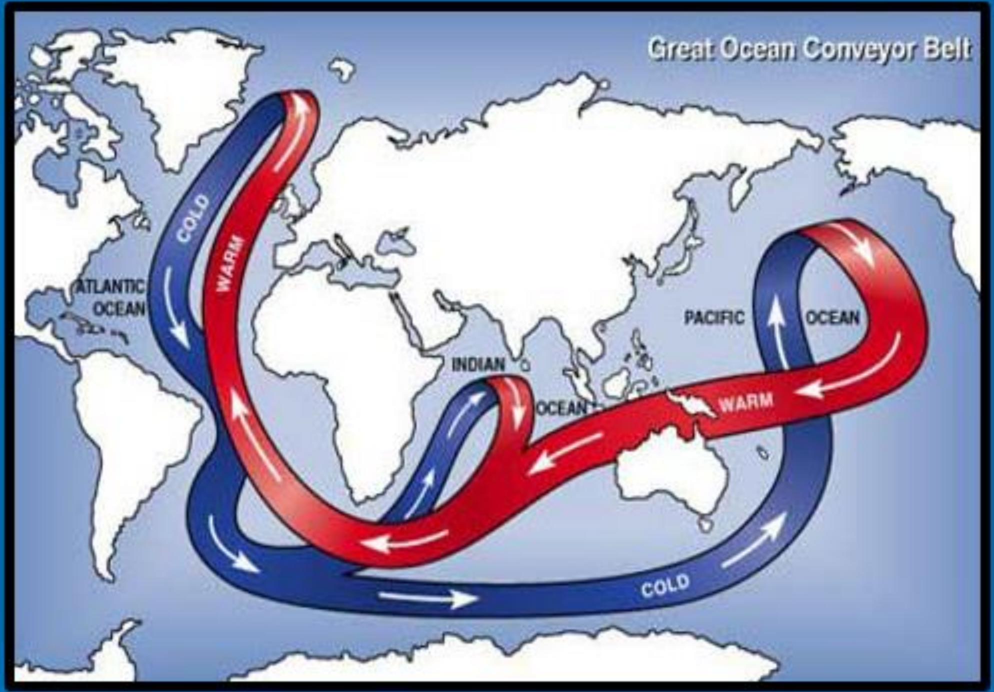

RIP CURRENTS
Break the Grip of the Rip!
ESCAPE
ESCAPE
ESCAPE
ESCAPE
CURRENT
RIP CURRENT
CURRENT
Rip currents are powerful currents of water moving away from shore.
They can sweep even the strongest swimmer out to sea.
IF CAUGHT IN A RIP CURRENT
◆ Don't fight the current
◆ Swim out of the current, then to shore
◆ If you can't escape, float or tread water
◆ If you need help, call or wave for assistance
SAFETY
◆ Know how to swim
◆ Never swim alone
◆ If in doubt, don't go out
More information about rip currents can be found at the following web sites:
www.ripcurrents.noaa.gov
www.usla.org
NOAA


ARGUS2.1 snap Argus02a Sun Jul 2 20:00:01 2000 EST5EDT F: 962582401
C: 0 S: 1 Inc: 0 Qual: 80


Delaware Sea Grant

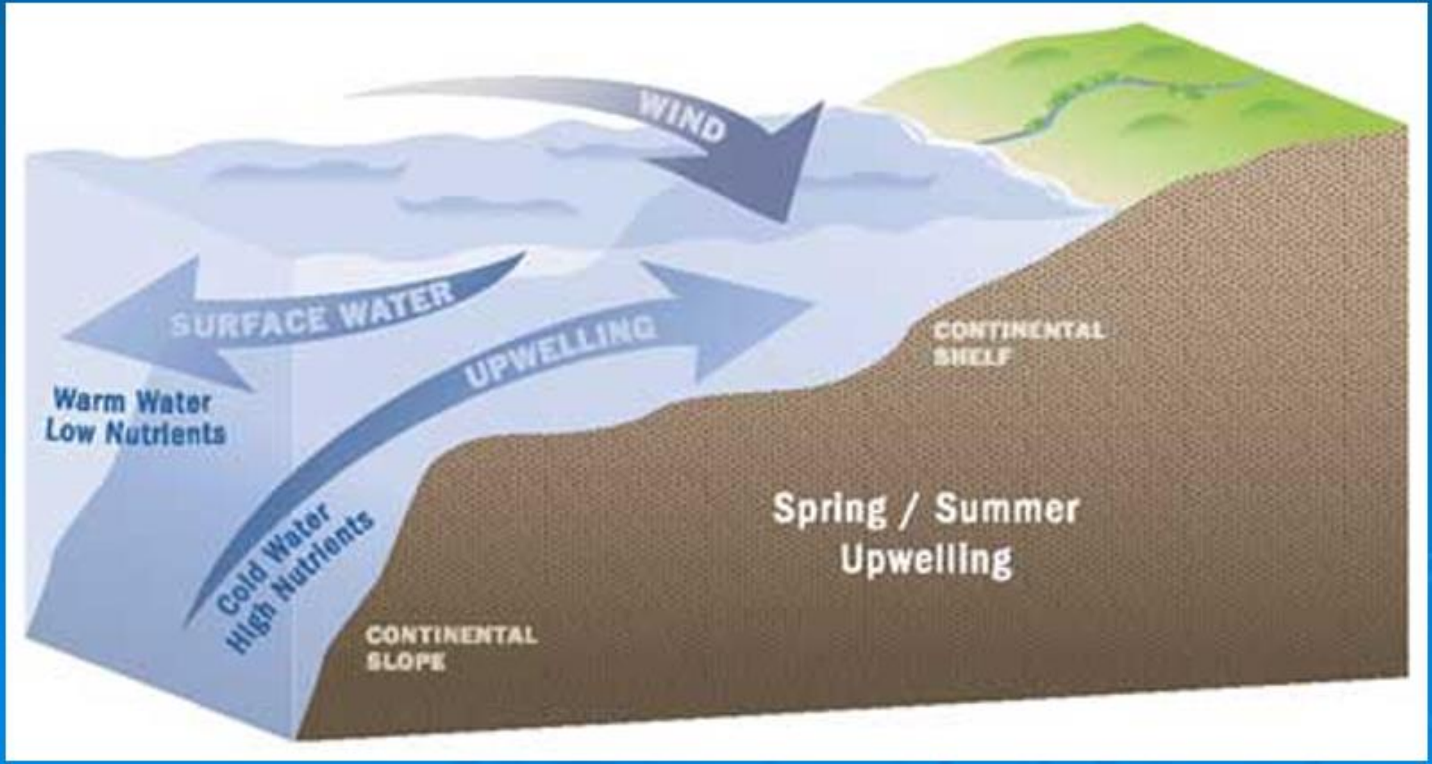
# Deep Ocean Currents

- Flow beneath surface; cross equator
- Move North to South
- Separated from surface currents by boundary called a "Thermohaline" (diff in densities)



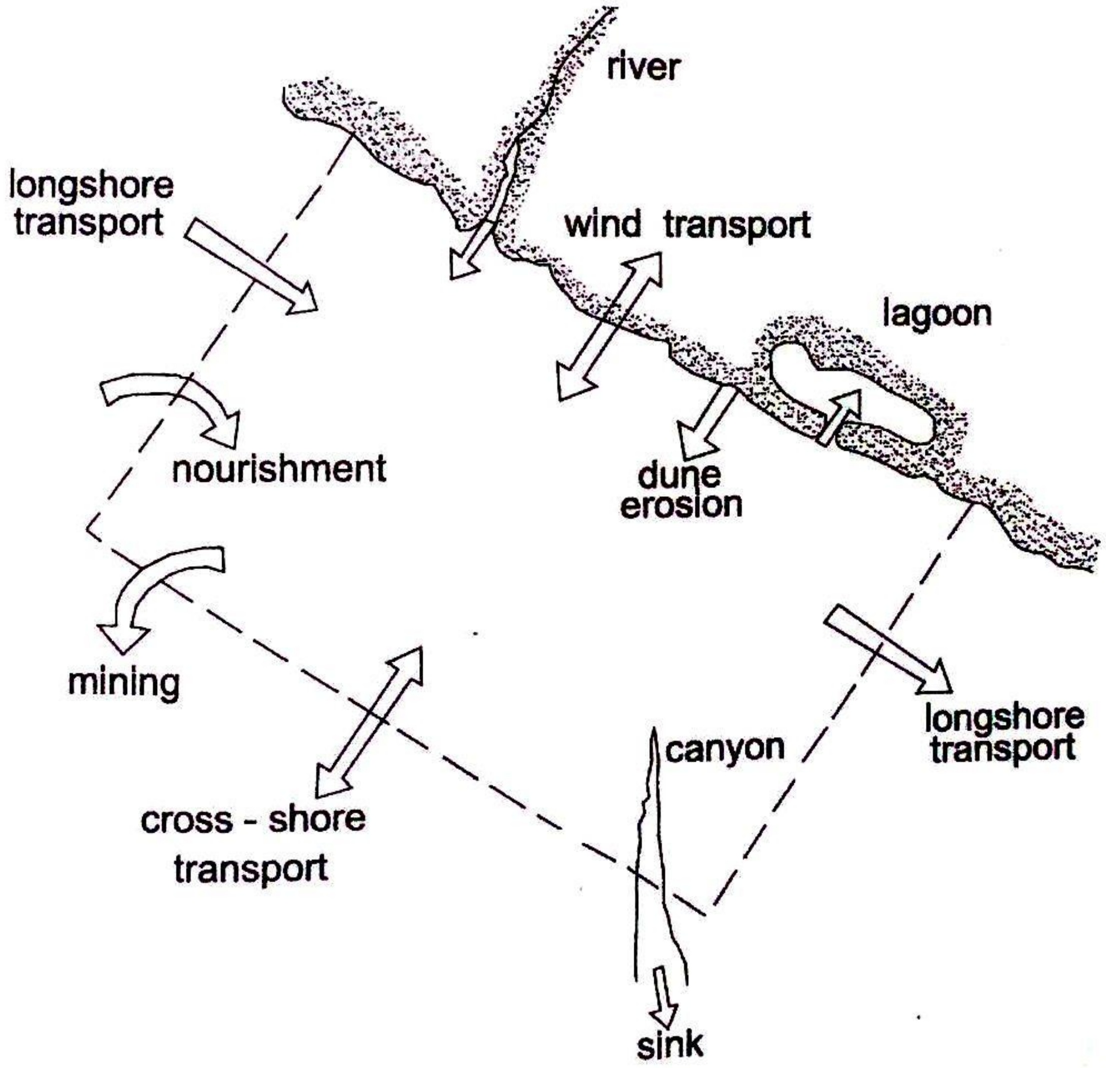
# Importance Of Deep Currents

- Upwelling
  - Brings deep water to surf.
  - Circulates nutrients up
  - Moves plankton & larvae



# SEDIMENT TRANSPORT

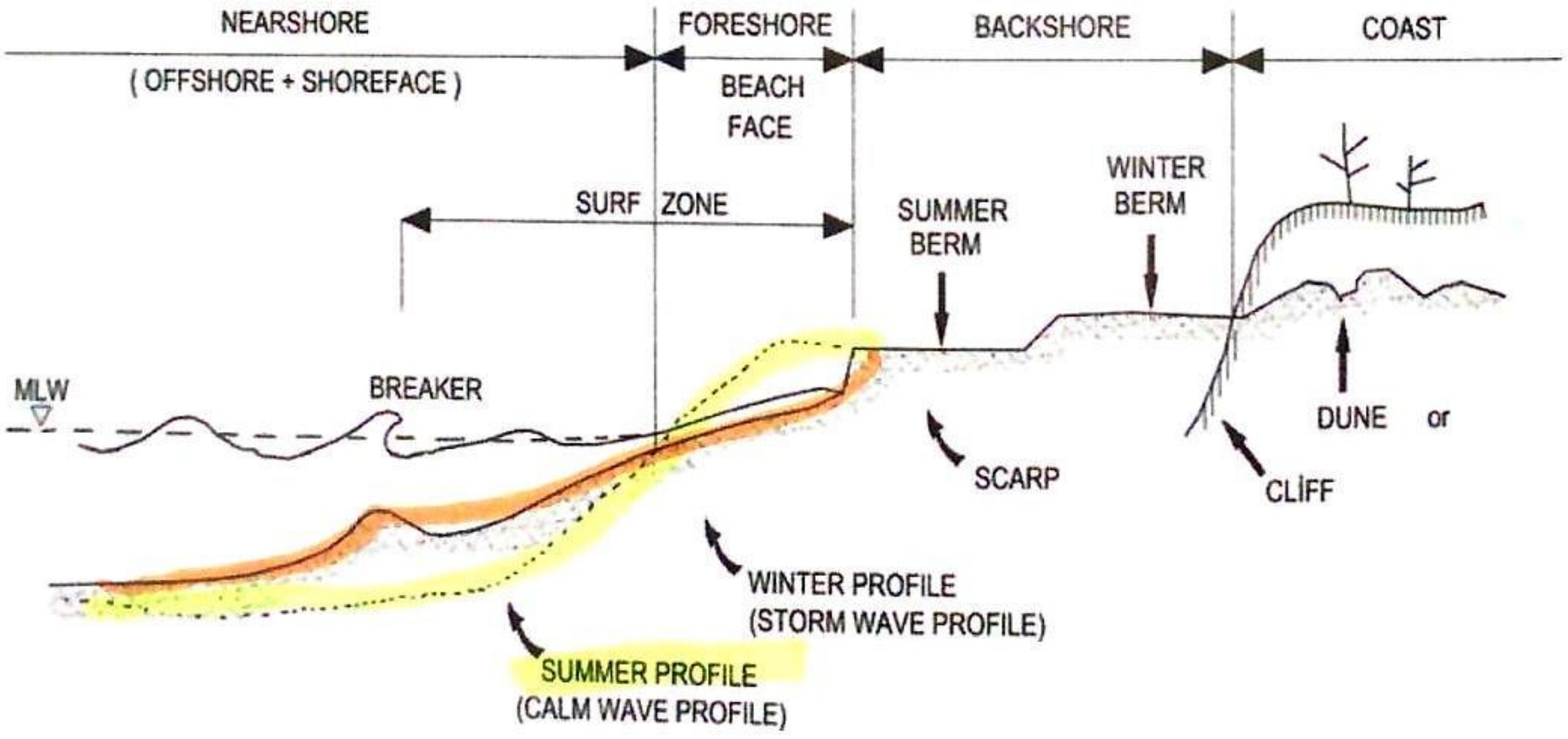
# Sediment Budget



# Sediment Budget

| Gains | Losses | Net |
|---|---|---|
| • Longshore transport into area<br>• River transport<br>• Sea cliff erosion<br>• Onshore transport<br>• Biogenic deposition<br>• Wind transport onto the beach<br>• Beach nourishment<br>• Dune Erosion | • Longshore transport out of area<br>• Offshore (or cross-shore) transport<br>• Wind transport inland<br>• Deposition in maintained navigation channels and lagoons<br>• Transport through submarine canyons<br>• Solution and abrasion<br>• Mining<br>• Other anthropogenic causes | • Beach accretion or erosion (sand gains and losses)<br><br>Accretion : Gains >Losses<br><br>Erosion: Gains < Losses |

# Typical Beach Profile

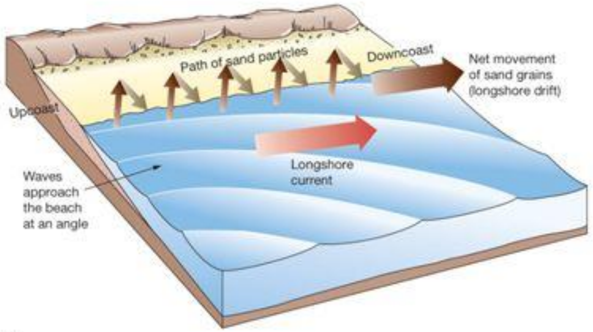


# Sand Movement Along Beach

Two Major Types

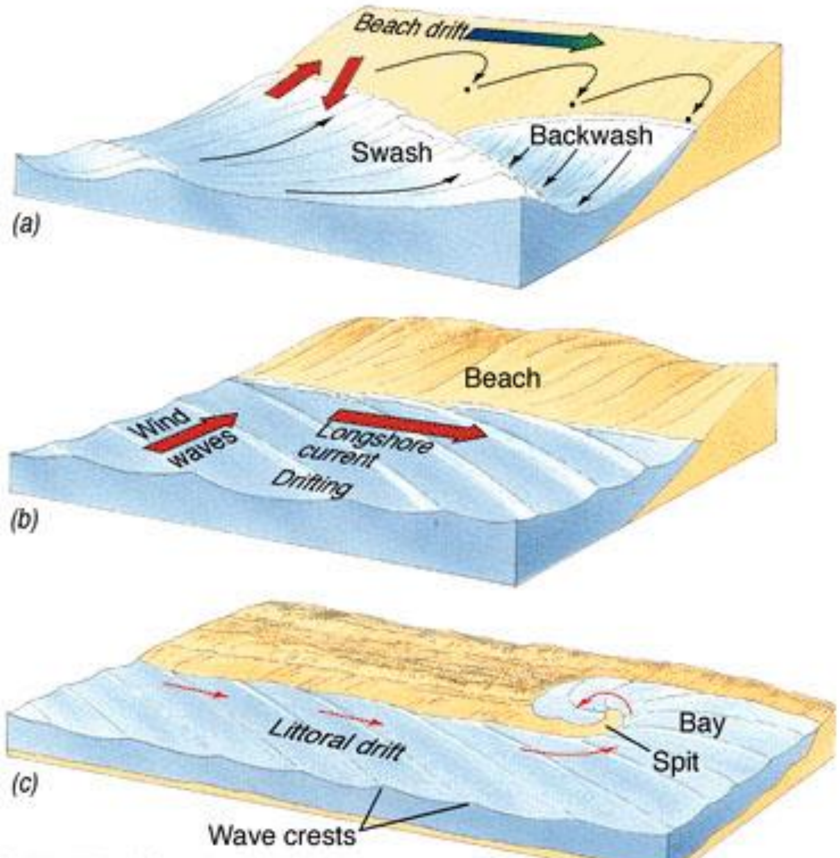
1. Perpendicular to shoreline (toward and away)
   - Swash – water rushes up the beach
   - Backwash – water drains back to the ocean
2. Parallel to shoreline (up-coast or down-coast)
   - Longshore current – transports sand along the beach

(a)




(b)





# COASTAL PROTECTION

- Coastal protection provides defense against flooding and erosion, caused by waves and tides, winds, currents and littoral drift.

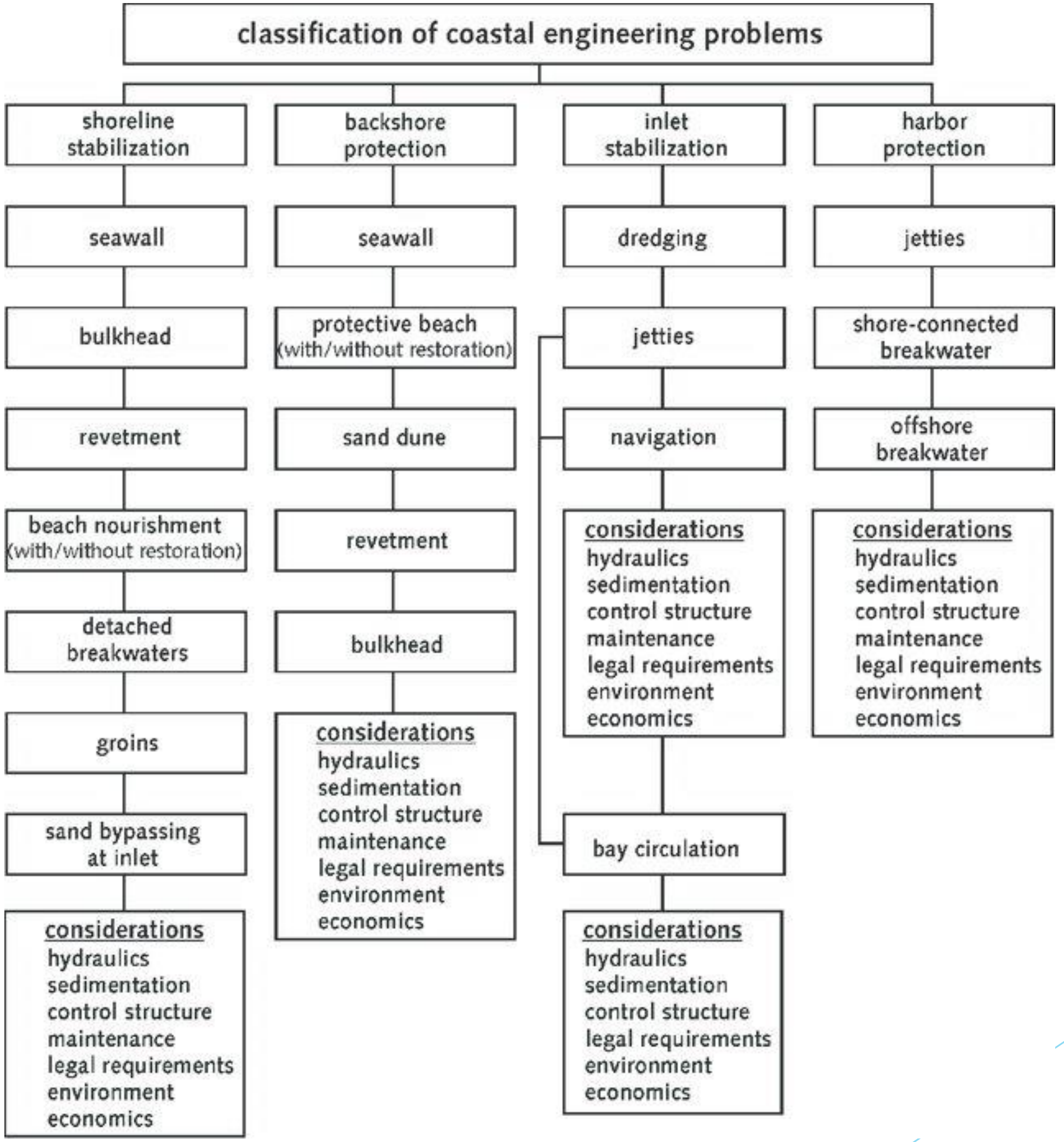
- **Coastal Protection Structures**
- Against erosion

- **Structures for Coastal Stability**
- Retarding the coastal erosion
- Providing a longer life of coastal fill

| NATURE | MAN |
| --- | --- |
| Shore Rock | Sea Wall |
| Rock Island | Offshore Breakwaters |
| Rock Reef | Submerged Breakwater |
| Headland | Large breakwater perpendicular to or at angle with shoreline |
| Rock perpendicular | Groins |
| Sea floor vegetation | Bottom mattresess |
| Dune | Dyke |
| Material transfer to the shore by: Wind drift, rivers, longshore littoral drift | Artificial nourishment from land sources |
| Sea bottom transfer | Artificial nourishment from offshore sources |
| | |

# Planning analysis

- **Hydraulic considerations**
  - WINDS, WAVES, CURRENTS, TIDES, STORM SURGE, WIND SET-UP, BATHYMETRY
  - LITTORAL PROCESSES, CHANGES IN SHORE ALIGNMENT
- **Navigation considerations**
  - DESIGN VESSEL DATA, TRAFFIC, CHANNEL ALIGNMENT AND DIMENSIONS
- **Structure considerations**
  - SELECTION OF PROTECTIVE WORKS, TYPE, USE, EFFECTIVENESS, ECONOMIC, ENVIRONMENTAL IMPACT
- **Economic considerations**
  - DESIGN OF MOST ECONOMICAL ENGINEERING WORK, COMPARISON OF VARIOUS PLANS ON AN ECONOMICAL BASIS, INTEREST AND AMORTIZATION, MAINTANENCE COST
- **Environmental considerations**
  - EFFECTS ON ADJACENT LAND AREAS, PHYSICAL AND ECOLOGICAL FACTORS, AESTHETICS, LEGAL AND SOCIAL CONSEQUENCES



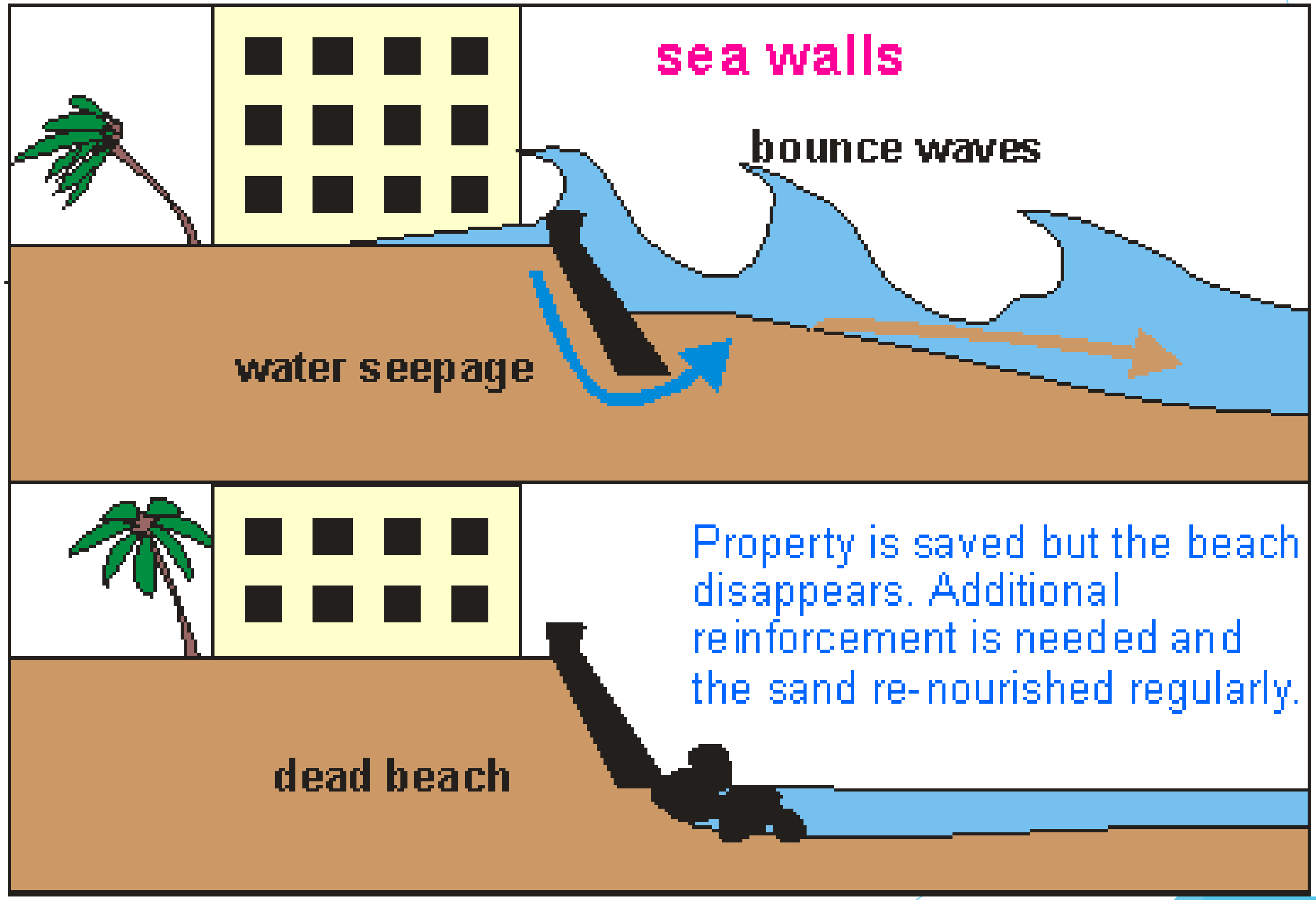
classification of coastal engineering problems
shoreline stabilization
seawall
bulkhead
revetment
beach nourishment (with/without restoration)
detached breakwaters
groins
sand bypassing at inlet
considerations
hydraulics
sedimentation
control structure
maintenance
legal requirements
environment
economics
backshore protection
seawall
protective beach (with/without restoration)
sand dune
revetment
bulkhead
considerations
hydraulics
sedimentation
control structure
maintenance
legal requirements
environment
economics
inlet stabilization
dredging
jetties
navigation
considerations
hydraulics
sedimentation
control structure
maintenance
legal requirements
environment
economics
bay circulation
considerations
hydraulics
sedimentation
control structure
legal requirements
environment
economics
harbor protection
jetties
shore-connected breakwater
offshore breakwater
considerations
hydraulics
sedimentation
control structure
maintenance
legal requirements
environment
economics

# SEAWALLS, BULKHEADS AND REVETMENTS

- Structures places parallel to the shoreline to seperate a land area from a water ares

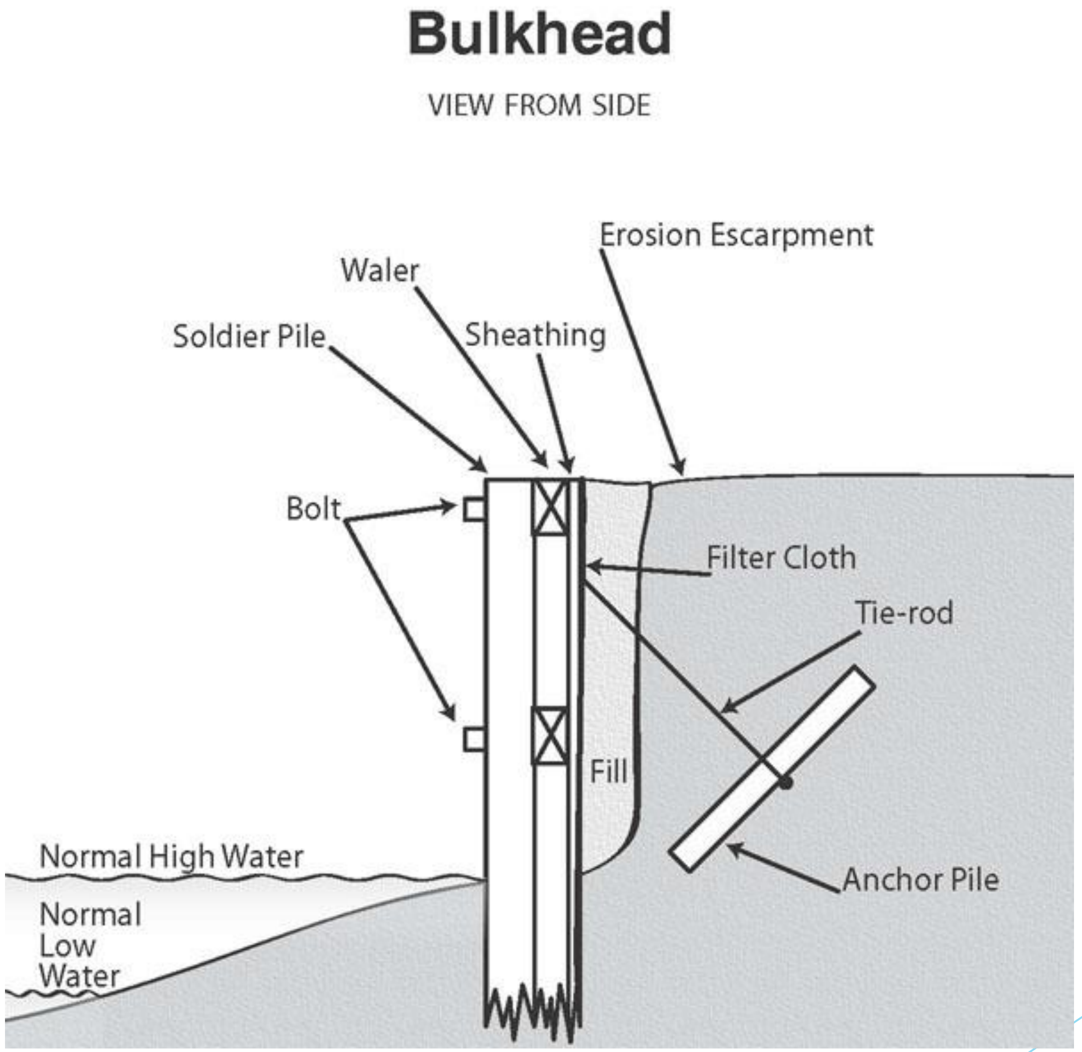
# SEAWALLS

Protects the land and upland areas from erosion by waves and currents



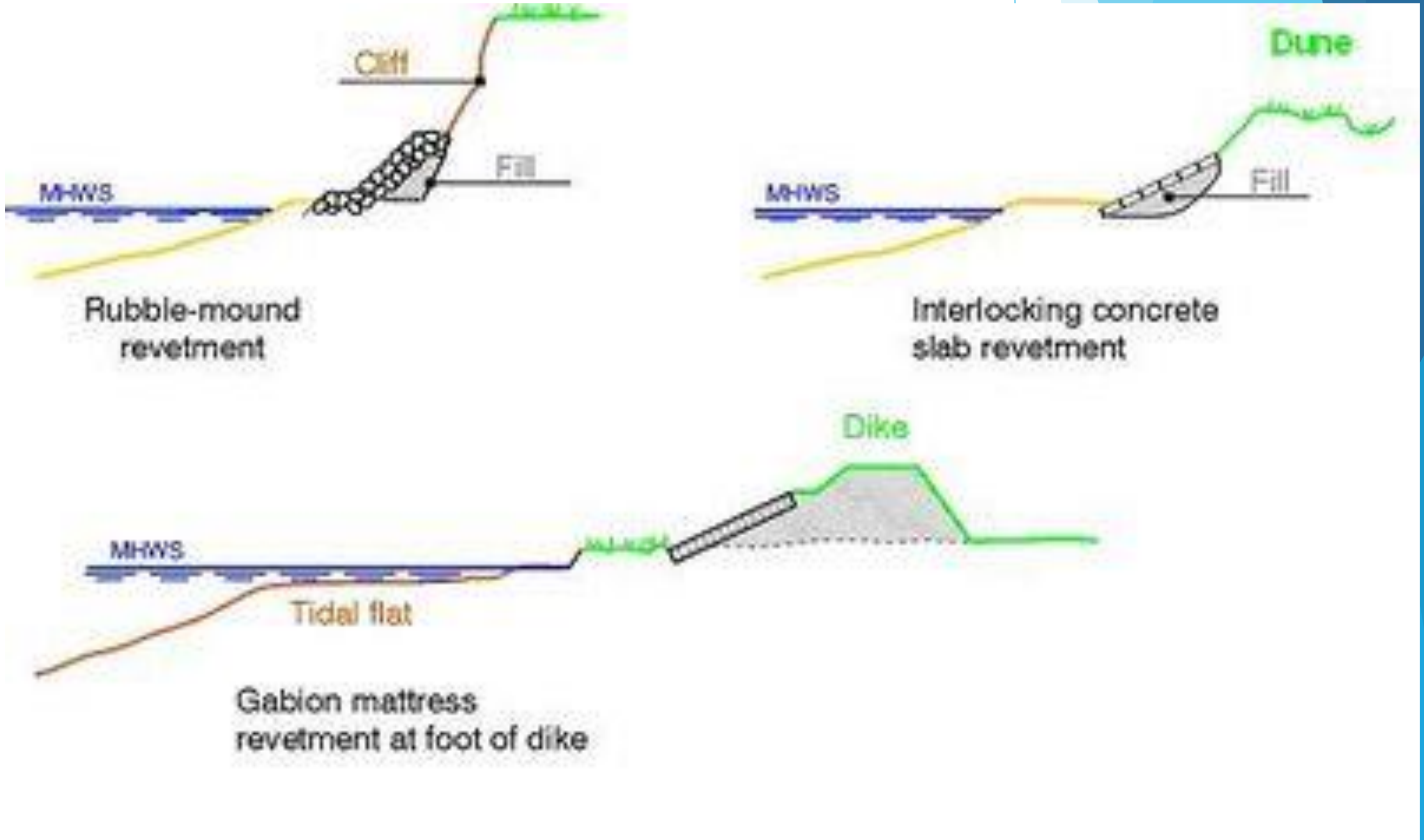
# BULKHEADS

- RETAINS LAND OR PREVENT LAND SLIDING
- PROTECTS TO THE UPLAND BY AGAINST DAMAGE BY WAVE ACTION



# REVETMENTS

Protects the land and upland areas from erosion by waves and currents



# GROINS

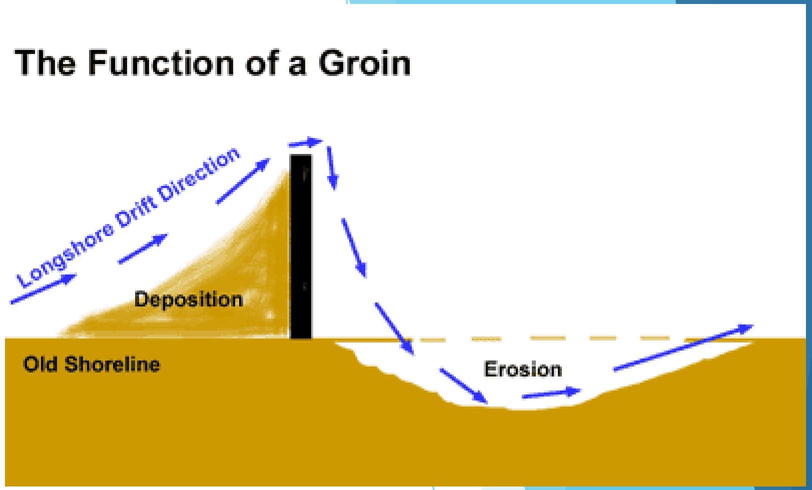
Traps  longshore drift for

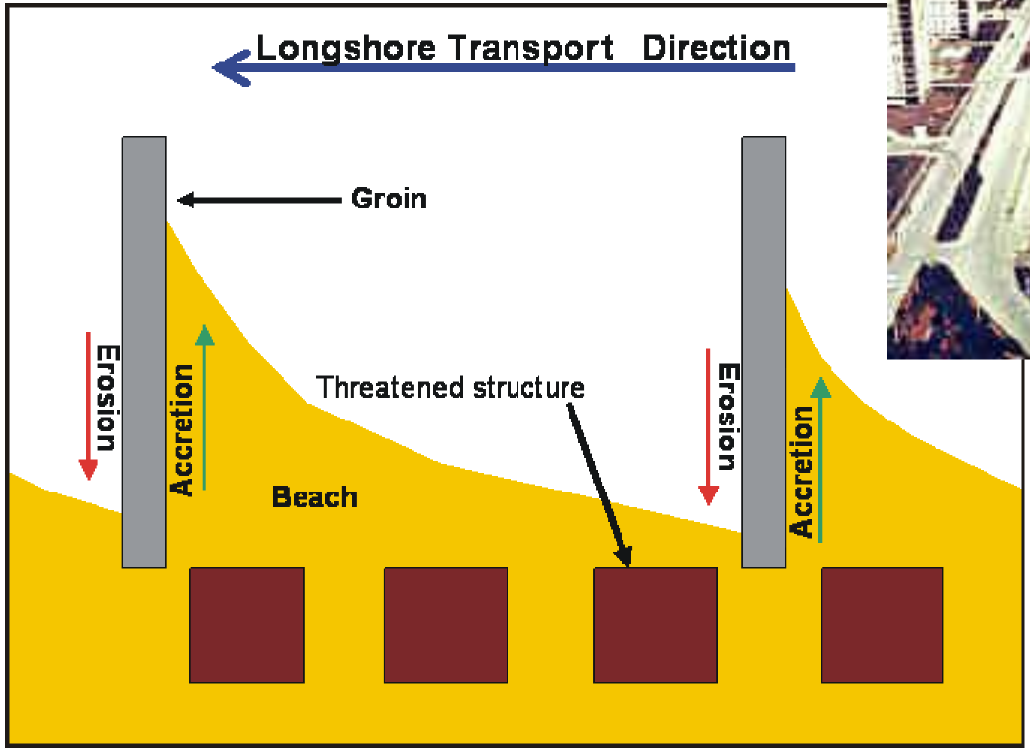
building a protective beach,

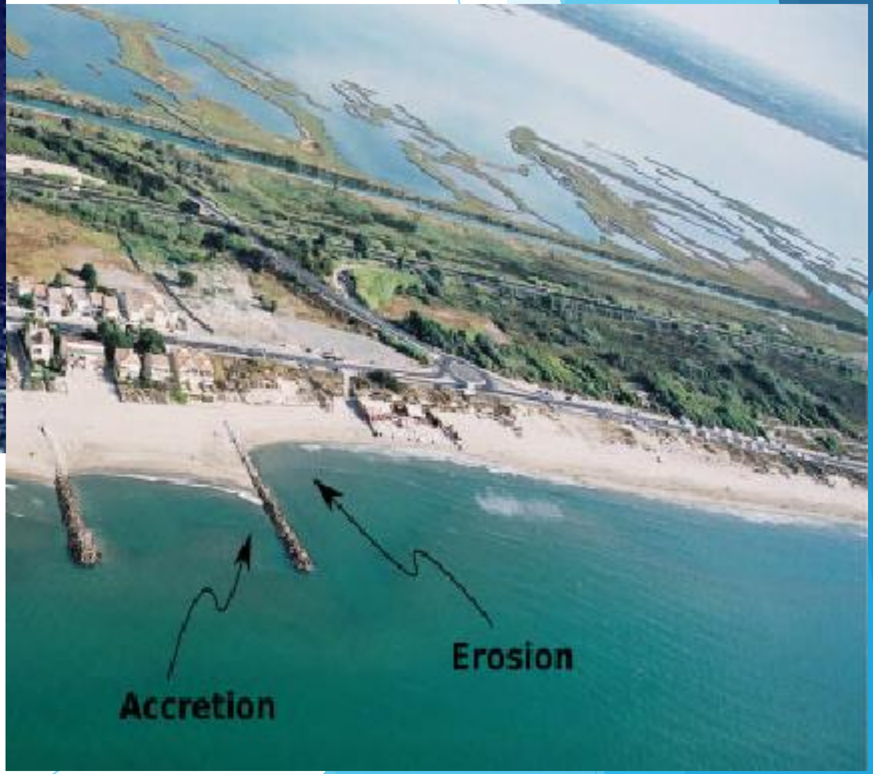
retarding erosion of an existing beach

preventing longshore drift from reaching some downdrift point,

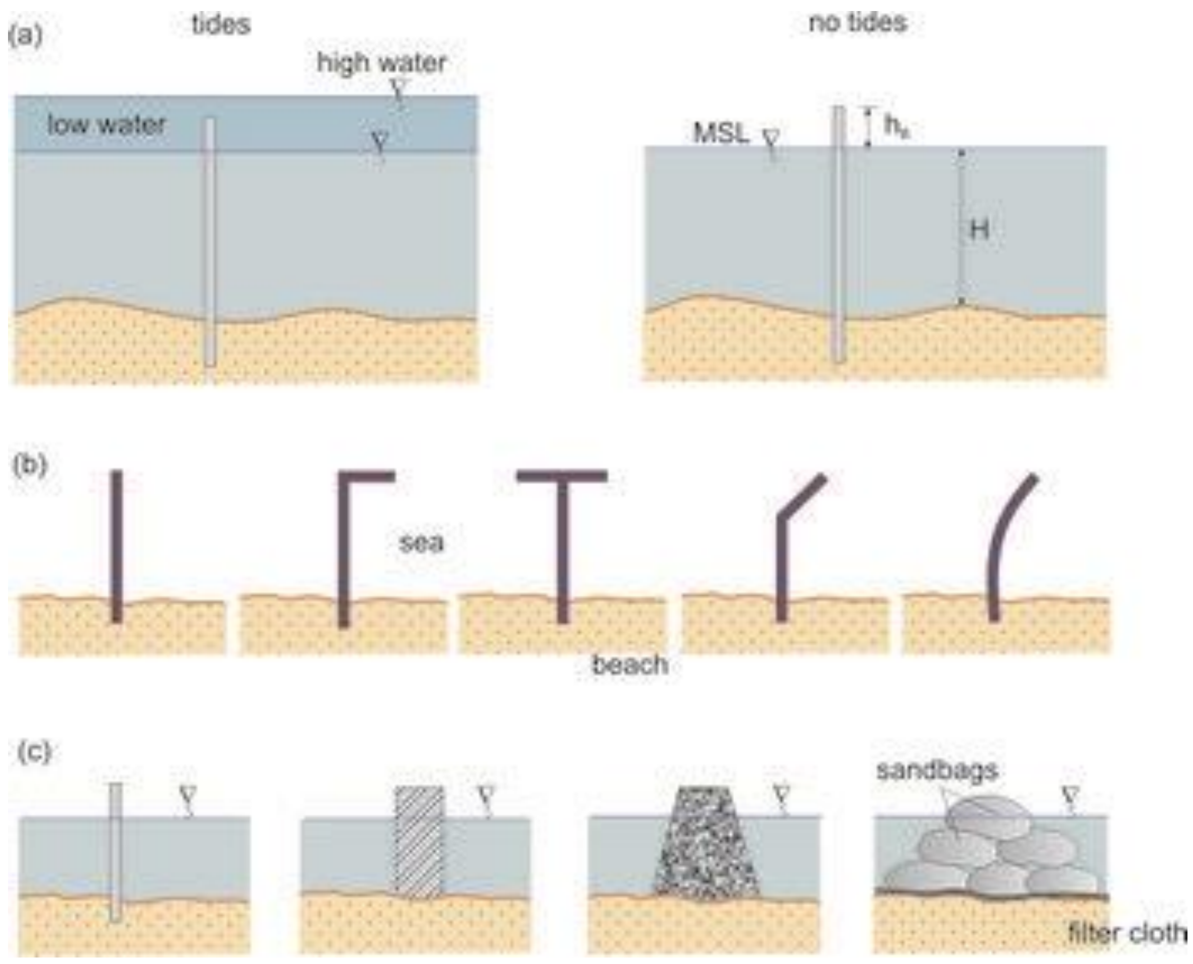
such as a harbour or inlet.



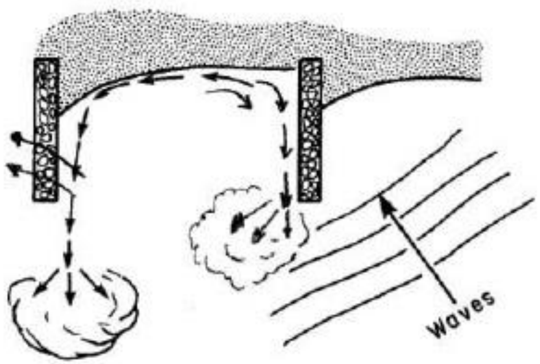



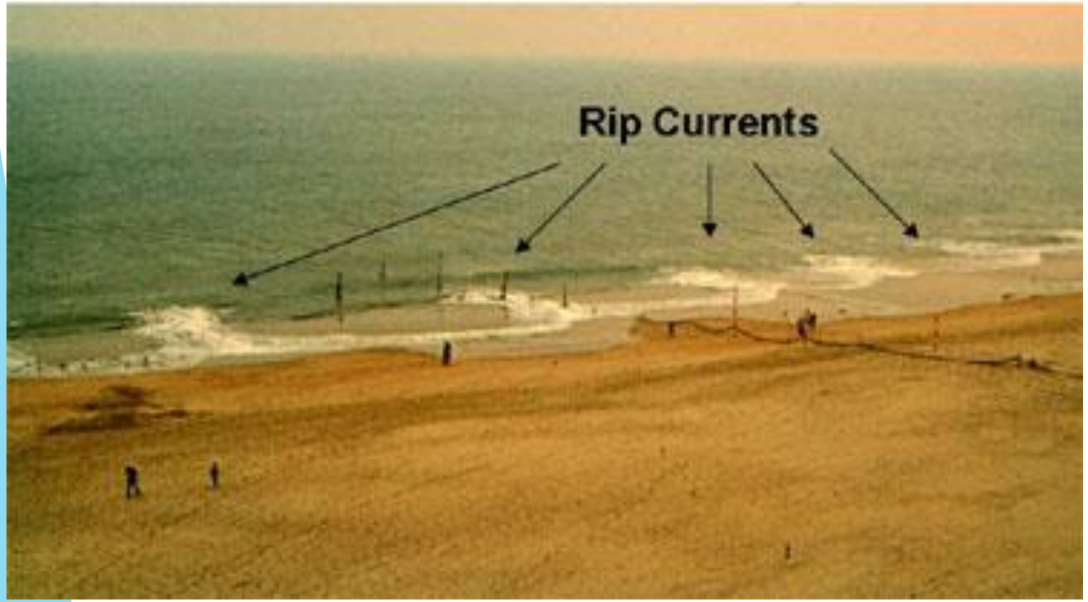



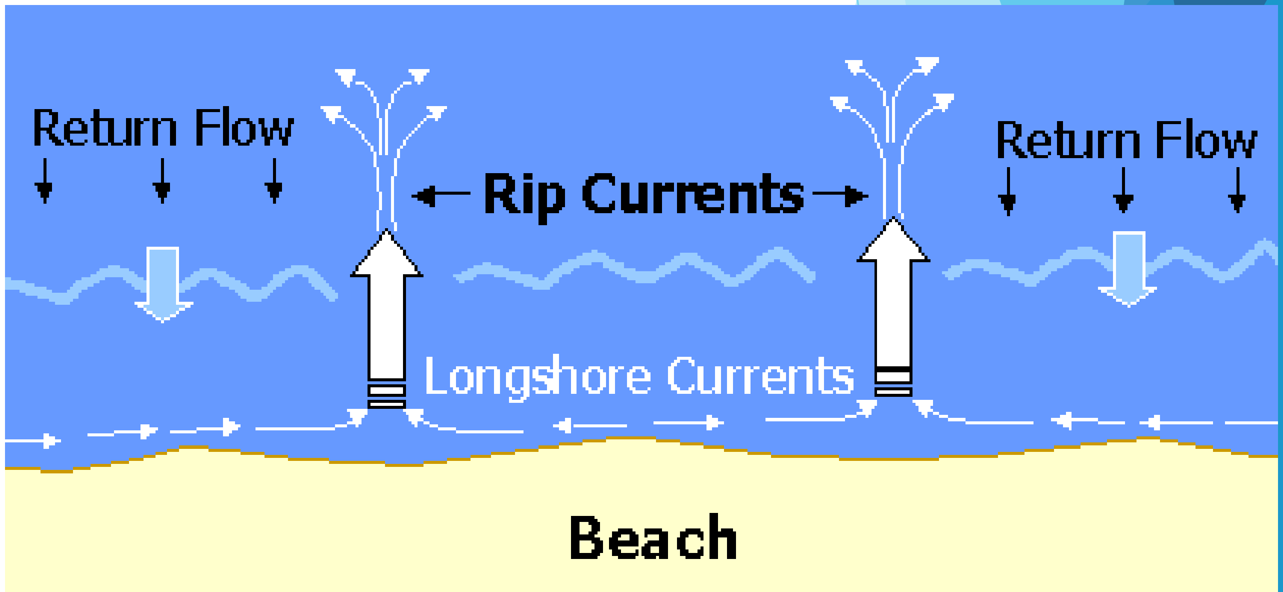
# TYPES OF GROINS



# Rip Current Formation between Groins

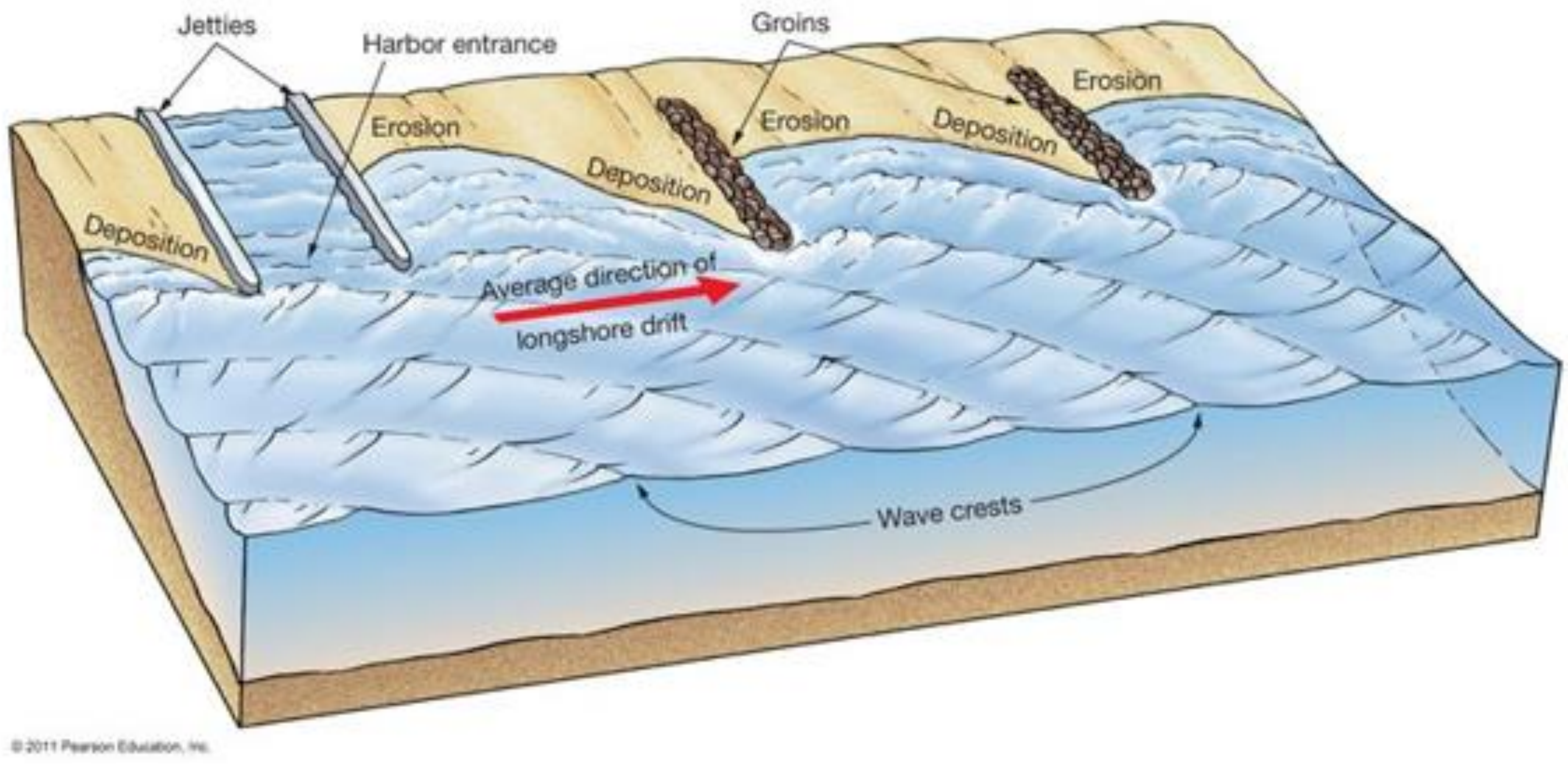


# JETTIES

- A STRUCTURE THAT EXTENDS INTO THE WATER TO DIRECT AND CONFINE RIVER OR TIDAL FLOW INTO A CHANNEL AND PREVENT OR REDUCE THE SHOALING OF THE CHANNEL BY LITTORAL MATERIALS
- AT THE ENTRANCE OF A BAY OR RIVER SERVES TO PROTECT THE ENTRANCE CHANNEL FROM WAVE ACTION OR CURRENTS
- STABILIZE THE INLET LOCATION



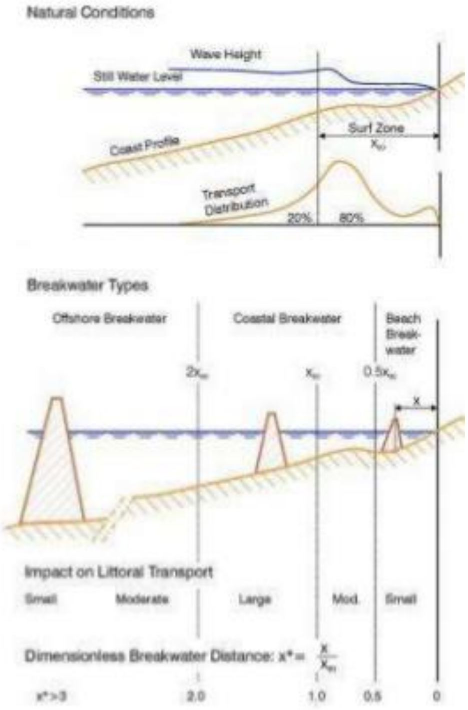
# BREAKWATERS

A structure that protects

a shore area, harbour or a basın from waves

## Types of Breakwaters

**-Detached breakwater**
(breakwaters can completely isolated from the shore)
**-Head land breakwaters**
**-Nearshore breakwaters**
**-Attached breakwater**
(Breakwaters can be connected to the shore line)
low crested structure
High crested strucure
Rubble mound strucure
Composite structure
*Using mass ( caissons )
*Using arevetment slope
(e.g with rock or concrete armor units )
**-Emerged breakwaters**
**-Submerged breakwaters**
**-Floating breakwaters**

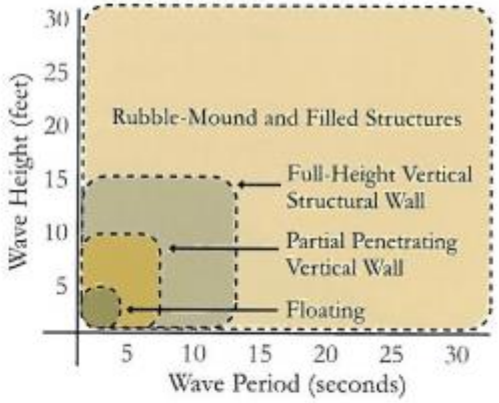



http://www.pndengineers.com/

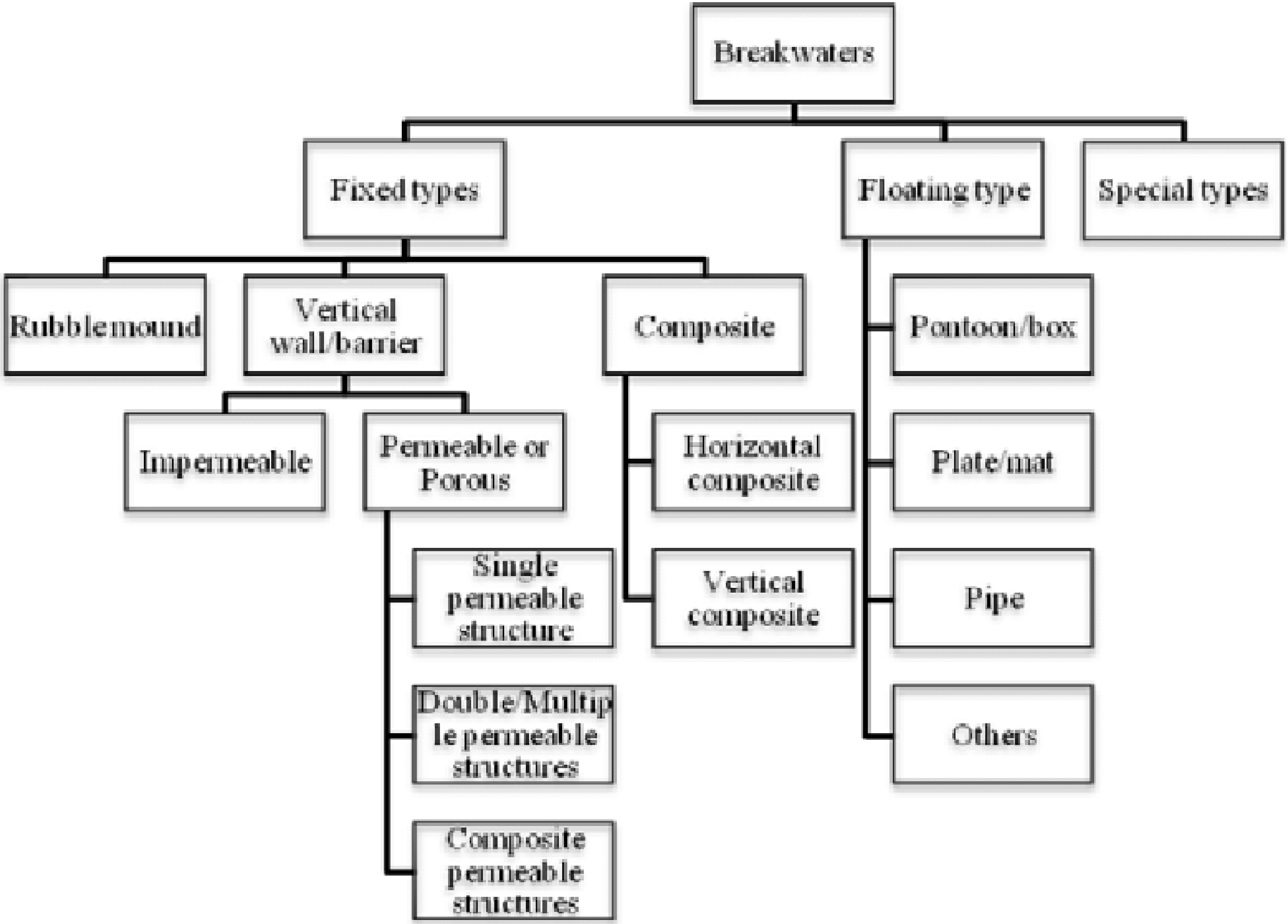
BREAKWATER TYPES

The choice of a breakwater type is largely dependent on wave height and period. The largest waves require rubble-mound structures that are able to absorb wave energy. Floating breakwaters can be used for smaller wave heights and periods, and allow for transient moorage space. Vertical structural wall types address the range falling between that of rubble-mound and floating breakwaters, as shown in the diagram on the right.

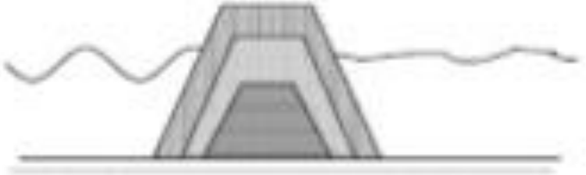
Structure Types for Typical Range of Wave Height & Period



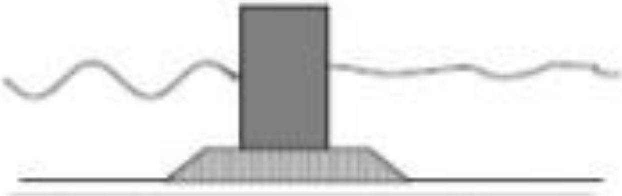
# Types of breakwaters



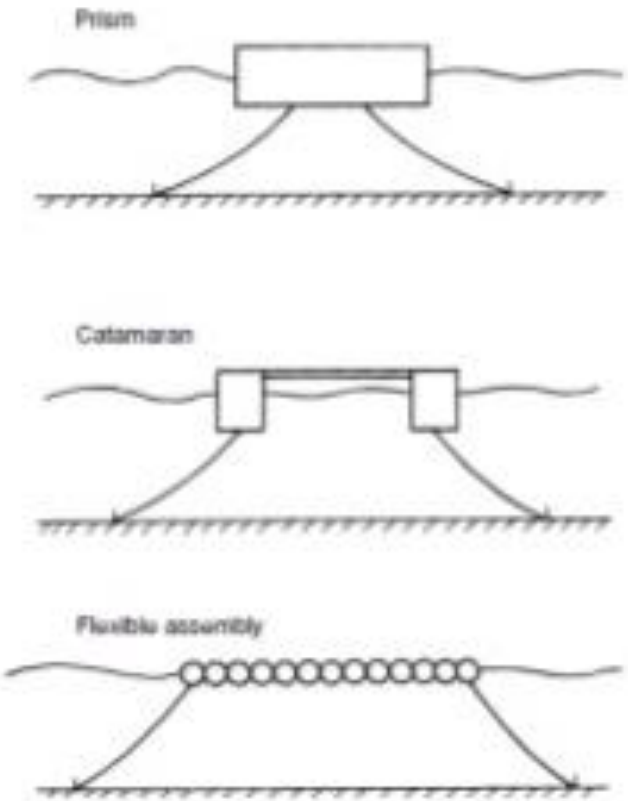
# Types of breakwaters



Rubble Mound Breakwater



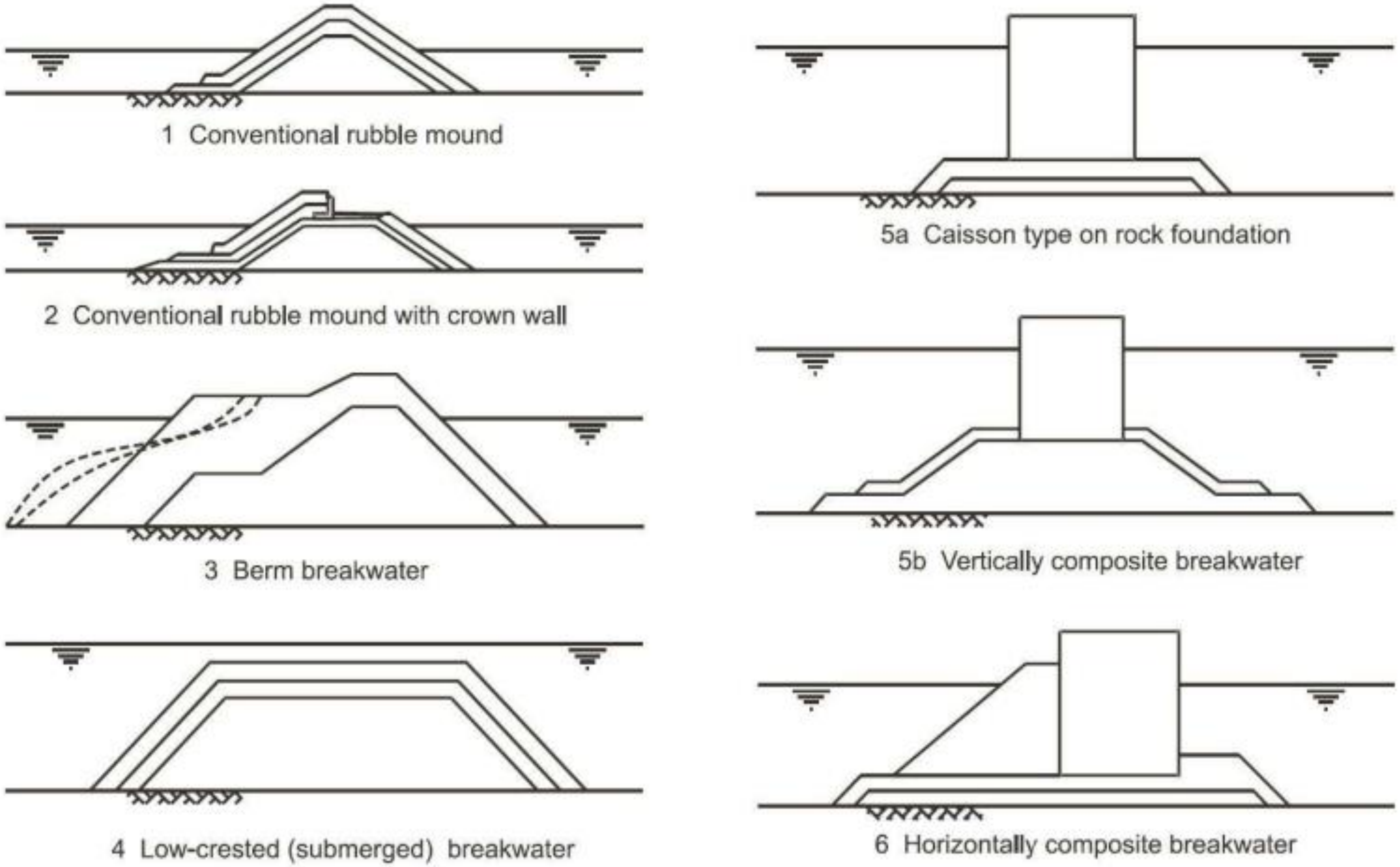
Composite Breakwater
(low mound)



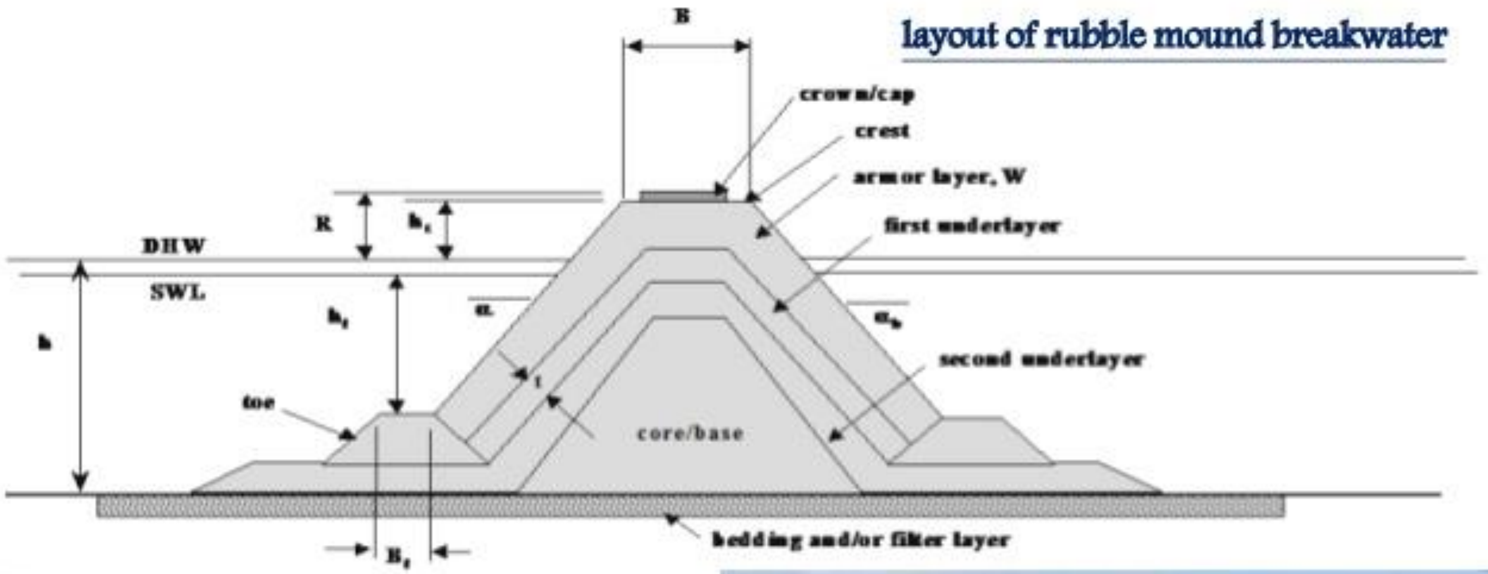

Common floating breakwater groups.

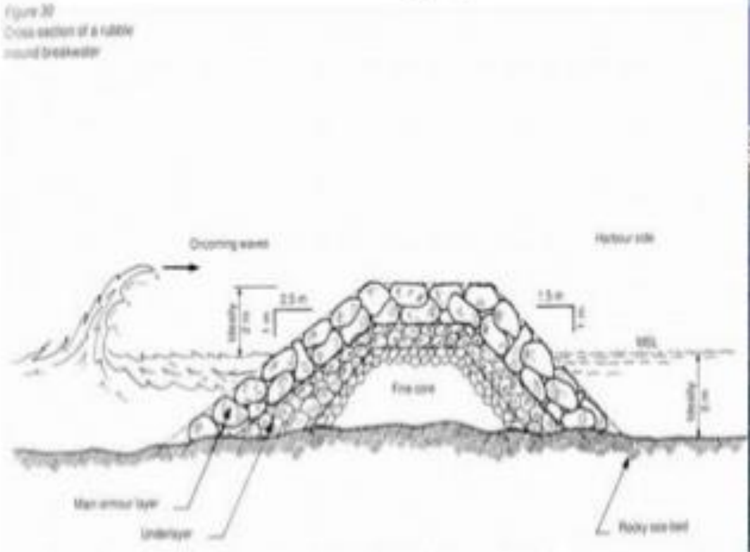
**Floating Breakwater**

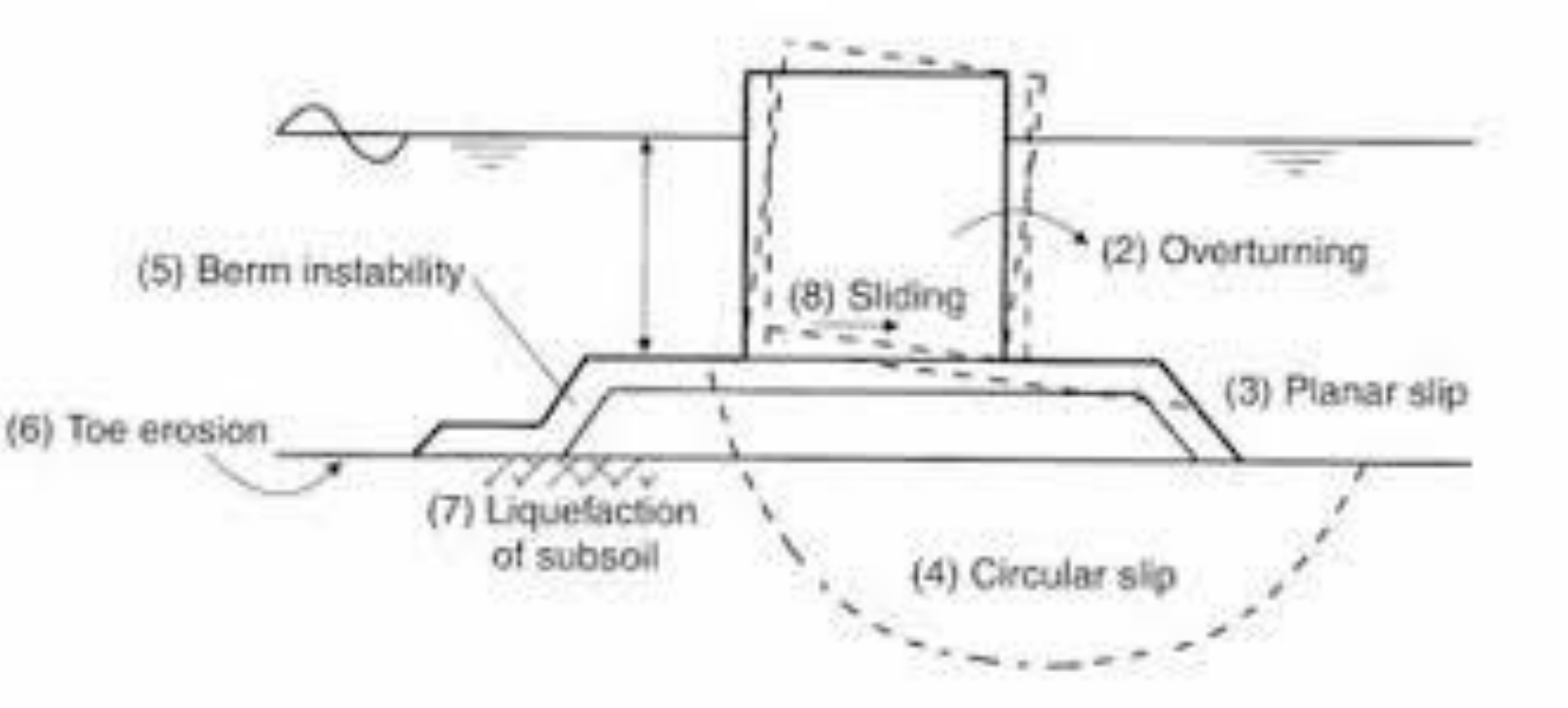
# Types of breakwaters

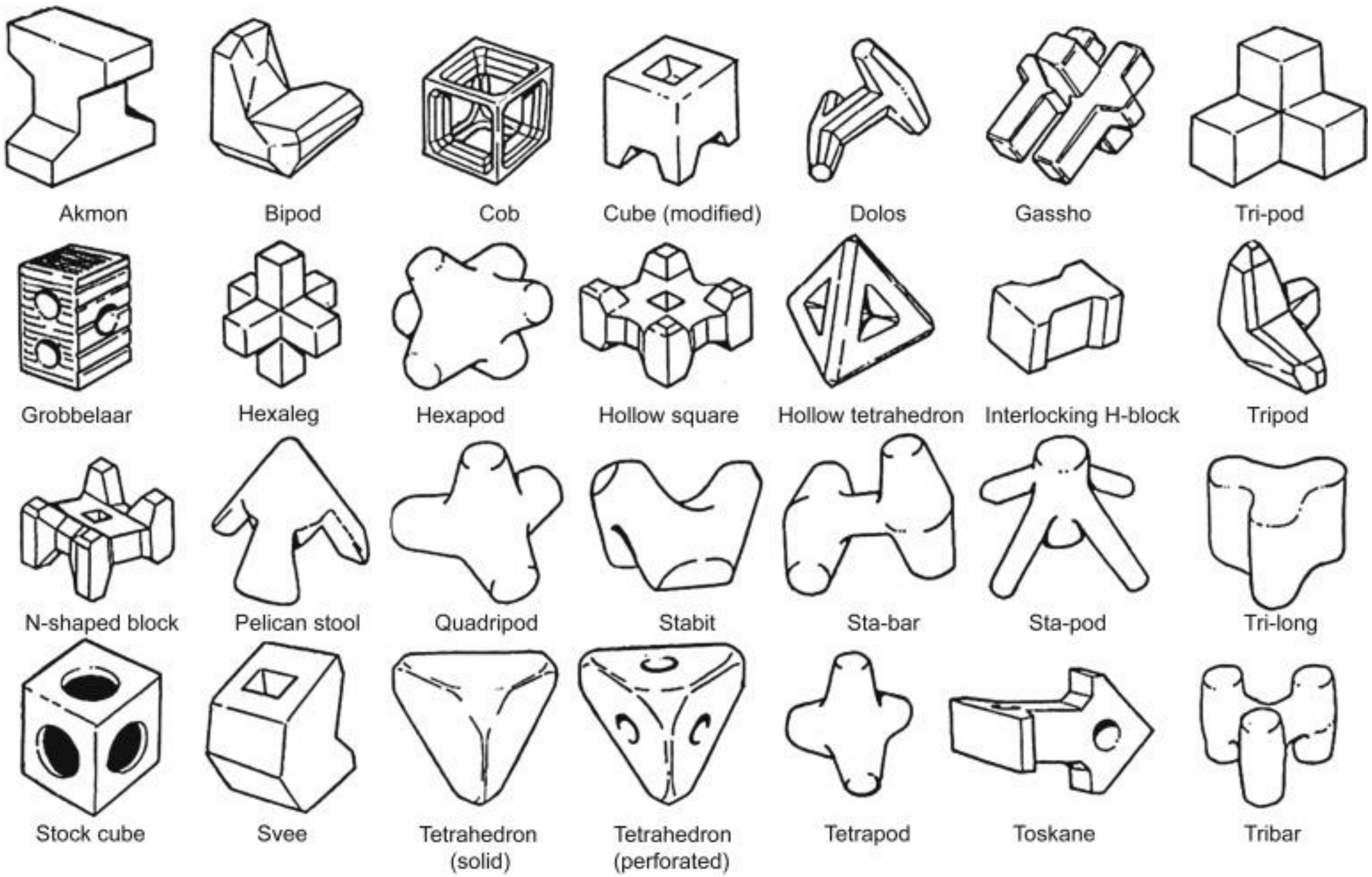


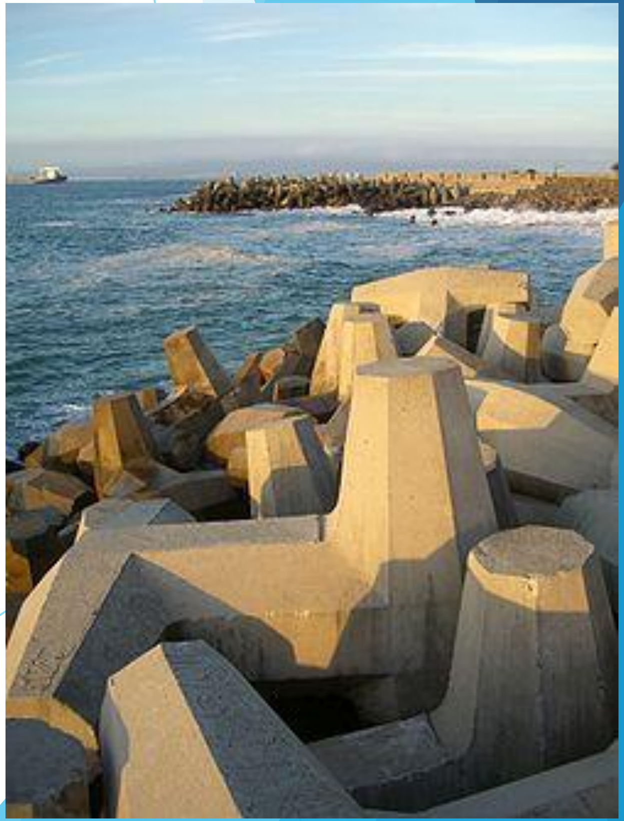
# layout of rubble mound breakwater





(5) Berm instability
(2) Overturning
(8) Sliding
(3) Planar slip
(6) Toe erosion
(7) Liquefaction
of subsoil
(4) Circular slip

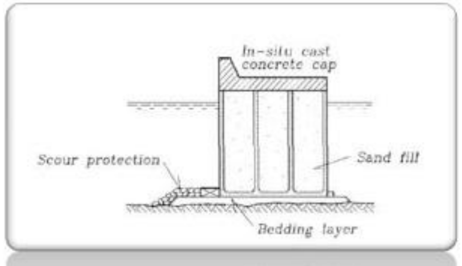

Akmon
Bipod
Cob
Cube (modified)
Dolos
Gassho
Tri-pod
Grobbelaar
Hexaleg
Hexapod
Hollow square
Hollow tetrahedron
Interlocking H-block
Tripod
N-shaped block
Pelican stool
Quadripod
Stabit
Sta-bar
Sta-pod
Tri-long
Stock cube
Svee
Tetrahedron (solid)
Tetrahedron (perforated)
Tetrapod
Toskane
Tribar



# Vertical Wall Breakwaters - Types

(breakwaters with vertical and inclined concrete walls)

Conventional type

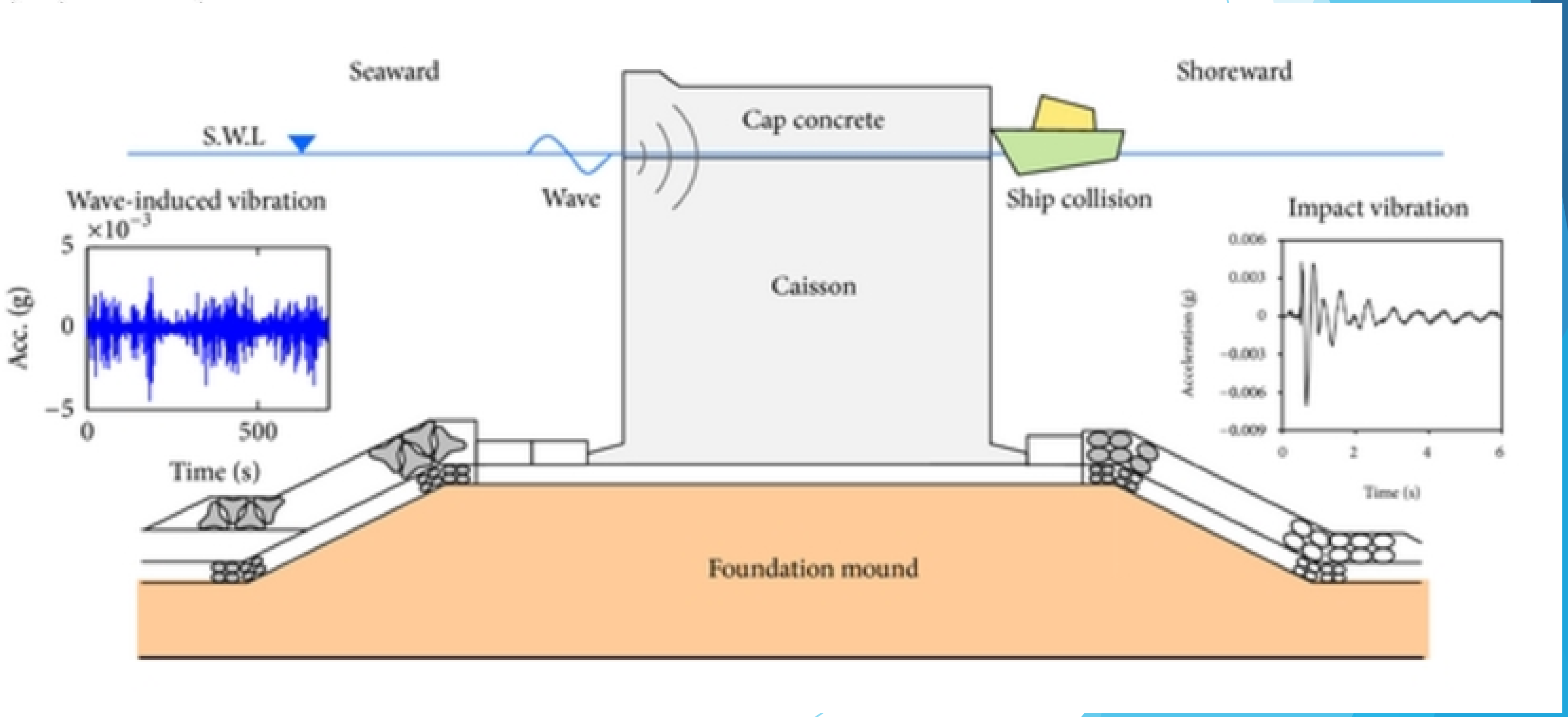




The caisson is placed on a relatively thin stone bedding.

Advantage of this type is the minimum use of natural rock (in case scarce)

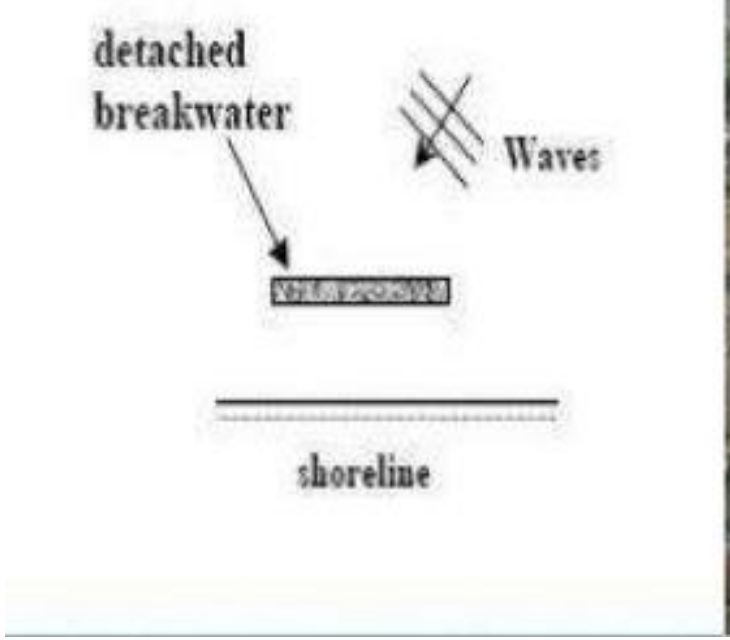
Wave walls are generally

caissons (reduce overtop

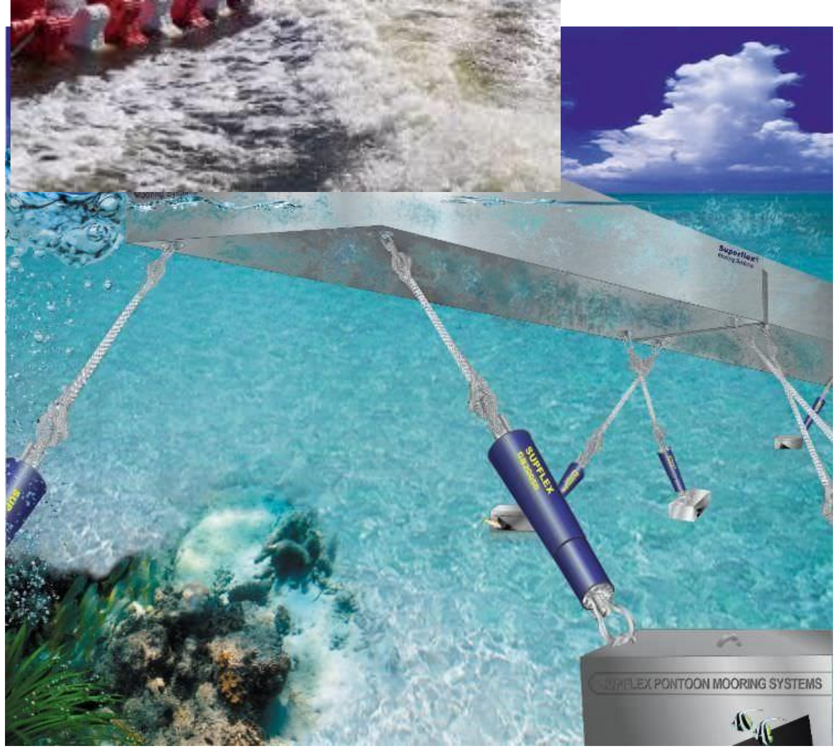


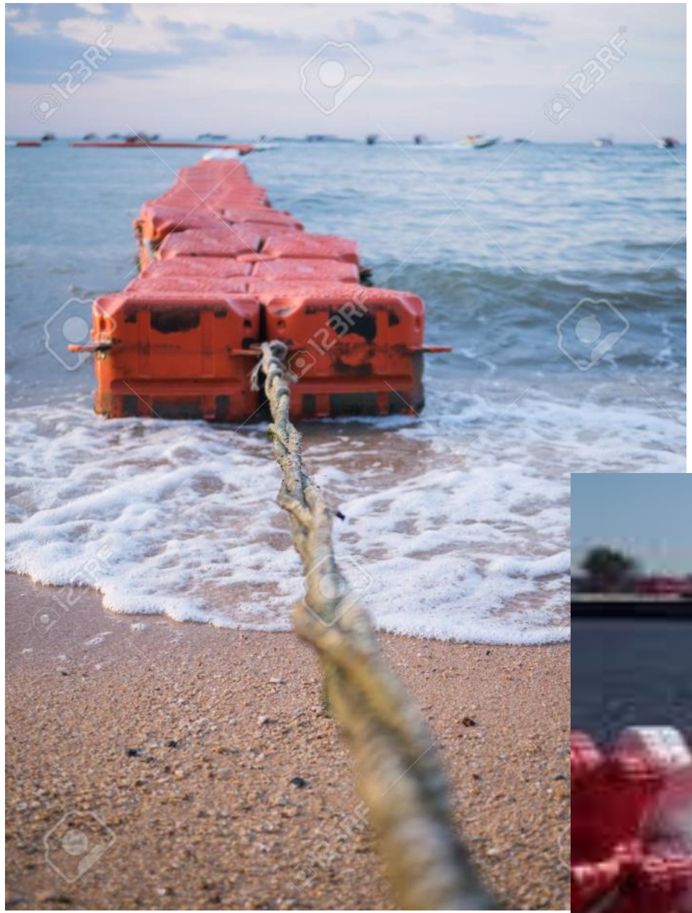
# DETACHED Breakwater

breakwaters without any constructed connection to the shore. This type of system detached breakwaters are constructed away from the shoreline, usually a slight distance offshore .they are designed to promote beach deposition on their leeside.appropriate in areas of large sediment transport




# Floating Breakwaters



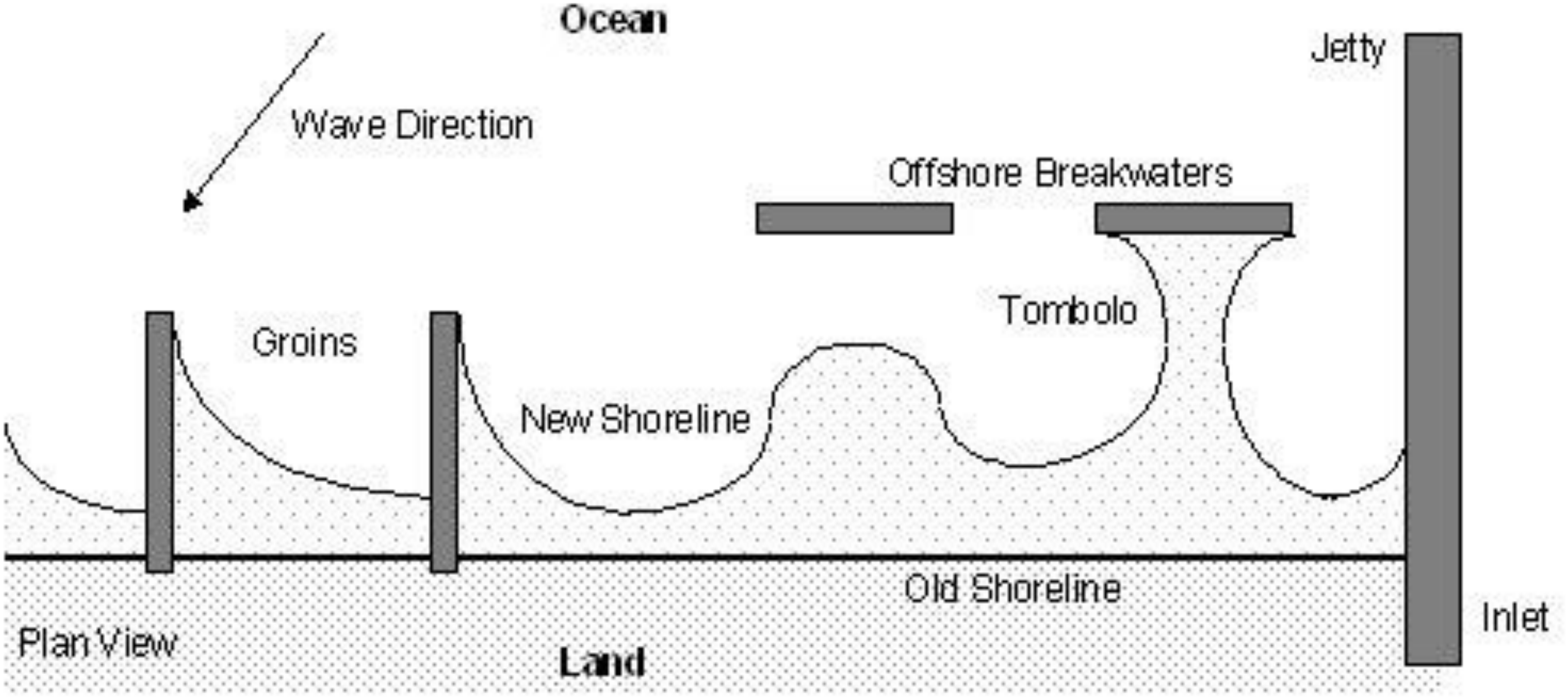
# Beach nourishment

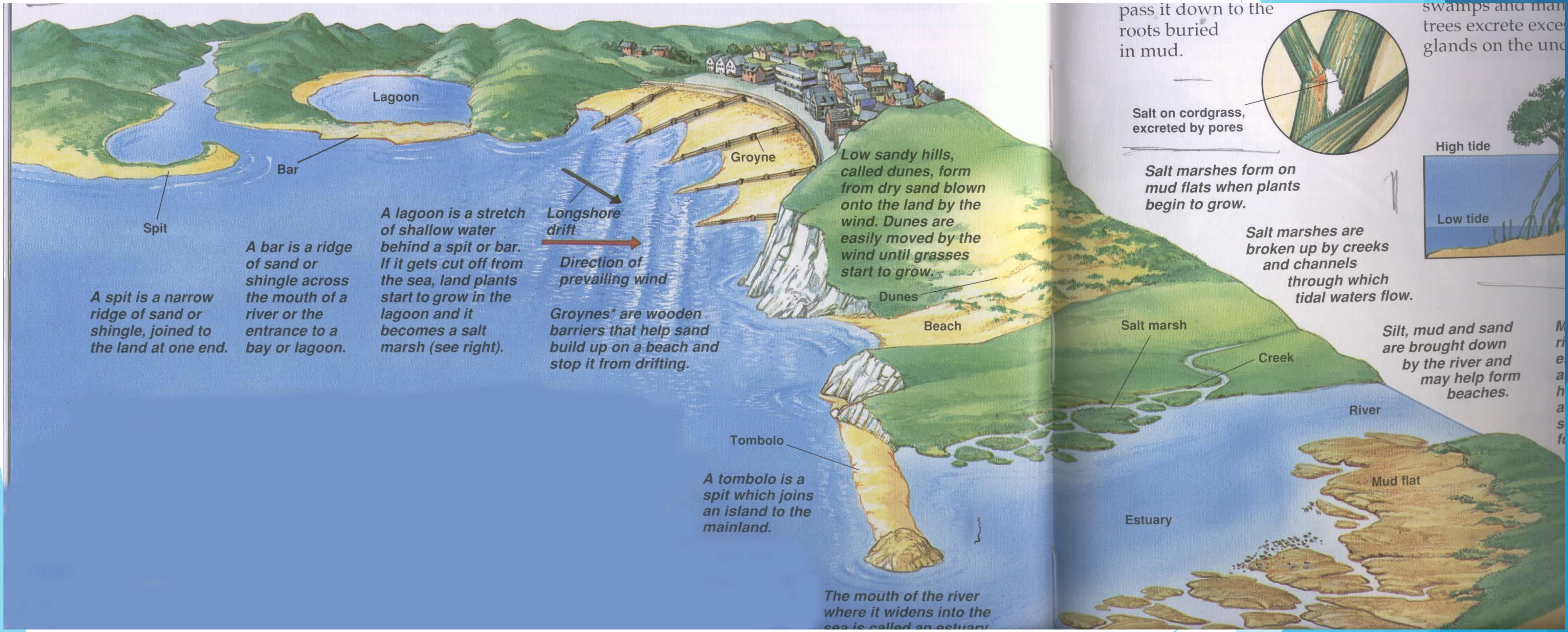
Low cost operation but has to be repeated periodically

Mostly used in combination with protective structures such as groins


Before


After


Ocean
Wave Direction
Jetty
Offshore Breakwaters
Tombolo
Groins
New Shoreline
Old Shoreline
Inlet
Plan View
Land



pass it down to the
roots buried
in mud.
Lagoon
Bar
Spit
Groyne
Longshore drift
Direction of prevailing wind
A spit is a narrow ridge of sand or shingle, joined to the land at one end.
A bar is a ridge of sand or shingle across the mouth of a river or the entrance to a bay or lagoon.
A lagoon is a stretch of shallow water behind a spit or bar. If it gets cut off from the sea, land plants start to grow in the lagoon and it becomes a salt marsh (see right).
Groynes* are wooden barriers that help sand build up on a beach and stop it from drifting.
Low sandy hills, called dunes, form from dry sand blown onto the land by the wind. Dunes are easily moved by the wind until grasses start to grow.
Dunes
Beach
Salt on cordgrass, excreted by pores
Salt marshes form on mud flats when plants begin to grow.
Salt marshes are broken up by creeks and channels through which tidal waters flow.
High tide
Low tide
Salt marsh
Creek
Silt, mud and sand are brought down by the river and may help form beaches.
River
Tombolo
A tombolo is a spit which joins an island to the mainland.
Mud flat
Estuary
The mouth of the river
where it widens into the