The Marine Environment – MSCI0501

Coastal Processes and Beaches

A brief history of coastal science

What is the coastal zone?

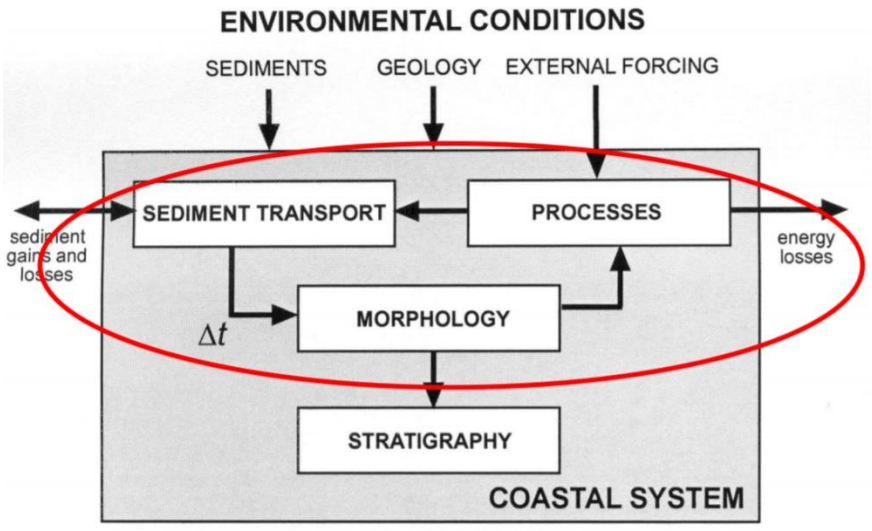
The coastal zone is the interaction between the land and water. It is where the sand is moved by waves, currents and wind.

What are the spatial and temporal scales and examples of each?

- **Instantaneous scale: things that happen quickly over short distances e.g. ripples**
- **Events: things that happen over weeks, months, years and affect bigger chunks of the coastline – bigger spatial scale e.g. storms, monsoons, el nino, frontal dune**
- **Engineering time scale: things that affect larger sections of the coast line e.g. sea level rude, transgressive dune**
- **Geology: studying how coast lines develop e.g. inner continental shelf**

What is the morphodynamic approach to coastal geomorphology?

It is a wholistic approach based upon the idea that the coast is a system and everything is connected together. Environmental controls such as sediments, geology and external forcing affect: sediment transport, processes and morphology which are all interconnected. Since the coast is a system it contains processes (waves, tides, currents, wind) and these processes move sand around (sediment transport). This sediment transport causes the shape of the coastline to change, called the morphology of the coastline, which in turn affects the processes → all linked together. If humans come and try and change the system this will affect the processes, sand and morphology, creating a feedback affect.



Coastal controls

What are the different coastal controls? (in order of importance)

1. **Geology: rocks**
   a. **Global scale: Plate tectonics: plates sit on top of a moving mantle and their interactions can cause earthquakes etc. There are two types of coasts due to plate tectonics: collision coasts (where two plates are colliding, creating mountains,**

volcanos, not well developed beached with not much sand), and trailing edge coasts (coastline sitting in the middle of a plate boundary creating flat coasts with rivers and lot of sand). This is how plate tectonics exert a geological control.
   b. Regional scale: Continental shelves: varies depending on where you are in the world. Continental shelves control the waves e.g. a steep and narrow continental shelf like the eastcoast of Australia causes large waves, a flat and wide continental shelf breaks the waves early, causing small waves. Flat, shallow and wide continental shelves also attract tsnuamis.
   c. Regional scale: Sediment type: The different sediment types are: gravel (mostly in cold coastal areas where there has been glaciation in the past or present), sand (mostly in the lower middle latitudes), mud (most common in humid, temperate, or tropical hot climatic zones) and bioclastics (broken up bits of shells and coral).
2. Sea level: the sea level changes daily and over thousands of years. We are currently in the Quaternary geological time period where the sea level has been rapidly rising and falling over the last 2 million years. The coast line looks different depending on sea level. The causes of sea level change are: movement of plates and astronomical changes (earth and sun orbits). The sea level is rising but there is uncertainty as to how much. The different types of sea level changes and their potential positive or negative change in metres are:
   a. Glacio Eutasy: where all the water in the ocean is affected (volumetric change) → related to the melting and re-freezing of the glaciers (dominant type) (100m)
   b. Glacio Isostasy: continental rebound, sea level adjustments due to the shifting of land (100m)
   c. Hydro Isostasy: weight of water can push continental shelves down (10m)
   d. Sediment isostasy: weight of sediment can cause land to sink (10m)
   e. Tectonic shifts: earth quakes can cause land mass to get shifted up (10m)
   f. Ocean temperature: can cause sea level to rise (1-2m)
   g. Ocean currents: strength and trajectory - shift water and push water against coastline – can push up sea level (1.5m)
   h. Atmospheric forcing: big storms can affect sea level
3. Wave climate: How we describe the waves over time using statistics e.g. average wave heights, frequency, origin of waves etc. There are different wave climates around the world, most waves in ocean are created in the ‘roaring 40 latitude”.
4. Tide range: high tide is crest, low tide is trough, affects the type of coastal landforms.
5. Daily processes: waves, currents, tides, sand transport, beaches change every day on a daily basis

What are the current sea level changes?

Over the last century the global temperature has increased by about 0.6 degrees Celsius and the global sea level has risen about 0.2m. This rise is due to melting of small glaciers and thermal expansion of water. The temperature is expected to keep rising and sea level is expected to rise at an accelerated rate.

Motions in the ocean

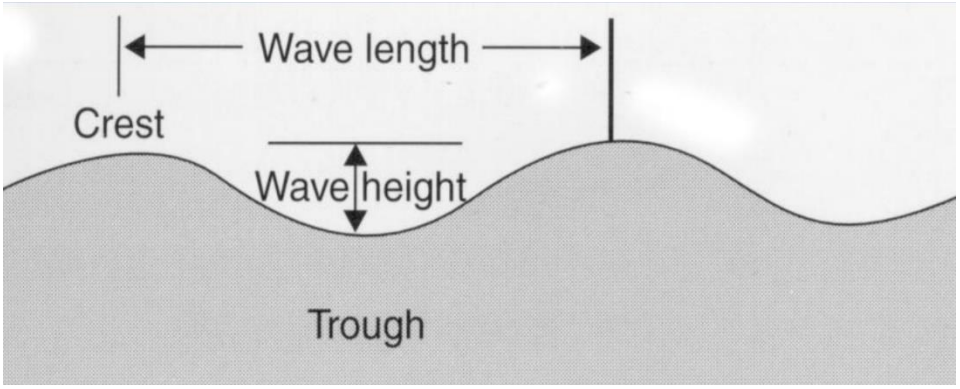
What are the high and low points of a wave called?

High point: crest, low point: trough

Wave height (H): vertical distance between wave crest and trough

Wave length (L): horizontal distance between consecutive wave crests

Wave period (T): time between consecutive wave crests passing a fixed point



How are waves formed?

Waves are generated by wind and the transfer of energy from wind to the water surface. Ripples on the water surface enhance this energy. As ripples grow in size, so does the rate of energy transfer.

What is the size of a wave dependent on?

- **Wind Speed: the faster the wind blows the bigger the wave will be**
- **Wind duration: the longer the wind blows the bigger the waves**
- **Fetch: distance over the water that the wind can blow across → the larger the distance the bigger the waves**

What are the two types of waves?

Waves are classified according to the period

- **Wind waves: have a period of 3-8 seconds**
- **Swell waves: have a longer wave length and formed – period: 8-20 seconds**

What is wave shoaling?

When part of a wave is in deeper water than the other part, the deeper water part will move faster than the shallow part. As a result, the wave will bend or refract.

What are the different types of breaking waves?

- **Plunging: when a wave goes from deep to shallow water in small distances – slows down so fast it curls over and crashes down – need steep beach**
- **Spilling wave: need flat beach, slows down gently**
- **Surging wave: fast, bulging waves which surge up quickly and retreat quickly**

Reflective wave: wave bounces off shoreline and cliff – hits next wave

How are tides formed?

Tides rising up and down are linked to the moon, earth and sun being related. The moon and sun exert a gravitational pull on all water in oceans and this along with earth's rotation causes tides.

What are the controls on the tide range?

The actual tidal range at any location is influenced by ocean bathymetry (the measurement of depth of water in oceans, seas or lakes) and coastal configuration (refraction), the width of the continental shelf (shoaling) and the location of amphidromic points (positions in the earth's ocean where the tidal range is zero. Tidal range rotates around these points).