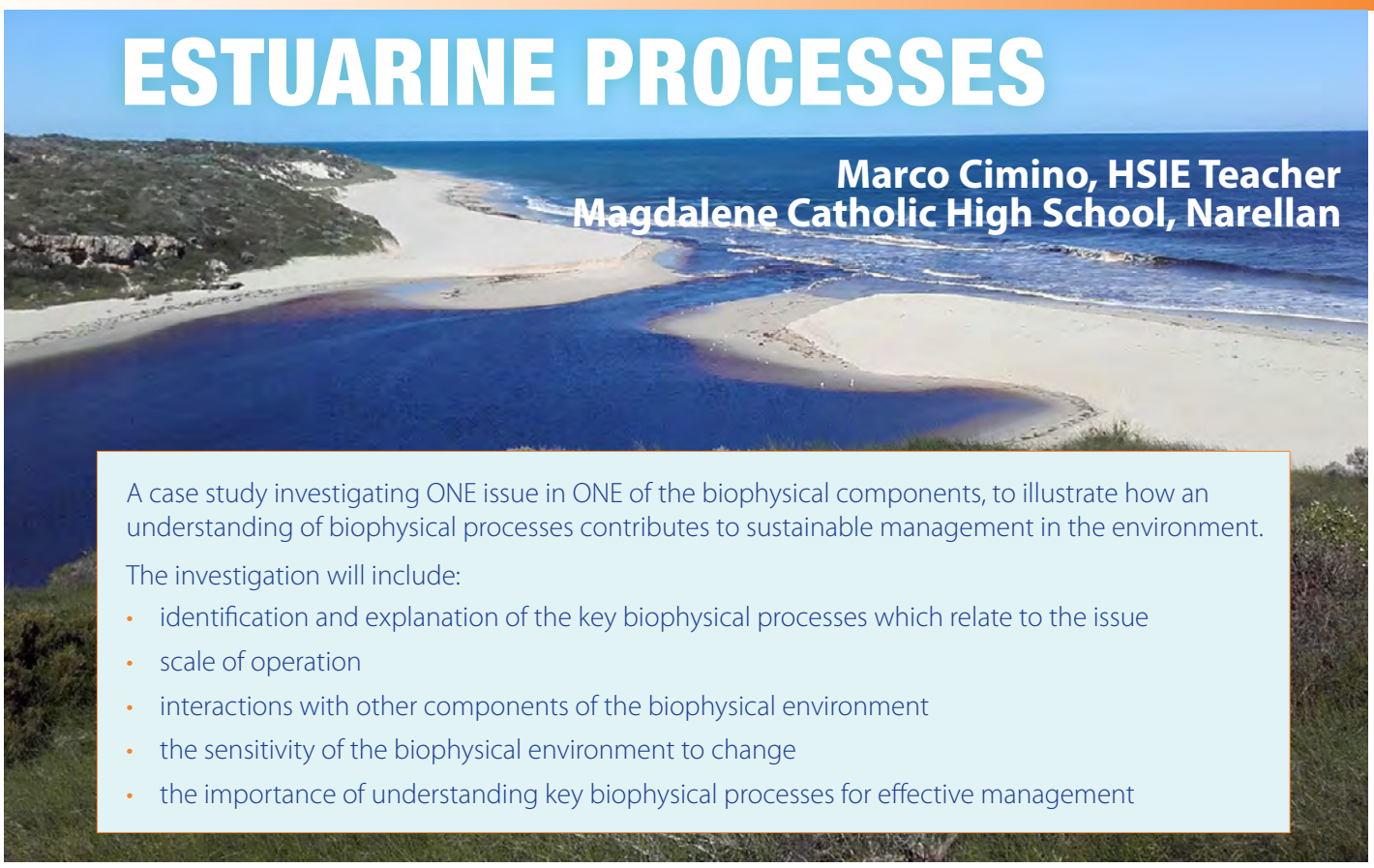
ESTUARINE PROCESSES



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A case study investigating ONE issue in ONE of the biophysical components, to illustrate how an understanding of biophysical processes contributes to sustainable management in the environment.

The investigation will include:

- identification and explanation of the key biophysical processes which relate to the issue
- scale of operation
- interactions with other components of the biophysical environment
- the sensitivity of the biophysical environment to change
- the importance of understanding key biophysical processes for effective management

Syllabus Link

This article provides a background for teachers to approach the Preliminary Stage 6 Geography unit of 'Biophysical Interactions.' This unit requires students to look at the four spheres we live and operate in, and their interactions with each other and ourselves. What this paper aims to achieve is to provide a case study that satisfies the syllabus dot-point of investigating an issue and showing how it can be sustainably managed. This paper will look at what estuaries are, the processes involved in shaping them, what activities are taking place in them, and finally, what this means for their sustainability.

Introduction

An estuary is a place where the land and the sea meet: it is a transition zone where water flowing off the surface of the land meets the regular ebb and flood of the tides. Surrounding mainland features or barrier islands help block freshwater flows and create a fertile mixing zone where organic and mineral nutrients from the land and sea accumulate. Freshwater flows are often ephemeral or non-existent and estuaries can be saltier than the sea, however, when floods arrive they can flow fresh to the mouth and beyond (Turner, 2004). An estuary can also be described as 'a semi-enclosed coastal body of water having a free connection with the open sea and within which sea water is measurably diluted with freshwater derived from ***land drainage'*** (Woodroffe, 2002, p. 325, my emphasis), meaning that land based activities have major implications on the ecosystem processes which take place in estuaries.

Why Are Estuaries Important?

Estuaries are unique environments that include some of the most biologically productive ecosystems on Earth. Turner (2004) states that estuaries provide sheltered habitats, nurseries and spawning areas for fish, crabs, prawns and shellfish. They help to filter pollutants, act as buffers to protect the shorelines from erosion and flooding and provide essential food and habitats for birds, fish and other wildlife. Any changes in the make-up of these processes can severely alter the way in which the estuaries operate, meaning a loss of biodiversity, and, more extremely, the erosion and degradation of the coastline itself.

What Are Estuaries?

According to Turner (2004), estuaries are classified into three types according to which of the three forces (wave, tide, or river) dominated during the evolution of the estuary. Over time, wave and tide dominated estuaries fill with sediment to become wave and tide dominated deltas. Because of three different forces acting upon the estuary, there are different degrees of effects which can severely alter the processes in the estuary. When wave energy is dominant, marine sand

can build up to form a barrier across the mouth of a river channel or shallow embayment. Turner (2004) further argues that they typically have a relatively calm central basin or lagoon. Coarser sediments are deposited at the head of the estuary, whilst the finer particles settle in the central basin. Woodroffe (2002) also makes note of the fact that sediments are likely to accumulate at the mouth of the river unless nearshore processes are sufficient to redistribute them. Estuaries can be a sink for fluvial sediments and for nearshore sediments.

Turner (2004) states that tide-dominated estuaries are funnel-shaped estuaries with strong tidal currents and often high tidal ranges. Sediment is both deposited and eroded in these flanking areas of inter-tidal flats. Due to the growth of mangroves along the flats, sediment is trapped along the sides, meaning tidal amplification occurs. Tide-dominated estuaries accumulate sediment from upstream catchments and from the sea, but much of this sediment load can be flushed offshore during floods. There are also residual currents that result from density differences. According to Woodroffe (2002), velocities of flow vary as the tide propagates up a channel, with both progressive and standing wave components. Most estuaries contain a barrier, which allows the fertile soils and sediments to remain inside the bay area. However, the barrier may also pose a risk to the health of the estuary, as pollutants from land based activities are prevented from leaving the bay area. Woodroffe (2002) continues to say that estuarine sediments can be derived from the catchment or from off the continental shelf. They can come from the atmosphere; they may be eroded from the shoreline or they may be biogenic material.

Land-Based Activities and Implications for Sustainability

Studies by Turner (2004) show that some 60% of NSW estuaries are intermittently closed or open lakes and lagoons, and their systems are sensitive to nutrient enrichment from cities and farms. In recent years, there has been a pattern of landward moving mangroves into saltmarsh areas in temperate eastern Australia. When streamside and floodplain vegetation is replaced with impermeable surfaces such as roads, rainfall can no longer filter into the ground. Instead, when it rains, water runs off into drains and eventually into rivers and estuaries. The study by Turner (2004) also showed that the run-off carries litter and pollutants, such as nutrients, sediment, hydrocarbons, heavy metals, and toxic organic compounds, directly to the estuary through storm water drains.

Many industries are located near estuaries, including smelters, pulp mills and sewage plants. Organic matter (from sewage plants) discharged into estuaries contains pathogens and heavy metals (from various other industries) which can accumulate in the tissues of shellfish, and make them unfit for consumption. Mining activities can contribute sediments, heavy metals and acid run-off, all of which degrade or destroy estuarine ecosystems. This is illustrated by studies undertaken by Turner (2004). Wetland vegetation slows water flowing towards the sea causing river sediments to deposit. It also physically traps sediment with roots and other structures. The suggestion by Turner (2004) is that intact wetlands retain nutrient rich sediment and stop it moving further down the estuary where negative impacts such as smothering sea grass can occur and altering or destroying wetlands interferes with this beneficial sediment trapping.

Aquaculture ponds and open cages may discharge nutrient-rich wastes, including uneaten feed, faecal waste and chemicals. Turner (2004) stresses the point that aquaculture can lead to an increased incidence of disease in wild population and to the introduction of exotic species through escape. Trawling operations can result in the death or injury of bycatch species. The use of fine mesh nets can result in the capture of juvenile and non-target species. This point is stressed clearly by Turner (2004), and claims that the impact of this activity should be reduced to stop the unnecessary catchment of marine life. As most estuaries are located at the exit of catchments, most sediments are naturally occurring, however, the addition of chemicals and pollutants to the sediments poses a major risk to the estuarine process system. Due to their location near exits of catchments, it is easier for species of small fish (prawns, crabs, etc.) to be washed out of the estuary during periods of heavy rain fall. This also leads to the increased risk of larger predator animals (sharks, etc.) approaching the coast line in order to feed.

An example of an estuary at risk is the Hawkesbury estuary, which is within the Hornsby Shire Council. The Council is working hard to ensure that the estuary and surrounding ecosystem is not damaged, however, they have identified several issues that may cause problems for the area. These include, but are not limited to: developments being allowed in the area, discharge from boats using the area, tourism, and aquaculture and fishing (Hornsby Shire Council, year unknown). More about issues facing the Hawkesbury estuary and what the Council is doing to mitigate them can be found by visiting http://www.hornsby.nsw.gov.au/environment/water-catchments/hawkesbury-estuary. Figure 1 below illustrates the different activities that could impact negatively on estuaries.

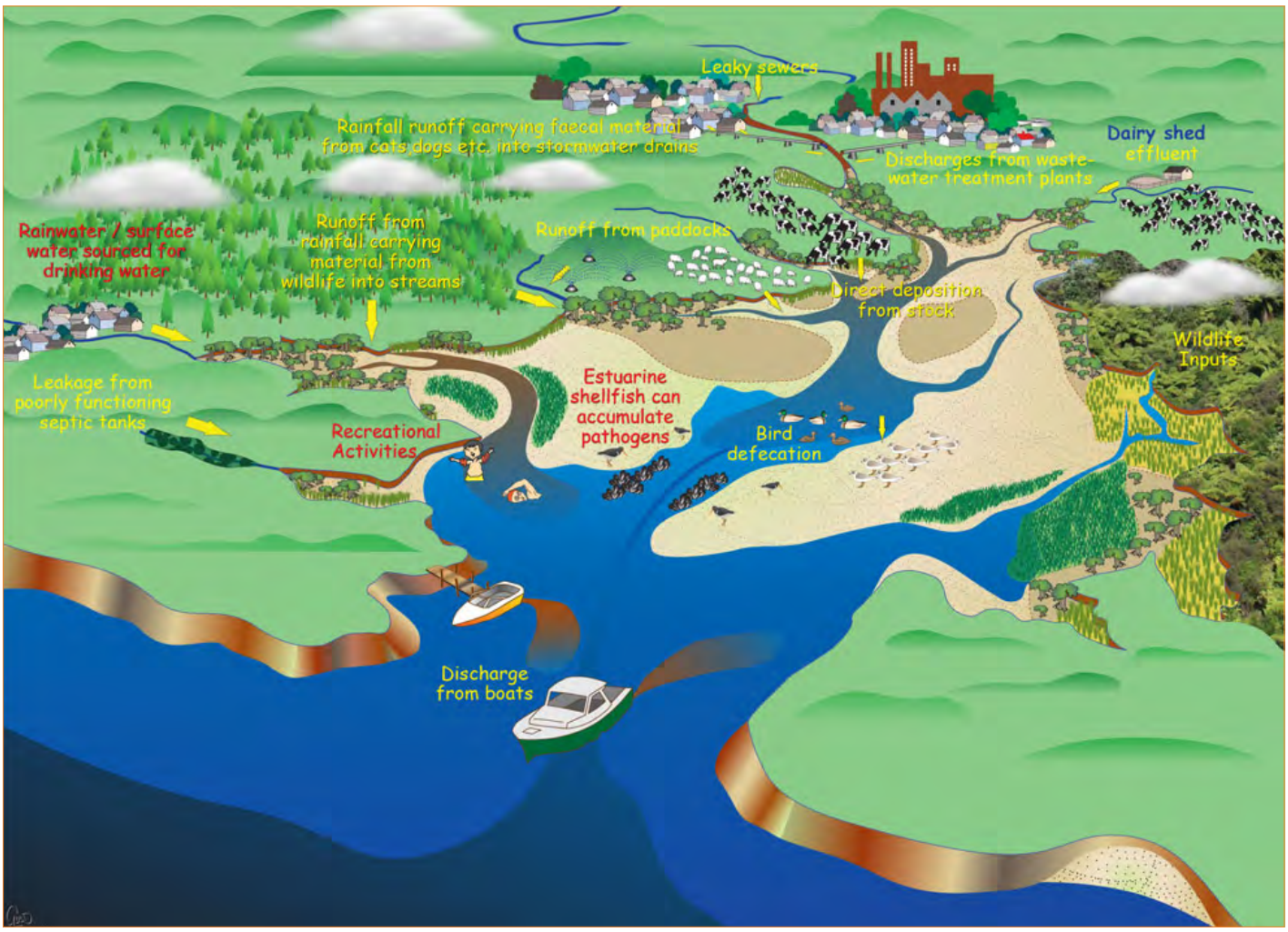

Figure 1: Land-Based Activities as Threats to Estuaries. (Threats to Estuaries. (Year Unknown). Retrieved from http://biome-estuaries.weebly.com/threats-to-estuaries.html)

Conclusion

The sustainability of estuarine ecosystems (mangroves, salt marshes, and various local fauna) and aquaculture is vital to the long-term health of coastal areas, as estuaries act as the buffer between land and sea. Anything that is trapped in an estuary will very rarely enter the ocean (determined by the type of estuary it is). This does not mean, however, that we can degrade estuaries with the knowledge that it is not doing to harm to the wider ocean. Estuaries house some exotic and rare flora and fauna, all of which are very fragile and susceptible to changes in the systems in which they operate.

References

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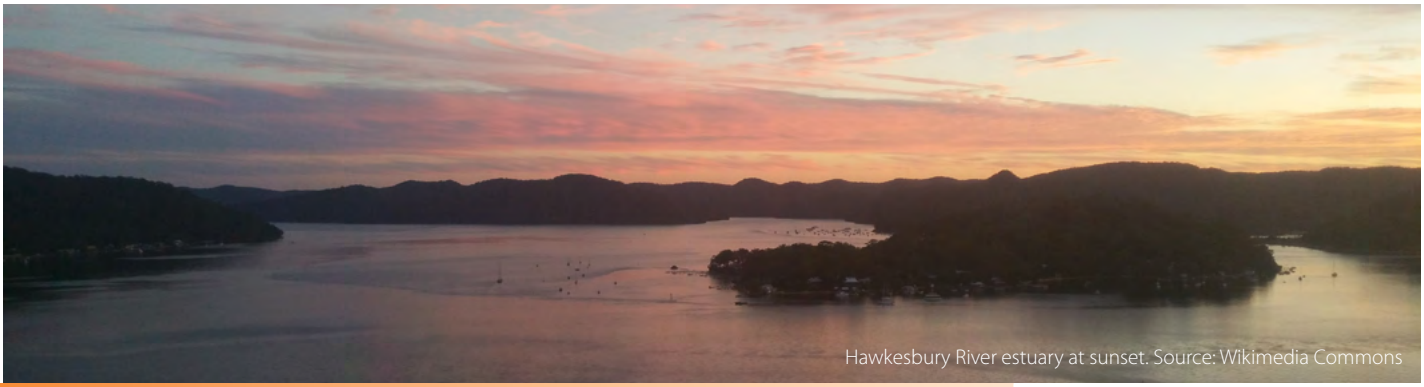

Hawkesbury River estuary at sunset. Source: Wikimedia Commons