GEOGRAPHY

'An ecosystem at risk is both vulnerable and resilient to natural stress and human induced modifications' Discuss this statement. 2010 HSC

Ecosystems are the dynamic complex of flora, fauna and microorganism communities with their abiotic environment as a functional, ecological unit.

The GBR is the world's largest single structure made of living organisms and thus has a large extent of 348 000 km2 and is situated 2300 km from PNG Fly River in the N (8' S) to Fraser Island in the S (24' S). The reef became listed as a WHS by UNESCO in 1981 due to its immense biodiversity. The location of this fragile ecosystem puts it at significant risk as tropical cyclones occur along this latitude, causing damage to coral through destructive waves that act as an erosive agent on the reef removing softer corals and destabilising harder ones, and is accompanied by a change in salinity levels from fresh water rain. The damaging consequences of TC is evident as the GBR has lost 50% of its coral cover in the past 27 years, in which storm damage contributed 48% of this reduction. However, through the interactions of the atmosphere tropical cyclones can allow for the maintenance of biodiversity and dynamic equilibrium as conveyed by TC Larry in 06 where the storm waves removed sediment and reduced water temp, thus protecting the reef from the possibility of bleaching from a 1 'C rise in temp. Furthermore, the reef has co-evolved with cyclones, as it has allowed for optimal functioning through the delivery of nutrients from the land to the ocean in order to boost phytoplankton, the base of the food chain, thus, reflecting GBR's resilience to natural stress. However, many geographers predict that the reefs most affected by Cyclone Yasi, particularly fringing reefs will take approx. 10 years for functionality and adequate coral formation to occur. Therefore, the low elasticity and malleability of these parts of the reef make it a highly vulnerable ecosystem.

Conversely, the intertidal wetlands of Careel Bay represent an ecosystem of much smaller extent than that of the GBR, and thus its functioning is affected by highly localised factors. Careel bay is situated on the Eastern Shore of Pittwater, 40 km north of Sydney, with an area of 1.5 km'. The location of this ecosystem at risk has developed through the interactions of the biophysical environment as the shallow, sheltered bay has been filled in due to NW winds pushing sand into the valley and SE storm winds not affecting the bay due to the protection of the headlands. However, the small extent of this ecosystem creates vulnerability in the long term due to fewer linkages and biodiversity throughout the niche ecosystem.

The interactions of the biosphere in regards to the production of the crown of thorns starfish can severely heighten the vulnerability of the GBR, as the highly destructive organism can reduce the malleability and functioning of the ecosystem in short periods. Empirical studies show that once the COT go beyond the amplitude level of 30 adults/ hectare, the 'outbreak popn' can reduce coral cover by up to 40% in several months. However, the GBR's resilience to biophysical interactions is evident as some ecologists argue, that the COT plays an active role in maintaining coral reef biodiversity and driving ecological succession as before overpopulation became an issue the COT prevented fast growing coral e.g. staghorns from overpowering slower growing corals e.g. brain corals, which would have resulted in a monoculture of species, thus resulting in vulnerability. However, the current issue of overpopulation due to increased nutrient levels from continental sediment runoff, particularly in fringing reefs, has resulted in the contemporary management strategy of "search and destroy" in recent years. This has resulted in the removal of over 70 000 COT in the last 5 years, thus, boosting the elasticity of recovery, as reflected in the diagram below. Thus, human induced modifications through management strategies contribute to the growing resilience of the GBR.

The biodiversity of Careel Bay wetlands is represented through the interactions of the biophysical environment as the highly specialised ecosystem can only function in particular conditions. For example, the functioning of the tides establishes the level of diversity in the ecosystem as seagrass is situated at low tide, followed by mudflats and mangroves at the low to high tide zone and finally, salt marsh in the high to High Spring Tide (HST) zone. The relatively small extent to which the particular niches can function in e.g. the salt marsh results in high levels of vulnerability when exposed to natural or human induced stresses. For example, the expected 40 cm sea level rise by 2050 will result in the encroachment of the mangroves into the salt marshes, causing them to be squeezed and fragmented due to their non-resilient nature, as they can't compete with other plants. However, the ecosystem is also highly resilient as the harsh environment it functions in with highly saline and unstable soils, regular tidal flooding and exposure to wind, waves and storms has resulted in adaptations such as shallow root systems that exclude salt and sacrificial leaves that excrete salt convey a highly productive ecosystem.

The GBR's growing vulnerability can be attributed largely to human induced modifications that adversely affect the functioning of the ecosystem. The numerous port developments occurring along the reef, such as, Abbot Point, lack the precautionary principle and could have long term ramifications for the ecosystem. A 20% increase in shipping in the last 5 years within the GBR, accompanied with these developments, has increased water turbidity and pollution in recent years. Additionally, the 2010 Chinese oil tanker spill created a 3 km scar on the reef that is expected to take 10-20 years to fully repair. However, the govts proposed extension of the GBRMP under the World Heritage (Property Conservation) Act 1981, in response to UNESCO criticism in 2012 would prevent any long term threats to IGE.

Similarly, Careel Bay wetlands have been degraded through human- induced stresses, such as the development of a marina adjacent to the ecosystem and the increased frequency of boats, constituting problems of oil spills and mooring ripping up sea grass beds. The use of antifoul on boats has caused the bioaccumulation of toxins up the food web of Careel Bay and has resulted in the depletion of aquatic reserves, both necessary for the functioning of the ecosystem and the recreational fishing industry.

Furthermore, human induced modifications in the form of overfishing can negatively contribute to an ecosystem's functioning and long term biodiversity levels. Targeting a specific level in the food web can have unintended ecological consequences, and reflects the tragedy of the commons, where resources are overexploited. The excess removal of key functional groups such as the herbivores of parrot and surgeonfishes can increase the risk that the ecosystem will undergo a shift from a coral to an algae dominated reef. Therefore, in order to increase the resilience and elasticity of the GBR, the GBRMP created the GBRMP Zoning Plan in 2004, in which they increased the coverage of 'no take' zones from 5% to 33%, in turn, allowing species to regenerate such as, the coral trout which is now 50% more abundant in Marine National Park Zones. Furthermore, the use of exclusion of humans from spawning areas and nursery grounds has facilitated the regeneration of the seahorse, turtles and pipe fish numbers as reflected in the Environment Protection and Biodiversity Conservation Act 1999 (Cth). Thus, improving the ecosystem's resilience, and enabling it to operate at dynamic equilibrium.

Additionally, the increase in both natural and human induced stress has heightened the GBR's vulnerability as reflected in the problem of runoff and nutrient levels. The human induced modification of land clearing, further contributes to the increase in nutrients and sediments on the GBR, subsequently this increases turbidity and adversely affects the process of photosynthesis which is needed for coral formation. Thus, the govt has implemented the Reef Water Quality Protection Plan or Reef Plan in 2003, in 2013 the govt has issued a further 200 mn in the Reef Rescue program in order to reduce water pollutants and ensure that 90% of agricultural management is using best management practice systems by 2018.

With reference to at least one ecosystem you have studied, explain the biophysical interactions which lead to a diverse ecosystem and their functioning. 2002 HSC

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The biodiversity of Careel Bay wetlands is represented through the interactions of the biophysical environment as the highly specialised ecosystem can only function in particular conditions. For example, the functioning of the tides establishes the level of diversity in the ecosystem as seagrass is situated at low tide, followed by mudflats and mangroves at the low to high tide zone and finally, salt marsh in the high to High Spring Tide (HST) zone. The relatively small extent to which the particular niches can function in e.g. the salt marsh results in high levels of vulnerability when exposed to natural or human induced stresses. For example, the expected 40 cm sea level rise by 2050 will result in the encroachment of the mangroves into the salt marshes, causing them to be squeezed and fragmented due to their non-resilient nature, as they can't compete with other plants. However, the ecosystem is also highly resilient as the harsh environment it functions in with highly saline and unstable soils, regular tidal flooding and exposure to wind, waves and storms has resulted in adaptations such as shallow root systems that exclude salt and sacrificial leaves that excrete salt convey a highly productive ecosystem.

Furthermore, the GBR's diverse ecosystem and its functioning is evident through the immense levels of biodiversity that have occurred as a result of the interactions of the biophysical environment. The reef has 330 species of coral, 13 000 species of fish and 200 species of birds, this diversity is a result of high rates of production from the constant recycling of nutrients. Furthermore, the resilience of these species allows for a diverse ecosystem and the maintenance of its functioning as shown through turtles altered migratory patterns due to increased sea temperature and salinity levels and the fact that fish have adapted to increased turbidity by swimming closer to the surface in order to reach additional light that is required for survival. Additionally, through the interactions of the hydrosphere with the biosphere, the reef has been able to maintain its functioning and diversity, evident as precise monsoonal conditions result in the warm, highly saline waters that flow down from the north brining relatively high nutrient levels that lead to overall biodiversity, and is an essential component for the ecology of the reef.

Moreover, biophysical interactions in regards to resilience to either natural or human induced stress have contributed to a diverse ecosystem and its functioning. The biochemical, symbiotic relationship of the coral polyp and limestone is evident as both organisms are highly fragile and thus not resilient to stress. Therefore, the polyp secretes calcium carbonate which secure the body to the previous limestone laid down and holds the polyp in place, thus, this relationship allows for the ecosystem to withstand the erosive power of waves and hence, contributes to its functioning. Furthermore, the ability of the ecosystem to adapt to stresses is evident as organisms often undergo acclimatisation, in which phenotypic changes by an organism to stresses in the natural environment result in the readjustment of the organisms tolerance level. For example, corals that are regularly exposed to stressful environmental conditions have in some cases, been shown to acclimatise and exhibit a physiological tolerance to elevated temperature and UV radiation that exceed normal thresholds. Corals have evolved temperature thresholds, close to average upper temperatures of their area at 33-34'C, therefore, allowing for the ecosystem to maintain its functioning and elasticity.