GEOGRAPHY

Explain the biophysical interactions which lead to diverse ecosystems and their functioning.

Ecosystems are complex systems formed through the interaction between abiotic components and biological environment in which they live. Despite the vast diversity of Earth's ecosystems, the functioning of each ecosystem correlates with its ability to capture, store and transfer energy, nutrients and water. Ultimately, the functioning of any ecosystem depends upon the interactions between the components of the biophysical environment: the atmosphere, hydrosphere, lithosphere. and biosphere. Each of these spheres plays a vital role in sustaining life on earth. It is the way in which these four spheres interact which determines how an ecosystem functions, and through these interactions, they form the diversity of ecosystems.

The dynamics of weather and climate consist of biophysical interactions crucial to the functioning and diversity of ecosystems. As atmosphere is the main source of climatic factors which impact on an ecosystem, it therefore partakes a large role in influencing temperature and rainfall – two variables imperative in determining the nature of all elements within a terrestrial ecosystem and the speed at which they function. Moreover, the climatic variables of precipitation and temperature significantly affects the diversity, geographical distribution and productivity of various biomes. For example, warm and moist ecosystems with a higher than proportional rainfall, such as tropical rainforests like the Amazon Rainforest (which contains the largest diversity of species on Earth), are copious in diversity. This is because conditions as such accelerate the rate of plant growth, the decomposition of dead material and the consumption of minerals. Although they cover less than two percent of Earth's surface, rainforests house an estimated 50 percent of all life on the planet. This contrasts greatly to polar ecosystems, which experience below freezing temperatures and very low rainfall, attributing to lack of complexity which characterises such Arctic and Antarctic ecosystems.

Moreover, the atmosphere is a source of elements, such as carbon, oxygen and nitrogen, fundamental to the biochemical cycles in an ecosystem. However, these atmospheric circulation patterns determine the spread of pollutants, such as the oxides and nitrogen and sulfur, and can further contribute to environmental degradation, fueling global warming. Aquatic ecosystems, ranging from oceans such as the Pacific Ocean to lotic and lentic ecosystems, such as Australia's Darling River and Blue Lake, are more so impacted by these circulation patterns as they distort the variations in the amount of nutrients dissolved in the water. This is because a significant source of nutrients in aquatic ecosystems is atmospheric deposition, either as rain, snow or as dry deposition of particles and gases. These create bioaccumulative toxic substances, which can accumulate in wildlife, causing reproductive problems and cause them to weaken to a point where they are vulnerable to disease. This is a problem currently impacting of the Great Lakes of North America, whereby the world's largest fresh water resource has become a major "sink" for a toxic stew of chemicals. Mercury contamination has been detected in many animal groups, among all levels of the food web and further across many different habitat types throughout the region, not only having a significant impact on the species diversity and therefore functioning of the Lakes' ecosystems, but of those which similarly interrelate.

The hydrosphere also plays an invaluable role in the diversity and functioning of ecosystems and is essential in sustaining all life on earth. As water is the only molecule which can be found naturally in solid, liquid and gas, its properties provide a perfect medium for biological reactions that occur within cells, allowing for plants to store energy through photosynthesis, and as well consume such energy through respiration. Moreover, the atmosphere and hydrosphere are also closely linked; in that the atmosphere determines the nature of the hydrological cycle in any particular area, significantly affecting to the diversity and functioning of an ecosystem. This is because the water that evaporates from the ocean through the sun's energy is transported by the circulation of winds around the planet. Upon rising, it condenses and then precipitates, providing moisture for forests,

jungles, grasslands and scrub. Sometime throughout this cycle, it is absorbed by plants and consumed by animals. Thus, the event of precipitation results in the diversity of an ecosystems, as it determines which plants, and hence animals, can survives in that particular ecosystem. For example, polar ecosystems are cold deserts which experience annual rainfalls of less than 250mm, with average monthly temperatures below 10°C, and have very little access to fresh water. The frigid climate and extremely low precipitation accounts for the slow functioning of polar and tundra ecosystems, in which decomposer activity is practically non-existent. On the other hand, in tropical rainforests, large volumes of rainfall occur within a relatively short periods of time. This provides an environment conducive to the maintenance of high levels of biodiversity. However, the same vigorous hydrological cycles as well leaches soil and erodes land. Whilst water is vital for life in an ecosystem, it can also cause destruction to various landscapes. For example, over the past 150 years, the Murray-Darling Basin in southeastern Australia has extensively eroded, with predicted erosion rates suggested to between 0.03 to 0.1 meters per year. Though a natural process, riverbank erosion poses significant threats to water quality as it increases sediments and nutrients into the river, threatening a range of native flora and fauna, which have declined in abundance since.

The lithosphere is also crucial in determining the nature of soils and providing habitats for many of the decomposer organisms that recycle the minerals essential to the plants that form the basis of the food web. Moreover, it acts as a store house for mineral nutrients and water within the the spaces between soil particles, allowing it to be utilised by plants. The capacity of the soil to perform these two functions helps determine that nature of a particular ecosystem. Where there are non-porous soils, wetlands may develop because water is trapped close to or above the surface. In areas with sandy soils, water drains quickly, allowing for plants to adapt to the low moisture concentration, as seen in xerophylic plants. Furthermore, climatic conditions may also impact soil as it influences its moisture content. An example is the permafrost soils of tundra ecosystems (the foundation for much of the region's unique ecosystem), such as the Arctic Tundra, whereby soil remains frozen for most of the year, hindering the availability of moisture to plants. Ecosystem functioning is also influenced by microclimatic features, such as the aspect of a slope, as small variations in elevation can result in marked differences in plant communities. This as a result of changes the availability of moisture. As well, average temperatures decrease with increasing altitude, so the climate and ecosystems of alpine regions often differ from those nearby valleys and planes.

However, when one thinks of the earth’s lithosphere they may not supposed to look past the terrestrial portion of the earth. Although, a change on the earth’s terrestrial lithosphere could affect the essential balances within aquatic ecosystems. Disturbances to biophysical interactions, such as human-induced pollutants and emission, can result in sediment that flows through the rivers into the ocean. This is a component of the earth’s lithosphere which can significantly impede on the diversity and functioning of aquatic ecosystems. Such is occurring in coral reefs like the Great Barrier Reef, whereby sediment runoff is increasing the turbidity, hindering light penetration and therefore affecting the process of photosynthesis. Recent reports have made aware that recent studies have found that ocean acidification can degrade not only individual species, as past studies have shown, but entire ecosystems. This results in a homogenised marine community, dominated by fewer plants and animals, and thus reducing the diversity of marine ecosystems and hindering their functioning collectively.

The biosphere can be considered the most significant aspect of the biophysical environment. It is the domain on or near the earth’s surface where the environmental conditions enable solar energy to produce the chemical changes necessary for life. It is within the biosphere which links the hydrosphere, atmosphere and lithosphere through biogeochemical cycles of nitrogen, carbon, oxygen and water cycling. As well, through these interactions, the biosphere determines which food chains and webs dominate an ecosystem, heavily facilitating the energy flows within, as well as its productivity. For example, in highly stressful environments, such as desert ecosystems like the Sahara Desert, energy flows are restricted as productivity is generally very low. This means that the

amount of biomass produced per area is limited due to the lack of precipitation within such harsh climate. This thus results in a lack of diversity and a less complex ecosystem as the essentials needed for survival are finite.

The interactions of each sphere creates a unique environment for each ecosystem, for which its functioning is dependent on a state of dynamic equilibrium. However, it is also the interdependence on the four elements that make an ecosystem vulnerable in its ability to withstand stress, as any distortion to these interactions will upset the way in which it functions, and may limit its diversity. With the increase in greenhouse gases, their contribution to climate change, and the continuous exploitation of the natural environment through human-induced modification, it is often debated the extent to which distortions in the biophysical interactions within ecosystems will significantly impede on their ability to maintain their functioning and diversity.