Research Paper: Rivers (Lotic Systems)

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Introduction

When we talk about lotic systems, we include all the flowing inland bodies such as rivers, streams, creeks and many more water bodies around the world. Rivers play a huge part as an aquatic ecosystem since water is an essential component of life which consists of various species living in their most preferred locations and creating their habitats that provide them with the most resources hence helping them grow and reproduce better (Reinbold, 2018). A river is a large course of flowing water which comes into play as the hydrologic cycle takes place. When the precipitation occurs, the water is absorbed by plants through processes such as transpiration. This water then continues to get absorbed into the soil or sediment where it either goes deeper where the groundwater is stored or it causes a surface runoff when the soil doesn't have any more capacity to absorb this water. This surface runoff water eventually ends up falling into a river which would later on lead to bigger bodies of water where the process of hydrologic cycle is repeated. The sediment that is carried along with this surface runoff along with other organic material are important characteristics of river ecology which benefit the ecosystems present within. The ecology of flowing water is unique in so many ways and is often shaped by the natural behaviors of flowing water. The major part of what makes these rivers a lotic system is the sediment that results in the change in the river bed variability which can either have positive or negative impacts on the species present in this habitat. Lotic systems can provide these species with the food source needed in order for their growth as the sediment from the land settles into

the river and goes deeper into the water (Wohl et al.). Such ecosystems play a fundamental role in supporting the environment and the economy. Rivers or lotic systems are indispensable for life on earth and are therefore vital due to the range of benefits it provides not only to species but to humans as well. However there are several factors that play a part in destroying these river biomes such as climate change and the impact it has on the hydrological cycle since climate change can eventually lead to permanent shifts in these lotic systems impacting the biome and their resources required for growth and survival (Dakova et al.).

River Biome and Limiting Factors

A river as a biome can be broken down into three types. The first type of river is a perennial river also known as a permanent river. These flow throughout the year and due to the lotic system present, the river works extensively by eroding and depositing sediments into this water body. The next two types include intermittent streams or ephemeral streams. The difference between both is that intermittent streams flow is seasonal however ephemeral streams flow is occasional or rare. They are alike in several ways since intermittent streams are ephemeral waterways that serve as rivers only during the rainy times of the year. This flowing body of water carries enormous amounts of salt and sediment which ends up along the bottom. The amount of sediment present in these lotic systems depends on the geomorphic factors and where these rivers are located (Svec et al.). There are several biotic and abiotic factors which control the lotic ecosystems such as physical and chemical properties of water which include temperature, color, water pH, salinity and the amount of oxygen present. Other factors contribute as well which include the flow of the water due to the wind, amount of sediment present, depth of light penetration and other climatic factors such as humidity, temperature, sunlight reaching these ecosystems in the rivers. However these abiotic factors change based upon the space and time of

the year depending on the weather and how it impacts the water temperature (Power et al.). The interface between the land and water also plays a significant role in controlling the environmental conditions around these bodies of water.

Lotic System Adaptations

Lotic system habitats are impacted by several factors such as water moving due to the wind hence changing the velocity of flowing water which impacts amount of sediments alongside river bed and other human activities. Species living in these habitats need to evolve in order to adapt to the changes in their environment so they can survive and reproduce efficiently (Lytle and Poff). Since the water body is constantly moving, species get attached to the closest hard body or material present in the river such as a rock, wooden logs and rock exposures. They tend to establish an attachment with their substratum and make it their habitat. This adaptation is usually seen in sponges or mosses. Another adaptation seen in lotic systems is Rheotaxis. This is a mechanism used by several fishes where they would swim against the flowing currents in order for the species to survive because the way a species positions itself depends on the amount of food resources they can access while spending less energy since they remain stationary (Colvert and Kanso). Another adaptation includes species body type being changed to fit in the environment. Some animals have a flat body to stay within the cracks and crevices of the rocks present in these water bodies. Similarly, some species have stream-lined bodies where their bodies are rounded anteriorly and tapering posteriorly which is mainly if this species is free swimming in the lotic system. Some species would have sticky bottoms such as snails and worms in order to move along the base. Various species consist of pelagic adaptations which helps them survive in depths of water for example The mayfly consists of gills which helps them be more productive in lotic systems as compared to standing waters. Most of the species that can float and

swim are used to pelagic adaptations like planktons because they have a similar body structure where their walled bodies or needle like structures which include cilia, fins and appendages adapt to the lotic system motions.

Ecosystem and energy flow/ Biodiversity

Many factors influence a river's energy flow. A river is a naturally flowing body of freshwater that flows into a lake, ocean, sea, or another river. A river's transportation, deposition, and erosion work are all affected by different variables. When the water flows from head to mouth, the river streams significantly alter the landscape of the region through which they flow. When the river velocity is high, both transportation and erosion are at their peaks. Deposition occurs when the river's velocity is low. When the volume of water is bigger, the force of transportation and erosion is greater. Deposition, on the other hand, occurs more efficiently when the water volume is low and the load is high. The material carried by a river is referred to as the load. A river's load does all of the deposition and erosion work. The depth of river valleys, mass wasting, and landform creation are all affected by the load carried by the river. All this impacts the energy in the river with direct or indirect methods. Rates of leaf litter decomposition in streams are affected by species diversity. Leaf litter falls from terrestrial plants in riparian zones and provides critical food resources to aquatic invertebrates and microbes residing in small streams for example as (Jackrel et al, 2015), shows that Aquatic organisms that receive considerable subsidies may experience downstream effects due to biodiversity between and within species. So basically plant population genetic diversity in rivers can boost consumer diversity and ecological function rates. The ecological function may be impacted by living organisms' diversity between species, with effects spreading across the ecosystem. For instance, the variety of leaf species had

variable effects on decomposition, algal abundance, and invertebrate metrics in the river (page 9).

An important requirement for measuring soil quality and determining ecological function is the concentration of nutrients in the soil. In ecological systems, soil carbon (C), nitrogen (N), and phosphorus (P) are significant markers of nutrient restriction and plant production. Understanding the biological processes of nutrient circulation and ecosystem responses to climate change and disturbance can be enhanced by the soil C, N, and P stoichiometry. For example, (Jiao et al, 2019), mentions the distribution of soil C, N, and P varied, reflecting the variations in nutrient intake by plant communities in water. The greater SOC and TN concentrations in CT and LF suggested that there was a chance for SOC and TN to rise in forests. Due to soil carbon and nitrogen loss during the conversion of natural vegetation to farming communities at a certain temporal period, the reclaimed area had low SOC and TN. Reclaimed land's lower C: N ratios showed a detrimental impact on SOC and TN accumulation and poor residue return (page11).

Population growth rates, population persistence, and patterns of biodiversity have all been demonstrated to be impacted by modifications to riverine network connectivity. River connection changes could alter species distribution patterns. Specific tactics, such as flow regime restoration and integrated drainage basin management, are required for the protection of river biodiversity. For example, (Grant et al,2012), talked about how regional network structure is highlighted as a key factor influencing patterns of variety, with increased local diversity for a given migration rate being produced through increasing connection among communities. Because the connection is so important for species diversity and biogeography, taking changes in riverine networks' relative isolation into account could be a tactic for reducing the effects of IBWTs (page 1).

The impact of the climate change into the rivers

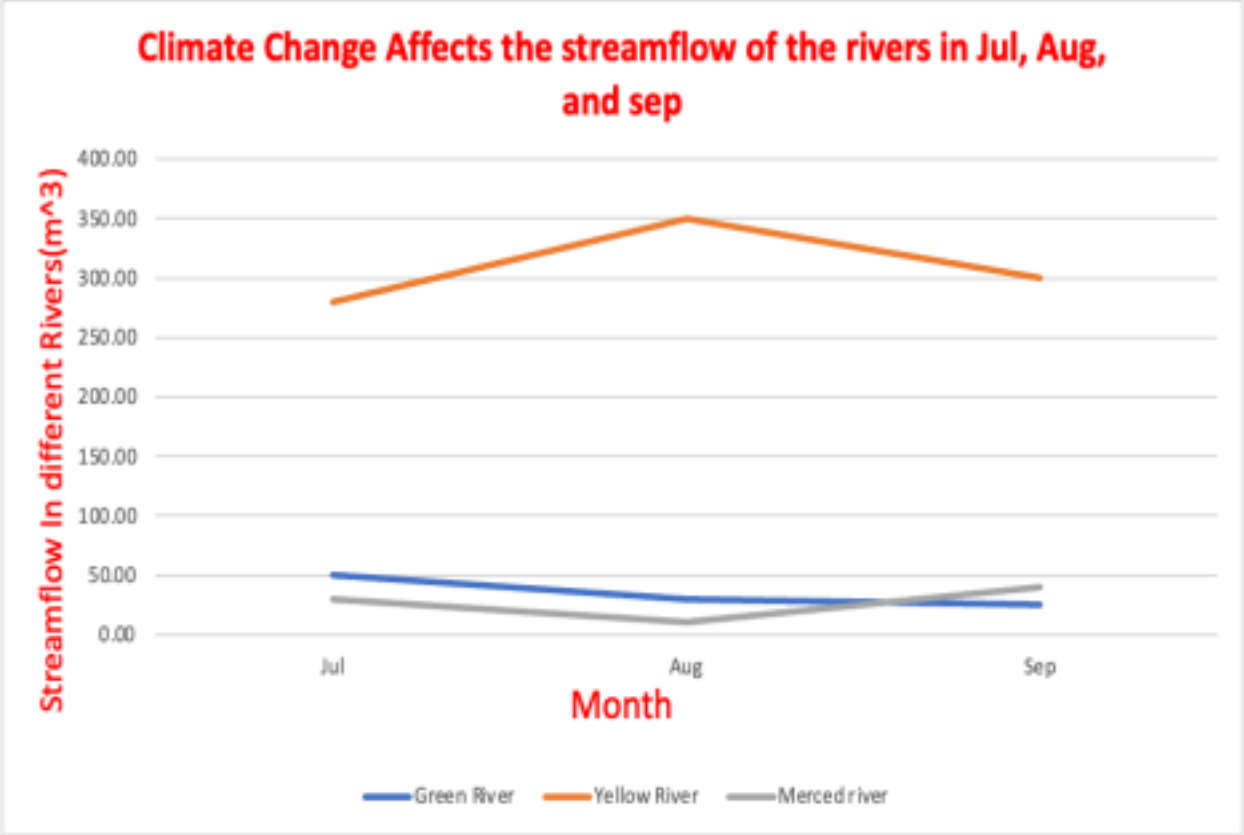
Climate change refers to long-term changes in temperature and weather patterns. Global climate change is causing more frequent wildfires, longer periods of drought in some areas, and an increase in the duration and intensity of tropical cyclones. In this study, we will look at how climate change affects rivers. Climate change poses a great danger to the environment and rivers. An example of this is the extreme rise in temperature, recurring storms, and permanent changes in changing precipitation rates, all of which will affect rivers. When the air temperature rises, see the water temperature change in the rivers, which reduces the presence of freshwater habitats for cold water species. When the temperature of the water is warm in the rivers, it will slow down the processes of supplying the water with the necessary oxygen for the organisms that live inside the river water, which leads to the death of some organisms that could not adapt and increase the proliferation of harmful algae inside the river water.

Climate change has an impact on ecosystems and environmental systems that provide freshwater habitats for fishing. Most freshwater fish species can only thrive in specific water temperature or stream flow conditions. Climate change can endanger such aquatic habitats by modifying these circumstances, such as rising stream temperature, which produces a corresponding fall in oxygen levels, altering stream flow owing to drought or increased storms, and intensifying other stresses that might influence ecosystem health. For example, (Pittock 2003), gave an example of the changes that will occur in the rivers of Australia as a result of changing temperatures and changing the rate of precipitation and evaporation. Where he said that he expects that the surface runoff and soil moisture of the interior regions of Australia will be affected by changing volumes of rain and floods.

Precipitation patterns will vary as the Earth warms. This means that some watersheds will receive less precipitation. This is a serious issue. where snowmelt-dominated watersheds will be badly struck. Rising temperatures will lead precipitation to fall as rain rather than snow, reducing the reservoir that some communities rely on during the drier summer months. Reduced river flows due to a lack of precipitation can put a significant pressure on fish and wildlife species that rely on current river flows and levels. A warmer temperature will also increase evaporation in reservoirs, reducing the potential amount of river flow. Lower levels and higher evaporation will also endanger the people that rely on the river. On the other hand, other areas will have more precipitation, raising the risk of floods. Heavy runoff can increase water contamination and put a strain on fish and wildlife (Kiparsky et al, 2014). More frequent and stronger storms will cause river flow to increase, often to the point where they exceed their banks and flood neighboring ecosystems and communities, inflicting substantial property damage and pollution in settlements situated on floodplains. This is also a problem for populations located downstream of high alpine glaciers, which would melt at a faster rate as temperatures rise. For example, in the Upper Colorado River Basin, We saw how climate change impacts the streamflow inside this river. We saw how the streamflow impacts into the rivers every month and what are the reasons that make the streamflow increase or decrease. We knew that more precipitation is projected to result in greater average streamflow in the river in some months. A warmer temperature will also increase evaporation in reservoirs, reducing the potential amount of river flow. Lower levels and higher evaporation will also endanger the individuals who rely on the river (Ficklin et al, 2013). We look at the data for three primary resources, to compare how the stream flow of the river is affected by climate change each month. The three rivers that we are going to compare are the green river Greendale, yellow river, and merced river. As we can see from the data how climate

change affects the streamflow in different rivers in different months. More frequent and stronger storms will cause river flow to increase, often to the point, they overflow their banks and flood nearby ecosystems and communities causing significant property damage and pollution in communities built in floodplains. When water temperatures increase that will cause eutrophication and excess algal growth, which will reduce the water quality. When the water rises, other regions will experience increased precipitation which will increase the risk of flooding. Heavy runoff can cause rising levels of water population and again put a strain on fish and wildlife [(Ficklin et al, 2013), (Zhao et al, 2014), and (Kiparsky et al, 2014)].

Month	Green river Greendale (Stream flow)	Yellow River (Stream flow)	Merced river(Stream flow)
July	50	280	30
August	30	350	10
September	25	300	40



Sources: [(Ficklin et al, 2013), (Zhao et al, 2014), and (Kiparsky et al, 2014)]

Conclusion

We can conclude that the river ecosystem provides us with ecosystem services through the interrelated living and nonliving parts of a lotic system. However, there are several ecological factors impacting the river biome such as temperature, light, pH, salinity etc. These factors impact the species living in such habitats directly or indirectly which affects an ecosystems energy flow and materials such as sediments being recycled. It is ideal to understand how these species adapt to changes in their environment and to understand the energy flow within the food webs in order to see how the environmental system functions in such ecosystems. Climate

change plays an important role in affecting lotic systems which forces these species to adapt and evolve to their environment in order to grow and reproduce successfully. Paying attention to these ecosystems can help us understand how we as humans disrupt earth's process or how we can help keep these ecosystems and their habitats alive.

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