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An investigation of biodiversity fluctuations as a result of ocean pollution

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Abstract: Pollution is described as the emission of harmful materials into the environment, leading to a large-scale issue that affects habitats and societies globally. The significance of the study of pollution is to focus on the potential risk to human health from harmful pollutants. NASA data for analyzing environmental pollution is accurately presented as satellite imagery, remote-sensing data, etc. The main objective of this research is to determine distinct particulate matter and waste sources, evaluate their impact, and recommend standards and strategies to control their emissions in order to protect the environment and human health. The data source employed for this climate study is NASA datasets, which provide pollution data as remote sensing or graphs and allow researchers to detect where pollution is centralized. Key NASA datasets utilized include NASA Earth Observations (NEO), NASA EarthDATA, and NASA Air Quality. Key graphical analyses include bar graphs, comparative charts, and line graphs and specific pollutants studied are debris, particulate matter, and plastic fragments. Pollution hotspots are defined as areas where air emissions are exposed to individuals, resulting in health risks. In order to prevent this, remote sensing techniques identify pollution hotspots from a distance. My key findings regarding pollution include quantitative variation in the wastage within Gonzales Beach, plastic waste having the highest quantity. Reducing the use of fossil fuels is an optimal way to propel the environment into a healthier status quo. Based on this study's insights, some actionable recommendations are increased implementation of WWF's Environment Act 1997 and promotion of the efforts of the Oceana organization. This action plan aims to protect the Earth from the misuse of human-environment interactions. In conclusion, intensively monitoring pollution can help determine its impact and recommendations for reducing its pervasive impact. To improve our understanding of the climate, the study of how air pollution affects and interferes with habitats and biodiversity is essential.

Keywords: Environment, Pollution, Biodiversity, Climate Change, Global Warming

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[1] ***Abstract*****—***Pollution is described as the emission of harmful materials into the environment, leading to a large-scale issue that affects habitats and societies globally. The significance of the study of pollution is to focus on the potential risk to human health from harmful pollutants. NASA data for analyzing environmental pollution is accurately presented as satellite imagery, remote-sensing data, etc. The main objective of this research is to determine distinct particulate matter and waste sources, evaluate their impact, and recommend standards and strategies to control their emissions in order to protect the environment and human health. The data source employed for this climate study is NASA datasets, which provide pollution data as remote sensing or graphs and allow researchers to detect where pollution is centralized. Key NASA datasets utilized include NASA Earth Observations (NEO), NASA EarthDATA, and NASA Air Quality. Key graphical analyses include bar graphs, comparative charts, and line graphs and specific pollutants studied are debris, particulate matter, and plastic fragments. Pollution hotspots are defined as areas where air emissions are exposed to individuals, resulting in health risks. In order to prevent this, remote sensing techniques identify pollution hotspots from a distance. My key findings regarding pollution include quantitative variation in the wastage within Gonzales Beach, plastic waste having the highest quantity. Reducing the use of fossil fuels is an optimal way to propel the environment into a healthier status quo. Based on this study's insights, some actionable recommendations are increased implementation of WWF's Environment Act 1997 and promotion of the efforts of the Oceana organization. This action plan aims to protect the Earth from the misuse of human-environment interactions. In conclusion, intensively monitoring pollution can help determine its impact and recommendations for reducing its pervasive impact. To improve our understanding of the climate, the study of how air pollution affects and interferes with habitats and biodiversity is essential.*

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I. Introduction

In current situations, pollution is a major issue. Pollution causes biodiversity loss, respiratory and lung diseases, acid rain, and creates compounds that are harmful to the environment. Human wastage is the main cause of pollution. Human waste is considered to be the products of the human digestive system, bodily fluids, and includes sewage and trash, which often contain pollutants that can cause diseases in humans or other side effects (Cassidy, 2021) [1]. This is not only detrimental to humans, but also to biodiversity. Most human waste accumulates in oceans, increasing aquatic acidicity and impacting marine life because it is not disposed of in the correct way. This interferes with biodiversity health and declines population growth. Lastly, human waste also affects species diversity because some species are vulnerable to dying out, affecting the food chain and immediate ecosystem. These all factors are drawn back to affect humans.

Pollution plays a major role in global warming and climate change, being composed of harmful materials which are called pollutants (Duncan, 2023) [2]. These substances include greenhouse gases and the chemical compounds which form ozone, which is an air pollutant that harms humans, plants, and animals (Levy, 2024) [3]. Ozone in the atmosphere warms the climate while components of particulate matter (PM) can have warming or cooling effects on the climate, which ultimately influences global warming.

For the exploration of pollution, data was collected from NASA "Pollutants" Air Quality Observations from space, the NASA "What is Ozone?" Article, and the NASA Air Quality Observations "Particulate Matter". Beginning with NASA's "Pollutants," this article was most considered for the acquisition of satellite data points. The imagery provided in NASA Earth Observations "Ozone" was applied to understand what ozone is and explain how it affects the environment. Lastly, NASA's Air Quality Observations "Particulate Matter" was utilized to pinpoint what PM is made up of and its harmful effects.

The experiment was conducted in 3 phases: 1) Conduct rigorous research to find specific and relevant data regarding Earth's pollution and air quality. 2) Build body paragraphs beginning with an introduction. 3) Applying the information learned to construct an essay. Most data was collected through NASA datasets and was valuable in elucidating insights about the environment with the provided data and information—and allowing inferences and interpretations of the data as well.

Potential contributions to this experiment are pollutants, particulate matter (PM), and ozone, which all are associated with air pollution, as well as environmental pollution.

II. Data Collection and Analysis Procedure

NASA datasets that were utilized include NASA "Pollutants" Air Quality Observations (data from the Aura Ozone Monitoring Instrument (OMI), NASA Earth Observations "Ozone," and NASA EarthDATA "Particulate Matter" (PM). The data was mostly observed from satellite imagery and remote sensing data. The satellite imagery for pollutants is from the Aura Ozone Monitoring System (OMI), which shows air pollutants observed from space.

The information collected from NASA "Pollutants" and "Particulate Matter" can be considered to be accurate and timely because it was last updated on April 21st 2023, implying that the data was recently collected. The data relating to ozone in NASA Earth Observations is relevant as the source is satellite imagery from the OMI on NASA's Aura satellites, which provides daily measurements. Satellite imagery in NASA's "PM" Air Quality Observations is a resolved image source because it contains more detail with increased pixel count.

Throughout this data, one key environmental parameter is temperature, since particulate matter in the global climate can cool or heat up the atmosphere, depending on its factors (Levy, 2022) [4]. Elevation is another environmental parameter because pollutants have a significant effect on air quality at higher elevation, which has an impact on human health.

Particulate matter concentrations are solid or liquid matter existing as tiny fragments which can travel into the human respiratory system and affect the lungs and heart (Duncan, 2023) [4]. Air quality indices measure the health risk caused by the amount of pollution in the air from 0 to 500, where higher levels or values imply an increased health risk (Duncan, 2023) [5]. These variables are relevant to the study of environmental pollution because they both address air quality and allow humans to understand harms, such as through the Air Quality Index (AQI). This index informs us of how "clean" the air is, which aids in predicting the degree of health concern and how intensely particulate matter concentration fragments can affect the lungs and heart.

The duration of the data collected ranges from 27 November 2023 to 11 December 2023. In this time interval, the temperature was decreasing. The rationale for selecting this timeframe is to focus on collecting data points for this study of environment pollution. In my exploration of particulate matter (PM), the satellite imagery concerned the Eastern U.S., including Eastern Pennsylvania and the Mid-Atlantic region. These regions were pinpointed because they display rapid climate variation through the years. In the Mid-Atlantic region, which is known for agriculture, hotspots are associated with farming. The Eastern Pennsylvania land is utilized for crop production, which holds 64% of the state's total agricultural farmland (Thompson, 2024) [7].

III. Data Analysis

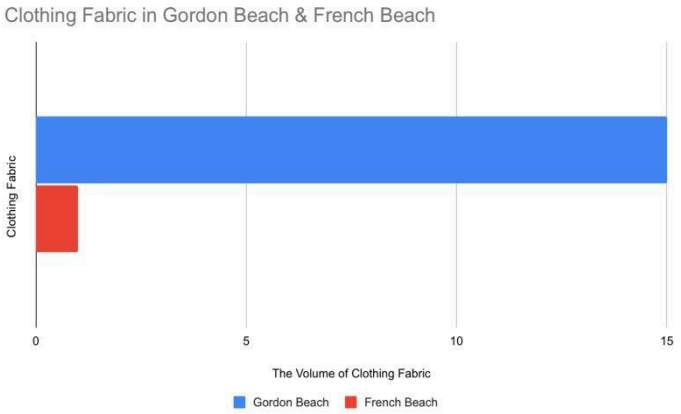

Fig. 1. Volume of clothing fabric waste on Gordon Beach (blue) vs. French Beach (red).

According to Figure 1, Gordon Beach and French Beach display variation in the volume of clothing fabric left as waste. This affects the survival chances of marine biodiversity by increasing the risk of becoming trapped or suffocated in fabric, which decreases available oxygen levels (Albers, 2018) [8]. Clothing fabric in oceans also interacts with oil-based products to release plastic fibers, causing fluctuations in marine biodiversity survival rates.

Fig. 2. Volume of Metal Waste in 5 Different Coastal Regions.

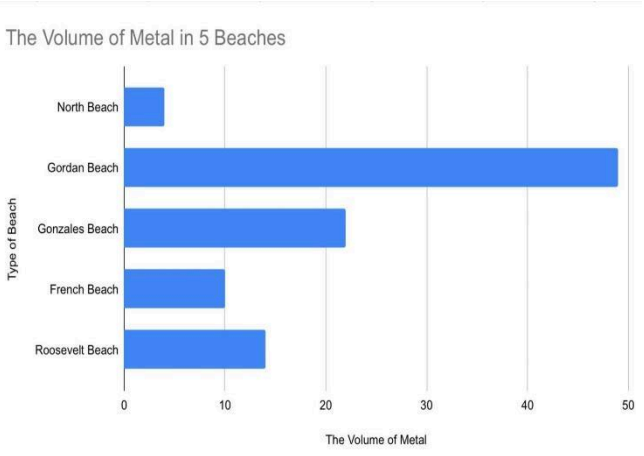

Figure 2 depicts the volume of metal waste in 5 different coastal areas, with an average of 19.8 kg and percentage of 0.198%. Metals can accumulate in aquatic habitats to toxic levels because of their lack of biodegradability, meaning that metals do not have the ability

to decompose or break down. The graph helps us infer that Gordon Beach potentially has higher toxicity levels than all other beaches shown because the volume of metal is higher for Gordon Beach.

Fig. 3. Different Forms of Waste Found on Gonzales Beach.

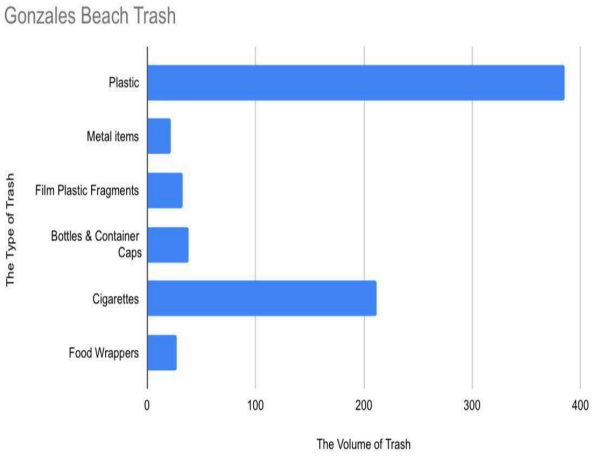

Figure 3 illustrates the high level of plastic found on Gonzales Beach in the form of plastic debris, film fragments, and plastic bottles and caps. This feeds marine plastic pollution, which in turn affects food quality, human health, marine sea life, and plays a part in climate change. Plastic in oceans can also lead to marine life endangerment when species become entangled in waste or consume plastic items. Though there is a high level of pollutants, Gonzales Beach has an AQI of 32, which is considered to be a fairly optimal score.

The volume of debris items in 4 different coastal locations displayed an average of 329.5 kg, or 3.295%. Marine debris is decomposed into small fragments known as microplastics, which can enter the marine food chain and cause immense damage to sea life.

My analysis addresses locations with an abundance of coastal waste, beginning with metal items within 5 different coastal areas: North Beach, French Beach, Roosevelt Beach, Gonzales Beach, and Gordon Beach, Gordon Beach displayed the highest volume of metal: 49%. Exposure to large amounts of metal are known to cause DNA damage in aquatic animals, resulting in genetic alterations. These variations can lead to the development of cancer for both marine animals and human beings.

The population of Gordon Beach, 1,127 people, is small when compared to other locations, but the higher percentage of volume of metal is due to the industrial activities nearby. This includes agriculture with excessive use of pesticides, mining, and irrigation of crop fields. Mining also results in carbon emissions that affect environments globally, but there are several ways to mitigate harmful efforts: 1) Reduce the usage of pesticides in the farm field. 2) Reduce drilling and mining, 3) Physically remove metals or other materials discarded. These strategies can potentially reduce risks for living organisms in the ocean.

Another significant trend is observed for debris items in 5 different coastal areas, out of which Roosevelt Beach has the highest percentage of volume of debris. Debris can be defined as “particle pollution” or, in other words, an air pollutant. Debris is able to kill animals when it is ingested or entangled and can interfere with human health as well.

Debris makes its way into the ocean due to natural processes like rainwater or wind carrying plastic waste into streams, rivers, and drains (Shah, 2021) [9]. Most debris comes from land-based sources. Many methods exist to prevent debric accumulation and diffusion, including reducing single-use plastics, recycling properly, participating or organizing beach cleanups, and spreading the word of the problem.

IV. Recommendations and Action Plan

Taking into consideration the information provided, presented below are my recommendations and action plan aimed at fostering a more robust marine environment. One key initiative involves engaging with environmental organizations, as their primary objective is to safeguard the environment against the adverse impacts of human activities. This collaboration can yield numerous benefits, primarily in the frequent cleaning of beaches, thereby mitigating ocean pollution and acidity, reducing the risk of marine animal mortality, and maintaining pristine shores that attract more visitors.

Another recommendation is the enforcement of environmental protection legislation, notably the Environmental Protection Act of 1997, which serves as the principal framework for monitoring the environmental repercussions of local activities. This legislation empowers councils to investigate complaints and issue directives for prevention and cleanup. By leveraging this legislation, councils can address the escalating issue of ocean pollution stemming from polluted air and compromised water quality. Additionally, the Clean Water Act aims to eradicate pollution in the nation's water bodies, thereby ensuring a habitat conducive to the well-being of marine life.

Furthermore, the involvement of reputable environmental organizations such as the World Wide Fund for Nature (WWF) holds significant promise. The WWF is committed to assisting local communities in preserving natural resources, fostering sustainable market practices and policies, and spearheading efforts to protect and restore species to their native habitats (Roberts, 2024). Given their expertise, the WWF can play a pivotal role in safeguarding coastal ecosystems by protecting marine animals and coral reefs within oceans, thereby contributing substantially to the preservation of aquatic environments in coastal regions.

In conclusion, these collaborative endeavors involving both environmental organizations and legislative measures can provide substantial support for marine life and coastal environments, particularly in areas such as Gordon Beach and Roosevelt Beach.

Author Contributions

I contributed to the design and implementation of the research and analyzed the data from NASA datasets. I wrote this paper.

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