Group Name: Harbor Tide
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Introduction:

The Department of the Navy's (DON) 'Climate Action 2030' strategy provides instruction for the DON's response to the threat of climate change, emphasizing its impact on military operations, particularly coastal installations. Climate change is considered one of the most destabilizing forces of the 21st century, posing multifaceted threats to national security and military readiness. These threats extend beyond rising sea levels to include extreme weather events, droughts, and changing global temperatures. The operational capacity of the U.S. Navy and Marine Corps is threatened by these phenomena, which demand immediate and decisive action to mitigate their effects.

'Climate Action 2030' outlines the urgent need for the DON to build climate resilience, ensuring forces and facilities can adapt to and withstand the worsening impacts of climate change. The decision to prioritize rising sea levels, as a direct threat to coastal military installations critical to national defense and security, is based on the strategy's call for climate-informed decision-making and resilient infrastructure development. While recognizing that rising sea levels are only one aspect of climate change's broader impacts, they can lead to the inundation of naval bases, disrupting operations and strategic capabilities.

It emphasizes collaborating with external partners to scale up mitigation and adaptation efforts, highlighting the interconnectedness of climate action with operational efficacy and strategic objectives.

Process:

Our team conducted a data analysis project to evaluate the trends of rising sea levels near coastal U.S. military installations. To fulfill this task, we had to navigate through a complex web of data sources, overcome various technical challenges, and apply innovative analytical techniques to extract valuable insights from intricate datasets.

Finding Data on Military Installations:

Finding data on military installations was easy thanks to the comprehensive database available. With this resource, we quickly proceeded to the next stages of our analysis. Our first step was to plot the identified military installations on a Folium map, paying particular attention to those located along the west coast of the United States.

Processing Military Installation Data:

To make the military installation data usable, we followed several key steps. First, we extracted and converted the data into a format suitable for analysis using Pandas. Next, we visualized the locations of these installations on a map using Folium, with a specific focus on the major fleet concentration installations situated along the west coast of the United States, as well as Hawaii. This geographical filtering was essential for honing our analysis on a specified region.

Finding Data on Sea Levels:

In addition to our work on military installations, we also tackled the challenging task of obtaining accurate sea-level data. This undertaking presented numerous obstacles, beginning with the search for reliable tide data and sensors. The sea-level data we obtained was derived from quality-checked tide sensors and included minute-by-minute tide information. With approximately 8 million data points per sensor, the volume of data was significant. Our objective was to import the data efficiently, focusing on essential attributes such as time stamps, locations, and tide levels. A significant challenge arose due to the spatial distribution of tide sensors, which were not always conveniently located near the military bases under study.

Process for Sea-Level Data:

The methodology used to manage the sea-level data was multifaceted. Initially, a select number of sensors were placed on the map to test functionality. The next step involved converting timestamps into a datetime format that was more conducive to analysis. This conversion process initially took 60 seconds per dataset but was significantly reduced to 30-40 seconds per conversion after specifying the datetime format to ISO8601.

The process of organizing the tidal sensor data involved several techniques to refine the dataset for analysis. Due to the complexity and volume of the data, with each sensor contributing approximately 8 million lines of information, we faced the challenge of managing an initially large dataset size of around 2.5 GB. To address this, we employed strategies such as interpolating missing data, purging null values, and streamlining the dataset to its essence. The dataset was optimized for analytical needs, reducing its size to approximately 1.7 GB.

This made it more manageable and efficient for subsequent analysis. The data was grouped by sensor and datetime, enabling the calculation of monthly minimum, maximum, and average tide levels. These calculations generated plots illustrating the evolution of sea levels over time, providing a visual representation of the potential impact on military installations.

Results:

Our analysis of 16 years of tidal data indicates that the rise in water levels, although present, was not as dramatic as anticipated. The observed incremental changes suggest a relatively stable pattern over the period in question. However, this should not lead to complacency. Given the current trends in global warming, it is plausible to hypothesize that significant rises in sea levels will become a more pressing issue throughout the 21st century. Gradual changes in sea levels could accelerate, posing substantial challenges to coastal regions and necessitating proactive measures to mitigate potential impacts.

To gain a comprehensive understanding of the implications of rising sea levels, especially concerning coastal military installations, it is imperative to consider additional factors such as local topography and the specific altitude of these installations relative to high tide levels at each location. These elements are crucial in evaluating the susceptibility of military assets to flooding and erosion. Understanding the topographical details and the installations' positioning in relation to normal and extreme tidal events can aid in developing more effective strategies for adaptation and resilience, ensuring the operational integrity of these vital defense infrastructures against the imminent threat of climate change.

Conclusion:

This project demonstrated the complexities of conducting environmental data analysis, particularly when addressing the potential impact of global phenomena such as rising sea levels on critical infrastructure. Despite the challenges encountered in data sourcing and management, our team exhibited resilience and adaptability, utilizing innovative solutions to overcome technical obstacles. The analysis provides insights into the risks posed by sea-level rise to coastal military installations. It highlights the importance of effective data management and analytical strategies in environmental research. The project has emphasized the critical need for comprehensive, accessible datasets and has laid the foundation for potential future research on a critical national security issue.