**Data and Methods**

**1. Introduction**

This section outlines the data collection and analysis methods used to study the impact of climate change and changing rainfall patterns on Torrey Pine tree mortality coastal ecosystem.

**2. Data Collection**

* **Sources of Data**: Data was collected from a combination of field surveys, remote sensing, and historical climate records. The field surveys included measurements of tree health, mortality rates, and species identification. Remote sensing data provided information on vegetation cover. Additionally, gridded climate data from Prism Climate Group was used to train a linear regression model. This model aims to analyze the relationship between climate variables, specifically air temperature and precipitation, and their impact on tree mortality.
* **Data Description**: The dataset includes information on all Torrey Pine tree species across Torrey Pine State Park surveyed in the year 2006 & 2018. Climate data includes temperature and rainfall records for the years 2001-2018.

**3. Sampling Methods**

* **Sampling Techniques:** A two person crew mapped and measured about 200 trees per day during the survey. For some of the dead trees, Tierra used the 2006 SDSU census GPS data. For the rest, sub-meter GPS was used. Trees growing on difficult terrain were mapped and measured using rangefinders. Azimuth and distance from the tree was used to determine accuracy; in most cases, measuring diameter at breast height (DBH) remotely proved to be fairly accurate. Only those trees growing inside Reserve boundaries are included in the attached maps and tables. Trees were divided by “age class” according to DBH: adult, sub-adult, sapling.
* **Sample Size**: All Torrey Pines trees within the park boundary.

**4. Data Processing**

* **Data Cleaning**: Data was cleaned by removing records with missing or inconsistent values. Outliers- ignore the sick trees information and assume they were alive.
* **Data Transformation**: Tree mortality rates were calculated by comparing current tree health data with historical records. Climate data was standardized to account for seasonal variations.

**5. Methods of Analysis**

* **Analytical Techniques**: Time Series Analysisand Cox Proportional Hazardsmodels are used to analyze the relationship between tree mortality and climate variables such as temperature and rainfall.
* **Software Used**: Data processing was performed using Python (pandas, numpy) and ArcGIS for spatial analysis.

**6. Ethical Considerations**

* **Consent and Confidentiality**: The California State Parks contracted out a private company to map and measure Torrey pine tree along with the reserve.

**7. Limitations**

* **Data Limitations**: The study is limited by the accuracy of historical climate data and potential biases in field survey data.  Additionally, the study would benefit from the inclusion of a third data sample, which could provide a more robust and comprehensive analysis.
* **Methodological Limitations**: The observational nature of the study limits the ability to infer causality between climate change and tree mortality.

**8. Conclusion**

This section has detailed the data collection and analysis methods used in this study. Despite certain limitations, the methods employed ensure the reliability and validity of the findings regarding the impact of climate change and changing rainfall patterns on tree mortality.

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