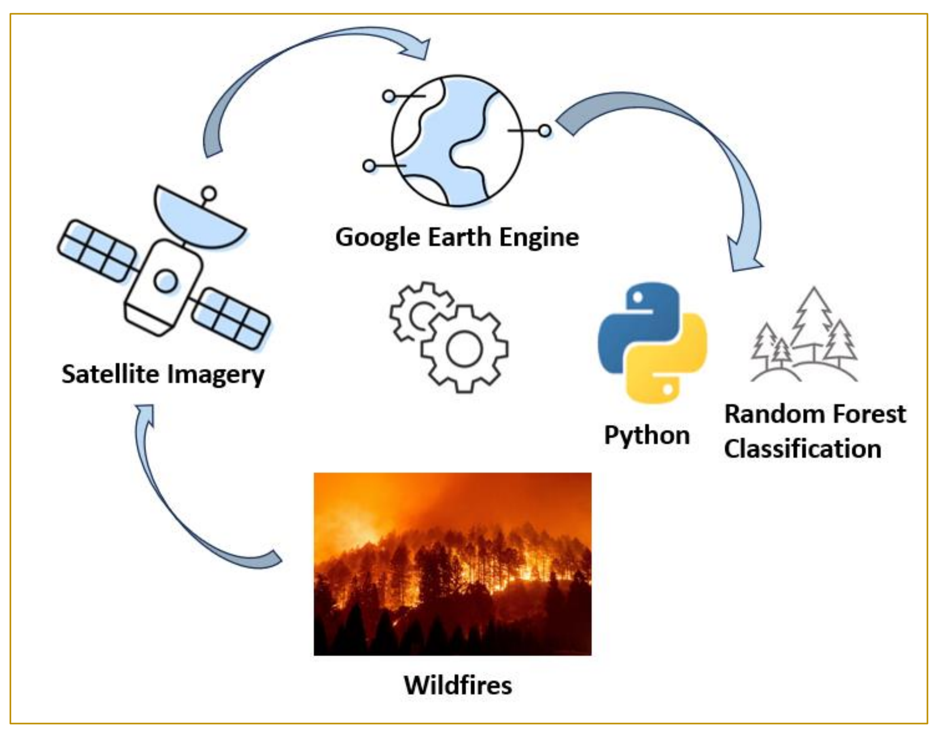
Analysis of factors affecting wildfire distribution.

How numerous geospatial tools help us achieve the goal of the study.

Geoinformatics Project Course , Geoinformatics Engineering, School of Civil, Environmental and Land Management Engineering, Politecnico di Milano

Introduction

- Climate change is expected to modify the geographic distribution of wildfire in the future[1]. In 2023, many regions experienced record-breaking wildfire activity [2].
- Climate change is expected to alter the spatial distribution of wildfires in the coming years. The damages of these wildfires extend beyond the direct impact of the flames, causing environmental and societal damage.
- Combustion is a very complex physical reaction, and the complex interplay of factors to initiate a wildfire is far from being trivial.



- Geospatial tools play a crucial role in addressing the complex dynamics of wildfires. By exploiting satellite imagery and remote sensing technologies, these tools enable us to analyze and monitor changes in vegetation, weather patterns, land cover, providing valuable insights into the spatial and temporal patterns of wildfire occurrences.

Input Products

- Diverse geospatial datasets are utilized for the study of wildfire dynamics.
- Through Google Earth Engine(GEE) collections, we incorporated datasets like Hansen Global Forest Change for detailed global forest cover analysis and MCD64A1 MODIS Burned Area data for precise information on wildfires.
- Additionally, the TerraClimate dataset provided monthly climatic water balance information, crucial for understanding climate influencing factors.
- The datasets, NASA SRTM Digital Elevation 30m and Human Impact Index (HII) by Wildlife Conservation Society, provided insights into elevation variables and cumulative human impact on the environment.
- Landsat 8 Collection containing multispectral data, was used in extracting key indicators like NDVI and NDMI to assess vegetation health and moisture content.
- MODIS Land Cover Type Yearly Global 500m, was used for analyzing the distribution of fires with global land cover types on a yearly temporal.
- These datasets contribute equally as a source for studying the factors influencing wildfire distribution, integrating environmental, climatic, and social variables.

Variables
Slope of the terrain
Aspect of the terrain
Wind speed
Maximum temperature
Minimum temperature
Climate water deficit
Precipitation accumulation
Soil moisture
Normalized Difference Vegetation Index (NDVI)
Normalized Difference Moisture Index (NDMI)
Land Cover
Human Impact Index

- Our selection for these factors was informed by reputable sources, including the French National Research Institute[1] and NASA's masterclass[3] on fire detection.

Acknowledgments

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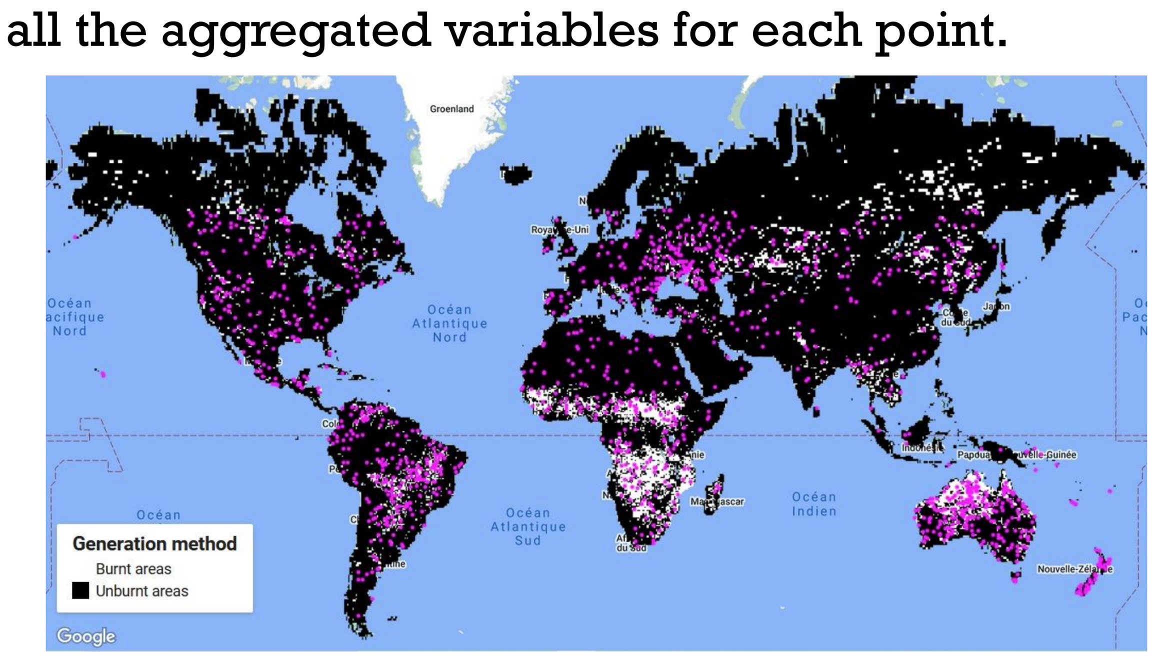
- External products, such as the Hexagon Map Grid, created using QGIS tools, and shapefiles, facilitated our spatial analyses.

Methods

- Two methods are followed, each with its distinct approach, but both serving to a wide group of spatial analysis requirements.
- Users can choose the method that aligns with their study objectives, temporal and spatial resolutions, ensuring flexibility and adaptability in wildfire analysis.

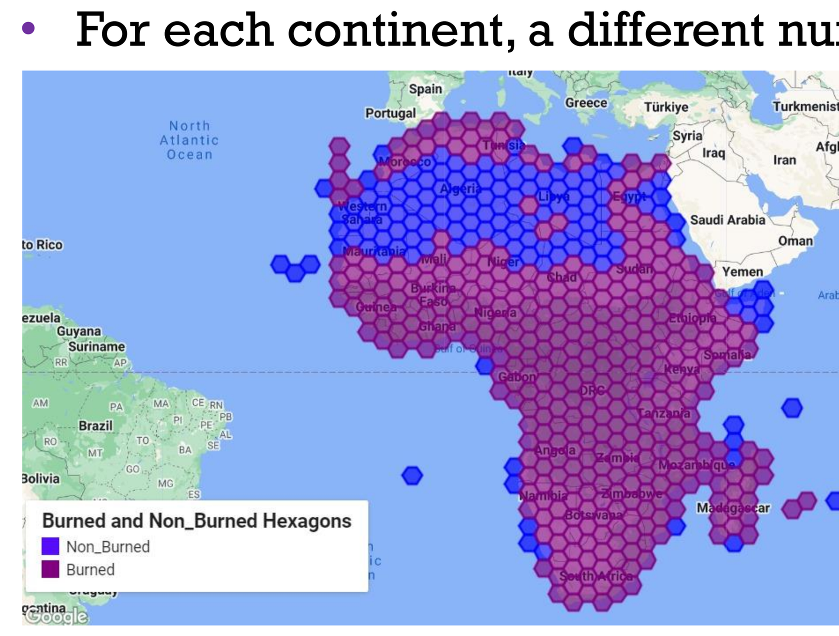
1. The first method focuses on a binary mask for broad-scale wildfire analysis, distinguishing burned and non-burned pixels.

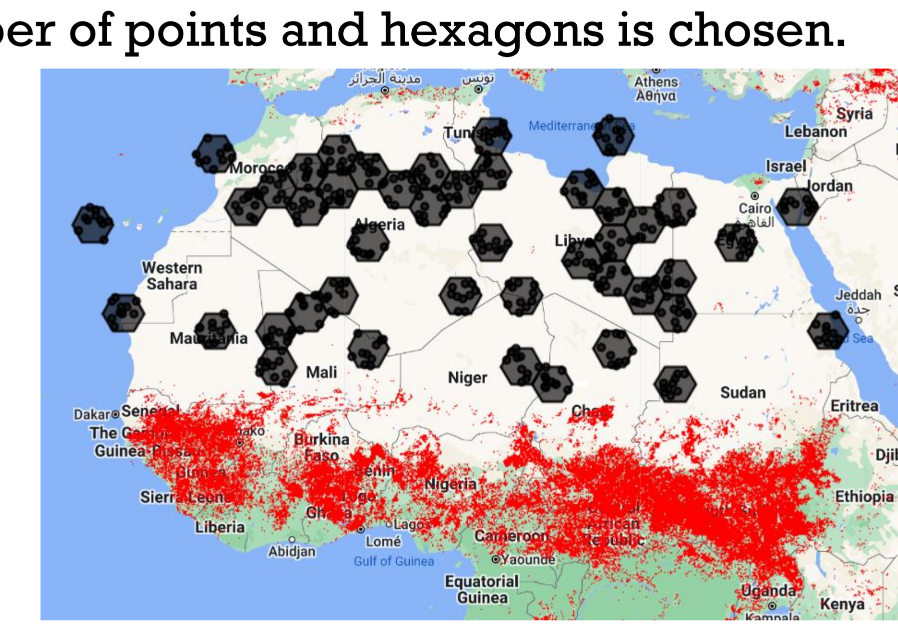
- Stratified sampling is applied for the creation of the dataset containing values for all the aggregated variables for each point.



2. The second method, utilizing a hexagon grid, offers a more detailed sampling approach, particularly suitable for smaller areas.

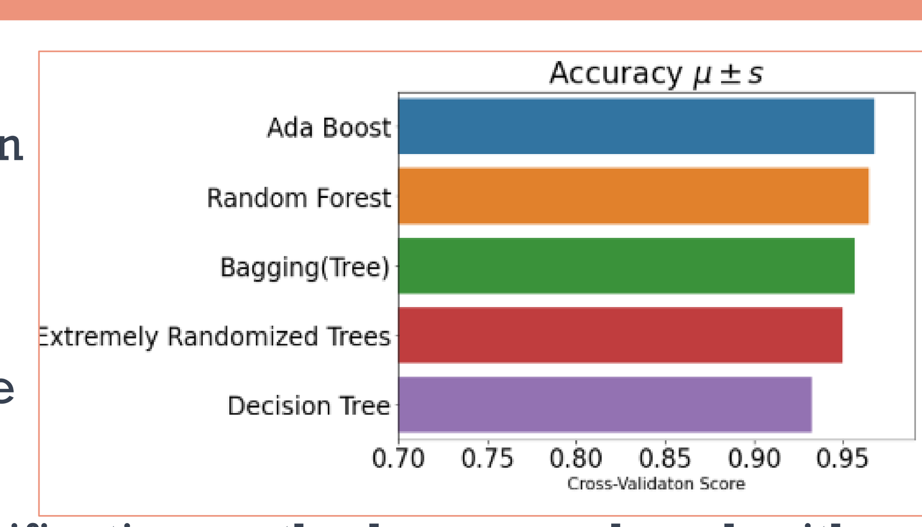
- This grid helps us reduce the computational time and the user memory limit of Google Earth Engine.
- Stratified sampling is executed in chosen hexagons, classified as hexagons with pixel sum 0 (not burned areas) and pixel sum not 0 (burned areas).
- For each continent, a different number of points and hexagons is chosen.





Analysis and Results

- The analysis presents the training results of both datasets, integrated in a Random Forest classification algorithm. Each model yields insights into model accuracy and feature importance, which is also the purpose of the study.



- Except Random Forest, various classification methods are employed, with Ada Boost resulting as the top-performing model.
- Wind speed, NDVI, and NDMI are identified as the most influential factors across methods.

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