AI Course

Capstone Project   
Final Report

For students (instructor review required)

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| <Detect Gasses Produce by Waste Burning> |

< Date (15/12/2024) >

Team Name

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1. Introduction

1.1. Background Information

This project tackles smog in Pakistan by analyzing waste-burning hotspots and their impact on air pollution using Google Earth Engine and QGIS. By correlating gas concentration data (CO, CH4 and NO2) with geospatial insights, it identifies high-smog areas and proposes mitigation strategies, such as improved waste management, to enhance air quality and reduce health risks.

1.2. Motivation and Objective

This project is driven by the urgent need to address severe smog in Pakistan caused by waste-burning emissions, which threaten air quality and public health. Using geospatial technologies like Google Earth Engine and QGIS, along with gas concentration data (CO, CH4, and NO2), it aims to detect waste-burning hotspots, analyze their impact on smog, and identify high-risk areas. The objective is to provide actionable insights for targeted mitigation strategies, including enhanced waste management and policy recommendations, to reduce pollution and safeguard public health.

1.3. Members and Role Assignments

**Ghayur Abbas** will be responsible for data collection and preprocessing. This includes gathering relevant datasets such as satellite thermal imaging data, gaseous concentrations, and supplementary environmental data. They will ensure the data is cleaned, normalized, and formatted for analysis, and will also perform feature engineering to extract meaningful insights like spatial clusters and temporal trends.

**Muhammad Shoaib** will focus on the model development phase, where they will research and implement detection algorithms such as Random Forest for waste burning classification and K-Means for anomaly detection. They will also fine-tune the models for optimal performance and evaluate their accuracy using metrics like precision and F1-score.

**Muhammad** **Hussnain** will handle geospatial visualization and system deployment. They will design an interactive dashboard using GIS tools to display real-time waste burning hotspots, integrate model predictions into the visualization platform, and ensure the system is user-friendly and accessible. Additionally**.**

1.4. Schedule and Milestones

**Phase 1: Project Initiation (Day 1-2)**

* Define project objectives and scope.
* Finalize datasets and tools.
* Assign roles and responsibilities.

**Phase 2: Data Preparation (Day 3-4)**

* Collect and preprocess Waste-Burning dataset.
* Perform data augmentation and normalization.
* Split data into training, validation, and test sets.

**Phase 3: Find out Gasses Indicator (Day 5-6)**

* Analyzed dangerous gasses produce by waste burning
* Find out air quantity index of CO , CH4 and NO2 through Google earth engine
* Visualize gasses in different areas of Pakistan using latitude and longitude

**Phase 4: Visualization and Heat map using QGIS (Day 7-8 )**

* Visualized CO , CH4 and NO2 Using heat map in QGIS platform
* Find out those areas where air quantity index of these gasses is high
* The insights support environmental policies and waste management

2. Project Execution

2.1. Data Acquisition

The data for this project is sourced from Google Earth Engine for satellite imagery and environmental indices, along with atmospheric monitoring systems for methane (CH4) and nitrogen dioxides (NO2) concentration datasets. Geospatial and temporal data, including latitude and longitude, are integrated to align gas measurements with waste-burning locations. These datasets are then preprocessed and merged to create a unified dataset for visualization and analysis in QGIS.

2.2. Workflow

The workflow of this project begins with acquiring geospatial data and gas concentration datasets (CH4 , SO2and NO2) from sources like Google Earth Engine and atmospheric monitoring systems. The data is then preprocessed by extracting relevant location and temporal attributes, followed by filtering for waste-burning hotspots in Pakistan. These datasets are merged to create a unified dataset, which is visualized using heat maps in QGIS to identify high-smog areas. Finally, the insights are used to propose targeted interventions for improving air quality and public health.

2.3. System Design

The system for this project integrates satellite imagery from Google Earth Engine to identify waste-burning hotspots, while atmospheric gas concentration data (CH4 , NO2 ,CO and SO2) is collected from monitoring systems. This data is processed, aligned by geographic coordinates and time, and visualized using QGIS to generate heat maps of gas concentrations. The system enables the identification of high-risk areas with elevated smog levels, supporting targeted mitigation strategies for environmental management.

3. Results

3.1. Data Preprocessing

Data preprocessing for this project involves extracting latitude and longitude from the geo-referenced fields of the CH4, NO2 and SO2 datasets, followed by filtering the data to focus on regions near Lahore. The datasets are cleaned to ensure consistency in geographic and temporal attributes, and gas concentration values are aligned with corresponding locations. Finally, the processed data is merged into a unified dataset for effective analysis and visualization in QGIS.

3.2. Gas Concentration Visualization

Heat maps were generated using QGIS to visualize the concentration of CH4 and NOx gases in areas with waste-burning activities. These visualizations highlighted high-pollution zones, with color gradients representing low to high concentrations. The maps provided clear insights into regions with severe smog, allowing for spatial analysis of pollution patterns.

4. Projected Impact

4.1. Accomplishments and Benefits

This project successfully identifies and visualizes waste-burning hotspots and their impact on air quality by integrating satellite-based gas concentration data (CH4 and SO2) with geospatial analysis in QGIS. It provides actionable insights into high-smog areas, supporting targeted interventions like improved waste management and environmental policies. The benefits include enhanced decision-making for pollution control, better public health protection, and a data-driven approach to managing environmental challenges in Pakistan.

4.2. Future Improvements

Future improvements to this project could include integrating real-time sensor data for more accurate, localized gas concentration measurements, expanding the spatial coverage to include more regions across Pakistan, and incorporating meteorological factors such as wind patterns to refine smog prediction models. Additionally, machine learning algorithms could be applied to predict future pollution hotspots based on historical trends, allowing for proactive environmental management.

5. Team Member Review and Comment

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| <ATTACH A TEAM PICTURE HERE> |

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| NAME | REVIEW and COMMENT |
| Ghayur Abbas | This project effectively combines geospatial analysis and gas concentration data to address critical air pollution issues in Pakistan |
| M Shoaib | The integration of QGIS and Google Earth Engine offers a powerful visualization approach, but adding real-time data could enhance its accuracy. |
| M Hussnain | The heatmap visualizations provide clear insights into pollution hotspots, making it a valuable tool for targeted environmental interventions |
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6. Instructor Review and Comment

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| CATEGORY | SCORE | REVIEW and COMMENT |
| IDEA | \_\_/10 |  |
| APPLICATION | \_\_/30 |  |
| RESULT | \_\_/30 |  |
| PROJECT MANAGEMENT | \_\_/10 |  |
| PRESENTATION & REPORT | \_\_/20 |  |
| TOTAL | \_\_/100 |  |