CS-FLARE: Citizen Science Fire Likelihood and Risk Evaluation

Leena Dudi, Sanaa Mulay, Anjali Singh, Amogh Thodati, Ashvin Tiwari, Vincent Villarreal, Zane Zacharia, Arnold Zhang, Charlotte Zhou, James Ervin, Nikita Agrawal

Partner

Abstract

Wildfires pose an increasingly significant threat to natural ecosystems, private property, and public health. However, precautionary methods can be taken to greatly reduce the possibility of a large-scale wildfire. Our research aims to inform citizens of wildfire risk factors by developing a mobile application, C.S.-F.L.A.R.E (Citizen Science: Fire Likelihood and Risk Evaluation), that analyzes wildfire risk on a local community level based on a culmination of factors that compose a typical wildfire. C.S.-F.L.A.R.E. utilizes YOLOv8, a state-of-the-art image segmentation model to identify the presence of flammable materials in the four cardinal directions at each Area of Interest (AOI) in the GLOBE Observer database. We use Google Teachable Machine to train a machine learning model to classify the downward photo at each AOI by ground moisture. We implement a U-Net model trained with temperature, precipitation, elevation, and slope datasets (factors determined to be significant in wildfire development) from Earth Map to provide users with accurate predictions that are validated by existing wildfire risk assessment datasets. Utilizing our identified fire risk factors and satellite datasets, we have created an algorithm that provides citizens with a quantified wildfire risk rating, while offering comprehensive insights of surrounding risks that can help prevent future wildfires. C.S.-F.L.A.R.E.'s user-friendly application interface, created on Flutter, presents these insights by proposing potential actions to minimize wildfire risk in the pictured area. We look to integrate this app into local fire departments and environmental agencies so that citizens have a trusted resource to better understand the risk and impact of fire near them.

Introduction

- Wildfires have become more prevalent in the United States in the past few years.
- 2,693,910 acres of land were burned in the US in 2023.
- 2022 federal data showed that over 85% of annual wildfires are caused by humans through unattended campfires, burning debris, discarded cigarettes, etc.
- In 2021, wildfires worldwide released over 1.8 million tons of CO_2 into the atmosphere.
- Citizen science allows the general public to participate in scientific research and take initiative.

Research Questions

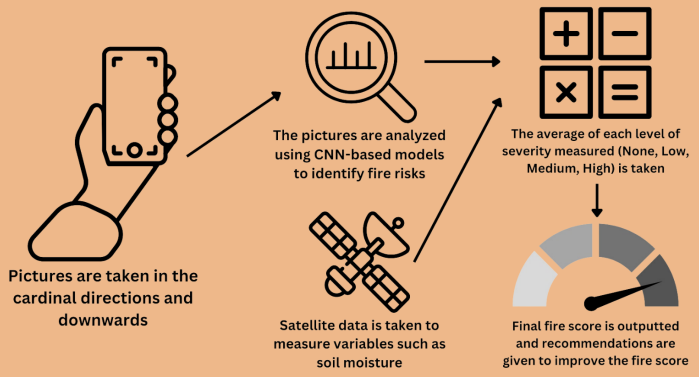
Will the CS-FLARE application be able to accurately predict wildfire risk in a given location based on satellite data?

This question focuses on the application's ability to analyze existing satellite data from Earth Map for specific user locations.

How well does the CS-FLARE application identify hazardous material in citizen science photography?

This question focuses on the application's ability to analyze components of new images that are qualified as dangerous.

Methodology



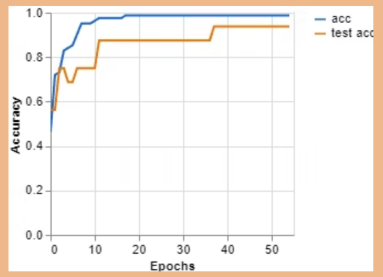
Datasets:

- Cardinal direction images from the GLOBE Observer Land Cover Dataset are hand-labeled with polygon semantic segmentation in four categories: tree, brush, leaf litter, and grass. Rotation, exposure, and noise are applied to augment the dataset's robustness to different environments.
- Downward images from Globe Observer with MUC codes within the M40s are hand-labeled as healthy grass, slightly dry grass, and very dry grass. Dataset was cleaned so that images were strictly grass to enhance quality of model.
- Temperature, precipitation, elevation, and slope datasets extracted from EarthMap

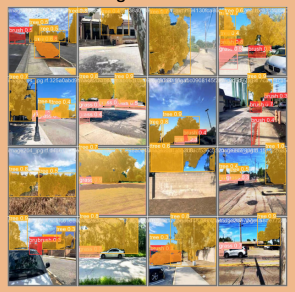
Image segmentation: Images from the dataset are split into training, validation, and testing sets and used to fine-tune the YOLOv8 image segmentation model on the custom dataset.
Grass moisture assessment: Images from dataset were split into training and testing sets to train a model in Google Teachable Machine at 55 epochs, 16 batch size, and 0.001 learning rate.
Climate risk assessment algorithm: Datasets are used to train U-Net model and validated by existing dataset of wildfire risk assessment.

Results

Grass Classification Model Metrics



Fire Risk Segmentation Model



App interface will continue to be refined using Figma

Conclusion

CS-Flare is able to:

- Accurately recognize significant fire risks surrounding the user's location.
- Generate a fire risk rating determined by satellite data regarding the user's area of interest.
- Use machine learning models trained by Globe Observer data to detect wildfire risk factors (grass, trees, brush, leaf litter) and downward vegetation dryness present in a user's location.
- Provide users with relevant information about how they could reduce the fire risk around them.

CS-Flare is an app that will continue to be honed as we look to include more environmental factors that contribute to wildfire risks allowing users to better recognize how to mitigate fire risk near them.

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