**Nasa Space APPS Challenge
Morón**

# "Wildfire Busters"
## A fire tracking tool

Team: **UM Challengers 2020 (Interdisciplinary group of University of Morón)**

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**Project Title:**

WILDFIRE BUSTERS: A fire tracking tool for global wildfire control and mitigation

**Summary:**

Wildfires cause negative effects around the world. Therefore, we consider that victims and decision makers need to have real-time information of wildfires evolution and their probable impact. In this sense, our main objective is to create an application that offer information to users about the minimum distance to hotspots and its properties (location, detection time, fire energy power, reliability, fire event condition) and information about fuel, landscape characteristics, wildfires history behavior, weather conditions and potential impacts. In turn, users could enrich the application with their knowledge of area. The application can be a great help, for the development of fire mitigation strategy as well as in the implementation of policies before, during and after the environmental disaster.

**Describe how your project addresses this challenge:**

A fire is a violent oxidation process that begins with the presence of a fuel, the oxidizer (oxygen) and the heat or activation energy. When this process is not controlled and affects undesirable things, it becomes a fire. Currently, a large part of terrestrial ecosystems is affected by fires, altering their structure, composition or functioning (Di Bella et al. 2006, Fischer et al. 2010, Di Bella et al. 2011, Albanesi et al. 2014). These events cause, for example, reduction and

damage of vegetation cover, deaths of people or animals (Moeltner et al. 2013, Jhariya et al. 2014), even changes in the water cycle, nutrients or energy balance (González-Pérez et al. 2004). That alterations involve catastrophic consequences at ecosystem level (Komareck 1964, Crutzen and Andrade 1990, Mueller-Dombois and Goldamer 1990, González-Alonso et al. 1996, 1997 and 1998, Houghton et al. 1999, Jenkins et al. 2001 and 2003, Nabuurs et al. 2007, Chen et al. 2011, McDaniel 2008, Fagan and DeFries 2009, Pausas and Keely 2014, Sommers et al. 2014, Huang et al. 2015).

Despite the previously impacts, the negative effects of fires were largely ignored in history. In fact, fires were generally considered natural events, so large areas were wildly affected by fires every year during decades. With the growing eagerness to protect and conserve natural resources and ecosystems services, the need to study wildfires has grown over the past years. In consequence, scientist community began to analyze fires and their relation with environmental factors along history. In fact, South America was identified as a region of concern due to human trigger factors outweigh climatic drivers for wildfire occurrence. In this sense, the probability to predict fire occurrence decreases due to the increase in anthropic factors and their randomness. Humans burns by multiple reasons. For example, a large part of the fires in livestock production systems is associated with the need to reduce dry plant biomass and promote the regrowth of vegetation for feed livestock. Likewise, man burns for coverage reduction in order to change land cover choosing agriculture. In addition, man-made fires due to accidental causes should be considered. Therefore, in order to detect and predict the anthropic trigger factor it is very difficult, so in this project it is proposed to analyze the fires danger once started.

Currently, satellite information offers an unparalleled opportunity to study fire events along large surfaces with great objectivity and high temporal frequency (Di Bella et al. 2006, Fischer et al. 2012, 2015). There is a lot of information allowing the analysis of active hotspots throughout the world hourly (Giglio et al. 2003, Justice et al. 2002), as well as having meteorological information, fuel coverage, among others. Clustering such information together to make it user-friendly is essential to provide the important data for decision-making.

In this sense, the main objective of this group is to create an application "Wildfire Busters: A fire tracking tool" that offers information to users about the minimum distance to hotspots and their properties (location, detection time, fire energy power, reliability, fire event condition) and information about fuel, landscape characteristics, wildfires history behavior, weather conditions and potential impacts. All variables are grouped in classes that provide a global danger score.

In turn, Wildfire Busters application offer the opportunity for users to upload information about local conditions like weather, available fuel or nearest fire tails. This information can be seen by other users but not altering the original score calculated by our team. This kind of feedback could enrich the application by adding in situ data, not available actually.

## Describe how you developed your project

Fires are very frequent extreme events that cause negative effects in a large part of the ecosystems (Chuvieco 2000). Around the world last week more than 126 thousand hotspots (FIRMS NASA) were detected by only MODIS sensor, equivalent to a potential area of 126,000 km$^2$. In addition, in Argentina more than 10 provinces area affected by fire events nowadays.

Therefore, we consider that victims and decision makers need to have real-time information of wildfires evolution and their probable impact. In order to board this, our main objective was to create an application "Wildfire Buster" for mobile devices that offers users the ability to identify active fire hotspots, providing information about the surrounding areas and the danger of fire reaching them. For this, we considered several features: meteorology (wind speed and direction), quantity and state of the fuel (integral of the vegetation indices during the previous growing season and its level of fall before the fire), physical aspects of the landscape such as topography (slope and orientation) and the presence of physical barriers (routes, firebreaks, water courses, etc.), and the fire history as behavior and frequency of fires and their impacts. In addition, we also considerer information about protected areas. From this

data the application provides a fire event score with 5 classes from least harmful to very harmful.

The application "Wildfire Buster" also offers to users the option to change the weight of some of variables in a module visible by other people but not changing our original score. The goal is that module fed by in situ user's knowledge.

The next figure schematizes the input data for wildfire score of 5 classes provided. Hotspots are an essential data combined by information of weather, fuel, landscape, fire history and temporary fire impact of nearest wildfire calculated from burned area, biomass consumption, smoke emission, and affected resources value. Also, the lower module shows the features that could be modified by users.
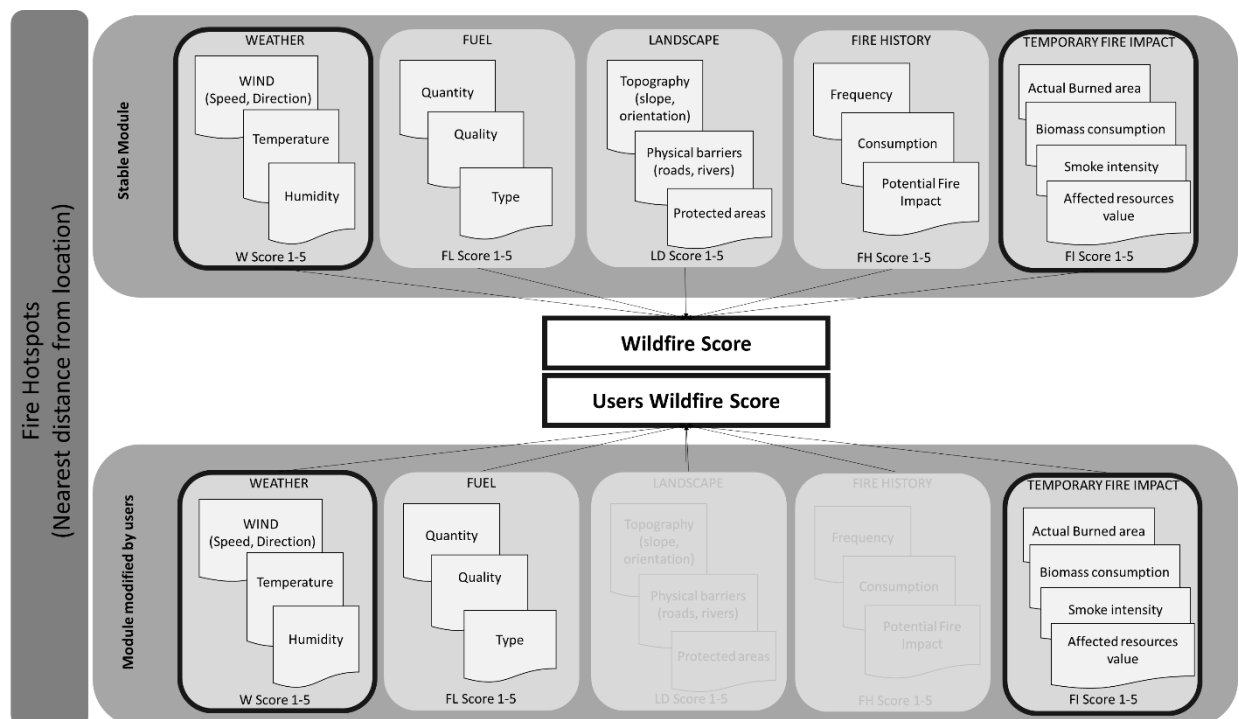


The prototype of WildFire Busters or mockup will be generated using Balsamig Mockups. For the development of the application, the Android Studio Framework will be used, using JAVA language, having a module that contains all the requirements of the application.

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The following images show the screens that illustrate the functioning of the application "WildFire Busters" from the main access page to all utilities that it offers:
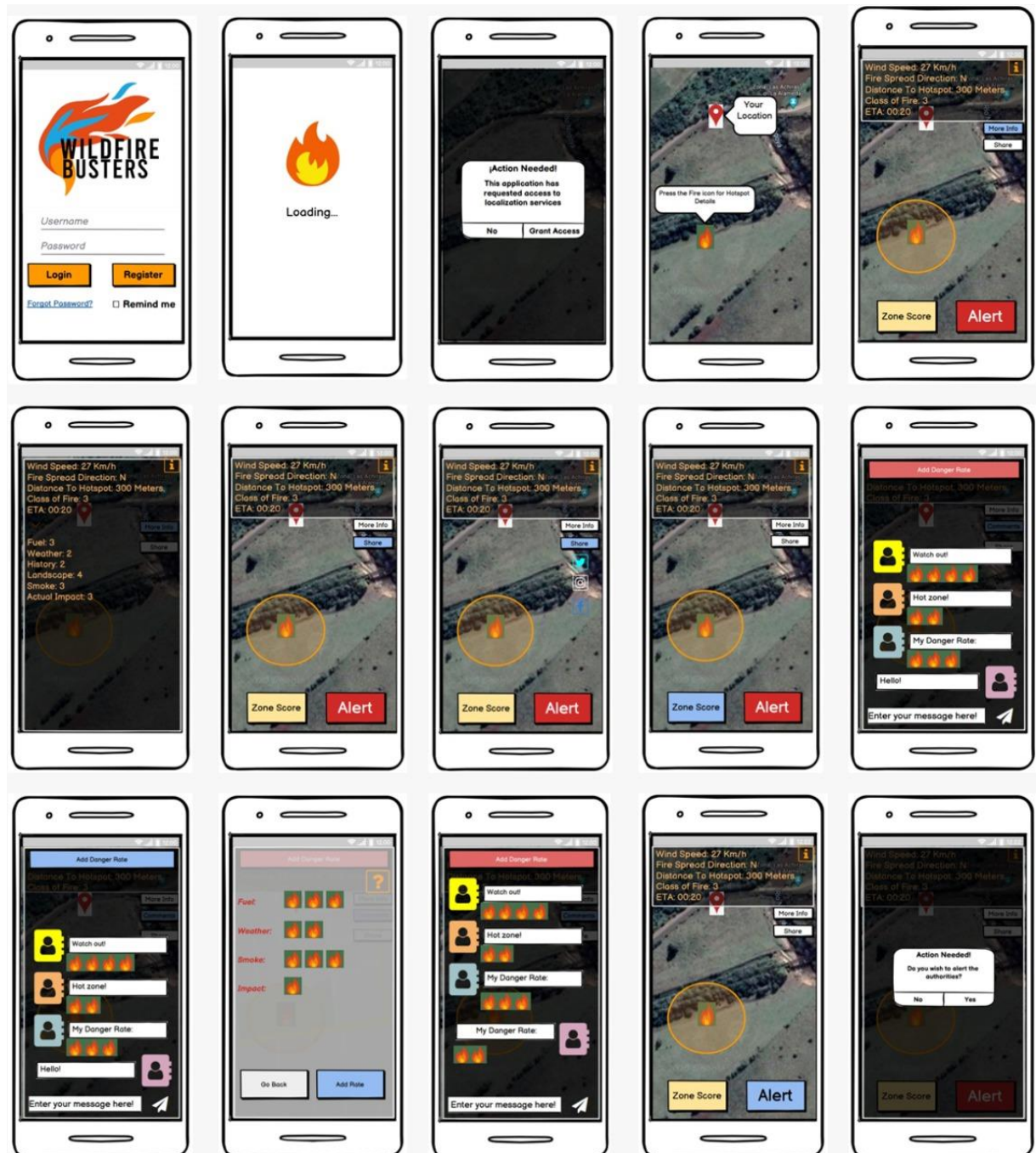


The great variety of satellite resources creates a world full of information that if it not be used, it not be useful for make decisions. Basically, the scientific information will be decoded and provided in a friendlier way for users.

In order to define the people reached by our project, the application "WildFire Busters" will have two different targets with two different communication strategies are proposed. The first target is mainly oriented towards those who are part of the agribusiness, environment and sustainable development and social development team. It is also aimed at government decision-makers (governors, mayors, deputies and senators). Our application can be of great help for the development of the fire mitigation strategy as well as in the creation and implementation of policies, both social and economic, before, during and after the environmental disaster. The second target would be the common citizen. People with a university education level and / or professional training. All people who have a mobile device or smartphone and access to the network. Those who are interested in nature, ecology and sustainable agricultural production. People who are committed to the preservation of the environment and the climate change.

At the communication strategy for our application "Wildfire Busters", it would be necessary to identify which government agencies are dealing with the fire problem in their respective countries. The next step is to contact this government decision-makers, starting with the secretaries of the environment and sustainable development, social development, firemen.

As part of the communication strategy, we will highlight the concept of fire detection, control and mitigation measures, giving life to our slogan "*A fire tracking tool*". The massive campaign will be guide to social networks, radio and television. The different parts of communication will seek to generate an impact by emphasizing the results of this type of catastrophe in the world, their victims, the impact in the ecosystem, the amount of losses in infrastructure, production facilities, crops, livestock and grasslands. It will encourage the download of the application as the main ally for the prevention, control and mitigation of this type of events.

We develop the name and the slogan. We also create and design isologotype.

"WILDFIRE BUSTERS": A fire tracking tool

## How did you use space agency data in your project?

The application used inputs data providing by Space Agencies around the world and free and open data available in order to address features influencing fire propagation and impact. The following table shows the data and the sources of information consulted to address the issues:

| Data | | Satellite | Sensor | Spatial resolution | Temporal resolution | Source |
|---|---|---|---|---|---|---|
| **Weather condition** | **Wind** | Goddard Earth Observing System Model, Version 5 (GEOS-5). MERRA Proyect. | - | 0,5 x 0,625° | Hourly | https://giovanni.gsfc.nasa.gov/giovanni/#service=TmAvMp&starttime=&endtime=&variableFacets=dataFieldMeasurement%3AWind%20Velocity%3B |
| | **Temperature** | GCOM-W | AMSR | 11 km | Daily | https://www.eorc.jaxa.jp/AMSR/viewer/index.html |
| | **Humidity** | | | | | |
| **Fuel conditions** | **Spectral index** | Sentinel 2 | Landsat and SWIR | 5 km | Daily | NDVI: https://www.eorc.jaxa.jp/JASMES/SGLI_STD/<br><br>SWIR 2: https://apps.sentinel-hub.com/sentinel-playground/?source=S2&lat=40.46296978223787&lng=-3.8068771082907915&zoom=11&preset=93-SWIR-2-11-12&layers=B01,B02,B03&maxcc=22&gain=1.0&gamma=1.0&time=2020-03-01%7C2020-09-30&atmFilter=&showDates=false |
| **Landscape conditions** | **Topography** | Sentinel 2 | Landsat | 250 m | Monthly | https://earthexplorer.usgs.gov/ |
| | **Physical barriers** | VIIRS | - | 375 m | Daily | https://firms2.modaps.eosdis.nasa.gov/map/#d:2020-10-02..2020-10-03;l:countries;@-47.4,-31.0,6z |
| | **Protected areas** | VIIRS and Terra/Aqua | MODIS | 375 m | Daily | https://firms2.modaps.eosdis.nasa.gov/map/#d:2020-10-02..2020-10-03;l:protected_areas,viirs_crtc;@-42.9,-27.6,4z |
| **History** | **Fire emissions** | Terra and Aqua | MODIS | 500 m | 2003-2016 (annually) | https://www.globalfiredata.org/fireatlas.html |
| | **Burnt areas** | PROBA-V | PROBA-V | 300 m | Every 3 days | https://land.copernicus.vgt.vito.be/PDF/portal/Application.html#Browse;Root=513584;Collection=1000059;DoSearch=true;Time=NORMAL,NORMAL,1,DECEMBER,2017,31,OCTOBER,2020;isReserved=false |

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Satellite data sources:

Weather conditions:

Wind:

- Satellite: Goddard Earth Observing System Model, Version 5 (GEOS-5). MERRA Proyect.
- Spatial resolution: 0, 5 x 0,625°.
- Temporal resolution: Hourly.
- Source: GIOVANNI.

https://giovanni.gsfc.nasa.gov/giovanni/#service=TmAvMp&starttime=&endtime=&variableFacets=dataFieldMeasurement%3AWind%20Velocity%3B

Temperature:

- Satellite: GCOM-W.
- Sensor: AMSR.
- Spatial resolution: 11 km.
- Temporal resolution: Daily.
- Source: AMSR (Earth Environment Viewer).

https://www.eorc.jaxa.jp/AMSR/viewer/index.html

Humidity:

- Satellite: GCOM-W.
- Sensor: AMSR.
- Spatial resolution: 11 km.
- Temporal resolution: Daily.
- Source: AMSR (Earth Environment Viewer).

https://www.eorc.jaxa.jp/AMSR/viewer/index.html

Fuel conditions:

- Satellite: Sentinel 2.
- Sensor: Landsat and SWIR.
- Spatial resolution: 5km.
- Temporal resolution: daily.
- Source:

NDVI: https://www.eorc.jaxa.jp/JASMES/SGLI_STD/

SWIR 2: https://apps.sentinel-hub.com/sentinel-playground/?source=S2&lat=40.46296978223787&lng=-3.8068771082907915&zoom=11&preset=93-SWIR-2-11-12&layers=B01,B02,B03&maxcc=22&gain=1.0&gamma=1.0&time=2020-03-01%7C2020-09-30&atmFilter=&showDates=false

Landscape conditions:

Topography:
- Satellite: Sentinel 2.
- Sensor: Landsat.
- Spatial resolution: 250 m.
- Temporal resolution: Monthly.
- Source: https://earthexplorer.usgs.gov/

Physical barriers:
- Satellite: VIIRS.
- Spatial resolution: 375 m.
- Temporal resolution: Daily.
- Source: https://firms2.modaps.eosdis.nasa.gov/map/#d:2020-10-02..2020-10-03;l:countries;@-47.4,-31.0,6z

Protected areas:
- Satellite: VIIRS and Terra/Aqua.
- Espatial resolution: 375 m.
- Temporal resolution: Daily.
- Source: https://firms2.modaps.eosdis.nasa.gov/map/#d:2020-10-02..2020-10-03;l:protected_areas,viirs_crtc;@-42.9,-27.6,4z

Fire history

Fire emissions:

- Satellite: Terra and Aqua.
- Sensor: MODIS.
- Espatial resolution: 500 m.
- Temporal resolution: 2003-2016 (annually).
- Source: Global Fire Emissions Database.

https://www.globalfiredata.org/fireatlas.html

Burnt areas:
- Minisatellite: PROBA- V.
- Sensor: PROBA-V.
- Spatial resolution: 300 m.
- Temporal resolution: Every 3 days.
- Source: Copernicus Global Land Services Burnt Areas Map.

https://land.copernicus.vgt.vito.be/PDF/portal/Application.html#Browse;Root=513584