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A Machine learning algorithm approach to map the wildfire probability based on static parameters

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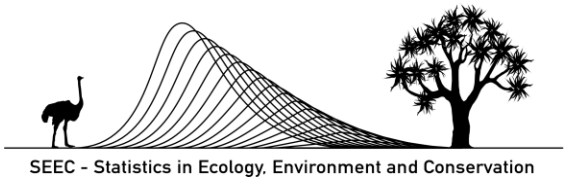

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Introduction

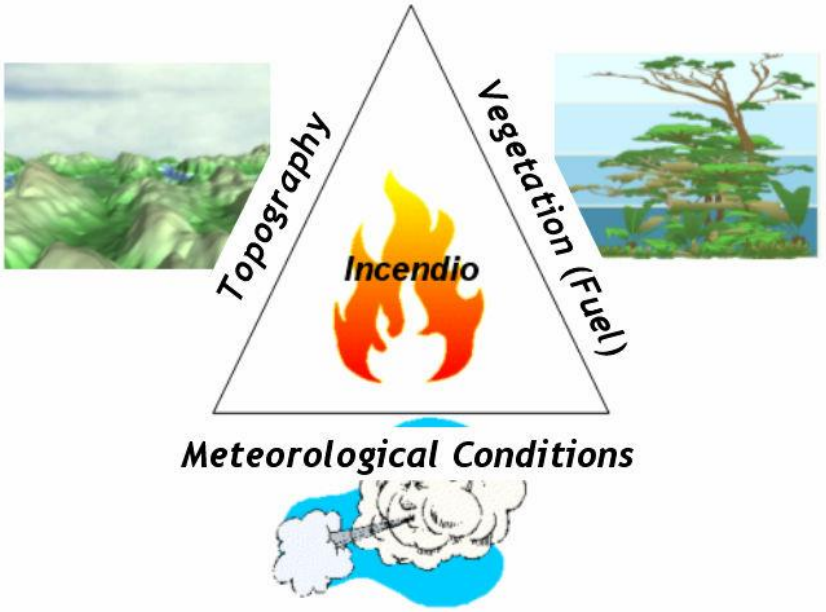
- Wildfires, either natural or man-made occur throughout the world causing adverse ecological, economic and social impacts (Pyne et al., 1996; Cochrane, 2003).

- The term "**fire danger**" describes the probability that a fire can occur due to natural causes and anthropogenic activities as well as spreading factors (Bachmann & Allgower, 2001; Hardy, 2005).

- The prediction of wildfire danger is essential for fire management activities.

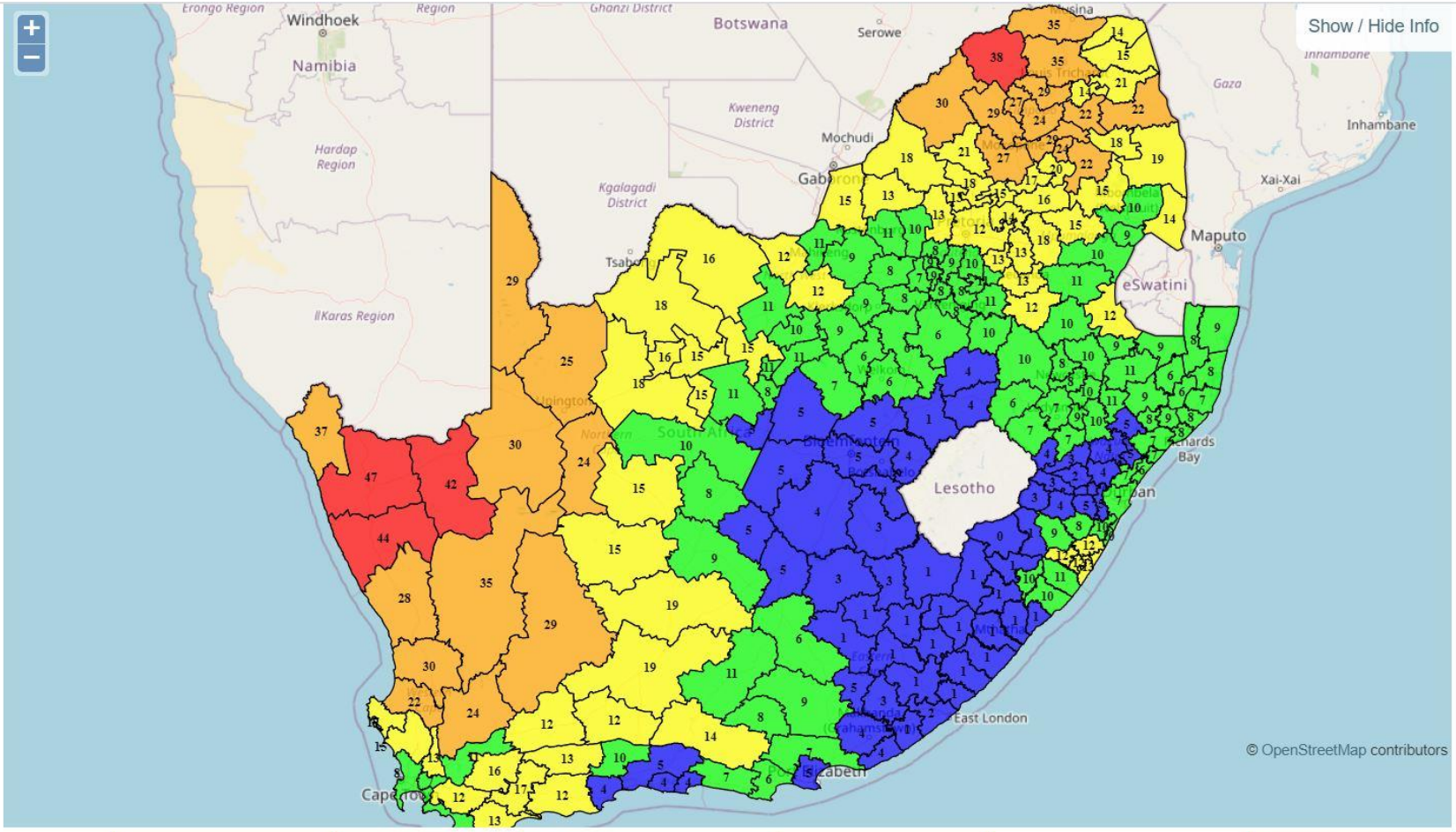
Fire alerts-Fire Danger Rating System

- NASA FIRMS disseminating Near real time fire alerts using TERRA and AQUA satellite datasets (1 km) and SNPP-VIIRS sensor (375 m)
- Limitations of fire alerts
- A **Fire Danger Rating System** is a Decision Support System.
- A **Fire Danger Rating system** is an integration of dynamic and static fire danger rating indices.



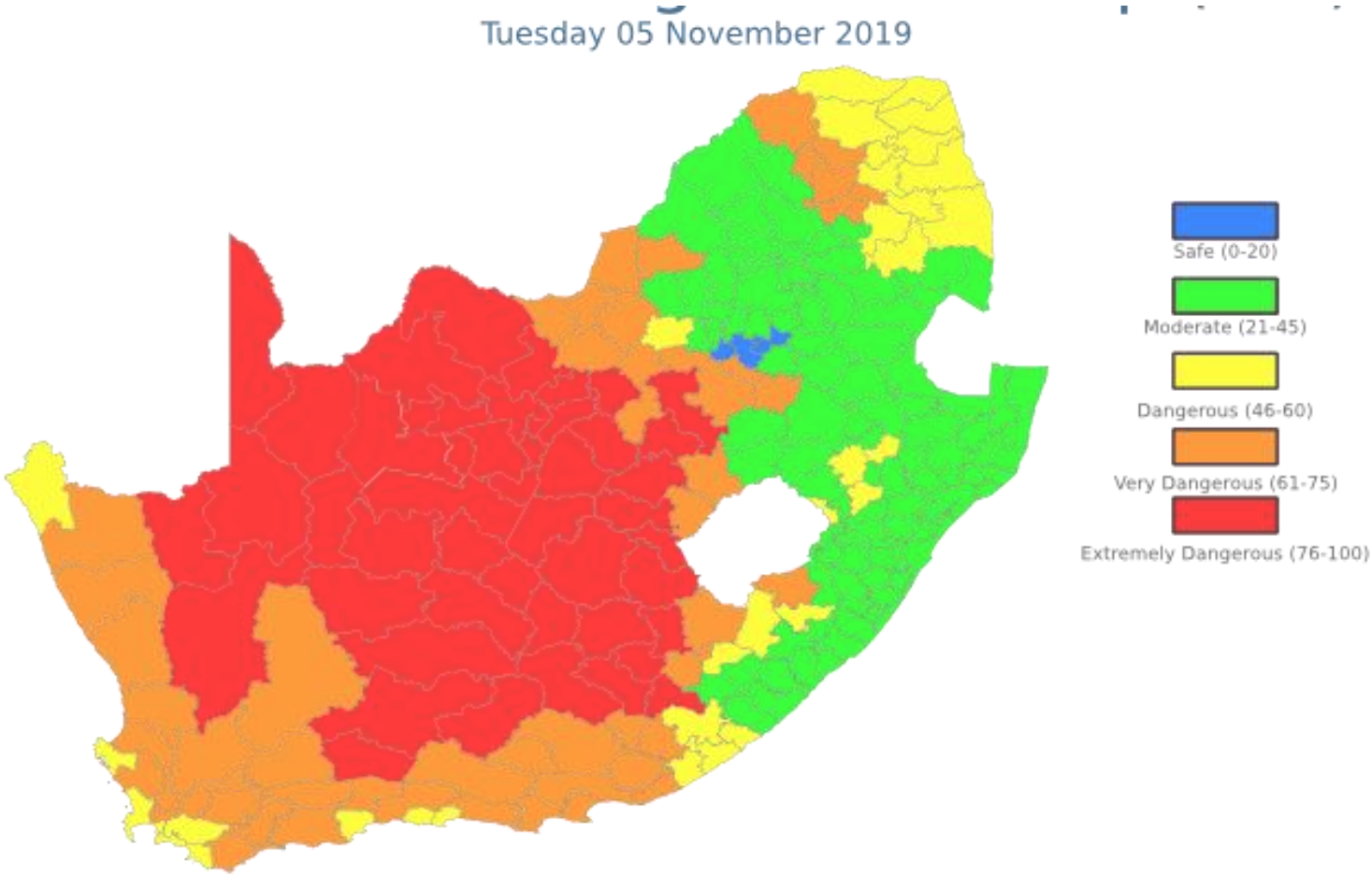
The Fire environment triangle
(Countryman, 1972)

South Africa Fire Danger Model



Source: https://fdi.afis.co.za/South_Africa_Fire_Danger.html

Lowveld Fire Danger Index



Source: http://www.weathersa.co.za/home/fireindex

Need for a integrated Fire Danger Index

- Automatic weather stations data and fire danger maps are generated by using the interpolation techniques.
- Spatial resolution of these models are lower (110*110 Sq.km)
- These models doesn’t include the fuel and topographic parameters while generating the fire danger maps.
- Therefore, there is a need of integrated fire danger index consists of both static and dynamic parameters.

Objective

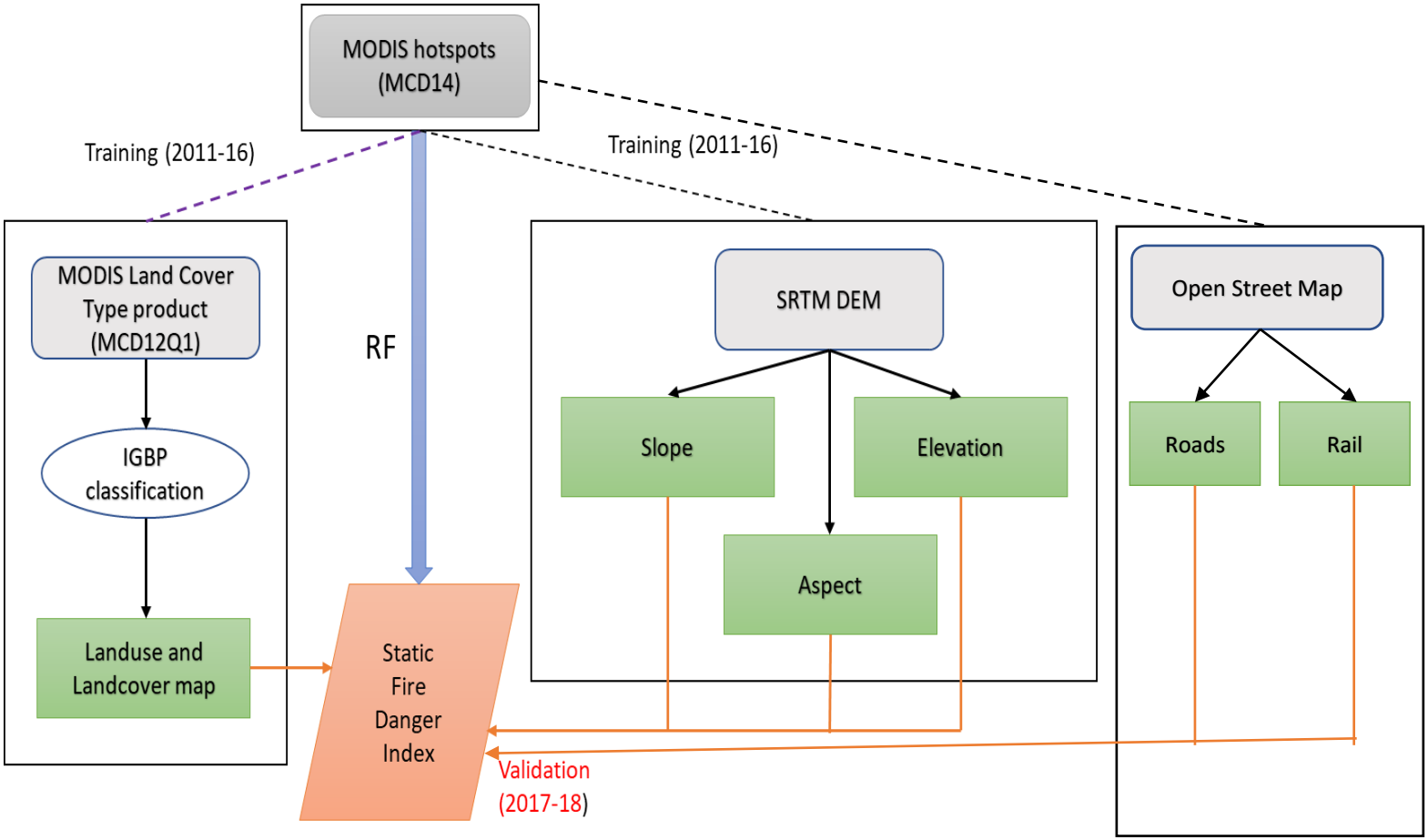
- To develop a Static fire danger index using machine algorithm approach

Datasets

Name of Datasets	Product ID	Spatial Resolution	Temporal Resolution
Landcover type	MCD12Q1	500 m	Yearly
Digital Elevation Model	SRTM GDEM	90 m	-
Fire and Thermal Anomalies	MCD14	1 km	Daily

- Road and Rail network

Static Fire Danger Index (SFDI)

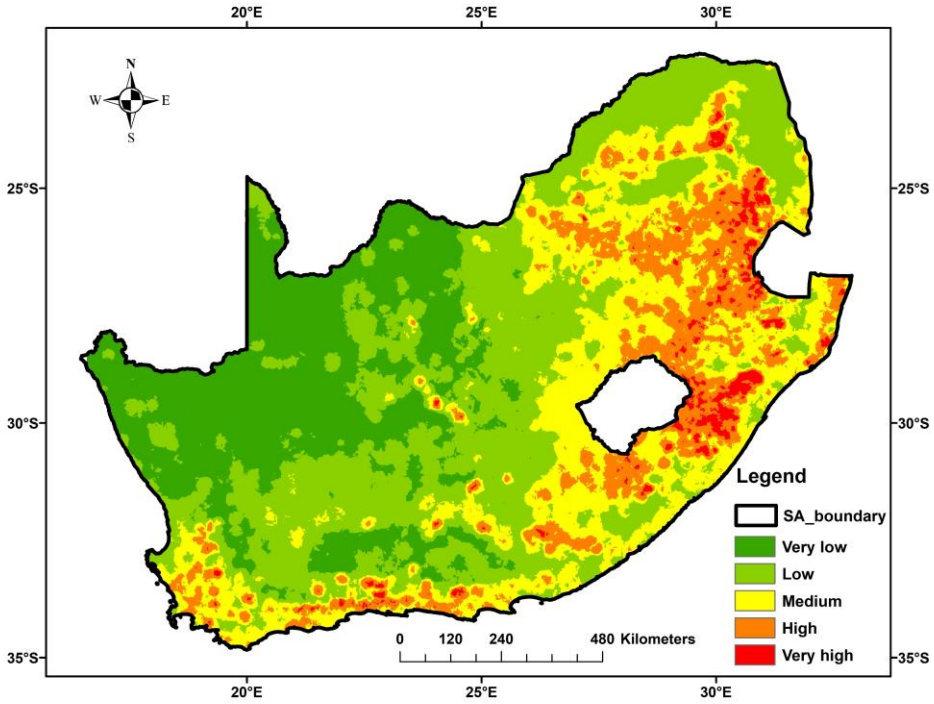


Random Forest algorithm

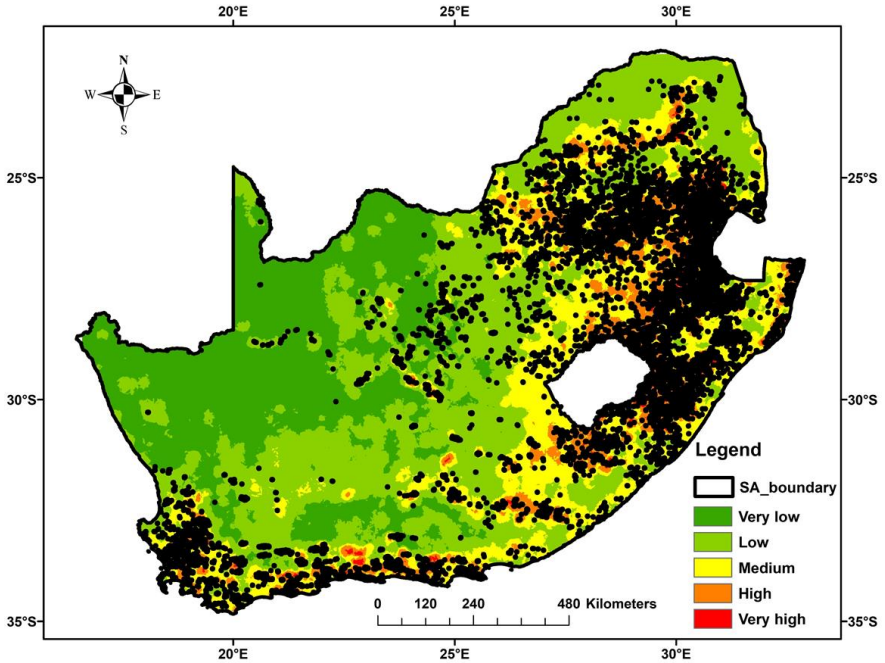
- Random forest is a machine learning algorithm, which can automatically select important variables and flexibly evaluate the complex interaction between variables.

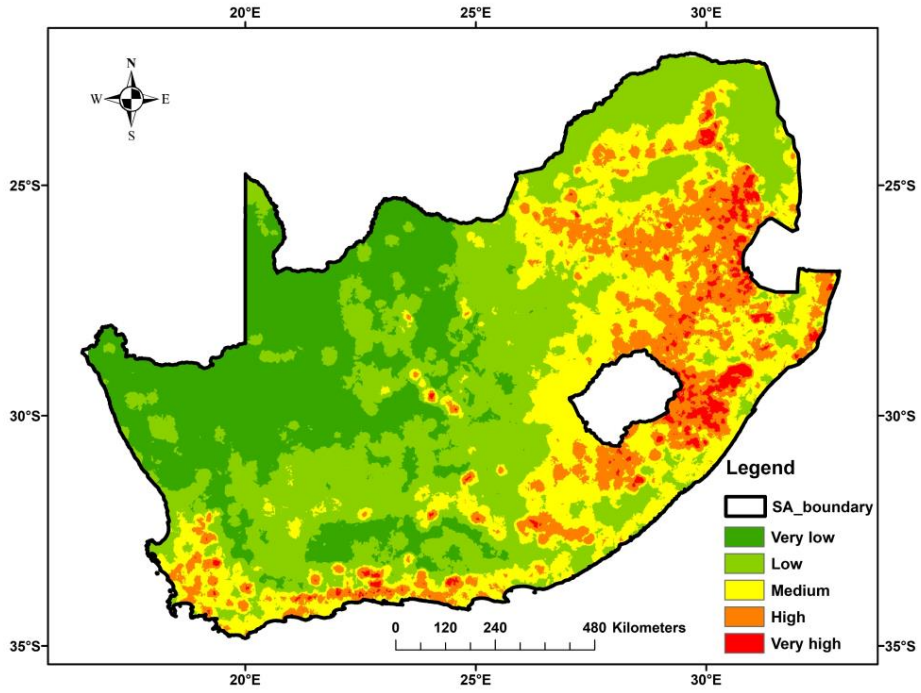
- RF algorithm run with the datasets of 2011- 16 fire presence points and randomly generated fire absence points.

- Fire occurrence probability maps were generated using the Kriging interpolation method. Five fire danger classes based on the RF probability (Chang et al., 2013; Guo et al., 2016).
    - Very low (<=0.1);
    - Low (0.1-0.3);
    - Medium (0.3-0.5);
    - High (0.5-0.7);
    - Very high (>=0.7)

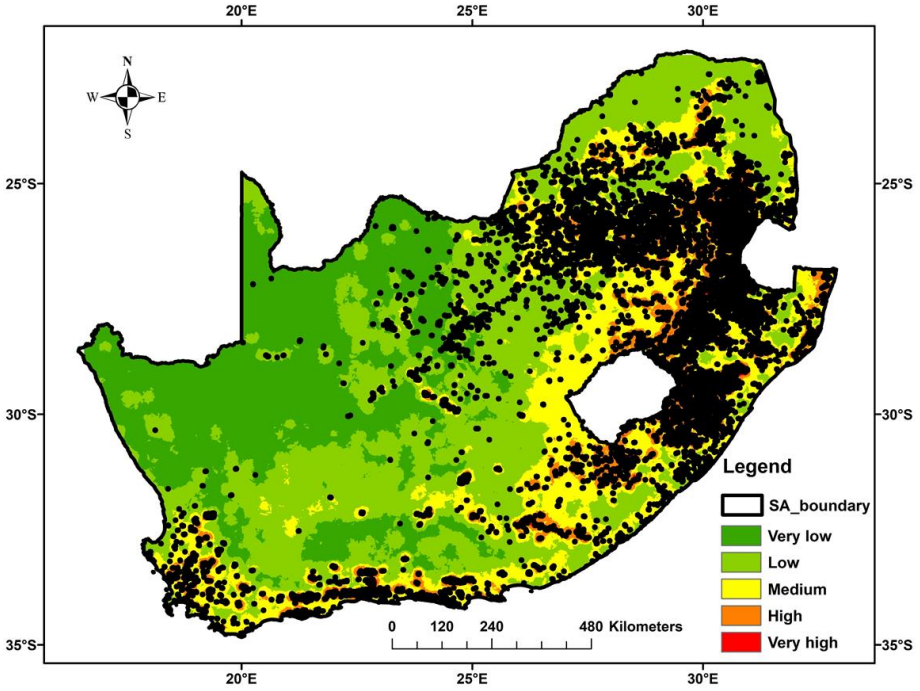


Prediction map 2018





Prediction map 2019



Accuracy - SFDI

- In most studies, accuracy is estimated based on the number of fire incidents falling in different fire danger classes (Alexander et al., 2008; Sitanggang et al., 2013; Saeedeh Eskandari and Emilio Chuvieco, 2015; Akhtar and Hussain 2016; Mitri et al., 2017; Venkat et al., 2017).

- In this study, fires fell in high and very high fire danger classes were considered as a fire is predicted (Babu et al., 20116 a, b; venkat et al., 2017).

$$Accuracy = \frac{Total\ number\ of\ fire\ incidences\ in\ High\ and\ very\ high\ danger\ classes}{Total\ number\ of\ fire\ incidents\ in\ all\ classes}$$

Fire danger class	Number of fire points	
	2018	2019
Very low	12	6
Low	37	32
Moderate	208	159
High	1321	1280
Very high	224	152

Accuracy: 85.74 % (2018) & 87.91 % (2019)

Conclusions

- Static fire danger index was developed for South Africa using Random Forest algorithm.
- Accuracy is more than 85% i.e. RF algorithm successfully predicted the fire probability accurately.
- Static Fire Index is useful to understand the spatial pattern of fire occurrence in the study area and used to determine areas of high fire danger due to the fundamental conditions that leads to fire occurrence.

way forward

- ✓ Dynamic fire danger index – Satellite derived datasets.
- ✓ Wildfire Danger Index – Integration of static and dynamic fire danger indices.

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THANK YOU