Investigating wildfire risk for a small island and the potential use of remotely sensed data: A Jamaica case study

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A. Research Motivation and Study objectives

Bushfires result from severe droughts, which have devastating consequences in the Caribbean (Farrell, Trotman, & Cox, 2011). Severity of droughts have increased since the last decades. For example, the 2013-2016 event was a one in one hundred year event for most Caribbean countries (Herrera, & Ault, 2017). There are several limitations in assessing past and future trends in the occurrence of bushfires in Small Developing States (SIDS) and their impact on the economies of these islands.

The objectives of this study are to:

- Create a digitized dataset of reported bushfires in Jamaica
- Determine the applicability of remotely sensed data for investigating bushfires in the absence of a native dataset .

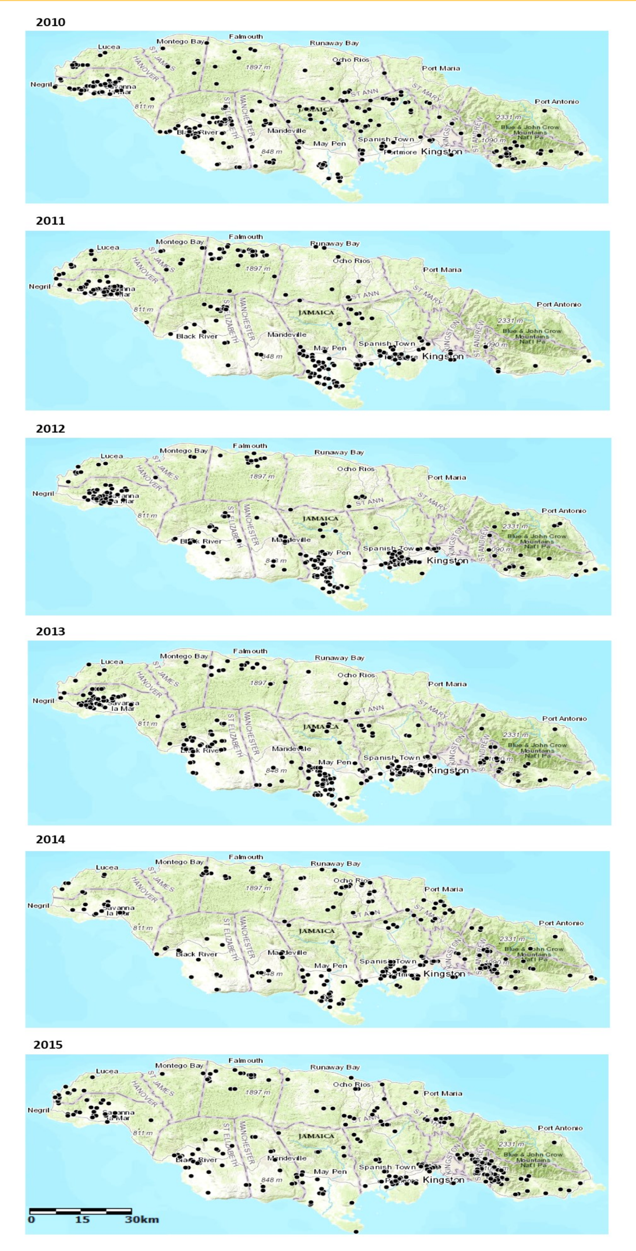


Figure 1: Showing FIRMS MODIS C6 fire activities across Jamaica for 2010 to 2015.

B. Data

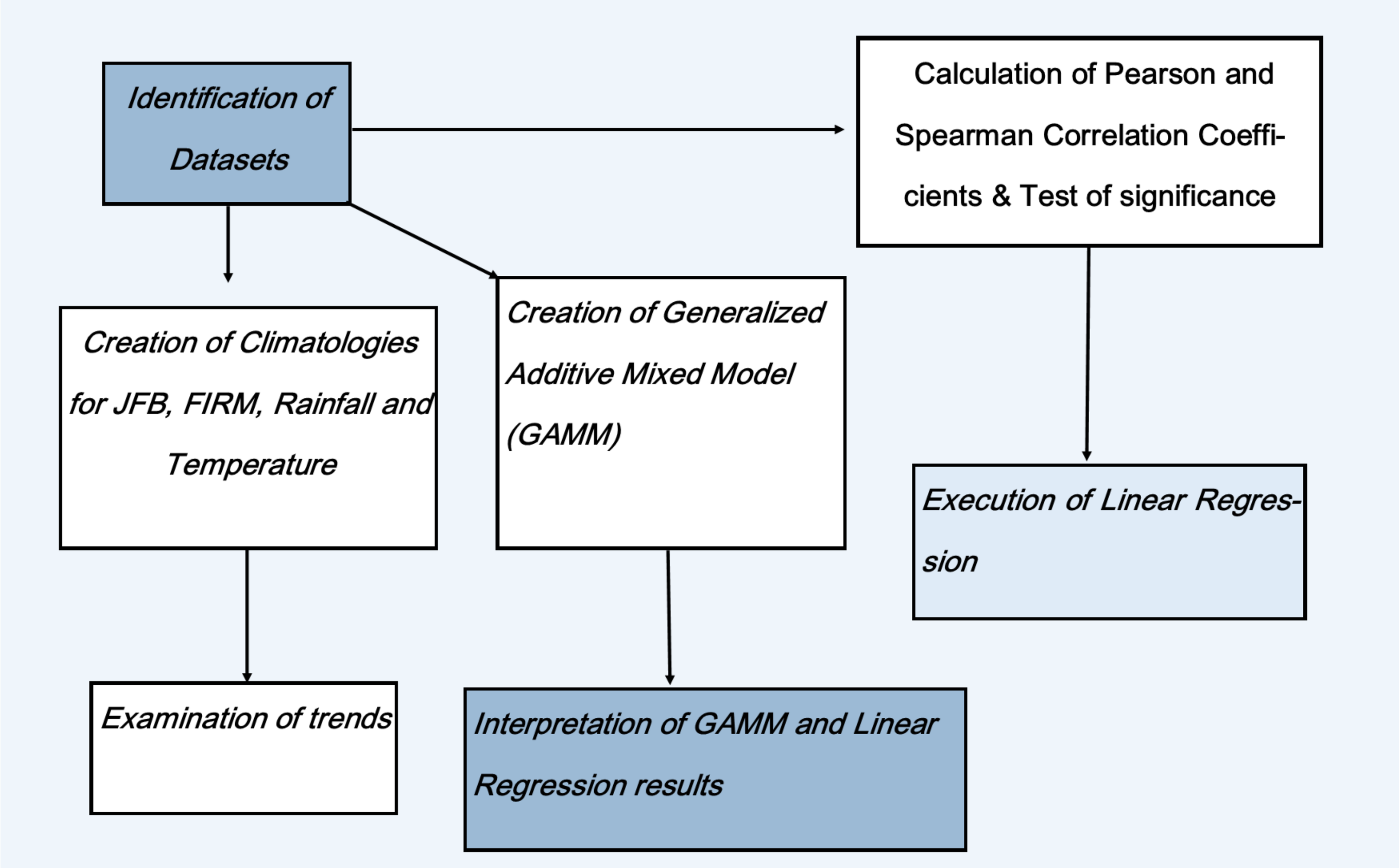
The datasets created and identified to investigate wildfires and the potential for using remotely sensed data in Jamaica for the 2010-2015 period are shown below. The data used does not distinguish between naturally occurring and human caused fires.

- Meteorological Service of Jamaica provided daily rainfall and temperature data for the island.
- Jamaica Fire Brigade (JFB) bush/wild fire data was digitized for the period under investigation .
- LANCE Fire Information for Resource Management System (FIRMS) MODIS C6 version 6.1 was downloaded from the NASA Archives to complement the JFB fire data. This contains Aqua and Terra Spectroradiometer readings with a 1 km resolution (Giglio, Schroeder,& Justice, 2016).

References:

- *Climate Studies Group, Mona (CSGM). (2017). State of the Jamaican Climate 2015: Information for Resilience Building (Full report). Produced for Planning Institute of Jamaica (PIOJ), Kingston Jamaica*
- Farrell, D., Trotman, A., & Cox, C. (2011). *Drought Early Warning and Risk Reduction: A Case Study of The Caribbean Drought of 2009-2010.* United Nation International Strategy for disaster Reduction.
- Giglio, L., Schroeder, W., & Justice, C. (2016). The collection 6 MODIS active fire detection algorithm and fire products. *Remote Sensing of Environment*, 31-41.
- Herrera, D., & Ault, T. (2017). Insights from a New High-Resolution Drought Atlas for the Caribbean. *Journal of Climate*, 7801-7825.

C. Methodology



D. Results

- Climatology of Jamaica 2010-2015 shows a bimodal pattern of rainfall that is typical of Jamaica with its corresponding early year dry season (Climate Studies Group, Mona (CSGM),2017).

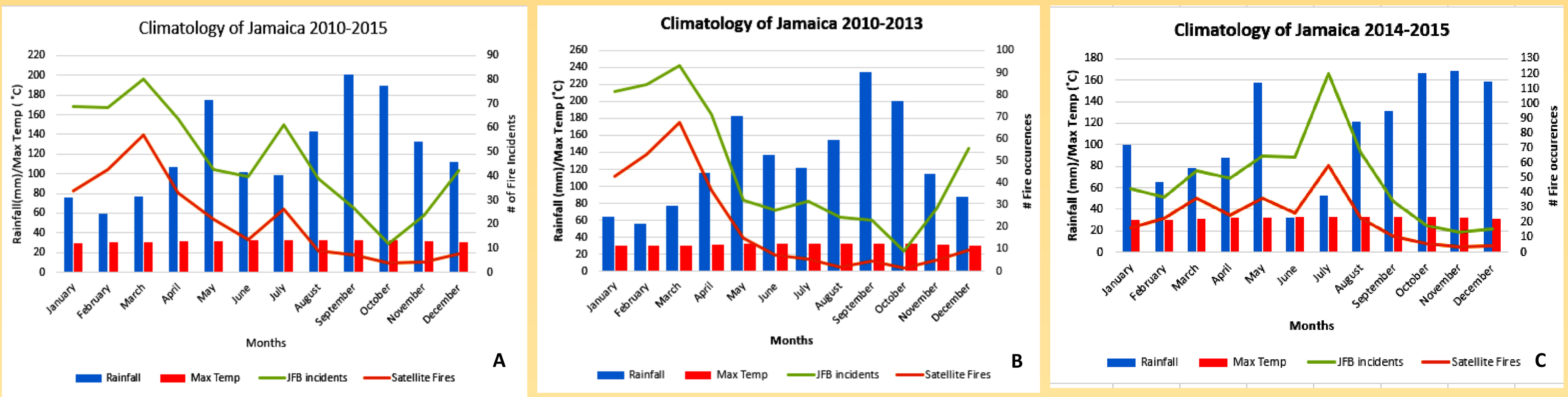


Figure 2: Showing **(A)** climatology of Jamaica for the investigation period of 2010-2015, **(B)** climatology of Jamaica 2010-2013 with peaking between December—March during a La Niña and **(C)** 2014-2015 during an El Niño With peaking between June –August.

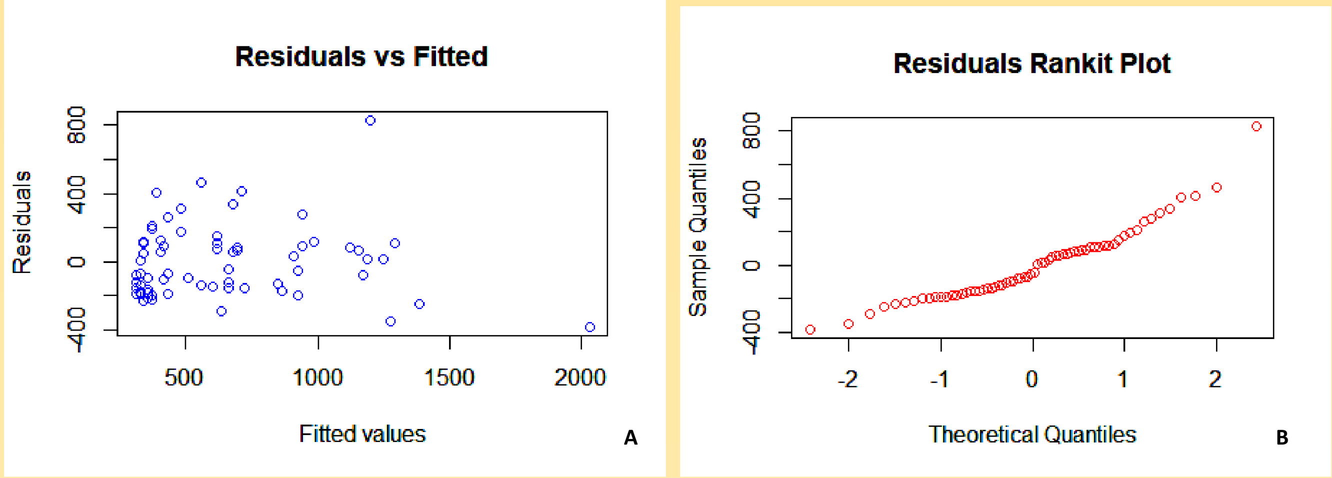


Figure 3: Results from linear regression; 'A ' showing residual vs. fitted -validating homogeneity, 'B' showing q-q plot– validating normalcy of the data set.

Table 1: Results obtained from Linear regression, Generalized additive and generalized additive mixed model (GAM and GAMM) for the use of FIRM satellite data as a predictor for JFB fire occurrence between 2010-2015. Table shows t and f statistics, significance values , adjusted R^2 and the Akaike Information Criteria.

Models	Parameter	Value	standard error	t/f value	P value	Adj. R^2	AIC
Linear Regression	Intercept	294.66	37.53	7.851	5.9E-11	73%	-
	FIRM	15.36	1.16	13.242	<2e-16		
GAM	Intercept	-7.925	2.75	-2.873	0.00552	73%	
	FIRM	0.048	0.0036	13.24	<2e-16		517
GAMM	Intercept	22.93	1.297	17.69	<2e-16	79%	
	s(FIRM)	-12.597	1.2419	48.43	<2e-16		496

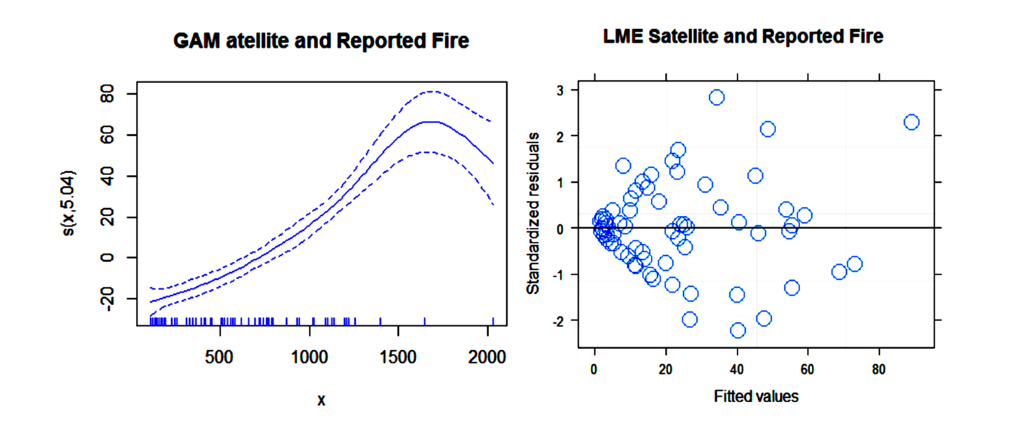


Figure 4: Results obtained from GAMM showing variance of satellite data with JFB dataset

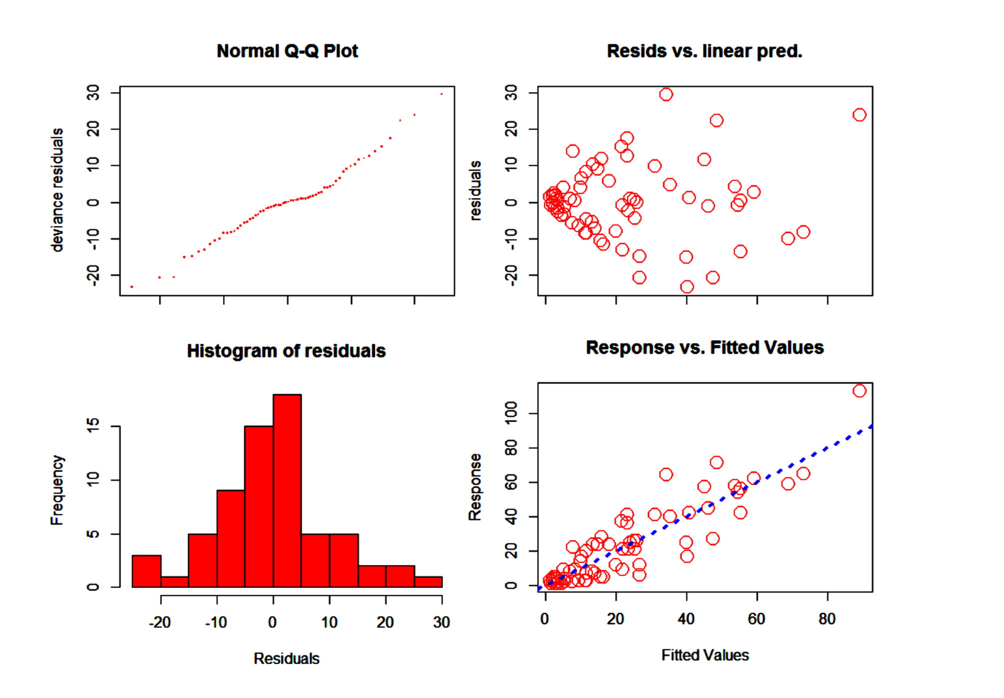


Figure 5: Validation plots for GAMM where q-q plot and histogram shows normalcy and residuals vs fitted shows a majority homogeneity.

E. Conclusion

- JFB and FIRM dataset have a strong positive linear relationship with each other. With the Pearson Correlation which assumes that the variables are linearly related, the satellite data explained 85% of the Jamaica's wildfire annual variation. However using the non-parametric spearman rank correlation the satellite data explained 87% of the annual variation.
- GAMM suggests that the FIRM dataset has the potential to be used as a predictive variable of local fire data. The analysis suggests that 79% of local fire variability can be explained by the FIRM data.
- The risks of bush fires increase greatly with the severity of drought. Remotely sensed data are a good proxy for determining likely incidence of break-out. The FIRM data will allow extended spatial and temporal analyses to be undertaken.