Consumer Data Research Centre

An ESRC Data Investment

West Midlands Fire Service

Geospatial Fire Service Decision-Making and Risk Management Utilizing Text Analysis and Machine Learning

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1. Background and Motivation

Emergency Reponse systems are designed to provide efficient assistance during emergency situations。In fire department, responders determine the dispatch of fire fighters and engines based on seeker's phone calll and on-site images.There is also a research gap in the textual analysis of fire fighting text.

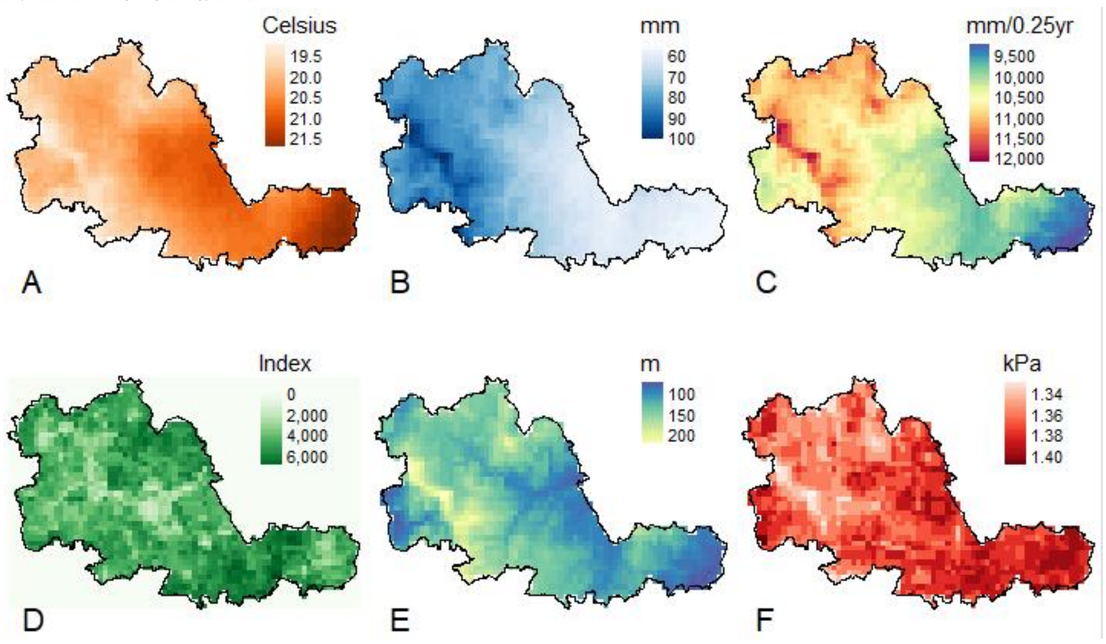
2. Data

The Dataset used in this paper include:

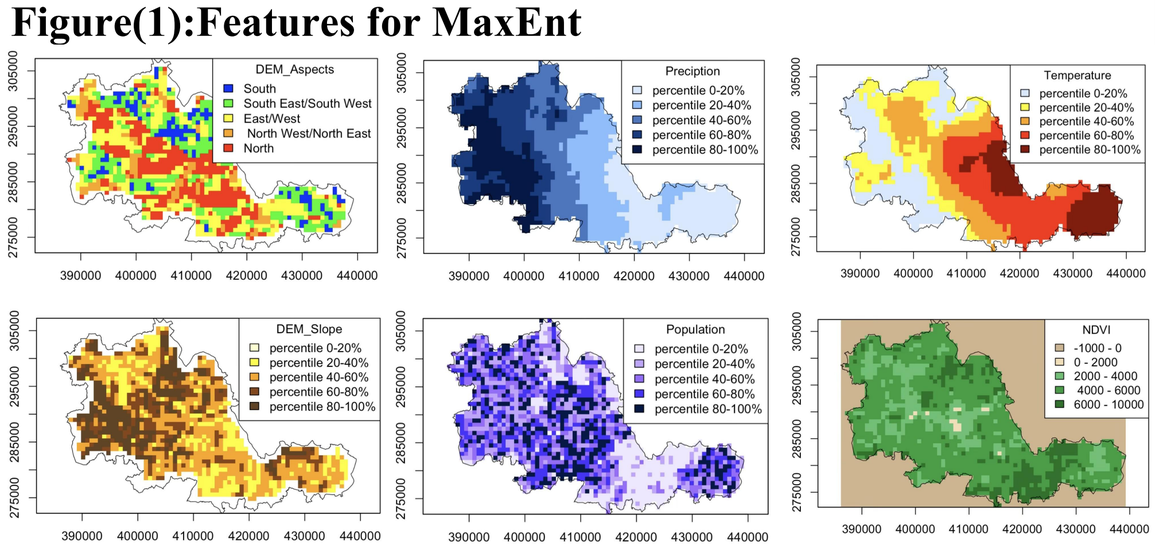
2.1 The text data form West Midlands Fire Service(WMFS)

Incident number	Riders	Details
FW001692-09012023	5	RTC FLUIDS LEAKING - NO REPORTS OF ANYONE TRAPPED OR INJURED - AIRBAGS HAVE DEPLOYED IN ONE OF THE VEHICLES _x0001_JCT CROMWELL LANE_x0001_2 VEHICLES INVOLVED _x0001_POL ARE EN ROUTE
FW001696-09012023	3	RTC ROLLOVER_x0001_CAR VS PARKED CARS_x0001_1 PERSON TRAPPED_x0001_AMB EN ROUTE ETA 8 MINUTES x0001 AMB LOG 5783

2. 2 Raster data



Figure(1):Features for MaxEnt



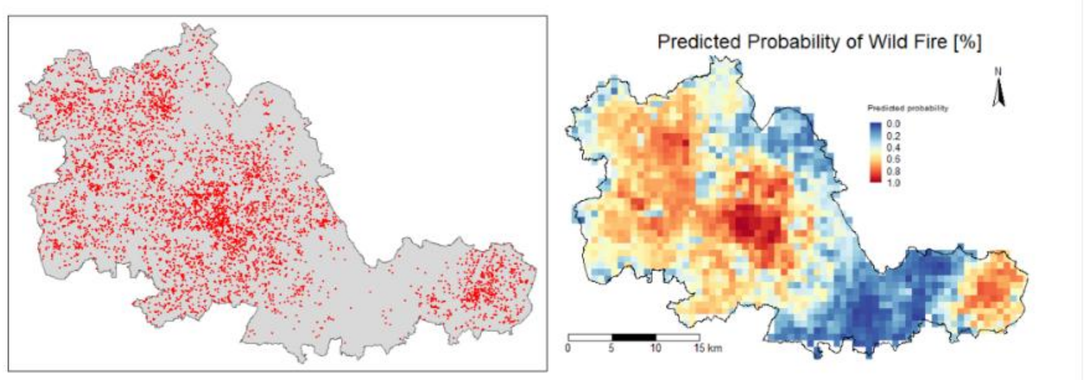
Figure(2):Reclassified features for suitability

3. Method:

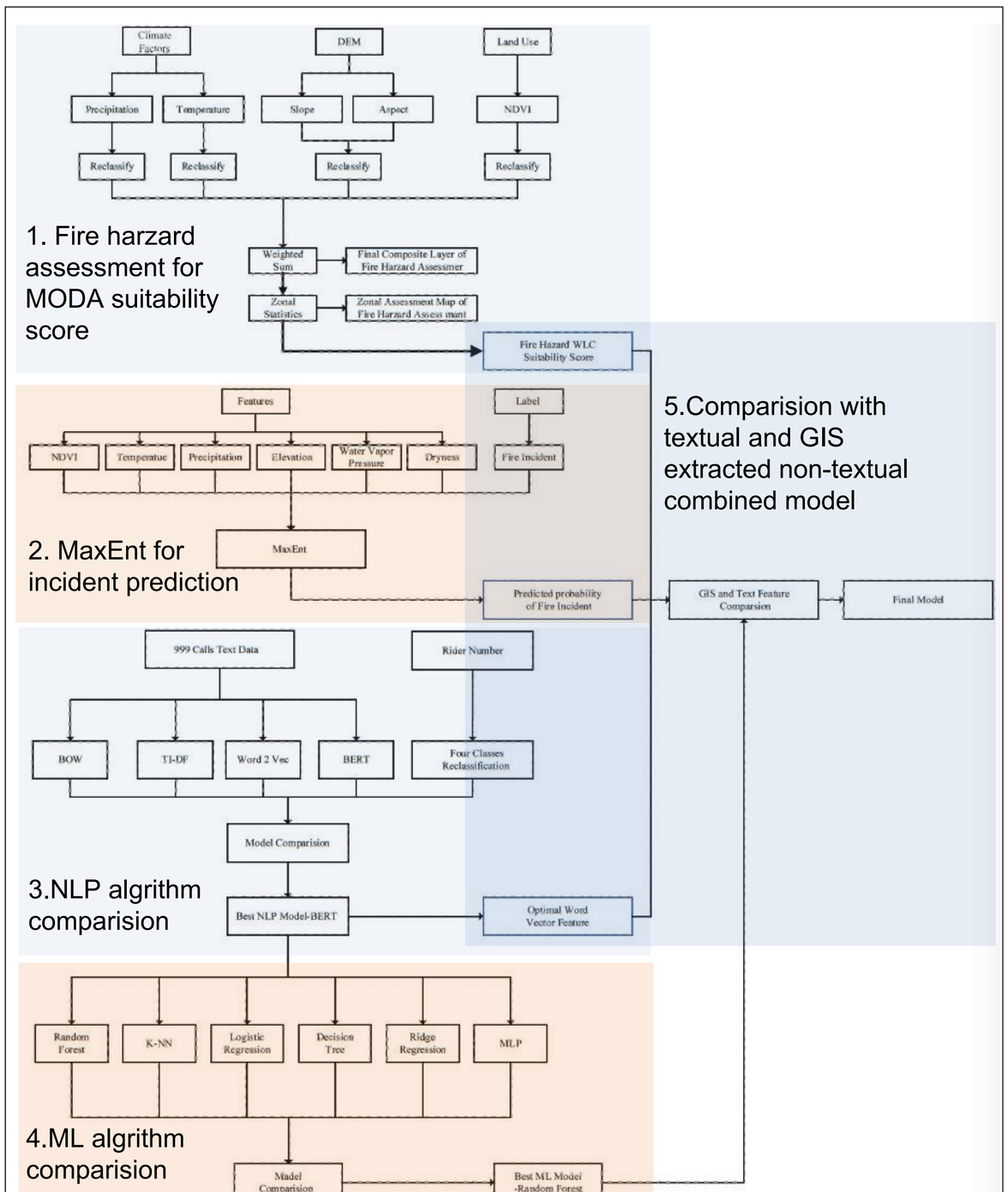
The article attempts to simulate the decision-making process passed by responders using text analysis and machine learning, as shown in the flow chart in **Figure(4)**

4. Results and Findings:

4.1 MaxEnt can predict the fire occurrence from remotely sensed data with an accuracy of over 70% and the spatial distribution of the predicted values is consistent with the real values.The predicted trend is also consistent with fire stations distribution.

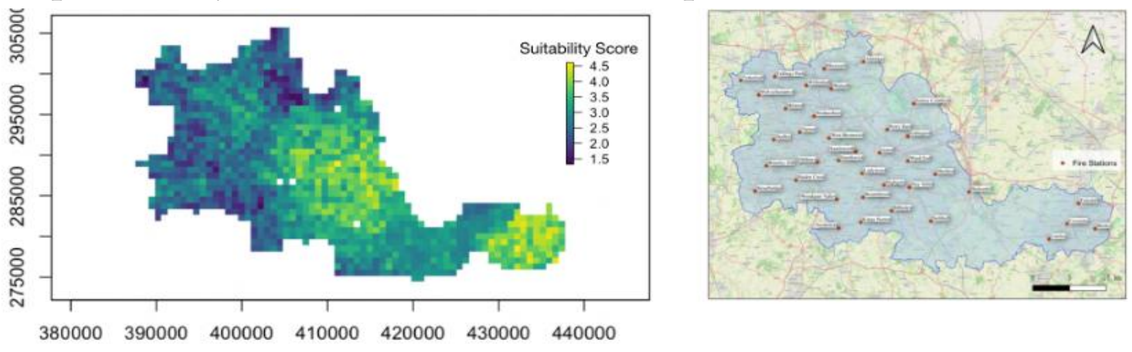


Figure(3): Real VS MaxEnt predicted incident distrbution



Figure(4):The flow chart

4.2 There is higher risk of fire incidents in the centre and northeastern of Birmingham and Coventry area under the responsibility of WMFS also manifests potential fire risk factors.



Figure(5):Sutability overlay VS Fire station distribution

4.3 This paper bridges the research Gap of fire emergency response text analysis and finds that the deep learning BERT model performs best in fire text. As the dataset size increases, a 10% reduction in model accuracy is observed, highlighting the imperative for future training on larger original telephone datasets enriched with additional information.

4.4 This work simulates the decision-making process when a responder receives a call to implement dispatch. The final result found that combining non-textual data derived from GIS can improve the accuracy of the classification decision model with the results shown in **Table(1)**.

		precision	recall	f1-score	support
BERT + MaxEnt	Class 1	0.73	0.61	0.66	406
	Class 2	0.81	0.75	0.78	1308
	Class 3	0.70	0.53	0.61	580
	Class 4	0.78	0.89	0.83	2115
BERT+Sutability	Class 1	0.75	0.60	0.66	406
	Class 2	0.82	0.75	0.78	1308
	Class 3	0.69	0.54	0.60	580
	Class 4	0.78	0.90	0.83	2115
BERT+MaxEnt+Suitability	Class 1	0.78	0.57	0.66	406
	Class 2	0.81	0.75	0.78	1308
	Class 3	0.71	0.52	0.60	580
	Class 4	0.77	0.90	0.83	2115

Table(1):Text and non-text features comparison