Emerging methods for early detection of forest fires

Literature Review:

Significant causes of forest fire are human-based and nature-based. Human-based forest fires are Arson (human-made fire), Smoking and throwing cigarettes, Sparks in power lines, explosive or fire during hunting, picnic fires, shepherd fires, stubble burning. Nature-based forest fires are lightning strikes due to high environmental temperature, etc. Major factors for the forest fires include Weather factors (Temperature and relative humidity, precipitation wind speed, rainfall, striking probability of lighting), Time factors (holiday season, month, time of the day), population-based factors (population density, human activities in the forest, human behaviors), Landscape factors (Tree types, slope, distance from agricultural land, etc.) and Human-made factors (Short-circuit on power grid lines passing through the forest).

Volkan Sevinc, et al. offers the Bayesian network model (BN) to predict possible causes of forest fires in the southwest of Turkey, specifically in Mugla Regional. The data set contained 3231 fire records. The General Directorate of Forests recorded the fire data for ten years from 2008 to 2018 in the region. Features such as temperature, relative humidity, month, distance from leveling, wind speed, distance from agricultural land, amount of burned area, tree types, and distance from the road are recorded. A Bayesian network model is trained on the data to

predict possible causes of the forest fire. The Bayesian network produced a high AUC of 0.9, 0.89, 0.89, 0.82 for hunting, picnic, stubble burning, and shepherd fire, respectively.

Simulation of forest fires to study fire behavior is very useful in predicting the rate of fire spread, fire size, and the number of trees lost in the fire. BehavePlus V6 is currently used by the US and Canada to study fire behavior [69]. It is one of the most widely used forest fire modeling systems that predict wildfire behavior and prescribe fire planning. Other similar systems also exist [70,71]. BehavePlus provides much useful information, including the rate of fire spread and spotting distance, fireeffect, and fire environment, and includes over 40 fire models. Rapp modeling system (http://redapp.org) is developed in Canada with the support of the Canadian Interagency Forest Fire Centre (CIFFC). Fire is a fire behavior prediction simulator that calculates fire effect on stand characteristics [72]. Stacy A Drury [73] compared predicted fire behaviors from four models (BehavePlus, RedAPP, CanFIRE, and Crown Fire irritation and Spread System) with the observed fire behavior on the Alaskan black spruce forest. He studied the rate of fire movement, predicted flame length, energy, and ecological impact, and concluded that Canadian models, including RedAPP and CanFIRE provide more accurate predictions than BehavePlus. Similarly, many tools exist for fire, and smoke models, which are crucial in decision making and planning to tackle the forest or a wild-land fire [74-77]. A lot of research has been done in the last two

decades, especially after the increase of computation power during the last few years [77-80]. Satellite active fire data such as Visible Infrared Imager Radiometer Suite (VIIRS) [81], moderate-resolution imaging spectro-radiometer (MODIS) [82] etc., can be

Used to validate the simulation models [83]. Performance of the forest fireprediction models depends on measuring important input parameters such as topology, meteorological conditions, vegetation, fire front situation, etc. Evolutionary algorithms are used to reduce the uncertainty in the forest fire propagation models [13]. Evolutionary statistical systems can reduce the uncertainty in the input parameters of the forest fire prediction models to improve their accuracy [13,84]. We will present a review of how different machine learning algorithms are used to predict the occurrence and spread, decision-making, and planning of the forest or wild-land fires.