Hydroclimatology Based Wildfire Susceptibility Automated Geospatial Model Development for Forest Management

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Abstract. Wildfire is one of the biggest natural hazards that United States faces every year and it is concentrated mostly in the western parts of the country. As a con-sequence of global warming and climate change, and the subsequent El-Niño and Na-Niña effects, wildfire vulnerability has increased in United States. Locations having good rainfall for few years are experiencing exceptional drought in next few years. Due to these drought conditions in previous years and following incessant rain next year with lightening is increasing the wildfire probability in USA. States that have not seen much of wildfire earlier are experiencing it in recent times. Southern states like Georgia and South Carolina have experienced increased wildfire in last 3-4 years. It is very difficult to fight wildfire without proper disaster management and planning. Information system is crucial to disaster management both for disaster prediction and relief. Most of the data requirements for such emergency management are of a spatial nature. Therefore, geospatial technology is one of the most important tools for this decision support system development. The goal of this study was to develop an automated geospatial model to predict the wildfire susceptibility in the Sumter National Forest in South Carolina. The objectives of the study to accomplish the goal is to: i) collect and process spatial data for wildfire vulnerability parameters; ii) develop an automated geospatial model in ArcGIS ModelBuilder using Map Algebra and advanced spatial analyst tools to locate most vulnerable locations in the study area, and iii) suggest wildfire hazard mitigation measures including post hazard management decision making. The geospatial data used for this study are 1m resolution, year 2013 four band (R, G, B, and NIR) National Agricultural Imagery Program (NAIP) image, 1 m DEM developed with 30 cm LiDAR, SSURGO soil, TIGER road, and most importantly a Lightning Strike data. Four-band NAIP images were obtained from Farm Service Agency (FSA) of USDA, mosaicked, clipped to the study area (Sumter NF), and band separated with ArcGIS 10.2 software. The LiDAR tiles for the study area were collected from SC DNR, mosaicked, and processed to develop nDSM and subsequent 1m DEM for the study area. Image segmentation was performed in eCognition software using Object based Image Analysis (OBIA) technology to develop the land use classification map of the study area. Different bands of NAIP imagery were used to develop NDVI and Dryness Index raster and DEM was used to develop slope, suppression, rate of spread, and sun aspect raster using proper algorithm. Biomass and urban fuel load raster were created using the classified land use map. Soil drainage raster was developed using the SSURGO soil data. A road buffer was created different buffer distances using the multi-ring buffer tool of ArcGIS and the vector file was converted to a raster using Polygon to Raster tool. Finally, a lighting strike raster was created by digitizing the hard copy file obtained from the USDA Forest Service for entire South Carolina and converting that to raster in ArcGIS. Once all the raster were obtained, they were all reclassified giving different 'weight values' developed by the team and other literature review according as the layer parameters' (e.g., a score of 300 for moderately drained soil, 500 for somewhat well-drained soil, and 700 for well-drained soil) wildfire susceptibility rate. Finally, the Weighted Sum tool was used with a different weight specification for individual wildfire susceptibility based reclassified layer (raster) to develop the final study area wildfire susceptibility map. The final map was classified into five different categories using Jenks algorithm to show the susceptible regions for wildfire. Above all, all the geospatial processes were completed through an automated geospatial model developed with ArcGIS ModelBuilder. As the last outcome, a decision support system was developed by the team to suggest wildfire hazard mitigation measures on spatial basis for the study area. This automated model can be replicated in any forest wildfire management.