Climate Drivers of Wildfire Size in North Carolina: Thresholds and Cross-scale Dynamics from 1970-2012

Rachel E. Burnett
Mark A. Megalos

Wildfire in the Southeast

The Southeast experiences more individual fires and acres burned than any other area in the United States. Wildfires can

- Endanger residents and structures in the Wildland-Urban Interface,
- Threaten natural forests and pine plantations,
- Release vast amounts of carbon and particulate matter, and
- Absorb resources and inflict large costs on fire service agencies.

Fire and Climate Interactions

Climate influences fuel loading and moisture content which impact fire activity. Changes in climate are likely to produce the following shifts in fire activity across the Southeast:

- Higher fire frequency,
- Increases in area burned,
- Longer fire seasons, and
- Larger, higher-intensity fires during drought conditions, often caused by the Bermuda High in summer and La Niña events in winter.

Large, intense fires such as the Pains Bay, NC and Bastrop, TX fires in 2011 are likely to be more common in the future (Fig. 1).

Fig. 1. The Pains Bay, NC fire in 2011 burned over 45,000 acres of coastal pocosin after a severe drought produced dry fine fuels. Photo credit: Skeeter Sawyer.

Thesis Objectives

- To describe the fire size distribution in North Carolina
- To quantify thresholds of wildfire size
- To identify and quantify climate drivers of wildfire size
- To describe cross-scale dynamics within and among climate variables

We will use 200,000 fire reports representing all wildfires on record with the North Carolina Forest Service from 1970-2012 to create a wildfire dataset. The North Carolina State Climate Office is providing climate data. Climate variables include several measures of temperature, precipitation, and drought.

Wildfire Size Distribution

The distribution of wildfire size is heavy-tailed, meaning most fires are very small; larger fires are increasingly rare (Fig. 2).

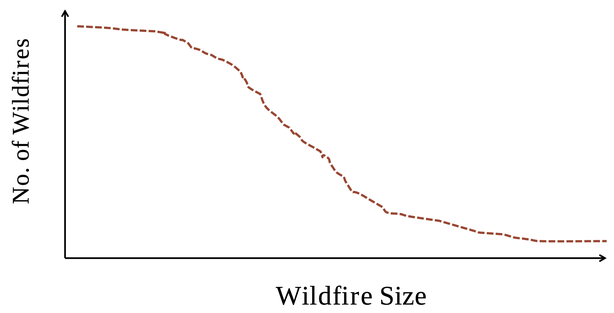

Fig. 2. Wildfire sizes are plotted against their frequencies to reveal a heavy-tailed distribution.

Power-law statistics will pinpoint breaks in the distribution that suggest environmental thresholds of wildfire size.

Climate Drivers and Cross-scale Dynamics

The extent of area burned generally increases with time, but the rate of change is not constant. Fires typically grow in magnitude and intensity at an approximately constant rate until some threshold is reached. At the threshold, the previously dominant driver of fire spread switches to another dominant driver that exerts a different, and often increased, rate of spread (Fig. 3). The periods between thresholds are behavioral stages (scales).

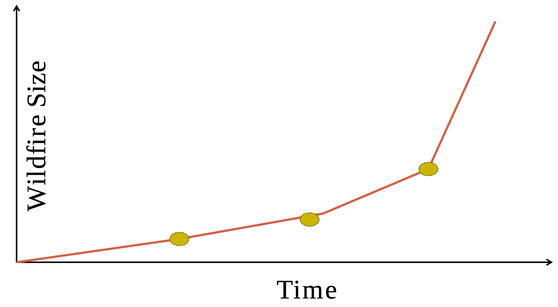

Fig. 3. Rates of spread change between behavioral stages (red) as the magnitude of wildfire size passes scale thresholds (yellow).

Climate drivers will be quantified with quantile regression. We will also examine the dynamics of how the influence of each climate variable changes within and between scales (cross-scale dynamics) and relative to one another.

Deliverables

- Recommendations of climate indicators of large wildfires for fire management and mitigation by fire service agencies and landowners
- Incorporation of climate drivers into existing fire decision support systems