

C. Wade Ross¹, Sabine Grunwald¹

¹ University of Florida, Department of Soil and Water Science

Rationale and Significance

Global warming has been well documented and there is growing concern that increases in anthropogenic greenhouse gas (GHG) emissions may alter regional climate patterns and carbon (C) pools. Increasing the capacity of the terrestrial biosphere to act as a “C sink” has been suggested as a means for mitigating anthropogenically induced global warming.

The terrestrial biosphere stores substantial amounts of C in both aboveground biomass (650 Pg C) and soils (3,150 Pg C), approximately 6 times greater than the atmospheric C pool (750 Pg C). As such, relatively small changes in terrestrial C stocks could have a significant effect on the atmospheric concentration of CO₂, and therefore affect temperature and climate. In the Southeastern U.S., nearly 1/3 of all forest C is stored within privately owned pine forests. These forests supply 16% of global industrial wood and 7.5% of industrial economic activity in the region. Through proper land use management, these forests can help offset anthropogenic GHG emissions by increasing the C sink capacity.

Results from this project will improve the understanding of terrestrial C dynamics and potential effects of climate driven changes on soil moisture and fire regimes and allow land managers to implement best management practices to increase C sequestration while increasing forests resilience to climate change stressors.

Objectives

Objective 1: Implement multiple factor experiments to study the complexity and biogeochemistry of soil C dynamics along trajectories of soil moisture/hydrology and fire regimes which are projected under various climate change scenarios (e.g., drier climate) in a prominent southern pine ecosystem (FL). Develop and validate a new soil submodel that describes factors controlling belowground processes and transformations which govern C dynamics in the context of a changing climate. The new soil submodel will be integrated into a process-based (mechanistic) simulation model (e.g., DNDC, DayCent, or GEFSOC models) to simulate climate change effects in southern pine ecosystems.

Objective 2: Investigate the disturbance effects of fire on the structure and function of C stocks in pine ecosystems, including above and belowground components. Since projected drought conditions are expected to increase in the S.E., the risk of severe wildfire is likely to increase as well. This research will exemplify the response of C budgets to changing fire regimes.

Objective 3: Develop a spatially-explicit stochastic/deterministic model to upscale site-specific changes in terrestrial C stocks and budgets under disturbance and climate change projections to regional scale; and compare results to a mechanistic model. The aim of this objective is to reduce the uncertainty in model predictions considering non-linearity's and interaction effects among various environmental factors.

Hypotheses

We will investigate the following overarching hypotheses motivated by research questions:
How will increasing temperatures and changes in soil moisture dynamics conditioned by global climate change impact terrestrial C (active, recalcitrant, total soil C and aboveground biomass C pools)?

Hypothesis 1:

Moisture effects are more pronounced to foster significant change in soil C in southern pine ecosystems than temperature effects induced by climate change.

Research Question 1 (RQ 1): How permanent is the soil C sink in southern pine forest under increased fire frequencies conditioned by climate change effects in the future?

Hypothesis 2:

Moisture effects on disturbance regimes, primarily fire, and the resulting impact of disturbance on C cycling is likely to be greater than direct effects of moisture on net ecosystem C storage at both plot and regional scale.

RQ 2: Which factors impart control on scale-dependent behavior to assess soil C stocks and pools across large regions?

Hypothesis 3:

Functional relationships between terrestrial C and spectral metrics are scale-variant at increasing extent (study area size) due to increasing variance in soil and environmental properties and processes; thus, spectral informed models that aggregate terrestrial C stocks and pools across escalating spatial scales (site → region → large landscape, such as the Southeastern U.S.) demonstrate significant non-linearities.

RQ 3: What is the magnitude of scale-dependent behavior to assess terrestrial C stocks and pools across large regions?

Study Area

Plots in FL will be chosen to represent various trajectories of soil moisture and fire regimes.

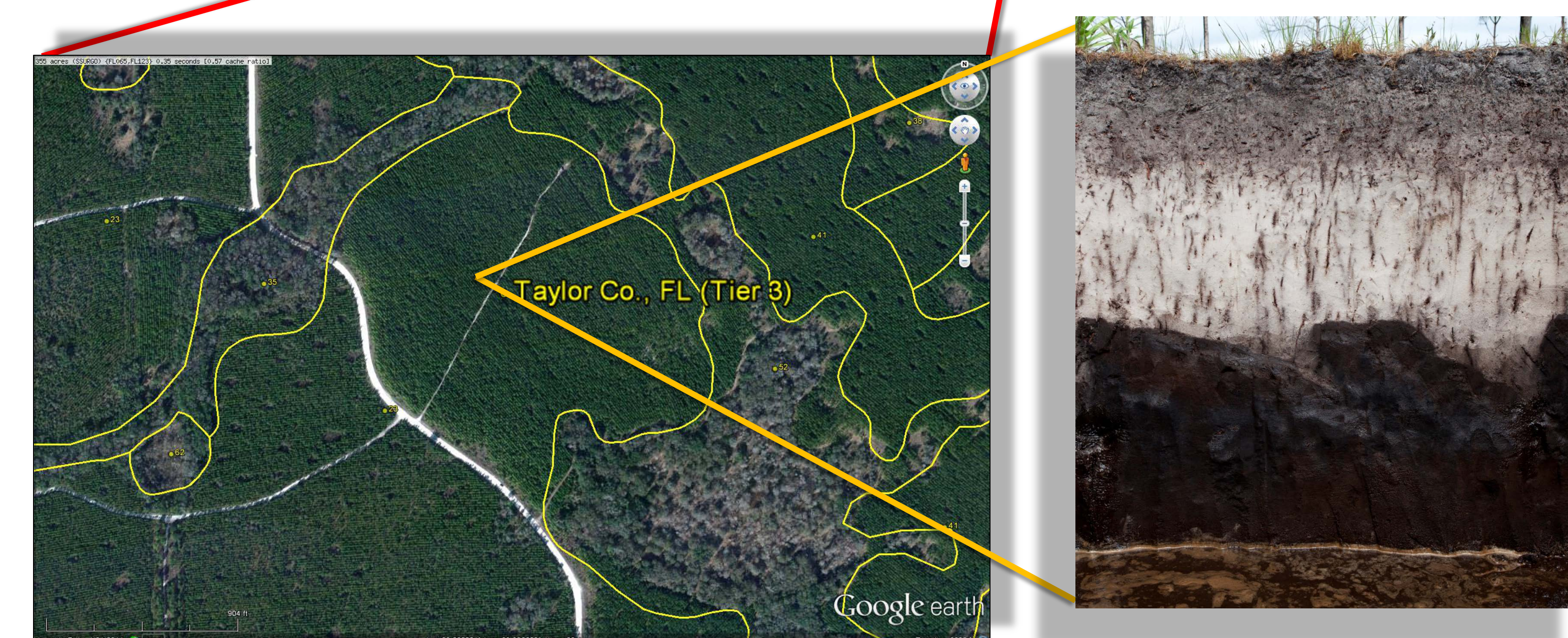
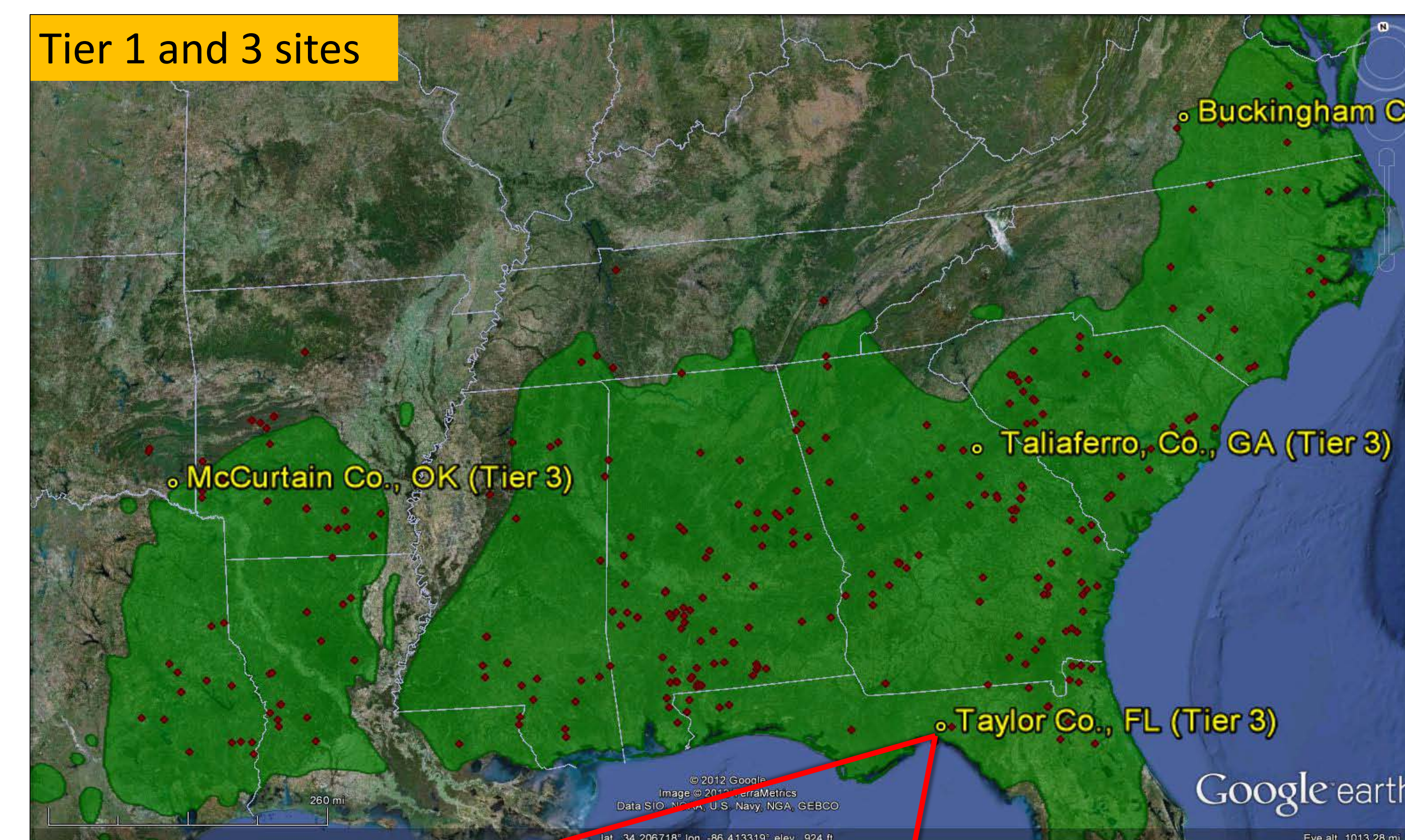
Tier 3 site (Taylor County, FL): ‘fire and hydrologic’ trajectories representing different stages of fire (disturbance) and moisture regimes to represent climate effects

Tier 1, 2, and 3 sites: PINEMAP study area (southeastern U.S.)

Remarks

This project will be complemented by soil C, soil spectral, and remote sensing-derived spectral data from other sources and research projects

Data from several tier sites will be synthesized to populate C simulation models and/or verify model output.



Tier 3 site in Taylor County, FL.

Spodosols profile at a Tier 3 site

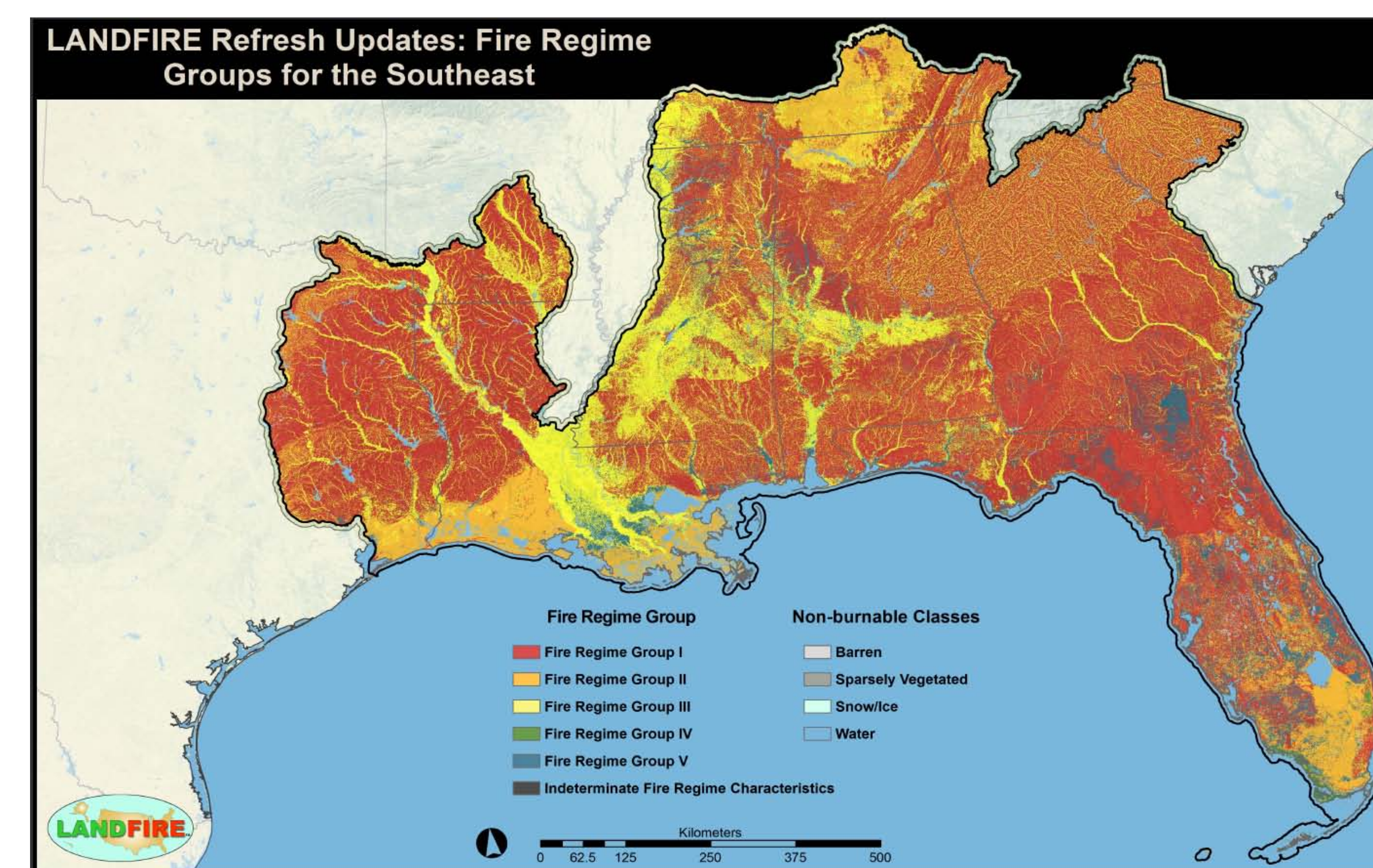


Image courtesy of LANDFIRE.gov