NATIONAL INTEGRATED DROUGHT INFORMATION SYSTEM
COASTAL CAROLINAS
DROUGHT EARLY WARNING SYSTEM

COMPARING ENVIRONMENTAL INDICES IN EASTERN NORTH CAROLINA

Assessment of indicators for coastal zone fire risk

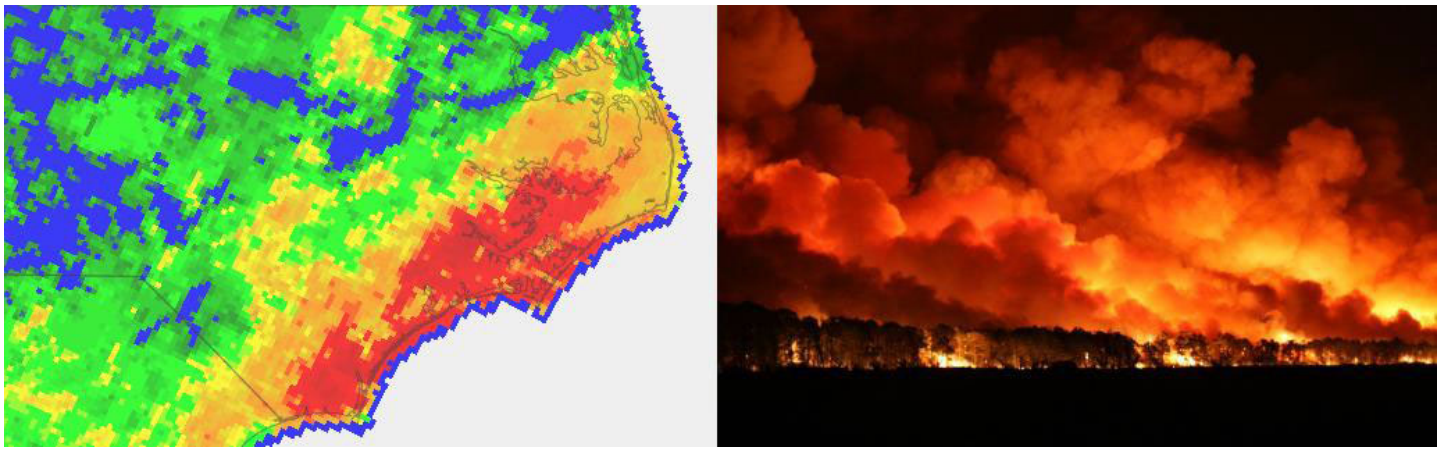

Figure 1: Gridded KBDI values in eastern North Carolina (left) exceeded 500 in mid-June 2011, when the Pains Bay fire (right, by Lloyd Brown) and several others burned.

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Monitoring burning conditions in eastern North Carolina's organic soils can be challenging. Existing measures of near-surface dryness, such as drought indices and National Fire Danger Rating System (NFDRS) parameters, have often been considered poor indicators of fire risk in organic soils, which have complex compositions, can burn and smolder several feet underground, and are often found in regions with subtle but meaningful terrain differences. This project sought to further compare these commonly used environmental indices, including several new gridded products, with an experimental Estimated Smoldering Potential dataset in search for better indicators of organic fire risk.

A GRIDDED KBDI DATASET

One commonly used fire risk parameter is the Keetch-Byram Drought Index (KBDI), which estimates dryness in the uppermost eight inches of the soil. KBDI has historically been available only at Remote Automatic Weather Stations (RAWS), so much of eastern North Carolina did not have direct coverage. Using daily radar-derived precipitation estimates from the National Weather Service and daily maximum temperature and annual average precipitation data from the PRISM dataset, a gridded KBDI dataset was created at 4 km resolution for the period beginning in March 2007.

A comparison with the RAWS KBDI observations showed that the gridded data generally underestimates values, with annual maximum values 136.65 points lower in the gridded dataset, on average. This difference is likely due to the underestimation of maximum temperatures in the PRISM dataset and/or a warm bias in RAWS temperature observations.

ESP COMPARISONS

Several gridded indices including KBDI, daily precipitation, and the Standardized Precipitation Index (SPI) over one- to four-month periods, were then compared with soil moisture data from an experimental Estimated Smoldering Potential (ESP) dataset.

This ESP data was collected intermittently from 2012 to 2014 at three coastal stations: in the Pocosin Lakes National Wildlife Refuge in Hyde County, in the Alligator River National Wildlife Refuge in Dare County, and near Green Swamp in Brunswick County (Figure 2).

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The results showed that all three gridded indices were only weakly correlated with the ESP data. (Table 1). Separate comparisons with Energy Release Component (ERC) data from nearby RAWS stations using both fuel models G and O also showed only weak relationships with the soil moisture observations from the ERC dataset.

The weak correlations are likely because these indices cannot capture the terrain, drainage, and composition of organic soils. To that extent, few to no existing indices can model this combination of environmental and non-meteorological characteristics.

Because of this, no single index based on current widely available data is likely to be a consistent indicator of organic fire risk. A combination of monitoring recent NFDRS parameters to assess surface fuel burning, local soil sampling, and groundwater levels is recommended until further improvements are made.

	Alligator River (n = 349 days)	Allen Road (n = 278 days)	Green Swamp (n = 51 days)
Soil moisture vs. 1-month SPI	0.253	-0.075	0.833
Soil moisture vs. 2-month SPI	0.483	-0.235	0.725
Soil moisture vs. 3-month SPI	0.479	-0.316	0.648
Soil moisture vs. 4-month SPI	0.391	-0.352	0.711
Soil moisture vs. gridded daily precipitation	0.017	0.125	0.091
Soil moisture vs. gridded KBDI	0.372	-0.331	-0.563
Soil moisture vs. ERC (fuel model O)	-0.116	-0.057	-0.254
Soil moisture vs. ERC (fuel model G)	0.147	0.011	-0.217

Table 1: Correlation coefficients (r) between soil moisture data from ESP arrays and other gridded and point-based datasets.

FUTURE WORK

Additional research may suggest better options for monitoring organic fire and smoldering conditions. Separate studies are currently examining remotely sensed soil moisture data as an indicator of smoldering in organic soils. The deployment of soil moisture probes across eastern North Carolina could also establish a reliable sensor network and provide a longer period of record than the ESP stations.

Along with providing a finer-scale monitoring network in this part of the state, this would allow for a more robust comparison with existing datasets to search for good indicators of organic fire risk.

Although it does not provide meaningful guidance for organic regions, the gridded KBDI dataset should become a valuable monitoring tool, especially for assessing response and mop-up with lightning-caused fires, in non-organic regions since it provides local estimates between weather stations.

Additional evaluation of temperature datasets may suggest a more accurate option than the daily PRISM data. If a daily relative humidity dataset was also found, gridded 100-hour and 1000-hour fuel moisture and ERC datasets could also be created to aid in routine fire risk monitoring.

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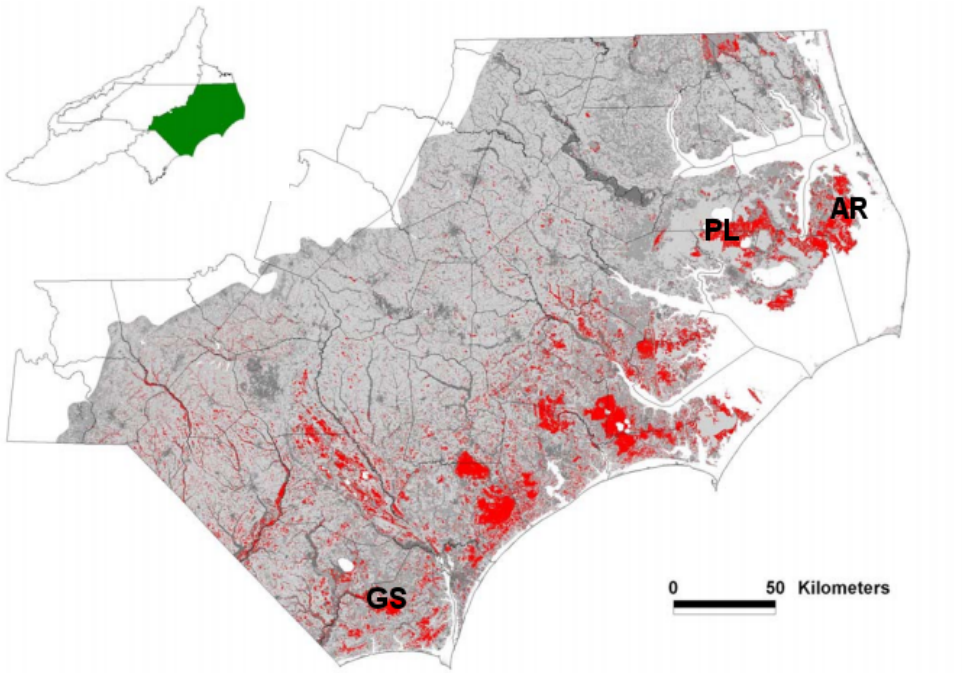

Figure 2: Organic soils in eastern North Carolina (in red, from NCGAP 1992) and ESP station arrays at Green Swamp (GS), Pocosin Lakes (PL), and Alligator River (AR).

What is a Drought Early Warning System (DEWS)?

A NIDIS DEWS utilizes new and existing partner networks to optimize the expertise of a wide range of federal, tribal, state, local and academic partners in order to make climate and drought science readily available, easily understandable and usable for decision makers; and to improve the capacity of stakeholders to better monitor, forecast, plan for and cope with the impacts of drought.

What is the Coastal Carolinas DEWS?

A diverse group of stakeholders convened in August 2012 in Wilmington, NC, to identify issues of concern about drought in the coastal regions of the Carolinas. Out of the meeting came the Coastal Carolinas Drought Early Warning System, a collaborative federal, state, and local interagency effort to improve early warning capacity and resilience to drought. CC DEWS activities focus on improving the understanding of drought's effects on coastal environmental resources and developing information to enhance drought monitoring and planning processes.