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Prepared in cooperation with the National Drought Mitigation Center, University of Nebraska, Lincoln

# Drought Monitoring with VegDRI

Drought strikes somewhere in the United States every year, turning green landscapes brown as precipitation falls below normal levels and water supplies dwindle. Drought is typically a temporary climatic aberration, but it is also an insidious natural hazard. It might last for weeks, months, or years and may have many negative effects. Drought can threaten crops, livestock, and livelihoods, stress wildlife and habitats, and increase wildfire risks and threats to human health.

Drought conditions can vary tremendously from place to place and week to week. Accurate drought monitoring is essential to understand a drought's progression and potential effects, and to provide information necessary to support drought mitigation decisions. It is also crucial in light of climate change where droughts could become more frequent, severe, and persistent.

## The Role of Remote Sensing

Satellite data are fundamental to accurate drought monitoring. From a vantage point in space, satellites efficiently track changes in vegetation across large areas of the Earth's surface over time. These data complement and extend information gathered by traditional, ground-based drought monitoring techniques that primarily rely on meteorological observations.

The Vegetation Drought Response Index, or VegDRI, is a hybrid drought monitoring and mapping tool that integrates satellite observations of vegetation status and climate data with information on land cover, soil characteristics, and other environmental factors. Developed by the U.S. Geological Survey's Earth Resources Observation and Science (EROS) Center and the National Drought Mitigation Center, VegDRI reveals vegetation conditions as plants respond to solar energy, soil moisture, and other limiting factors. Researchers use integrated VegDRI data to produce detailed VegDRI maps (fig. 1) that show levels of drought stress on vegetation across the conterminous United States. With a relatively high degree of spatial detail, VegDRI maps support near-real-time monitoring of drought effects at state and county levels.

VegDRI maps have high spatial resolution (1 square kilometer) compared to typical climate-based drought indicators and are updated weekly during the growing season. The maps provide a regional overview of crop and rangeland conditions--essential information for tracking agricultural and ranching conditions, or natural resource management.

## Accessing VegDRI Maps

To access VegDRI maps, go to http://drought.unl.edu/vegdri/VegDRI_Main.htm for national and state level quick map views, or http://vegdri.cr.usgs.gov/viewer/viewer.php for interactive map viewing of many drought indicators.

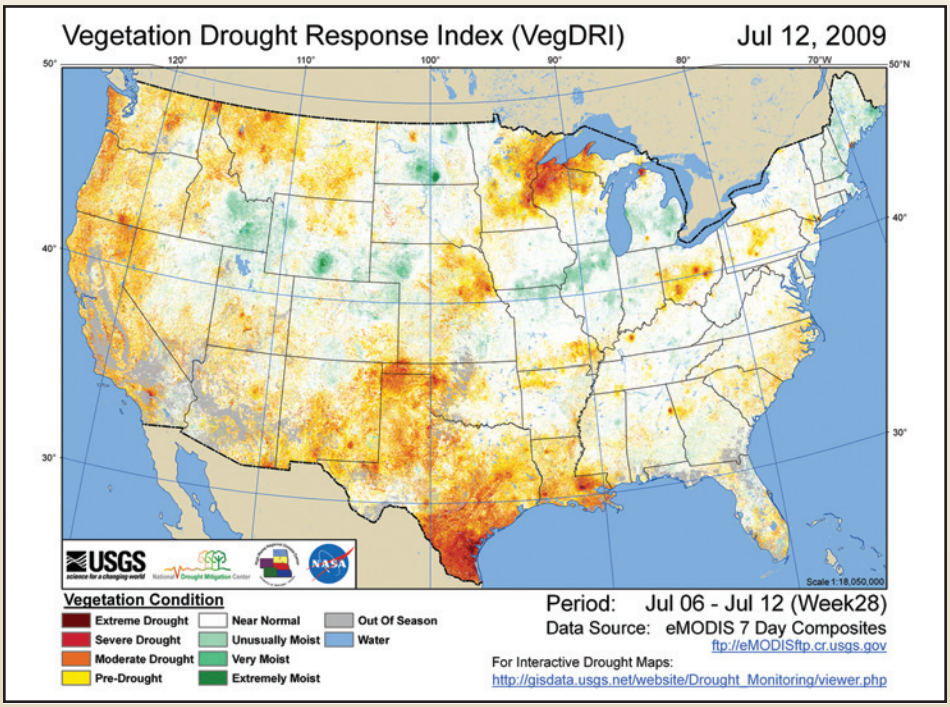


**Figure 1.** VegDRI map for July 12, 2009.

*"VegDRI maps did a good job of tracking the rapid onset of short-term drought conditions here in Arizona in October 2009. Drought effects on vegetation showed up very quickly. Natural Resource Conservation Service (NRCS) range experts were also impressed."*

—Michael A. Crimmins, Department of Soil, Water, and Environmental Science, University of Arizona

## VegDRI Model Methodology

Integral to VegDRI is Normalized Difference Vegetation Index (NDVI) data acquired by the Advanced Very High Resolution Radiometer (AVHRR) sensor carried aboard National Oceanic and Atmospheric Administration (NOAA) weather satellites, and the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor aboard NASA's Earth Observing System (EOS) satellites. NDVI is a measure of relative vegetation condition. Analyzed over time, it is used to calculate certain variables, or metrics, that are incorporated into the VegDRI model as a way to quantify seasonal vegetation changes across the conterminous United States. Combining the NDVI with climate data in a modeling scenario reveals where vegetation is stressed becacuse of drought as opposed to other environmental factors.

Vegetation drought stress can vary greatly depending on land cover type, soil characteristics, and land use practices. In order to represent such environmental differences, the VegDRI model includes biophysical data about soils, land cover, irrigation, and elevation derived from a variety of sources (fig. 2).

## Updates and Accuracy

Like any new tool or model, VegDRI continues to evolve as new information becomes available, and improvements and updates are incorporated regularly. During 2009, for example, adding near-real-time MODIS data from the EROS eMODIS system improved VegDRI's sensitivity to vegetation dynamics, as MODIS' spectral bandwidths are optimized for land applications.

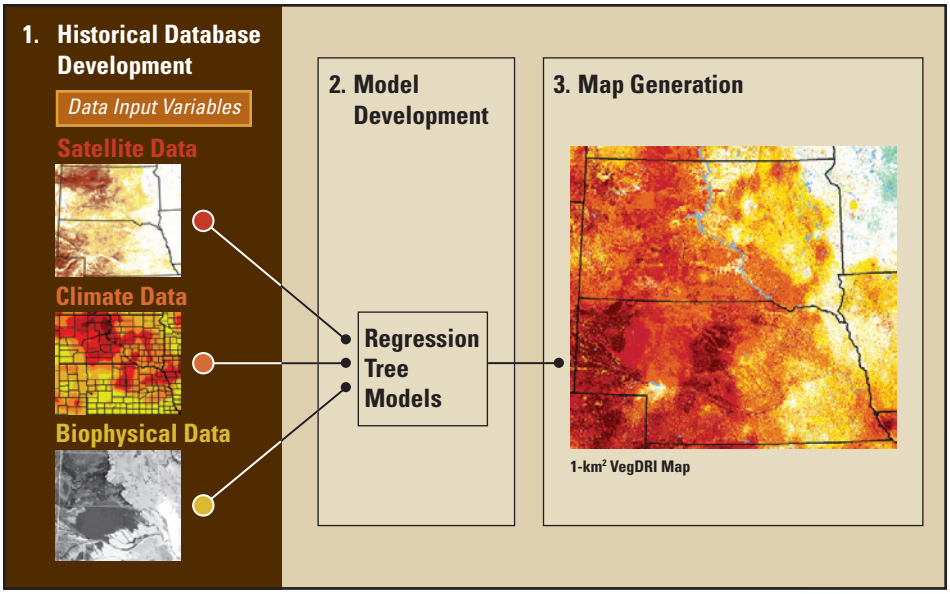


**Figure 2.** VegDRI methodology combines satellite imagery, climate data, and biophysical parameters.

Furthermore, MODIS NDVI is calculated at 1,000-meter, 500-meter, and 250-meter resolutions, making it possible to extend the VegDRI model to finer spatial resolutions where associated climate and biophysical indicators are available at comparable resolutions.

Periodically, a variety of information sources are reviewed to evaluate VegDRI's performance and accuracy, including quantitative comparisons with U.S. Department of Agriculture crop yield data as well as biophysical and soil moisture measurements collected by various agencies. Spatial and temporal patterns in VegDRI maps are also qualitatively compared to drought patterns depicted in U.S. Drought Monitor (USDM) maps and to the spatial distribution, type, and frequency of drought effects reported in the Drought Impact Reporter (http://droughtreporter.unl.edu). Feedback from state climatologists, USDM authors, and agricultural experts and producers is used to characterize the general strengths and weaknesses of VegDRI and highlight specific locations or trends that might be in error.

*"By integrating satellite data, surface climate data, and biophysical data, VegDRI builds upon the strengths of its components to overcome their individual weaknesses and produce a whole—the VegDRI index—that is synergistically stronger than the sum of its parts."*

**—Richard R. Heim, Jr., NOAA National Climatic Data Center**

## For more information, contact:

**Jesslyn F. Brown**
U.S. Geological Survey
Earth Resources Observation and Science (EROS) Center
Sioux Falls, SD 57198
605-594-6003
jfbrown@usgs.gov

**Brian D. Wardlow, Ph.D.**
University of Nebraska—Lincoln
National Drought Mitigation Center
Lincoln, NE 68583
402-472-6729
bwardlow2@unl.edu

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