

## MODELED SATURATION INDEX (MSI)

### Part I - Mission Connection

- a. Product Description – In meeting its hydrologic forecast responsibilities, the National Weather Service (NWS) Missouri Basin River Forecast Center (MBRFC) simulates soil moisture across the Missouri River basin in real-time. The Modeled Saturation Index (MSI) quantifies the relative degree of tension water saturation present within the soil column, and is calculated on a sub-basin level. The primary product is a graphical display of the MSI across the Missouri River basin.
- b. Purpose – Soil moisture directly impacts runoff potential, water resource management, debris flow formation, and agricultural productivity. A correlation exists between soil moisture and lower level atmospheric conditions. However, observed real-time soil moisture data is sparse and difficult to spatially interpolate. The production of the MSI graphic will enable the user to visualize the real-time relative degree of tension water saturation present geographically across the Missouri River basin.
- c. Audience - The target audience for this graphic is wide ranging. Partners, such as the Army Corps of Engineers (COE), the US Geological Survey (USGS), Federal Emergency Management Agency (FEMA), United States Department of Agriculture (USDA), the National Park Service, Regional Climate Centers, and river authorities have areas of responsibility that span multiple states. The RFC-wide extent of this graphic would provide these partners a visually intuitive overview of one major characteristic of soil moisture across a large portion of the U.S. State emergency managers, local water resources managers, and agriculturalists would also benefit from this information in evaluating conditions at the local level.
- d. Presentation Format – The MSI graphic is web-based and can be accessed via the following URL:  
  
<http://www.crh.noaa.gov/mbrfc/?n=msi>
- e. Feedback Method - We are always seeking to improve our services based on user feedback. Comments regarding the MSI graphic may be provided to:

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Experimental Feedback Period: December 1, 2008 through March 1, 2009.

## Part II - Technical Description

- a. Format and Science Basis - The National Weather Service River Forecast System (NWSRFS) river forecast model is the primary tool used by MBRFC to produce river stage and river flow forecasts. The precipitation-runoff component of the river forecast model is the Sacramento Soil Moisture Accounting Model (SAC-SMA). The SAC-SMA conceptually simulates the physical mechanisms driving water movement through the soil column. The ability of the soil to absorb and hold water is one such physical mechanism. "Tension water" is that volume of water which is absorbed and held by the soil column. Tension water is not available to produce immediate runoff from a precipitation event, or to produce longer-term base flow from water which has percolated downward in the soil column. Tension water deficits within the soil column are replenished by free water, such as is made available during precipitation events. The larger the tension water deficit, the greater the reduction of free water available for runoff or base flow. The modeled tension water within the soil column is represented by two portions, an upper portion which represents the amount of precipitation which has been absorbed and held (not available for runoff), and a lower portion which represents the amount of percolated water which has been absorbed and held (not available for base flow). The MSI is a mathematical representation of the degree to which tension water is present in the entire soil column, and is calculated by the following equation:

$$MSI = \frac{TW_{upper} + TW_{lower}}{TW_{up\ cap} + TW_{low\ cap}}$$

where:  $TW_{upper}$  is the volume of upper portion tension water

$TW_{lower}$  is the volume of lower portion tension water

$TW_{up\ cap}$  is the capacity available for upper portion tension water

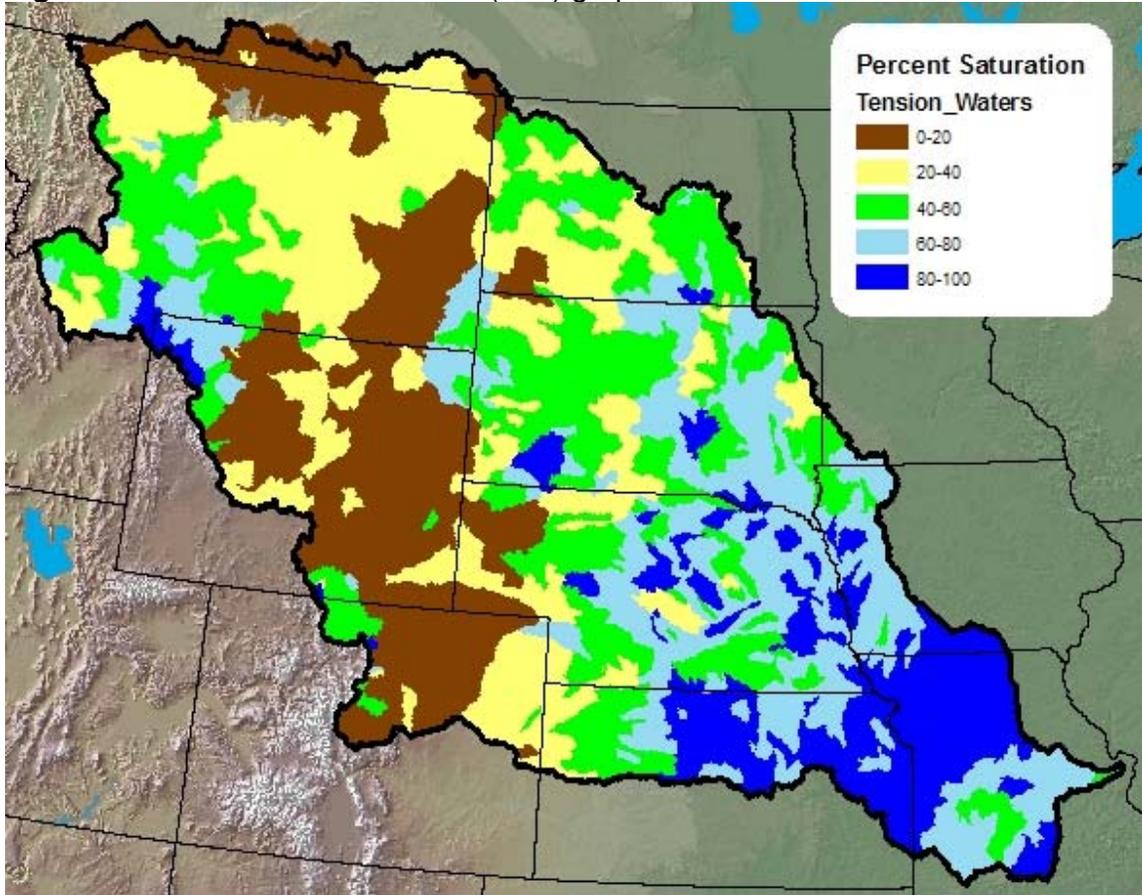
$TW_{low\ cap}$  is the capacity available for lower portion tension water

The 530,000 square mile Missouri River basin has been subdivided into approximately 1200 watersheds. These 1200 watersheds vary in size from about 30 square miles to over 8500 square miles, with the majority of basins being a few hundred square miles in size. A pceg/C program retrieves NWSRFS model output and performs the above computation on an individual watershed basis. The MSI graphic is a geographic display of the individual MSI's as viewed across the Missouri River basin. ArcGIS is used to prepare the web-ready MSI graphic. The MBRFC updates the MSI daily. A sample graphic is shown in Figure 1.

Tension water is only one of the several soil moisture types which the SAC-SMA models in simulating the natural precipitation-runoff process. These various soil moisture types and the mechanisms which determine their quantities interrelate and influence one another in a very complex manner. Viewed alone, the degree to which tension water is present in the soil column (the "MSI") does not give the complete picture of the hydrologic state of a watershed. While not conclusive, the MSI can give the user a sound indication of the potential hydrologic response of a watershed to a precipitation event, or its ability to sustain current streamflow conditions.

b. Product Availability - The MSI graphic is routinely updated once daily.

**Figure 1** Modeled Saturation Index (MSI) graphic.



## MBRFC Moisture Index (percent saturation)

Valid: 11/24/2008 at 6:00AM CST

Created 11/24/2008 at 2:38 PM CST