DROUGHT INDICES AT WORK – MONITORING THE FORMATION AND PROGRESSION OF THE 2006 DROUGHT

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Abstract: On March 26, 2003, Georgia Department of Natural Resources Board approved the Georgia Drought Management Plan (Plan). The hydrological conditions across the State have been such that the Drought Plan has not had a chance to be seriously tested by a severe drought. In 2006, hydrological conditions have been similar to those of the early stages of previous drought. Georgia Environmental Protection Division had monitored the drought indicators identified by the Drought Plan. In June of 2006, EPD Director declared a Level One drought response. This paper presents the first real test of the indicators in the Drought Plan.

Key words: drought, drought indicators, drought response, Georgia Drought Management Plan

INTRODUCTION

In March 2003, Georgia Department of Natural Resources (DNR) and Georgia Environmental Protection Division (EPD) published Georgia Drought Management Plan. The Plan sets forth a process of monitoring and determining the formation and progression of drought conditions. It also sets forth the procedure by which a drought response is declared.

On a regular basis, EPD staff monitors hydrological and meteorological conditions such as stream flows, lake levels, precipitation, and groundwater levels. These are called drought indicators. There are several indicators for each of Georgia's nine Climatic Divisions.

The data of these indicators are provided and routinely updated by various resource agencies, such as U.G. Geological Survey, U.S. Army Corps of Engineers, and National Drought Mitigation Center.

Depending on the severity and extent of dryness, thresholds and levels have been established for each of the indicators. With the formation and progression of a drought, one or more of the indicators will pass the thresholds and reach certain levels. For example, for all indicators, probability of recurrence is used to link indicator values to drought levels. A probability of 0.20 to 0.35 (1 in 3 years to 1 in 5 years of recurrence) puts an indicator into level 1. A recurrence of 1 in 5 to 1 in 10 years would put an indicator into level 2. A 1 in 10 years to 1 in 20 years probability would put an indicator into level 3, and a probability of less than 1 in 20 years would put it into the 4^{th} level.

According to the Plan, when any one of the numerous indicators reaches a certain level for two consecutive months, a preliminary evaluation by the State Climatologist and EPD Director is triggered. If the preliminary evaluation indicates that there might be the need for a drought response declaration for any one of the Climatic Divisions, then the Director will consult with members of the Drought Response Committee to determine the potential severity of the drought and it impacts. The Director will then make a determination of an appropriate level of drought response.

It is important to caution the readers against confusing the level of drought severity, as shown by the indicators, with the level of drought response. The former is a technical concept that shows the comparison between the current conditions and historical ones. The latter reflects a policy resulting from the former.

Depending on the severity of a drought, there are four levels of drought responses. For Municipal and Industrial water users, the responses include restrictions on the timing of outdoor watering to a complete ban on outdoor watering.

Since March 2003, the hydrological conditions have been such that no dry conditions had been severe or long enough to warrant a declaration until the year 2006. In June 2006, a Level One Drought Response was declared.

This paper reviews the drought monitoring efforts and the first utilization of this method in determining a drought condition and the subsequent drought response. The focus of this paper is the technical aspects of the

process. It is the authors' hope that this paper will provide useful information when the Plan is reviewed in 2008 (five years after its inception).

Inception of Dry Conditions in 2006

Signs of dryness began to emerge in the spring of 2006, as precipitation and stream flow crossed their corresponding thresholds and reached various levels in Georgia's Climatic Divisions. For example, in Climatic Division 2, after March 2006, six-month Standard Precipitation Index (SPI-6) and stream flow at Chestatee River near Dahlonega reached level 1, and stream flow at Etowah River at Canton reached level 2.

In Climatic Division 4, SPI-6 and stream flow at Flint River at Montezuma reached level 1 as early as February 2006. In Climatic Division 7, SPI-6 and stream flow at Ichawaynochaway Creek near Milford reached level 1 after March 2006. For Climatic Division 9, the early sign came into existence after April 2006, when stream flow at Satila River at Atkinson reached level 1.

By June 2006, most of the indicators across the State reached level 1 and above. Some of them reached levels 2 and 3. On June 21, 2006, after consultation with members of the Drought Response Committee, EPD Director declared a Level 1 Drought Response across the State.

Progression of Drought Conditions in 2006

Through the spring and summer months of 2006, the dry conditions across the entire State continued to deteriorate. After July 2006, stream flow indicator (Etowah River at Canton) reached level 4. Stream flow indicator reached level 4 in Climatic Division 4 after July 2006. In Climatic Division 7, stream flow (Ichawaynochaway Creek and Spring Creek) indicators reached level 4 after July 2006. All 5 indicators (3 precipitation and 2 stream flow indicators) in Climatic Division 8 reached level 4 after August 2006. Stream flow condition in Climatic Division 9 reached level 4 in November 2006.

To some extent, the 2006 drought resembles those in the years 2000 and 1999. Comparison of monthly cumulative precipitations in Climatic Division 2 of the years 2006 and 2000 is presented in Fig. 1. A similar comparison between the years 2006 and 1999 is presented in Fig. 2. It is interesting to see the similarity between the year 2006 and the previous drought years. This similarity can also be observed in stream flow and in other parts of the State. Figs. 3 and 4 show the comparison of monthly average flow in the Flint River (Newton, in Climatic Division 7) between 2006 and the previous years. Figs. 5 and 6 show a similar comparison of monthly average stream flow in the Ocmulgee River (Lumber City, near the boundary between Climatic Divisions 5 and 8) between 2006 and the previous dry periods.

Not too long after some of the indicators reached the highest level they could, conditions in some of the Climatic Divisions started to improve. Four out of six indicators for Climatic Division 1 started falling after October 2006. Six out of ten indicators for Climatic Division 2 fell after the same month. Six out of nine indications for Climatic Division 3 were at a lower level after October 2006. A few of the indicators for Climatic Division 5 improved to lower levels after November 2006. Climatic Divisions 6, 8, and 9 experienced slower improvement compared to other Divisions, and did not see their indicators recovering to lower levels until the beginning of 2007.

Figs. 7 and 8 show U.S. Drought Monitor in July 2006 and February 2007. It is obvious that, at this point, we are not totally out of drought conditions. Over half of the State is still under "Abnormally Dry" conditions. However, it is also clear that conditions across the State have improved somewhat over the past seven to eight months.

CONCLUSIONS

It appears that the drought indicators and the process set forth by the Georgia Drought Management Plan have had a successful run in detecting and determining the formation and progression of the 2006 drought.

The precipitation and stream flow records show that the dry conditions in 2006 are very similar to those of the previous severe drought years of 2000 and 1999. The actual impacts of these droughts may be different, given the difference in starting conditions. (Year 2000 was after a year and half of persistent dry conditions, and 2006 was a starting dry year that followed a rather wet 2005.) However, an early detection and determination of a drought of this magnitude is nonetheless very important in helping decision-makers making informed decisions on drought responses.

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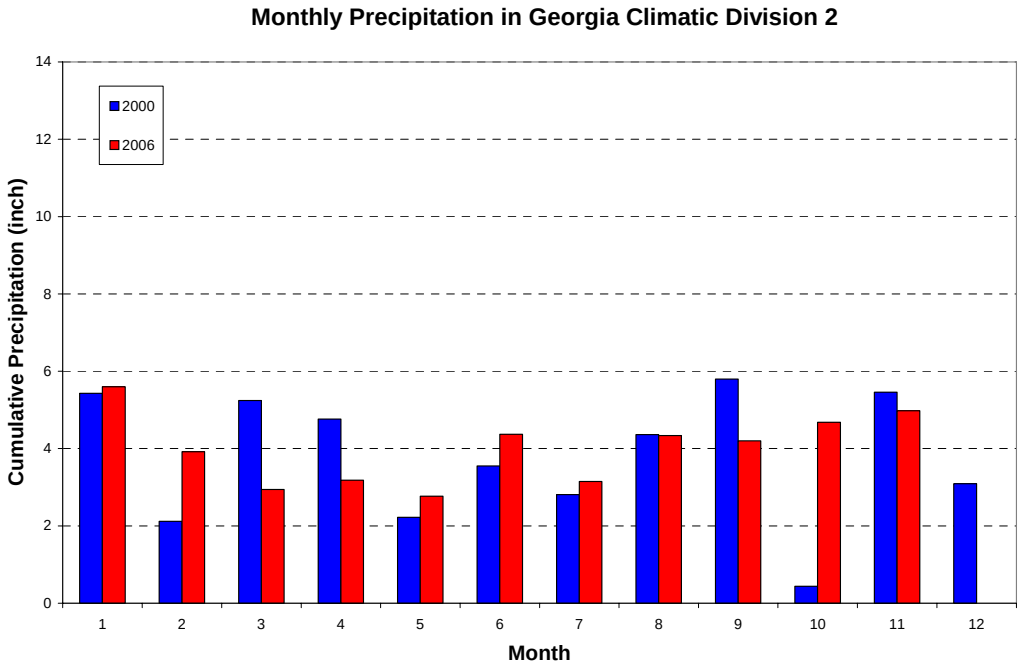

Fig. 1 Monthly cumulative precipitation in Georgia Climatic Division 2 (2006 and 2000)

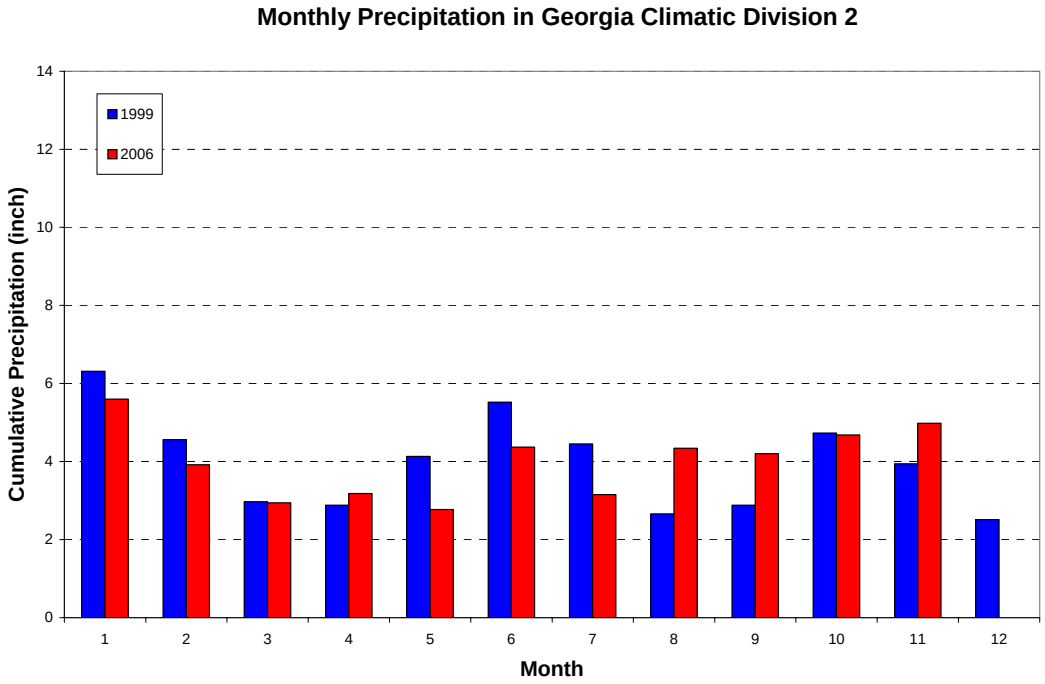

Fig. 2 Monthly cumulative precipitation in Georgia Climatic Division 2 (2006 and 1999)

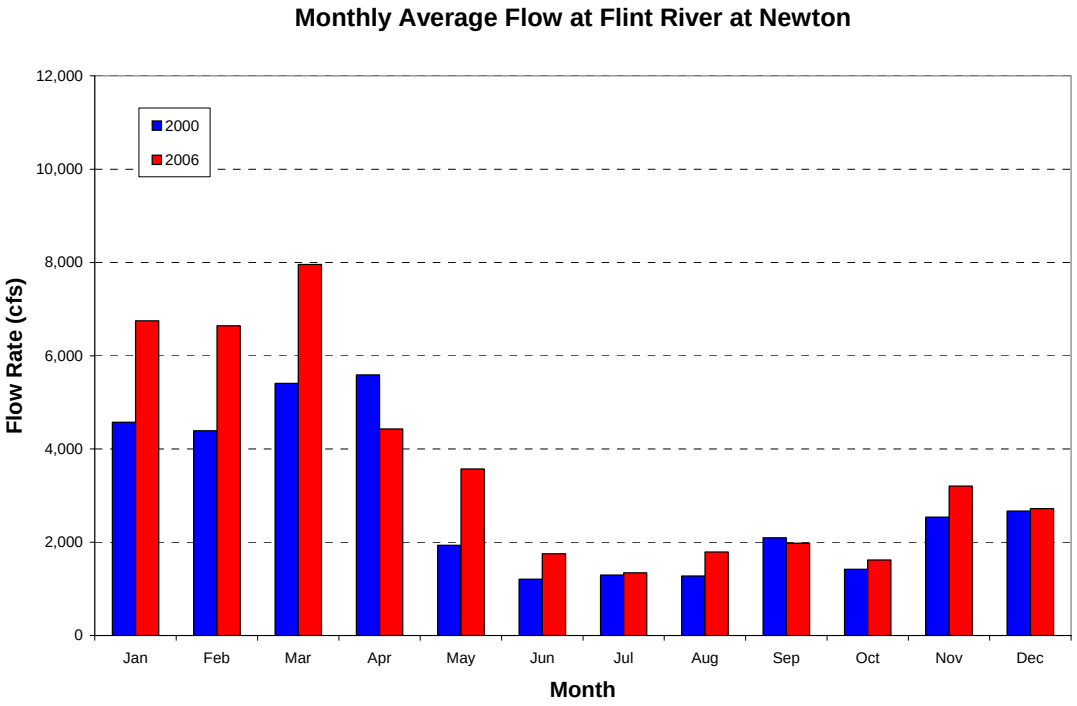

Fig. 3 Monthly average flow at Flint River at Newton (2006 and 2000)

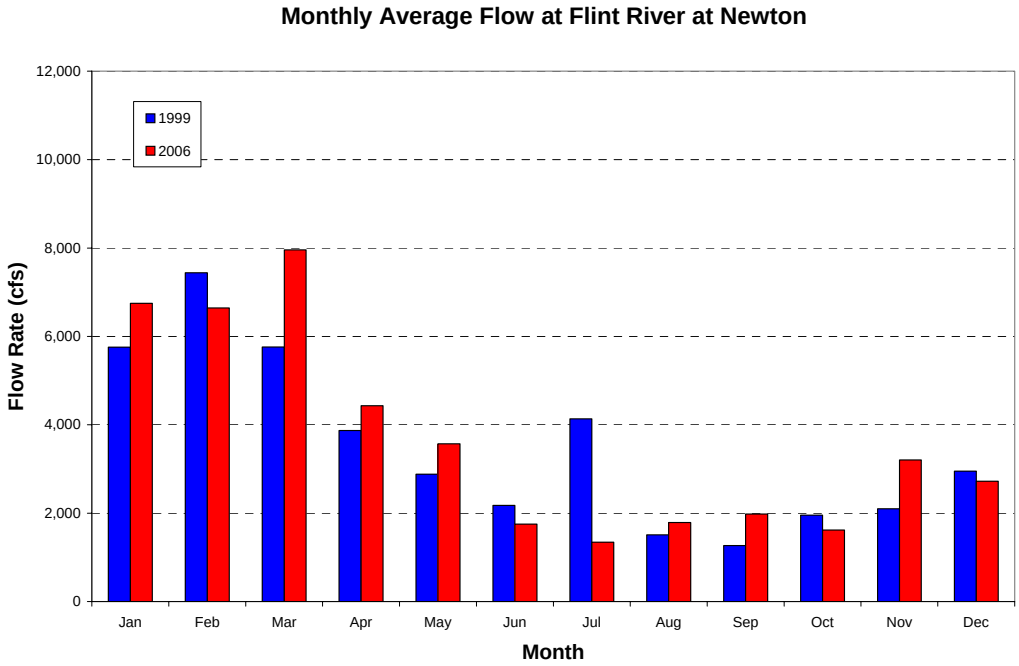

Fig. 4 Monthly average flow at Flint River at Newton (2006 and 1999)

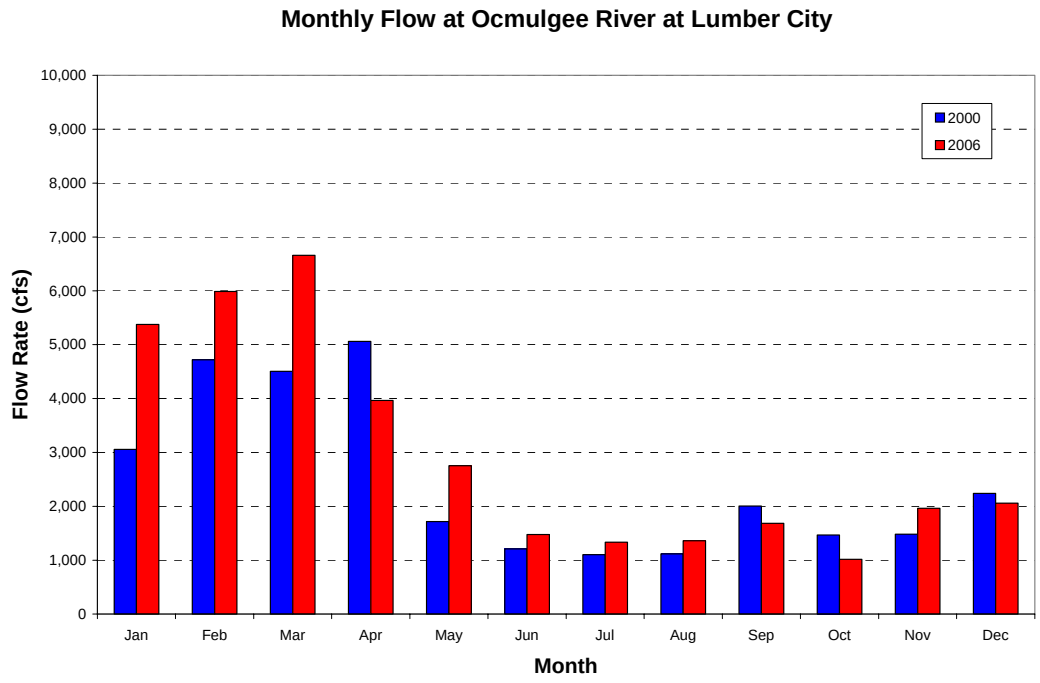

Fig. 5 Monthly average flow at Ocmulgee River at Lumber City (2006 and 2000)

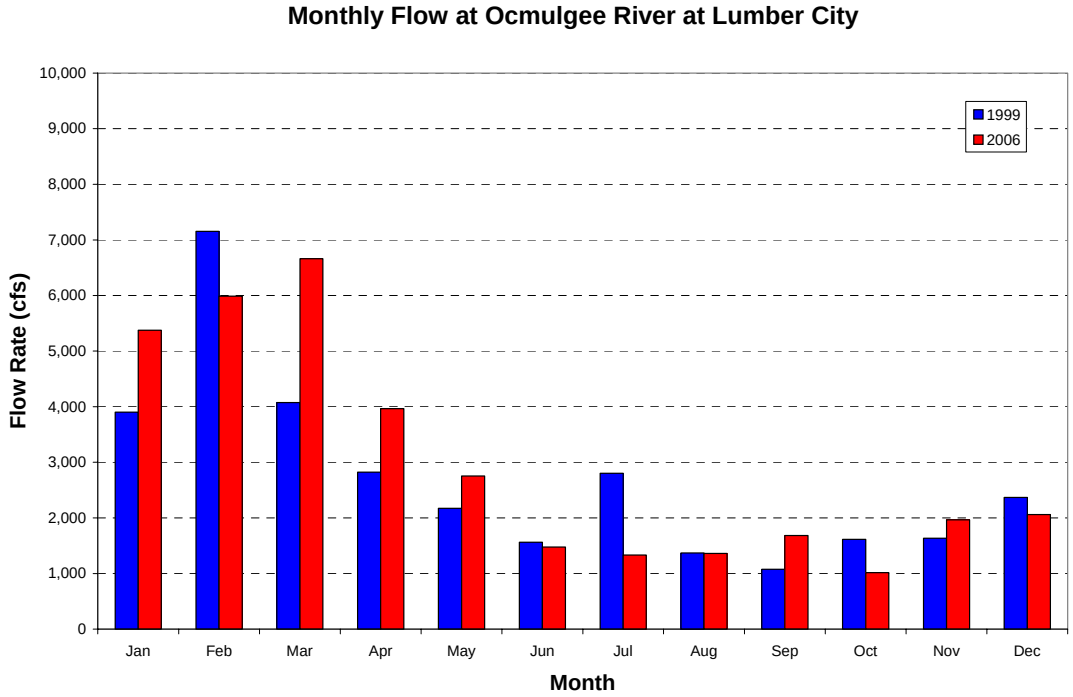

Fig. 6 Monthly average flow at Ocmulgee River at Lumber City (2006 and 1999)

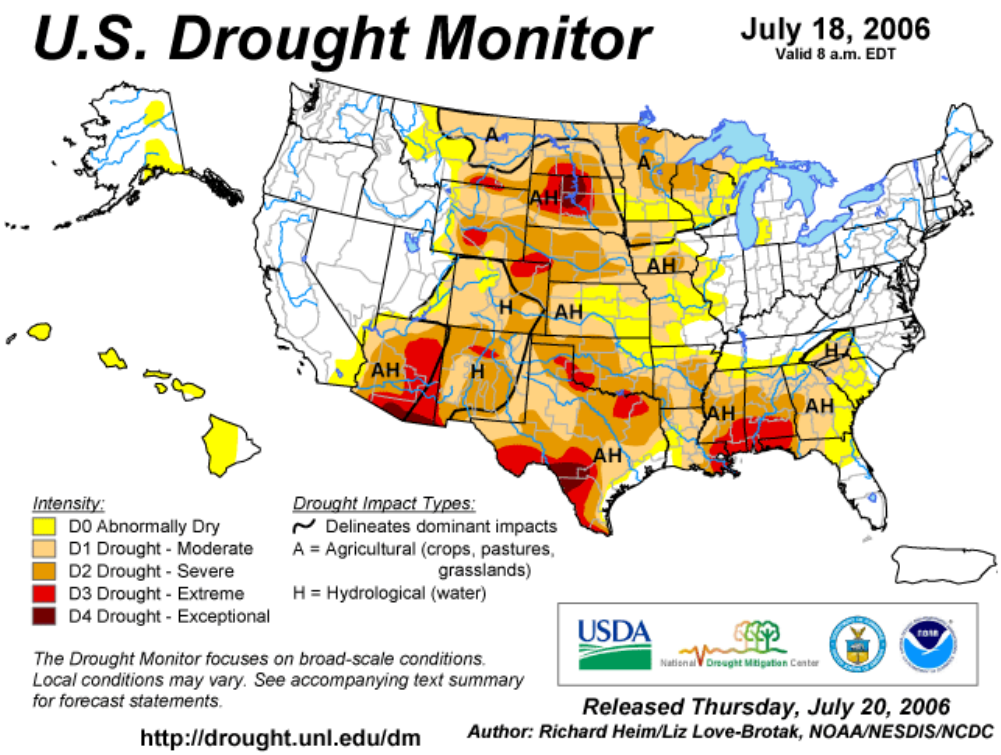

Fig. 7 Drought conditions in July 2006

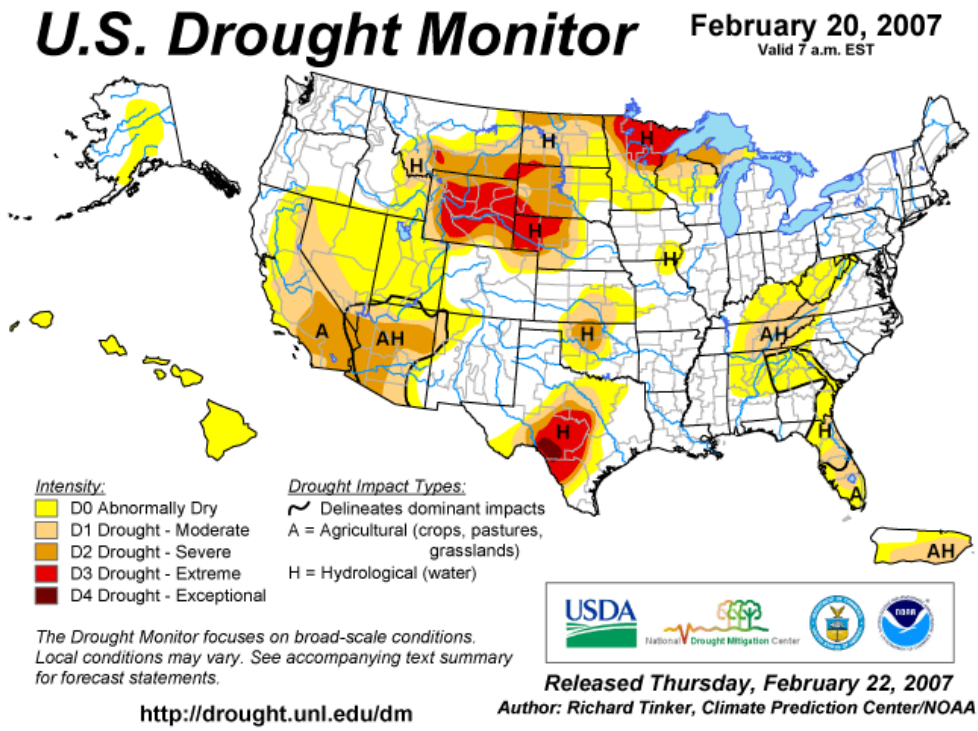

Fig. 8 Seven months later, somewhat alleviated dry conditions in February 2007