THE NADM: PAST, PRESENT, AND FUTURE
(Where Have We Been, Where Are We Going)

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1. INTRODUCTION

Drought experts from the U.S., Mexico, and Canada initiated an operational process in 2002 to provide routine monthly analyses of drought conditions on the North American continent (Lawrimore et al. 2002). Using the same principles and techniques established for the U.S. Drought Monitor (USDM) several years earlier, this process combines a number of drought indicators and indices in a process that includes objective and subjective analysis of conditions across the spectrum from agricultural to hydrological drought (Svoboda 2000). Each analysis results in a North American Drought Monitor (NADM) product which depicts drought conditions at the end of the previous month with severity separated into four categories (D1-moderate, D2-severe, D3-extreme, D4-exceptional). There is also a category depicting abnormally dry conditions (D0), which is typically used for areas that are transitioning into or out of drought.

This single depiction attempts to capture the broad patterns of drought across both short and long timescales. Short-term drought is characterized by changes in climate conditions that occur over periods from a few weeks to a few months with impacts that commonly affect the health of crops and other vegetation (Heim, 2002). Because of its effects on crops and rangelands, this type of drought is referred to as agricultural drought. When drought conditions persist for prolonged periods of many months to years, impacts to surface and sub-surface water supplies become more evident. These hydrological drought conditions typically include reductions in streamflow, groundwater, reservoir, and lake levels. A period of plentiful rainfall following years of drought can alleviate short-term drought while hydrological drought remains.

To help distinguish between the impacts of drought which occur on short and long timescales, the NADM depiction, like that of the USDM, includes an 'A' in regions impacted by agricultural drought, and an 'H' in areas where hydrological drought is occurring. Both are annotated in the areas where both short- and long-term impacts are present (Figure 1).

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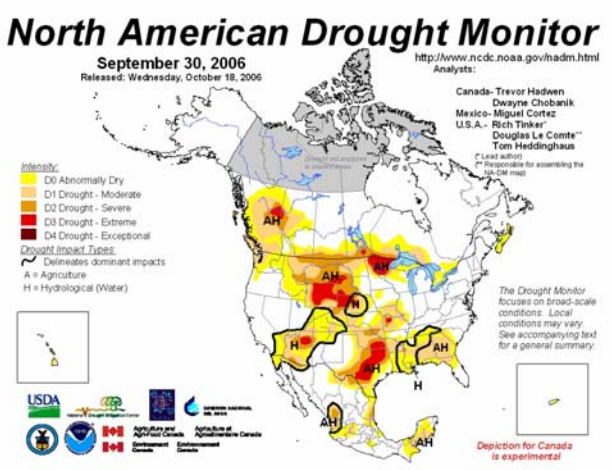

Figure 1. North American Drought Monitor depicting conditions at the end of September 2006. Conditions from abnormally dry to extreme drought are present. Areas impacted by hydrological drought indicated by 'H'. An 'A' indicates areas impacted by agricultural drought. NADM maps from March 2003 to present are available: http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/nadm-map.html.

2. EVOLUTIONARY STEPS OF THE NADM

The first integrated analysis of drought conditions on the North American continent occurred in December 2002 with an NADM product that depicted conditions as of the end of November. This began a process of procedural development and testing that eventually led to public release of the first monthly NADM map in April 2003. The depiction included the label *Experimental* to indicate that the analysis techniques and indicators of drought severity were undergoing a process of review and development (Figure 2).

The drought depiction on the first map covered all of the US and Mexico but included only the Agricultural Prairies of Canada. Areas of Canada outside this region were shaded to indicate no analysis of drought conditions was available. During subsequent months, scientists with Agriculture Agrifood Canada established new partnerships with experts at the provincial and local levels in Canada and developed procedures for analysis and information sharing which would make possible the

analysis of drought in areas of the country outside the Agricultural Prairies. These efforts led to the eventual expansion of coverage in two stages. The first occurred in April 2004 and extended the analysis of drought throughout all parts of the provinces of Manitoba and Saskatchewan, and all but mountainous southwestern Alberta. This was followed by an expansion to include all parts of Canada except the Yukon and Northwest Territories in August 2004 (Figure 3).

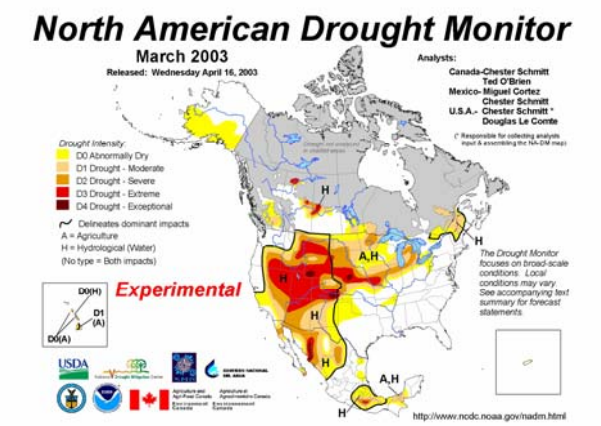

Figure 2. First release of an NADM product to the public in April 2004. Analysis covered all parts of the US and Mexico, and the Agricultural Prairies of Canada.

Other advances in the NADM process included the addition of French and Spanish translations of the NADM maps in October 2003. The text discussion that accompanies each NADM map and describes the drought conditions and major impacts across the continent is also provided in three languages. The initiation of French and Spanish translations of the text discussion occurred in May 2004.

As these and other advances were taking place during the first two years of the NADM, data sharing issues and resource limitations prevented the drought authors from releasing the NADM until well past the middle of each month. As procedures became more firmly established and analysis techniques were further refined, it became possible in 2005 to establish a deadline of the 16th of the month for release of the NADM product. This was the earliest possible date that would allow sufficient time for data collection, analysis, and creation of the NADM product.

Collection of climate data and processing of continent-wide drought indicators takes place at NOAA's National Climatic Data Center. Country-specific drought analyses quickly follow and the lead author then performs additional analyses along the US-Canada and US-Mexico borders in consultation with counterparts in each country. The last step includes a final review by the NADM partners before the NADM product is released to the public.

The evolution of this process eventually made it possible to remove the experimental label from the US and Mexico depictions. This occurred in May 2005. However, for Canada the experimental label remained as additional steps were taken to ensure the operational process for drought analysis and depiction was fully developed.

As part of Canadian capacity building, the rotation of lead authors for the NADM included someone from outside the U.S. for the first time in early 2006. The January 2006 NADM analysis was led by a drought expert from Agriculture Agrifood Canada. Lead authorship will continue to rotate among US and Canadian authors, and within the next year to two years, drought experts with the Meteorological Service of Mexico (Servicio Meteorologico Nacional of Mexico, SMN) will also assume lead authorship of the NADM. Current NADM responsibilities at the SMN include monthly analysis of drought using NADM drought indices for Mexico and other drought indicators across the country to create a country-specific depiction of drought. The lead author uses this analysis in consultation with the SMN scientist to merge the analysis into the GIS depiction for the continent. Ensuring consistency across the US-Mexico border, likewise across the US-Canada border, is an important aspect to developing the final product.

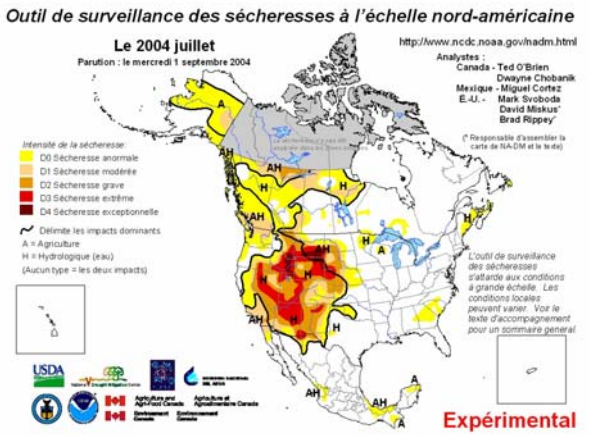

Figure 3. July 2004 NADM map, French translation. Expansion of analysis in Canada to include all but the Northwest and Yukon territories.

3. FUTURE STEPS

Since the inception of the NADM in late 2002, steady progress has been made toward providing an integrated analysis of current drought conditions which is accurate and provided with sufficient timeliness to be a valuable source of information for decision-makers throughout the public and private sectors. A primary long-term goal is the transition from a monthly analysis to a weekly analysis that is conducted with timeliness similar to the US Drought Monitor.

A major impediment to this effort, in addition to a lack of sufficient personnel resources in all three countries, is the lack of an adequate array of climate observations and drought indicators to conduct a complete analysis of drought conditions across the continent on a weekly basis. The current suite of continental scale indicators includes the Standardized Precipitation Index (McKee 1993), percent of long-term average precipitation, the Palmer Drought Index (Palmer 1965), and the Vegetation Health Index (Kogan 1995). The SPI and percent of average precipitation are available on the NADM website (Figure 4, 5), and additional country-specific indicators are used by drought experts in each country. NADM dot maps of SPI and percent of average precipitation cover the entire continent while contoured maps are created only for US-Mexico due to sparse station coverage in Canada.

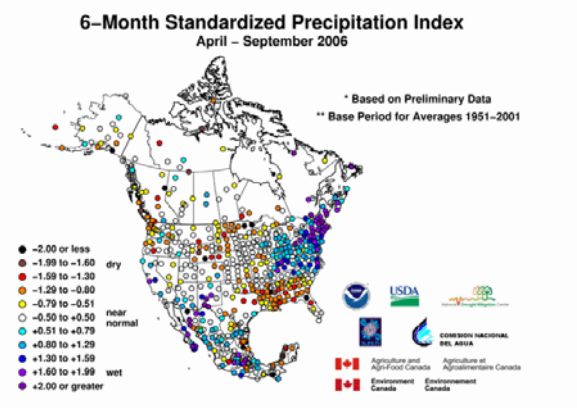

Figure 4. North American 6-month Standardized Precipitation Index for September 2006. Available at http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/spi.html .

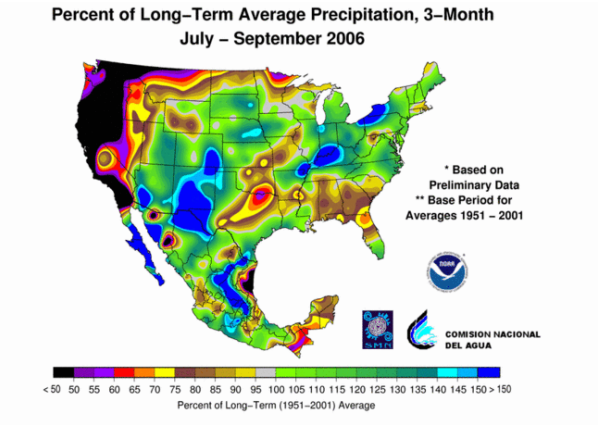

Figure 5. US-Mexico contoured 3-month Percent of Long-Term Average Precipitation for September 2006. Available at http://www.ncdc.noaa.gov/oa/climate/monitoring/drought/nadm/pctpcp.html .

Improvements in the timely availability of high quality in situ measurements with lengthy historical records is needed to improve drought analyses, particularly in parts of Mexico, Canada, and the western U.S. Continued development and integration of satellite and radar products into the drought analysis process is also essential to continued progress. Improvements in the availability of information on drought impacts from the regional to local level are also needed.

Possible solutions and steps toward addressing these and other issues in the coming months and years can be identified through the presentations and discussions which will take place during the NADM workshop. Recommendations and action items identified during the workshop discussions will be summarized and made available at the conclusion of the workshop.

4. REFERENCES

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