The North American Drought Monitor
- History, Approach and Benefits -

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Prepared for the CARIWIN 2nd Senior Administrators Workshop
Caribbean Institute for Meteorology and Hydrology, Barbados
January 19-20, 2009
Presentation Overview

• Why Monitor Drought?
• NADM Background
• USDM / NADM History
• Objectives
• Participants
• Procedure
• Input Indicators
• Where do we go from here?
Why Monitor Drought?

- Drought is a normal part of the Climatic Cycle
- Drought events will likely be more frequent in the future.
- Drought Impacts are significant & widespread
- Many economic sectors are affected
- Drought is expensive
  - Since 1980, major droughts and heat waves within the U.S. alone have resulted in costs exceeding 100 billion dollars
  - In Canada, over the same period, Droughts have resulted in close to 30 billion dollars, with single year droughts in excess of more than 5 billion
Why Monitor Drought?

From National Drought Mitigation Center
Lincoln, Nebraska
Why a “Drought Monitor”? 

• Drought Difficult to Quantify and Measure  
  – Many Drought Tools; None Universally Applicable  
• Important at the National Level  
  – Efforts to improve the planning, preparation and mitigation of drought now include drought monitoring programs at levels from national to regional and local  
• Important at the International Level  
• In today’s global economy the costs and effects of drought often extend beyond international borders  
  – Drought in the Southwest U.S. and a prolonged period of drought in Mexico led to debates about shared water rights  
  – Multi-year drought in the U.S. northern Rockies and western Great Plains extends into the agricultural prairies of Canada, affecting agricultural productivity in both countries  
• Consistent Drought Depiction Across International Boundaries
In the summer of 1998, a dialogue began between the NDMC and NOAA/CPC. What emerged was a plan to develop a classification system for droughts that would be as recognizable to the public as the Fujita tornado intensity scale and the Saffir-Simpson hurricane intensity scale. Early in the process, the U.S. Department of Agriculture (USDA) joined the effort. As a result of meetings held during the spring of 1999, an agreement was reached between NOAA, USDA, and NDMC to produce and maintain a drought monitoring product. Since 1999, NOAA (CPC and NCDC), USDA, and the NDMC have produced a composite drought map -- the U.S. Drought Monitor -- each week with input from numerous federal and non-federal agencies.
The Drought Monitor’s Original Objectives

• A consolidation of indices & indicators into one comprehensive national drought map
• Assessment of current conditions—NOT a forecast!
• A general assessment—not intended to capture all local details
• “Fujita-like” scale
• Try to capture these characteristics:
  – the drought’s magnitude (duration + intensity)
  – spatial extent
  – Probability of occurrence (percentile rank category)
  – Impacts (A – Agricultural & H – Hydrological/Water)
• Incorporates local expert input
• As objective as possible
• Keep things simple for the end user
A partnership between the NDMC, USDA, and NOAA’s CPC and NCDC – Authors

Incorporate relevant information and products from all entities (and levels of government) dealing with drought (RCC’s, SC’s, federal/state agencies, etc.) – Contributors

The Drought Monitor is updated weekly and provides a general up-to-date summary of current drought conditions across the lower 48 states, Hawaii & Alaska, and Puerto Rico.

Integrates daily rainfall reports from thousands of stations

Rates drought intensity by percentile ranks

Uses weekly feedback from local experts to reflect impacts and for the product’s “ground truth”

The US Drought Monitor: A new way of looking at drought in the U.S.
Areas depicted on chart are derived by consolidating information from a number of sources based on surface observation networks and satellite. "Drought" is used to mean abnormal moisture shortages resulting in imminent or actual damage to crops or pastures; high wildfire risk; or water shortages. Only relatively large areas are shown; local conditions may differ markedly from those shown on the map.

LEGEND:
D0 = Abnormal dryness but not currently classified as a drought.
D1 to D4 = Droughts ranging in severity from standard to exceptional.
a = impact on plant life (agric. or forests)
h = impact on water supplies (reservoirs, streams, wells)
+ of - refer to forecast 2-wk trend, where "+" means intensifying and "-" means weakening. No sign means no significant change.
Experimental
U.S. DROUGHT MONITOR
June 15, 1999

LEGEND:

YELLOW (D0) = Drought Watch Area (abnormally dry but not full drought status)
RED (D1-D4) = Current drought ranging in severity from standard (D1) to severe (D2-D3) to extreme (D4)
Drought Type: Used when impacts differ
A = agricultural (crops, grasslands)
P = forestry (wildfire potential)
H = hydrological (rivers, wells, reservoirs)
Plus = Forecast to intensify, Minus = Forecast to diminish

Areas depicted on map are derived by consolidating information from a number of sources based on surface observations and satellite products. "Drought" is used to mean abnormal moisture shortages resulting in imminently or actual damage to crops or pastures; high wildfire risk; or water shortages. Only relatively large areas are shown; local conditions may differ markedly from those shown on the map.
July 27, 1999
Experimental U.S. Drought Monitor

"Drought" means moisture shortages leading to damaged crops or pastures, high wildfire risk, or water shortages. The map is based on information from many sources, including both satellite and surface data, and it focuses on widespread drought. Local conditions may vary.

Yellow (D0) = Drought Watch Area (abnormally dry but not full drought status)

Red (D1–D4) = Current drought ranging in severity from standard (D1) to severe (D2–D3) to extreme (D4)

Crosshatching (,) = Overlapping drought type areas

Drought type: Used when impacts differ
Ag = agricultural (crops, grasslands)
Fire = forestry (wildfire potential)
Hydro = hydrological (rivers, wells, reservoirs)

Plus (+) = Forecast to intensify
Minus (-) = Forecast to diminish
USDM Growing Pains, 1999-2000 Cont’d...

September 28, 1999

U.S. Drought Monitor

Map focuses on widespread drought. Local conditions may vary.

D0 Watch
D1 Drought
D2 Drought-Severe
D3 Drought-Extreme
D4 Drought-Exceptional
Delineates Overlapping Areas

Drought type: used only when impacts differ

A = Agriculture
W = Water
F = Forest fire danger

Plus (+) = Forecast to intensify next two weeks
Minus (-) = Forecast to diminish next two weeks
No sign = No change in drought classification forecast

*Released Thursday, Sep 30, 1999*
The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Wednesday, December 31, 2008
Author: Brian Fuchs, National Drought Mitigation Center
• The North America Drought Monitor is modeled after the highly successful US-Drought Monitor

• The NADM is a cooperative effort between drought experts in Canada, Mexico and the United States.

• The objective is to monitor drought across the continent on an ongoing basis.

• Initiated at a workshop 2002 and is part of a larger effort to improve the monitoring of climate extremes on the continent and to provide an ongoing comprehensive and integrated assessment of drought

• The NADM has been delivering monthly assessments of drought severity on since March 2003.
Evolution of the NADM Effort

- **November 2001**
  - Meeting at NCDC to discuss assessment and monitoring of *climate extremes* across North America
  - The three countries agree in principle to establish extremes monitoring partnership *(NACEM)*
  - Decision to initiate assessment of extremes with most widespread problem – DROUGHT

- First, develop monthly continental drought monitoring capabilities (Develop monitoring program similar to U.S. Drought Monitor)

- Eventually assess long-term variability and trends in extremes *(National Climate Preparedness & Potential IPCC Applications)*
• April 2002
  – Combined USDM / NADM Workshop at NCDC (Ashville NC)
  – One day devoted to discussions on the new drought monitoring program for North America
  – The NADM concept was developed as part of the extremes monitoring initiative
  – Canada made a commitment to provide analyses in the agricultural landscapes of Canada

• December 2002
  – First experimental North America Drought Monitor Map completed

• April 2003
  – First experimental NADM map released
May 2003

- Canada held its first NADM Workshop (Edmonton AB) with the purpose to develop a Canadian team to conduct the NADM operationally. Included federal attendees from EC, NrCan, Statistics Canada as well as provincial representatives from Alberta, Saskatchewan, Ontario, Nova Scotia.

NADM Project Vision - from Edmonton 2003

- A long term co-operative strategy that assures access to **real time and historic** climate data (including non-standard).
- A set of **indicators** that defines drought and has the **flexibility to be geographically sensitive**.
- Indicators that meet the information needs of agriculture, forestry, water use sectors and native ecologies.
- A team from federal and provincial departments and other regional and local centers such as universities work in partnership to complete a national assessment of drought in support of adaptation programs.
- A North American assessment of drought completed on a **routine** and scheduled basis in partnership with the USA and Mexico.
• October 2004
  – AAFC Hosted the NADM International Workshop (Regina, SK)

• Fall 2005
  – AAFC hosted a special focus workshop on Canadian forested regions with the purpose to determine how to monitor conditions in forested regions of Canada (Edmonton AB)

• October 2006
  – The Mexican National Meteorological Service hosted the NADM International Workshop (Mexico City, MX)

• March 2008
  – Canada held its 2nd National NADM Workshop with the purpose to engage more participation in the program especially from Eastern and central Canada (Guelph, ON.)

• October 2008
  – AAFC hosted the NADM International Workshop (Ottawa, ON.)
Participants

- U.S.A.: NOAA, USDA, National Drought Mitigation Center
- Canada: Agriculture & Agri-Food Canada (PFRA), Environment Canada (Metrological Service of Canada)
- Mexico: National Meteorological Service (SMN)

Responsibilities

- Each country determines drought depiction & narrative within their national boundaries
- NADM lead authorship rotates amongst the participants
- NADM lead author integrates national drought assessments from each country, prepares continental monthly map & narrative
- All participants peer review product

Canadian Contributing Organizations

- AAFC-PFRA District and Regional Offices
- AAFC Climate Relate Risk Committee
- Environment Canada
- Natural Resources Canada – Canadian Forest Service
- Alberta Environment
- Alberta Agriculture, Food and Rural Development
- B.C Ministry of Environment – River Forecast Centre
- Manitoba Hydrologic Forecast Centre
- Ontario Ministry of Natural Resources – Low Water Response
- Saskatchewan Agriculture, Food and Rural Revitalization
- Saskatchewan Watershed Authority

All arrangements with contributing organizations are informal at this point
Drought can mean many different things to different people

- Depending on:
  - their normal climate
  - their needs

- Main categories of drought are
  - meteorological
  - agricultural
  - hydrological
  - (socioeconomic)

Most Drought indices measure meteorological drought

The availability of water depends largely on rainfall, (but) the concept of drought cannot be divorced from the use to which water is put. Gibbs & Maher (1967):
Types of Drought

Figure 1. Relationship between meteorological, agricultural and hydrological drought (NDMC, 2006)
The North America Drought Monitor blends science and art. There is no one 'correct' way to measure drought. Drought indices are used to detect and measure droughts, but different indices measure drought in different ways, and no single index works under all circumstances.
“The essence of drought is in its impact”

D. Wilhite, National Drought Mitigation Center, Lincoln, Nebraska
4 drought categories (D1-D4) plus abnormally dry (D0) category, based on percentile rank (Fujita-like scale)

- **D0 – Abnormally Dry** (30 Percentile Rank)
  - Once every 3 to 5 years

- **D1 Drought** – **Moderate** (20 Percentile Rank)
  - Once every 5 to 10 years

- **D2 Drought** – **Severe** (10 Percentile Rank)
  - Once every 10 to 20 years

- **D3 Drought** – **Extreme** (5 Percentile Rank)
  - Once every 20 to 50 years

- **D4 Drought** – **Exceptional** (2 Percentile Rank)
  - Once every 50 years or less
## Drought Severity Classifications

### Drought Severity Classification

<table>
<thead>
<tr>
<th>Category</th>
<th>Description</th>
<th>Possible Impacts</th>
<th>Palmer Drought Index</th>
<th>CPC Soil Moisture Model (Percentiles)</th>
<th>USGS Weekly Streamflow (Percentiles)</th>
<th>Percent of Normal Precipitation</th>
<th>Standardized Precipitation Index (SPI)</th>
<th>Satellite Vegetation Health Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>D0</td>
<td>Abnormally Dry</td>
<td>Going into drought: short-term dryness slowing planting, growth of crops or pastures; fire risk above average. Coming out of drought: some lingering water deficits; pastures or crops not fully recovered</td>
<td>-1.0 to -1.9</td>
<td>21-30</td>
<td>21-30</td>
<td>&lt;75% for 3 months</td>
<td>-0.5 to -0.7</td>
<td>36-45</td>
</tr>
<tr>
<td>D1</td>
<td>Moderate Drought</td>
<td>Some damage to crops, pastures; fire risk high; streams, reservoirs, or wells low, some water shortages developing or imminent; voluntary water-use restrictions requested</td>
<td>-2.0 to -2.9</td>
<td>11-20</td>
<td>11-20</td>
<td>&lt;70% for 3 months</td>
<td>-0.8 to -1.2</td>
<td>26-35</td>
</tr>
<tr>
<td>D2</td>
<td>Severe Drought</td>
<td>Crop or pasture losses likely; fire risk very high; water shortages common; water restrictions imposed</td>
<td>-3.0 to -3.9</td>
<td>6-10</td>
<td>6-10</td>
<td>&lt;65% for 6 months</td>
<td>-1.3 to -1.5</td>
<td>16-25</td>
</tr>
<tr>
<td>D3</td>
<td>Extreme Drought</td>
<td>Major crop/pasture losses; extreme fire danger; widespread water shortages or restrictions</td>
<td>-4.0 to -4.9</td>
<td>3-5</td>
<td>3-5</td>
<td>&lt;60% for 6 months</td>
<td>-1.6 to -1.9</td>
<td>6-15</td>
</tr>
<tr>
<td>D4</td>
<td>Exceptional Drought</td>
<td>Exceptional and widespread crop/pasture losses; exceptional fire risk; shortages of water in reservoirs, streams, and wells creating water emergencies</td>
<td>-5.0 or less</td>
<td>0-2</td>
<td>0-2</td>
<td>&lt;65% for 12 months</td>
<td>-2.0 or less</td>
<td>1-5</td>
</tr>
</tbody>
</table>

Revised 3/21/01

**Additional indices used, mainly during the growing season, include the USDA/NASS Topsoil Moisture, Crop Moisture Index (CMI), and Keetch Byram Drought Index (KBDI). In the West, indicators include the River Basin Snow Water Content, River Basin Average Precipitation, and the Surface Water Supply Index (SWSI).**

Indices used primarily during the snow season and in the West include the River Basin Snow Water Content, River Basin Average Precipitation and SWSI.
Initially Canada was only assessing the agricultural areas and maps were only produced in English.

- Added French and Spanish versions in November 2003
- Added northern regions of the prairies in the spring of 2004.
- Later in 2004 the rest of the Canadian Provinces, outside the agricultural extent were added.
- We still do not map the territories!
Regions in northern Canada may not be as accurate as other regions due to limited information.
• The U.S. portion of the NADM uses the **U.S. Drought Monitor (USDM)** for the week closest to the end of the month

• **USDM authors include:**
  - NOAA (NCDC, CPC)
  - USDA (JAWF)
  - National Drought Mitigation Center
  - Western Regional Climate Center

• **NOAA/NCDC:**
  - Maintains NADM web site
  - Computes continental indicators
  - Developing NADM objective blends

• **NDMC:**
  - Maintains USDM web site

• **NOAA/CPC:**
  - Maintains USDM / NADM ftp site

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[Image: U.S. Drought Monitor]
Integrates Key Drought Indicators:
- Palmer Drought Index
- SPI
- KBDI
- Modeled Soil Moisture
- 7-Day Avg. Streamflow
- Precipitation Anomalies

**Growing Season:**
- Crop Moisture Index
- Sat. Veg. Health Index
- Soil Moisture
- Mesonet data

**In The West:**
- SWSI
- Reservoir levels
- Snowpack
- Streamflow
1. Production of the near real time monitoring products. (1st of each month) *(Drought Watch – [www.agr.gc/drought](http://www.agr.gc/drought))*
2. Data sent from Environment Canada to NCDC and NAIS. (5-7th)
3. Production of the monthly National Drought Model products
4. Collection of other various maps and reports from a wide range of organizations. (including AAFC Climate Production Related Risk Committee)
5. Create Canadian Draft Assessment Map merged with US and Mexican assessments.
6. Send out the draft map to the Canadian Review Team. (8-9th)
7. Evaluate and incorporate feedback into a final map of Canada
8. Add impact areas on to the map
9. Work out border issues with the US authors
10. Draft Narrative
11. Finalize map and narrative (15th)
Monthly assessments are based on a wide range of products at national, provincial and regional scales.

The data consists of near real time monitoring (AAFC and others), maps from the national drought model (AAFC), and a wide variety of provincial/regional products.

Assessments also use many conditions reports from other agencies including provincial crop reports, stream flow reports, low water level advisories.
Near Real-Time Monitoring Network

- Mapped NRT stations = 508
- Complete List of NRT Stations = 761
- Maps include:
  - % of normal ppt
  - Percentile ppt
  - Accumulated ppt
The National Drought Model:

- **Drought Model Stations**
  - For April 2007 = 874

- **Standardized Precipitation Index (SPI)**
  - From 1 month to 5 years

- **Soil Moisture**
  - Percent of Average
  - Difference from Normal
  - Total Soil Moisture
  - Has the ability to do future projections

- **Palmer Drought Index (PDI)**
  - PDI
  - Palmer Z – Moisture Anomaly
Two Major Drought Indicator Types

1. “Relative Indicators”

Provide a measure of moisture relative to the long-term mean and variability at a given location.

e.g., - Standardized Precipitation Index,
- Palmer Indices
- Percent of Average

2. “Absolute Indicators”

Provide a measure of moisture conditions as they affect biophysical processes such as fire (fuel moisture), forest carbon & water fluxes (soil moisture) & stream flow (water runoff)

e.g., - Canadian Forest Fire Weather Index System
- Climate Moisture Index
The NADM drought assessments are determined independently, within each country, based on different data, indices, & analyses.

Drought indices covering entire continent are needed:
- Same indices, same analysis period, same methodologies
- This consistency needed for depiction across international boundaries

• Standardizing Period: 1951-2001 (for PCTPCP, SPI, PDI)
• Station Network Density in Canada Coarse
• Results in Unreliable Contours
Other indicators that could be used

- University College London’s Global Drought Monitor
Other Alternatives—Continental Modeled Data

NOAA/CPC Leaky Bucket Soil Moisture Percentiles

Calculated Soil Moisture Ranking Percentile
AUG 2006
Remotely Sensed Data

Near-Real-Time NDVI composite generation from MODIS

NOAA/NESDIS Satellite Vegetation Health Index

Weekly NDVI, AVHRR Data

Area with extensive aspen dieback during 2001-2002 drought

Weekly NRT surface wetness and surface temperature anomaly data from passive microwave data
Blended Indicators

- Operationally Integrate multiple indicators in a weekly update using a percentile ranking method
- The US produces these maps on a weekly time step using CPC’s real-time daily, weekly climate division data and NCDC’s Monthly archive of indices for 1932-2000.
- All products are first rendered as percentiles with respect to the 1932-2000 data.
- Canada is exploring the creation of blended indicators similar to USDM Objective Blends, but with different components and likely different weights
- Would need serially complete data, so could not be computed on station data

**Short-Term Blend**
- 35% Palmer Z Index
- 25% 3-Month Precip.
- 20% 1-Month Precip.
- 13% CPC Soil Model
- 7% Palmer Drought Index

**Long-Term Blend**
- 25% Palmer Hydro. Index
- 20% 24-Month Precip.
- 20% 12-Month Precip.
- 15% 6-Month Precip.
- 10% 60-Month Precip.
- 10% CPC Soil Model
The Importance of Local Expert Input

- The U.S. Drought Monitor Team Relies on Field Observation Feedback from the Local Experts for Impacts Information & “Ground Truth”
  - Listserver (140-150 Participants: 2/3 Federal, 1/3 State/University)
• Lack of station data for northern regions.
• Lack of understanding of drought assessment and drought issues in northern areas, especially north of the treeline.
• Research is required on how to address these issues.
• First priority is to improve monitoring in the boreal regions.
• We need to develop relative indicators for northern regions. CFS currently uses Absolute indicators.
• Remove sensing may be able to assist in some regions.
• Currently EC is sending data to the NCDC to be used in creating the NADM indicator maps.

• Lack of station density in Canada has prevented us from providing and interpolated map of all of North America.

• The data that is represented on the dot maps is far below what we currently get from EC for our Drought model products.

• This issue needs to be examined.
The Importance of Station Density

Percent of Average Precipitation in Agricultural Areas
September 1, 2001 to April 30, 2002

- Extreme Dry (<40% of Average)
- Well Below Average (40-60% of Average)
- Below Average (60-85% of Average)
- Average (85-115% of Average)
- Above Average (115-150% of Average)
- Well Above Average (150-200% of Average)

Environment Canada/Ontario Weather Network
= 101 Stations

Environment Canada/Ontario Weather Network + TCMN
= 231 Stations
Roadblocks in the Drought Monitoring Process: Portrayal of Drought Resolution

**Maryland:**
- 8 Climate Divisions
- 10,460 square miles
- Elevation Range: sea level to 3,360 feet

**Colorado:**
- 5 Climate Divisions
- 104,091 square miles
- Elevation Range: 3,320 to 14,433 feet
Potential Data – Untapped Data Options

New sources of data from:

- Private networks i.e. Weather Innovations (WIN) and the Weather Bug.
- Provincial seasonal networks - i.e. agriculture and forestry departments
- New projects such as Crop Insurance Weather Derivatives
The USDM is moving toward state-level trend analysis capabilities (left) and providing more county-level drought assessment information (right).

Is this a model that we would like to follow? Do Canada and Mexico have the ability to monitor at this scale?
Spatial resolution is also critical to drought monitoring and assessment.
Continental US Impacts
11-21-06 – 11-21-06
- 2 Society & Public Health
- 5 Agriculture
- 5 Disaster Declarations & Aid
- 3 Energy
- 8 Water Supply & Quality
- 2 Wildfire
- 1 Plants & Wildlife
- 4 Other Business & Industry
- 2 Tourism & Recreation

USDA extends emergency grazing on CRP acres in 30 states
- Disaster Declarations & Aid
- Agriculture Secretary Mike Johanns has lengthened the time allowed for emergency livestock grazing on land in the Conservation Reserve Program (CRP) in 30 states for farmers and livestock owners who were affected by drought. The deadline is usually September 30... more
Exploring Internet Mapping Systems (IMS)

an option of receiving data and reports
The National Integrated Drought Information System

NIDIS is an integrated, interagency national drought monitoring and forecasting system that provides:

- An early warning & forecast system for drought.
- Drought impact and causation education.
- Information for drought mitigation.
- An interactive, web-based drought portal.
- Improved observational capabilities.

A Web site and services that improve the access, processing, and sharing of structured and unstructured information within and across a given “enterprise” through Service-Oriented Architecture that Fosters ease of communication.

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Moving Forward: Spatial Overlays

(For more advanced GIS features, launch the NOAA Climate Data Viewer)
Moving Forward: Spatial Overlays Cont’d...
The Layer Selection enables the customization of the Map View overlay menu. The 'Active Map Layers' section determines what is available in the overlay menu, as well as, the order in which the layers will overlay. To Add/Remove layers, or change the order in which the layers are rendered, simply click-and-drag the items to the desired location.

**Active Map Layers**

- USGS-NDMC: VegDRI
- National Drought Mitigation Center (NDMC): U.S. Drought Monitor
- U.S. Geological Survey (USGS): County Boundaries
- U.S. Geological Survey (USGS): Climate Divisions
- U.S. Geological Survey (USGS): State Boundaries
- National Geophysical Data Center (NGDC): U.S. Hydrologic Regions
- U.S. Geological Survey (USGS): Total Precipitation - 7 day
- U.S. Geological Survey (USGS): Total Precipitation - 30 day
- U.S. Geological Survey (USGS): Max Consecutive Dry Days - 7 day
- U.S. Geological Survey (USGS): Max Consecutive Dry Days - 30 day
- U.S. Geological Survey (USGS): Percent of Avg. Seasonal Greasiness
- U.S. Geological Survey (USGS): USSPI
- Iowa State: 45 Minute NEXRAD

**Inactive Map Layers**

- National Climatic Data Center (NCDC): Climate Division Data - Precipitation Index
- National Climatic Data Center (NCDC): Climate Division Data - Palmer Drought Severity Index
Moving Forward: Spatial Overlays Cont’d...
Potential Opportunities and Areas of Growth and Limiting Factors

- Possibilities are endless, however we face some significant limited factors including:
  - **Lack of data** - Most of our data is for the agricultural areas of Canada. Very little is available for artic or even the boreal areas. There is certainly room to improve this by adding more provincial data.
  - **Need for research**. We need to better understand how to assess drought regionally, including in northern Canada.
  - **The resources** (people and money) dedicated to this project is very low in Canada (as well as Mexico); we need to expand the team within Canada to deliver the NADM more efficiently and more accurately.
  - In order to progress the NADM in Canada we must link the assessments to **programs and policy**
Current Research Activities to Improve Monitoring and our Understanding of Drought in Canada

• Relevant Indicators
  – Can we apply these indicators uniformly across the continent?
  – Are these indicators sensitive to the climate variations in the diverse geography of Canada’s agricultural landscape, and throughout North America, and can they be applied in the generalized and uniform way they are proposed?
  – Using percent of normal precipitation criteria as defined for NADM, in humid locations obtaining a drought classification beyond D1 (moderate drought) would be rare

• Trigger levels – **intensity, duration**

• **Timing** of moisture deficiencies as it relates to:
  – Runoff – stream flow, pond, lake and reservoir levels
  – Soil moisture
  – Perennial crop yield
  – Annual crop yield
  – Groundwater levels
Summary of issues

- Canadian environment is complex (making a summary of what is going on is not easy)
- Inputs to generate DI’s are not always there
- A number of indices may not be meaningful at some locations
- Sensitivity analysis has not been done- uncertainties in most of the indices are unknown
- Conflict among indices:
  - Moderate drought (D1) using the percent of normal precipitation while the SPI values classified an extreme drought (D3).
NADM - Strengths

• Continental-scale depiction of drought
• Consistent across international borders
• Integrates many indicators
• Provides a integrated image (easy-view) of all drought conditions in one product
• Pool resources, increase communication, increased cooperation and collaboration.
• Uses input from local experts.
• Catches local errors
NADM – Future Goals

- Increase spatial density of stations across North America
- Better understand the application of indicators on local conditions
- Continue to research and develop a set of indicators that defines drought but has the flexibility to be geographically sensitive and meaningful to all sectors.
- Better understand the needs of each of the regions in terms of drought monitoring and reporting.
- Develop blended of indices for Canada on a regional scale.
- Develop contacts with in the regions to assist with local conditions reporting
- Improve our understand and ability to monitor outside the agricultural region of Canada.
- Do a better job incorporating hydrologic data
- Improve our data density Incorporate Remote Sensing data into the assessments
- Explore linking NADM to policy and programs in Canada.
Thank You

Trevor Hadwen
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Agriculture & Agri-Food Canada

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Other Benefits of the NAD

North American Drought Monitor
Climatology Maps
National Oceanic and Atmospheric Administration
National Climatic Data Center

North American Drought Monitor
Geographical Reference Maps
National Oceanic and Atmospheric Administration
National Climatic Data Center

Click on maps for full-size image.

Canadian Ecozones
(Provided by Agriculture and Agri-Food Canada)

U.S. Crop Areas
(Provided by USDA/Joint Agricultural Weather)

U.S. Geographical Regions
(After Weekly Weather and Crop Bulletin)