Monitoring agri-environmental risk using satellite soil moisture from SMAP

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Science and Technology Branch
**Risks** = short or long term exposures to conditions that negatively impact agricultural production or the long term sustainability of agricultural lands

### 2016 National Dashboard of Agroclimate Risks

<table>
<thead>
<tr>
<th>Date</th>
<th>BC</th>
<th>AB</th>
<th>SK</th>
<th>MB</th>
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*Green/Yellow/Orange/Red is a continuum of "No significant risk" to "Large or Urgent risk."

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**Drought Monitoring**

*Prepared by Agriculture and Agri-Food Canada's National Agroclimate Information Service. We also acknowledge various provincial, territorial and non-governmental organizations whose inputs and assessments are included. The Drought Monitor reflects " Kremlin " conditions. Whereas in southern Canada may not be as accurate as other areas due to limited information.*
Assessing Risk Using Geospatial Data

Risk reporting and modelling integrates a large number of spatial data sets to achieve a confluence of evidence approach to determine risk.

Risk assessments are largely based on characterizing historical risks and using current data to identify and model impacts.

Data need to provide both current and historical characterization of conditions, therefore climate stations have been the most reliable source of information for this:

- Stations lack spatial representation, particularly in rural areas where it is most needed.
- Remote sensing data lacks historical data, and doesn’t map well statistically to more traditionally used data sets.

- Use a confluence of evidence approach – need multiple data sets to verify spatial extent, intensity and duration of risk events.

- Link to impacts – can data sets and thresholds be established that map to specific impacts (crop loss, too wet to seed).
Where does satellite soil moisture fit it?

- Satellite soil moisture quantifies surface moisture, so when used directly to assess moisture availability for agriculture, it provides a ‘wetness index’ for the surface that accounts for differences in soil water holding capacity.

- Simple difference from long term average provides a fairly robust indicator of moisture extremes.

SSM/I Water Index, AMSR-E, SMOS

Provides a useful index that can be combined with other data sets for risk assessment.
Satellite Soil Moisture

The following maps and data show levels of moisture in the top five centimeters of soil in Canada on a weekly, bi-weekly and monthly basis. These information products highlight where conditions are wetter or drier than normal.

Soil moisture difference from average – interactive map showing data from previous month

Legend:
- < -10%
- -10% to -7.5%
- -7.5% to -5%
- -5% to -2.5%
- 0% to 2.5%
- 2.5% to 5%
- 5% to 7.5%
- 7.5% to 10%
- > 10%
Evaluation of SMAP for Agricultural Risk Assessment

Objectives for SMAP

• Evaluate SMAP soil moisture data sets (Active-Passive, Passive, Level 4 Analysis Update) for use in agricultural risk assessment over two growing seasons
  • Evaluate for accuracy in capturing relevant trends during the growing season
  • Does SMAP improve assessment of surface hydrology relevant to risk assessment
  • Can SMAP improve prediction of impacts to agriculture (ie improved quantification of crop water stress for yield forecasting)

• Compare against current tools in use (SMOS, VSMB modelled water uptake)

• Preliminary Results
Evaluation Against In Situ Sensors (RISMA sites)

Ontario

Manitoba
SMAP Soil Moisture Trends

Soil Moisture near Edmonton Alberta

- In Situ Soil Moisture
- Level 3 Active-Passive
- Level 3 Passive (Enhanced)
- Level 4 Analysis Update

Soil Moisture (Standardized Normal Deviate)

SMAP Soil Moisture (9km Passive Enhanced)

- Compare SMOS and SMAP time series
- Use SMOS history recalibrated to SMAP soil moisture to create SMAP soil moisture index
- Compared against Climate Risk Reports, Drought events and in situ stations

Used RQF flag to remove SMAP soil moisture retrievals over areas with greater error in the retrieval (SMOS is not flagged for high VWC)
Climate Production Risk Categories

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- SMOS and SMAP soil moisture for each province was extracted at a monthly time scale and categorized according to risk severity and risk type.
Designating Risk Groups with SMOS and SMAP

SMAP Soil Moisture Index

SMOS Soil Moisture Index
Relating Soil Moisture to Impacts – Crop Yield

- Relationship between yield and satellite soil moisture is crop dependent and region dependent
- Need to improve understanding of how soil moisture from satellites tracks yield variation
- How accurate does soil moisture need to be to quantify yield differences?

2015 Wheat Yield AB & SK

2015 Canola Yield AB & SK
Preliminary Conclusions

• Improved accuracy of SMAP showing a small improvement in assessing risk areas at provincial scale – need to look at localized impacts to better assess magnitude of the improvement

• Crop water stress is a significant factor in determining yields, but the magnitude is region and crop dependent – need to improve regional assessment of soil moisture impacts on crop yield
  – Township level assessment using statistical and process based methods (DSSAT)

• SMAP-SMOS have both provided improvements in assessing risks to agriculture; further improvements in data accuracy and spatial support of measurements (ie root zone measurements) will likely further improve this assessment.
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Open Data:
[http://www.agr.gc.ca/atlas/geoplatform#home](http://www.agr.gc.ca/atlas/geoplatform#home)

[www.data.gc.ca](http://www.data.gc.ca)

Drought Watch:
[http://www.agr.gc.ca/eng/?id=1326402878459](http://www.agr.gc.ca/eng/?id=1326402878459)