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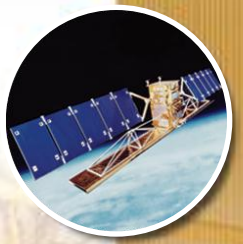

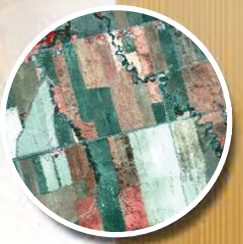

Soil Moisture Retrieval and Plans to Implement Soil Moisture Mapping for Monitoring in Manitoba

3rd Canadian SMAP Workshop
Ottawa, ON – March 20-21, 2013

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Agriculture & Agri-Food Canada – Science & Technology Branch

Canada

PRESENTATION OVERVIEW

1. Importance of Soil Moisture Information to the Agricultural Sector.

2. Agriculture & Agri-Food Canada (AAFC) - Current Research

3. Next Steps, In Situ Soil Moisture Network, SMAPVEX12

Impact of Soil Moisture Extremes on the Canadian Agricultural Sector

- Extremes in soil moisture dramatically reduce farm income, triggering large-scale responses in risk-management and disaster financial assistance.

- The 2001-02 drought cost the Canadian economy **$5.8 billion.**

- In 2010 excessive moisture conditions in the Prairies reduced the productive capacity of over 15 million acres, affecting over 30,000 Canadian producers, and resulting in production losses of more than **$2.4 billion.**

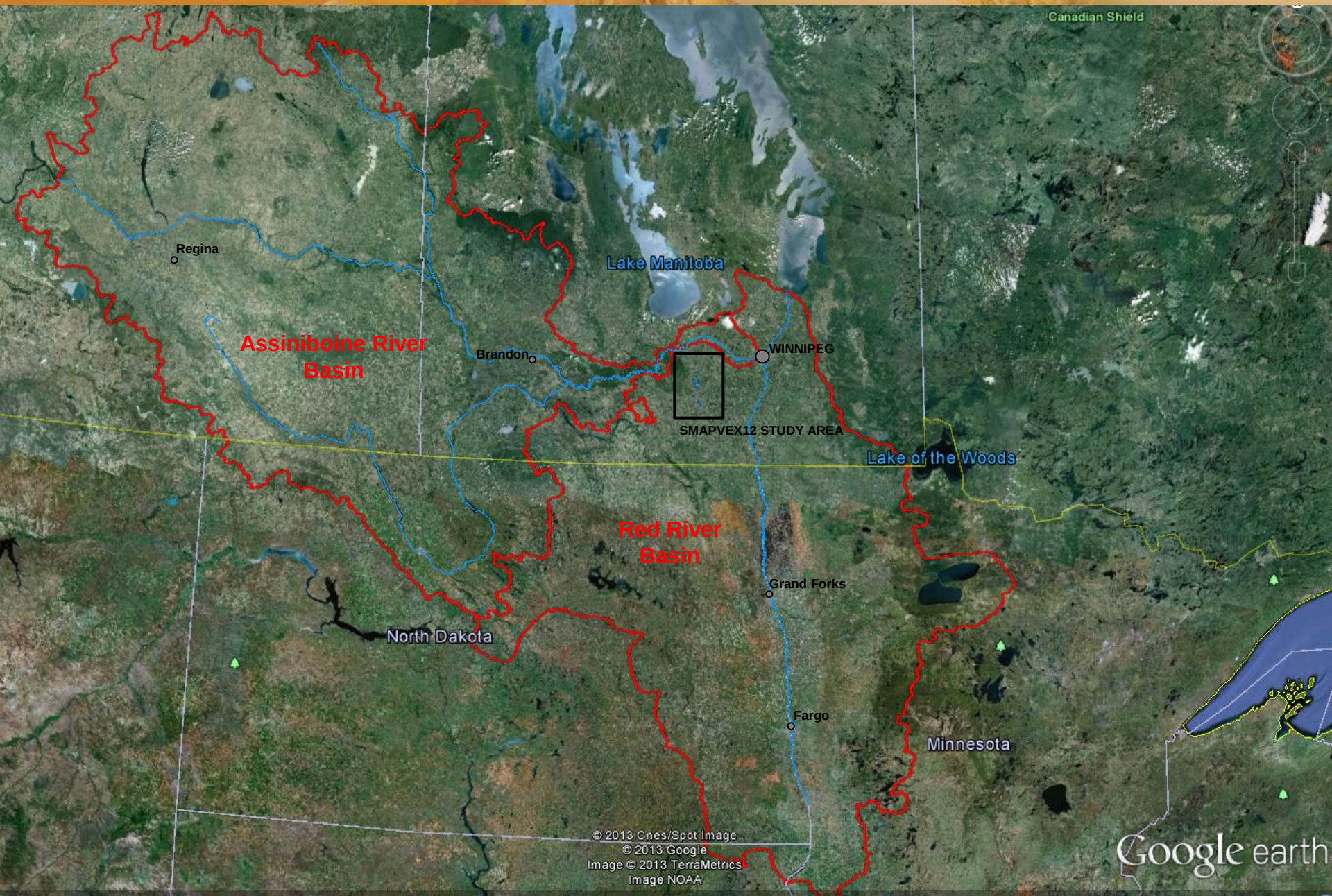
- Timely soil moisture information would improve the sector's ability to
  - support resource planning and decision making to mitigate risk;
  - quantify the severity and extent of emerging risks to aid program planning;
  - improve the timeliness and efficiency of responses and delivery of agri-recovery programs.

Flood Forecasting and Surface Water Management

- Soil moisture information is a critical component in hydrologic forecasting models.
- Satellite-derived soil moisture information has the potential to improve flood forecasting and provide decision-makers with timely and accurate data over agricultural basins.
- Increasing our ability to predict floods will improve operation of flood and surface water infrastructure. This helps to minimize the impact of floods to the agricultural sector and rural economy while helping to efficiently manage water supplies for rural communities and irrigation uses. This helps to improve the resiliency of the agricultural sector to climate extremes.
- Improved soil moisture data will assist AAFC decision-makers in identifying areas affected by excess moisture and drought and designating areas for federal livestock tax-deferral and Agri-Recovery programs.

2011 Assiniboine River Flood - Breach in the Assiniboine Diversion Dike (above); Floodwaters surround a farm operation and rural homes west of Winnipeg (below). Costs from the 2011 Manitoba Flood have exceeded $1 billion with over $320 million going to the agriculture sector in Agri-Risk and Recovery Programs.

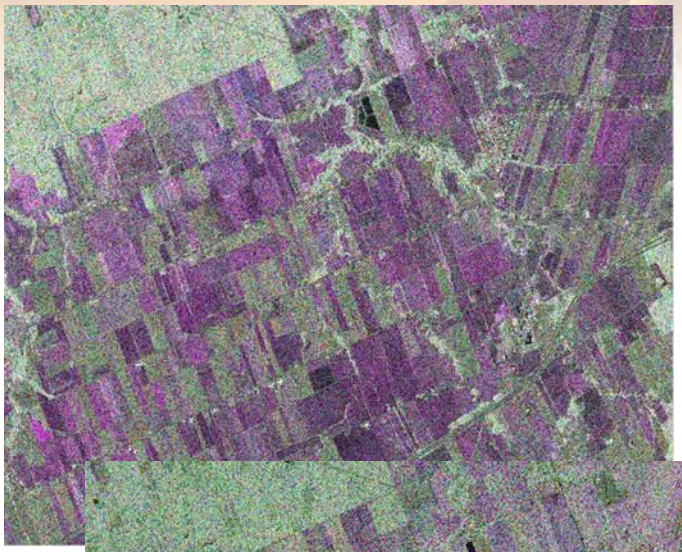
Red and Assiniboine River Basins

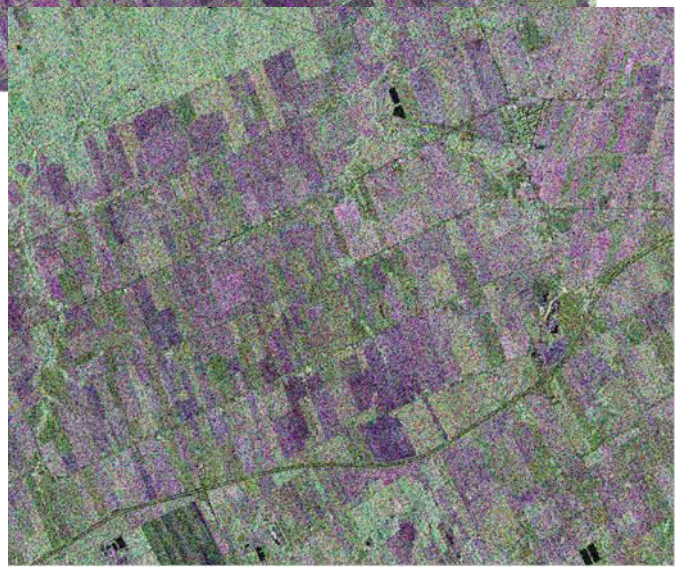


RADARSAT-2 – Model Development and Testing

May 5, 2008 (RSAT-2 FQ19)

R-HH, G-VH, B-VV





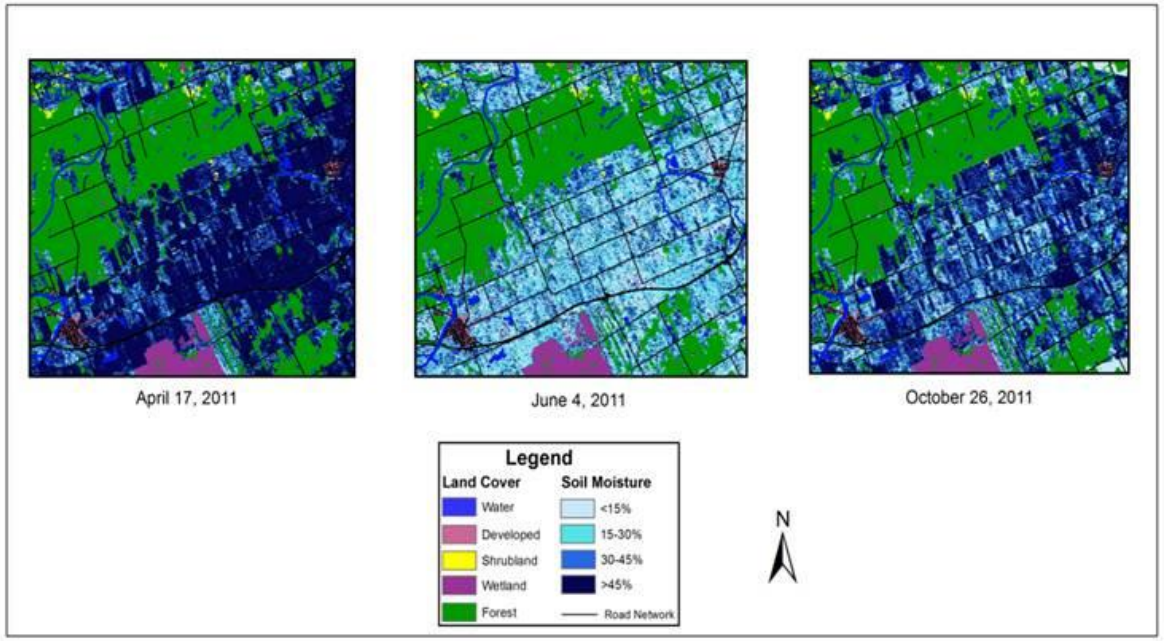
May 23, 2008 (RSAT-2 FQ16)

R-HH, G-VH, B-VV

- AAFC has been acquiring RSAT-2 data since it's launch in 2007, to develop and test methods for soil moisture estimation
- research has evaluated various model approaches to estimate soil moisture from RSAT-2
- initially sent crews into field to collect validation data
- since 2011, have relied on data from Casselman in situ stations to verify soil moisture retrievals
- best results achieved using IEM, and new hybrid approach to soil moisture retrieval
- hybrid approach uses 2 RADARSAT images acquired at 2 incidence angles (dual angle – dual polarization)
- model is currently only applied on bare or sparsely vegetated fields (spring/fall)

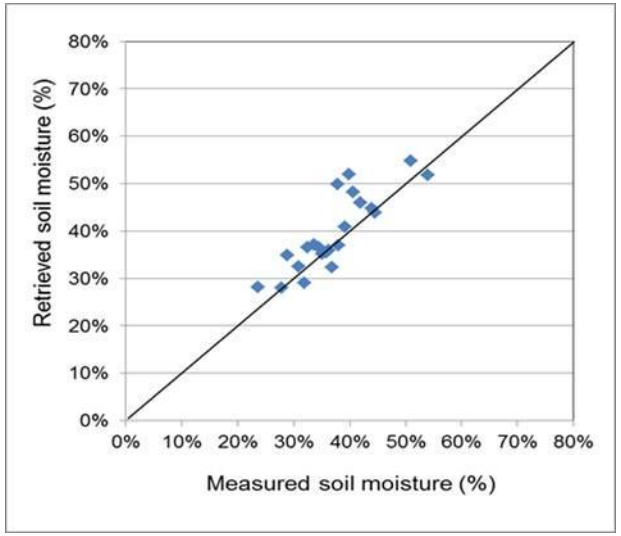
Validation Results Using In Situ Stations

Estimates from RSAT-2 (using hybrid IEM method) compared to moisture recorded by surface soil moisture probes from Casselman in situ stations



Errors Statistics – Hybrid Model 2011-2012

RMSE (%)	MAE (%)	R
4.82	3.45	0.85



Next Steps – Research Developments

- AAFC has developed a 3 year project proposal that will continue to develop our knowledge and understanding of satellite-derived soil moisture data utilizing RADARSAT & SMAP.

- need to develop strategy to expand application of model to conditions with greater vegetation cover
  - adapt the hybrid model to work with L-Band (use SMAPVEX data to evaluate)
  - “remove” vegetation contribution from radar signal using polarimetric approaches
  - investigate multi-parameter model that accounts for both vegetation and moisture

- will adapt model to use RADARSAT-Constellation data
  - RCM will have advantage of rapid revisit using 3 satellites
  - AAFC will work with Canada Centre for Remote Sensing to adapt existing model to use compact polarimetry mode. CP mode offers increased swath coverage.

- develop methods to extrapolate soil moisture estimates to the rooting zone (University of Manitoba)

Next Steps - Implementation

- AAFC will work to streamline processing to provide operational products that provide spring/fall soil moisture estimates. Information can support various applications, **including flood forecasting**

- existing approach is a patch work of research tools to process and estimate soil moisture from RADARSAT-2

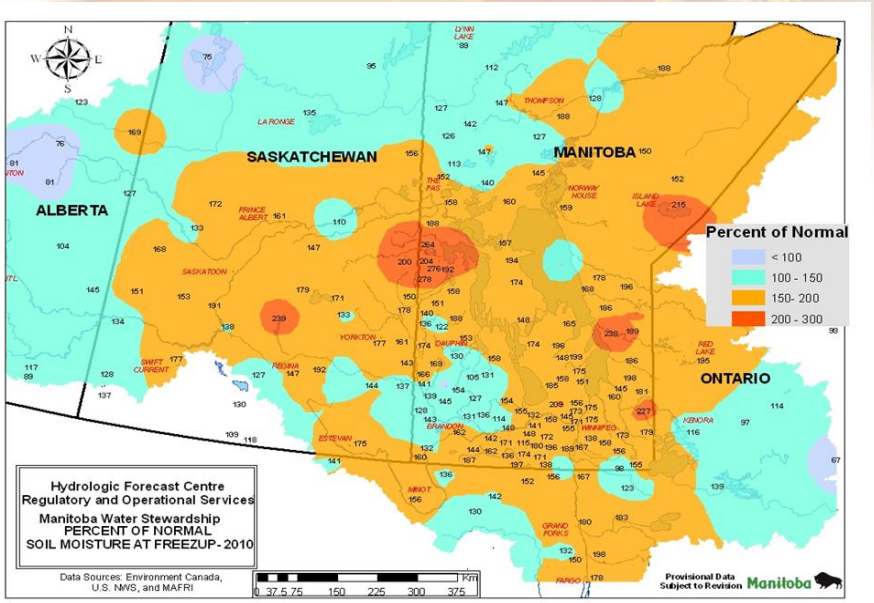
- Step 1: over next year, AAFC will develop processing stream to create surface soil moisture maps within 1 hour of reception of RADARSAT-2 data

- Step 2: as soon as Spring 2014, begin producing and delivering near-real time soil moisture maps to provincial flood forecasters

- Step 3: incorporate soil moisture maps from new sensors (such as RCM, SMAP) as soon as methods are adapted and validated

- in situ networks (Ontario, Manitoba, Saskatchewan) will continue to be used to calibrate and validate satellite-derived soil moisture products

Next Steps - Implementation



- Spring flood modelling requires soil moisture within the root zone at the time of freeze-up (mid-November).
- Currently information is derived from
  - soil moisture index based on weighted May-Oct precipitation empirical model;
  - air based Gamma surveys;
  - field surveys prior to freeze-up.

In Situ Soil Moisture Stations

AAFC In-Situ Soil Moisture Stations

- **3 Soil moisture probes at surface**
- **3 Probes at 5cm (vertical and horizontal), 20cm, 50cm and 100 cm**
- **Probes are 50-100 feet from field edge**
- **Tipping bucket rain gauge**
- **Data is transmitted hourly via cell phone**

SMAPVEX12 - Manitoba

SMAPVEX12 field crew during training at the AAFC Regional Operations Centre in Winnipeg June 6th, 2012