Growing Forward: A New Agriculture Policy Framework

“A profitable and innovative agriculture, agri-food and agri-based products industry that seizes opportunities in responding to market demands and contributes to the health and well-being of Canadians”

- Desired Policy Outcomes – A sector that:
  (a) Is competitive and Innovative;
  (b) Contributes to Society’s Priorities;
  (c) Is Proactive in Managing Risks.
Proactive Risk Management: AAFC Policy Directions

- Work with industry to safeguard animal and plant resources
- Enable enterprises to adapt to risks posed by environmental factors (climate change, drought etc.) and safeguard future viability of land and water resource base
- Enable the sector to take proactive steps to reduce the risk of disease outbreaks or other emergencies and respond and recover should an outbreak occur
- Create an investment climate that encourages industry to make the efforts and investments needed to effectively mitigate risks and improve profitability
- Provide tools to mitigate financial risks to agriculture, where farmers primarily manage normal fluctuations and governments take a greater role in wide-spread disasters

Proactive Risk Management: NAIS Policy Directions

1. Assess climate related risk to agriculture:
   - Timely, state of the art monitoring, analysis and reporting of weather and climate related events that affect Canada’s agriculture industry,

2. Improve management of climate related risk:
   - Address client needs by enabling development of high quality, state of the art, relevant value-added products for decision and policy support to manage climate-related risk.

3. Improve industry’s ability to adapt to climate change and variability:
   - Address client needs by contributing analysis and interpretation to support Sustainable Production, Marketing, and Policy related to climate change impacts and adaptation.

EO data products and applications will be extremely valuable in supporting the above policy directions.
Ongoing Challenges

1. **Do more with less**
   - Reduced operating budget; Changing business approaches; Looking to collaborate, sharing capacity and resources to meet objectives.

2. **Data availability**
   - Increased move towards comprehensive spatial coverage by use of EO data; Improved timeliness and identification of problem areas.

3. **National Service:**
   - Move from Prairie to national service with little increase in resources; Increased demand to be timely and efficient.

4. **Integration Issues**
   - Climate interactions with water, land, etc…; Increased need to work collaboratively across departments, sectors and internationally; Need for standards on data (e.g. QA/QC, instrumentation, indices).

Main Collaborative Activities

**Two Concurrent and Related Projects**
- Government Related Initiatives Program (GRIP) – AAFC and Partners (CSA).

**Partners and Collaborators**
- Carleton University.
- Statistics Canada.
- Canada Centre for Remote Sensing.
- Canadian Forest Service.
- Australian National University.
- Environment Canada.
- US Partners???

**AAFC’s role to develop and integrate EO, climate and other geospatial data with applications to produce essential value-added agricultural information.**
Remote Sensing of Vegetation Health

- Canadian crop conditions are required weekly for crop condition assessment purposes.
- Remote sensing is the best way to monitor the condition of Canada’s agricultural landscapes.
- RS has been shown to provide reliable and repeatable data on plant parameters relating to crop condition (e.g. Biomass).
- RS crop monitoring is often based on the use of spectral vegetation indices (e.g. NDVI).
- AAFC currently uses weekly AVHRR-derived 1km-resolution NDVI data for crop assessment.
- However, these data are at a spatial resolution that is coarser than some of our applications require.
- Use of weekly 250m-resolution NDVI data from MODIS would directly address these limitations.

http://daac.ornl.gov/
Physiological Basis of the NDVI

- NDVI relationship with vegetation biophysical parameters is based on inverse relation between R and NIR reflectance.
- As biomass increases, R reflectance decreases, NIR reflectance increases, and thus the NDVI increases.

Using NDVI for Drought Assessment (*)

- Drought-induced plant water stress is detectable spectrally from space.
- These effects are most evident when NDVI anomalies are used.
- Anomalies calculated by comparing NDVI for a given week with NDVI for some historical baseline.
- Historical baseline may be NDVI of (a) previous week, (b) same week previous year, or (c) NDVI of for same week over historical record.
NCMS: AAFC’s National Crop Monitoring System

- NLWIS aims to develop a production system to provide MODIS NDVI data on the internet.
- Our specific goals are to:
  a) demonstrate a system that uses MODIS data to create a weekly composite NDVI product that is ready for web posting;
  b) provide an operational system that can create weekly NDVI datasets with a few-day lag for posting on the internet.

AAFC’s National Crop Monitoring System is scheduled for web delivery in 2009.

NCMS: Weekly NDVI from MODIS daily reflectance

<table>
<thead>
<tr>
<th>Dataset Shortname</th>
<th>Description</th>
<th>Level</th>
<th>When Available</th>
<th>Additional Datasets Required</th>
<th>Processing effort</th>
</tr>
</thead>
<tbody>
<tr>
<td>MOD02QKM (250m)</td>
<td>Daily R and NIR TOA calibrated radiances (&quot;swath&quot;)</td>
<td>1B</td>
<td>Near-Real time?</td>
<td>Atmospheric, adjacency, and BRDF correction; QA/QC; Mosaicing; NDVI calculation and compositing</td>
<td>Cloud Mask (MOD35), aerosols (MOD04), precipitable water (MOD05), ozone (MOD07), surface BRDF (MOD43), Geolocation Angles (MOD09GA); Observation Pointers (MOD00GA); Ancillary data.</td>
</tr>
<tr>
<td>MOD09GQK (250m)</td>
<td>Daily R and NIR surface reflectance</td>
<td>2G</td>
<td>&lt;2 days?</td>
<td>QA/QC; Extracting NDVI calculation and compositing; Mosaicing</td>
<td>Surface Reflectance and QC (MOD09QG); QC State, Sensor Zenith, Observation Pointers (MOD00GA).</td>
</tr>
<tr>
<td>MOD09Q1 (250m)</td>
<td>8-day R and NIR surface reflectance</td>
<td>3</td>
<td>&lt;7 days?</td>
<td>Mosaicing; NDVI calculation</td>
<td>None</td>
</tr>
<tr>
<td>MOD13Q1 (250m)</td>
<td>16-day NDVI</td>
<td>3</td>
<td>&lt;14 days</td>
<td>Mosaicing</td>
<td>None</td>
</tr>
</tbody>
</table>

Why choose L-2G over L-1B Products?
- CCRS L1-B algorithms (incl. downscaling) may improve spatial feature representation. BUT L-1B data volume and long processing time makes L-2G product AAFC’s current NRT option.
- Our tests show L-2G Max-NDVI comparable to L-1B CCRS NDVI data at various geographic scales.
- L-2G data products well-supported by USGS and used widely as “standard”.

The National Land and Water Information Service
NCMS: Processing System

(1) MODIS LEVEL-2G DAILY GRIDDED DATA PRODUCTS (V005)
• Acquisition of tiles from USGS LPDAAC (“L2G-Lite”).
  (a) R and NIR Surface reflectance, band QA files (250m) [MOD09GQ]
  (b) Surface reflectance QC state (1km), Geolocation file, Observation layer pointer file (500m) [MOD09GA]

(2) DATA EXTRACTION
• USGS MODIS Reprojection Tool (MRT): (a) Refl, QA, geolocation, pointer data extracted from each file.
  (b) Data processed on a tile-by-tile basis.

(3) WEEKLY MAX-NDVI COMPOSITING
• MAX-NDVI Compositing: (a) Daily NDVI calculated from highest quality R & NIR data.
  (b) Weekly Max-NDVI is Max daily NDVI in 7-day period.
  (c) Day-of-week week grids show DoW max-NDVI correspond to.
  (d) Individual tiles mosaicked to cover CAE.
  (e) All composites provided in ESRI grid format.
• NLWIS METADATA EDITING TOOL
  (a) Metadata generation.

(4) SERVICES AND APPLICATIONS
• WEB SERVICES: (a) User-controlled on-the-fly output.
  (b) Temporal and spatial statistics calculation.
  (c) Data download options (e.g., file format; reprojection).
• INPUT TO OTHER APPLICATIONS.

(5) ARCHIVING AND STORAGE
• Storage of HDF-EOS tiles, intermediary and final products.

NCMS: Pixel Screening Criteria

• Screening for poor quality data uses band QA [MOD09GQ], state QA [MOD09GA] and geolocation angle [MOD09GA] data.

• Pixel reflectances are retained only if:
  a) cloud-free [MOD09GA];
  b) contain no cloud shadow [MOD09GA];
  c) contain no/little aerosol [MOD09GA];
  d) contain no/little cirrus [MOD09GA];
  e) sensor zenith angle < 45º [MOD09GA];
  f) atmospherically corrected to the highest quality in R and NIR bands [MOD09GQ].
NCMS: NDVI-Related Data Products

(a) Intermediary Products:
- Daily R, NIR and NDVI composites. Necessary to create final output.

(b) Weekly NDVI Products:
- Maximum-NDVI weekly composites for Canada south of 60°N. Uses best quality reflectances.
- Day-of-week composites show day (1-7) NDVI values are from. Additional information for user.
- Various NDVI anomalies.

(c) Custom Products:
- Custom $n$-day NDVI and reflectance data for AAFC-related projects.
- Manitoba Pilot project of digital soil mapping (Canadian Soil Information System, CANSIS).
- Manitoba Soil Moisture Experimental Project (Red River) (PFRA).

LCC-Projected MODIS NDVI for Canada South of 60°N and Great Plains
Weekly and $n$-day NDVI produced for Manitoba Pilot project of digital soil mapping (CANSIS)

NCMS: NDVI-Related Web-Delivered Products

(a) User-Controlled “On-the-Fly” Output
- Masking of lakes and oceans, Canada’s agric extent, crop area vs pasture.
- Various other functionalities proposed.

(b) Temporal and Spatial Statistics Calculation
- Spatial analysis:
  - Calculation of NDVI statistics by CAR, CSD, DA, TWP, user-defined units.
- Temporal analysis:
  - NDVI anomalies compare current conditions to previous week, to same week in previous year or MODIS historical baseline mean.

(c) Data Download
- User data download options. Download data in various formats with complete metadata.
Integration with other EO and Geospatial Data

Other EO Activities
- MODIS LST (AAFC-CCRS)
- AVHRR (CCRS-STATCAN, GIMMS).
- MERIS (AAFC-CCRS)
- SSMi moisture and temp anomalies (AAFC).
- AWIFS (AAFC-USDA)

Geospatial Data
- Soils.
- Land Cover, Crop Mapping.
- Climate.
- Hydrology.
- Census.

Inputs to Modeling
- RHESSys / Drought modeling (CU).
- EALCO (CCRS).

Current GRIP focuses on climate and EO data processing and integration.

Current Issues and Future Considerations

(a) Identify Best Data Management Practices
- Working on identifying best ways to download, archive and store large volumes of raster data.

(b) Contingency Plan for Failure of Sensor
- Working on a contingency plan if MODIS Terra sensor fails (e.g. use of AVHRR, MODIS Aqua, MERIS).

(c) Extend the historical record pre-MODIS
- Need to extend MODIS record back beyond 2000 if weekly NDVI is truly to be put into historical context.
- To do this, we must calibrate MODIS data with data from other medium-resolution sensors (e.g. AVHRR).
- Discussions with various agencies ongoing.

(d) Data Continuity
- Need plan for continuity of data stream after MODIS lifecycle expires.

(e) L-1B vs L-2G Products
- Issues: Community of Practice / MOU / reliability.

(f) Addition of other Indices and Data
- Useful to generate other vegetation indices (EVI, NDII)?
- Useful to generate other MODIS products (LST, snow)?

(g) Integration with other EO & Geosptl Data
- Integration and input to models.