COMMERCIALIZING REMOTE SENSING TECHNOLOGY FOR ENVIRONMENTAL MANAGEMENT: MOVING FROM DATA TO DECISION

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Executive Summary

Considerable resources are expended by government and industry to collect environmental data to support planning, design, development, operational monitoring, closure activities, and reporting activities. As a result, there is increasing interest in improving effectiveness and efficiency of these processes while at the same time considering options allowing for the diversification of Alberta's economic base. The development of integrated geomatics and remote sensing technologies for environmental management holds promise to meet these two provincial objectives.

Alberta Innovates – Technology Futures (AITF), in partnership with the Government of Alberta, Alberta Data Partnerships, TECTERRA and LOOKNorth, held two Workshops in April, 2016 to provide a venue for government and industry to identify environmental management needs that could be enhanced by integrated approaches and a forum for technology providers and researchers to identify tools that could support these needs. One of the desired outcomes of the Workshops was the identification of possible *Research and Commercialization Challenges* that could be issued by the Alberta Innovates Corporations, like AITF, and organizations such as Alberta Data Partnerships (Data and Data Accessibility), TECTERRA (Geomatics and Visualization), and LOOKNorth (Data Analytics and Earth Observation) to technology solution providers, and in particular Small- and Medium-Sized Enterprises (SMEs) to fill these gaps. Ultimately these Challenges would lead to one or more demonstration projects, while also supporting technology commercialization and economic diversification in the province.

Prior to the Workshop a survey was sent out to gather information on current and future Earth Observation (EO) / Remote Sensing (RS) needs and the perceived impediments to enhanced adoption of EO/RS for environmental management.

Thirty seven people from government, EO/RS and resource industries attended a Workshop in Edmonton, April 20, 2016 and 39 in Calgary, April 21, 2016. Thirty four people responded to the survey. Presentations on EO/RS trends and government and industry needs were made by: Alberta Economic Development and Trade; TECTERRA; Alberta Data Partnerships; LOOKNorth; GeoDiscover Alberta; Alberta Agriculture and Forestry; Sturgeon County; Suncor (COSIA); Petroleum Technology Alliance Canada; and, WaVv Strategic Consulting.

Based on the workshop discussions and survey responses, the following recommended actions and potential Champion(s) for each are proposed:

1. The Alberta Open Data Areas proposal should proceed and there should be rapid communication of the opportunities associated with the project to ensure the widest possible uptake.
    a. *Champion*: Alberta Data Partnerships.
    b. *Support*: Government of Alberta, Alberta's innovation system, commercialization centres (i.e., TECTERRA, LOOKNorth).

2. Government should collate and publish all existing EO/RS standards associated with regulatory requirements. This will help ensure common and consistent standards, and provide SMEs with targets against which to assess, modify and create products and services.

    a. *Champions*: Government of Alberta (e.g., newly created Monitoring and Science Division, Environment and Parks) and Alberta Energy Regulator (co-leads).

    b. *Support*: Alberta's Innovation System, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).

3. Government should identify all existing public data sources and data collected pursuant to regulatory requirements with an eye towards increasing open, accessible and free data sources. A business case for making data more open and freely accessible should be developed.

    a. *Champions*: GeoDiscover Alberta and Service Alberta (Co-leads).

    b. *Support*: Alberta Energy Regulator, Alberta's Innovation System, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).

4. Government and industry should strive to better articulate and publish EO/RS needs. Ideally this would be made available in the least number of locations practicable and updated on an annual basis.

    a. *Champions*: Government of Alberta (i.e., newly created Monitoring and Science Division within Environment and Parks) and Alberta Energy Regulator (co-leads).

    b. *Support*: Government of Alberta, Alberta's Innovation System, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).

5. Government, the resource industry, the EO/RS industry and academia should work together to develop a formal Community of Practice to enhance communication, education and awareness. Efforts should be made to include broad participation by companies, organizations and individuals with an interest in advancing EO/RS technology development and use in Alberta.

    a. *Champion*: Alberta Innovates.

    b. *Support*: Government of Alberta, Alberta Data Partnerships, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).

6. Government, industry, and academia should work together with the EO/RS sector to explore the opportunity to create an innovation cluster or consortia – exploring different models, and building on the work of existing organizations and centres – to enable and enhance

collaboration across the commercialization spectrum from the support of basic and applied research to aiding in the adoption of EO technologies. A key function of this cluster/consortia may be to facilitate implementation of the other six recommendations.

   a. *Champion*: Alberta Innovates.
   b. *Support*: Government of Alberta, Alberta Energy Regulator, Alberta Data Partnerships, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada’s Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).

7. Government, the resource industry and the EO/RS industry should explore the concept of an approved body to vet existing and new EO/RS technologies.
   a. *Champion*: Alberta Innovates.
   b. *Support*: Government of Alberta, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada’s Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).

Acknowledgments

This project was supported by funding from Alberta Innovates – Technology Futures and sponsorship from TECTERRA and LOOKNorth.

We also wish to thank the organizations that participated in organizing the Workshop.

1. Introduction

Considerable resources are expended by government and industry to collect environmental data to support planning, design, development, operational monitoring, closure activities, and reporting activities. As a result, there is increasing interest in improving effectiveness and efficiency of these processes while at the same time considering options allowing for the diversification of Alberta's economic base. The development of integrated geomatics and remote sensing technologies for environmental management holds promise to meet these two provincial objectives.

Over the past five years, there have been several workshops that have engaged government, industry and the research community with respect to remote sensing technologies[1]. In 2011, a workshop on *Earth Observation Monitoring of the Oil Sands* was held in Edmonton (Ryerson 2011). At this workshop, participants from provincial and federal government agencies and academia discussed issues and opportunities surrounding Earth Observation / Remote Sensing monitoring in Alberta, specifically, the oil sands. That Workshop led to a series of research projects to identify technology that might be used to meet a select group of those needs. These projects were summarized in a 2015 Workshop in which participants developed a high-level roadmap for applying remote sensing technology to regulatory processes (De Abreu et al. 2015). From 2012 to 2014, LOOKNorth, TECTERRA and PTAC sponsored several remote sensing technology workshops, including: *Remote Sensing Technology Projects Workshop (2012); Remote Sensing for Water Monitoring (2013)*; *Remote Sensing Technology Workshop (2013), and Geospatial Monitoring and Analytics Forum (2014)*.

Alberta Innovates – Technology Futures (AITF), in partnership with the Government of Alberta, Alberta Data Partnerships, TECTERRA and LOOKNorth, held two Workshops in April, 2016 to provide a venue for government and industry to identify environmental management needs that could be enhanced by integrated approaches and a forum for technology providers and researchers to identify tools that could support these needs. One of the desired outcomes of the Workshops was the identification of possible *Research and Commercialization Challenges* that could be issued by the Alberta Innovates Corporations, like AITF, and organizations such as Alberta Data Partnerships (Data and Data Accessibility), TECTERRA (Geomatics and Visualization), and LOOKNorth (Data Analytics and Earth Observation) to technology solution providers, and in particular Small- and Medium-Sized Enterprises (SMEs) to fill these gaps. Ultimately these Challenges would lead to one or more demonstration projects, while also supporting technology commercialization and economic diversification in the province.

1.1 Workshop Purpose

The purpose of the Workshop was to bring together government, industry, and technology commercialization organizations to collaborate on *identifying the next steps required to commercialize the application of integrated geomatics, remote sensing, data analytics, and visualization technologies*.

[1] See Appendix B for background information on recent needs assessments and technology reports.

Thirty seven people from government, EO/RS and resource industries attended a Workshop in Edmonton, April 20, 2016 and 39 in Calgary, April 21, 2016 (Appendix A).

1.2 Pre-Workshop Survey

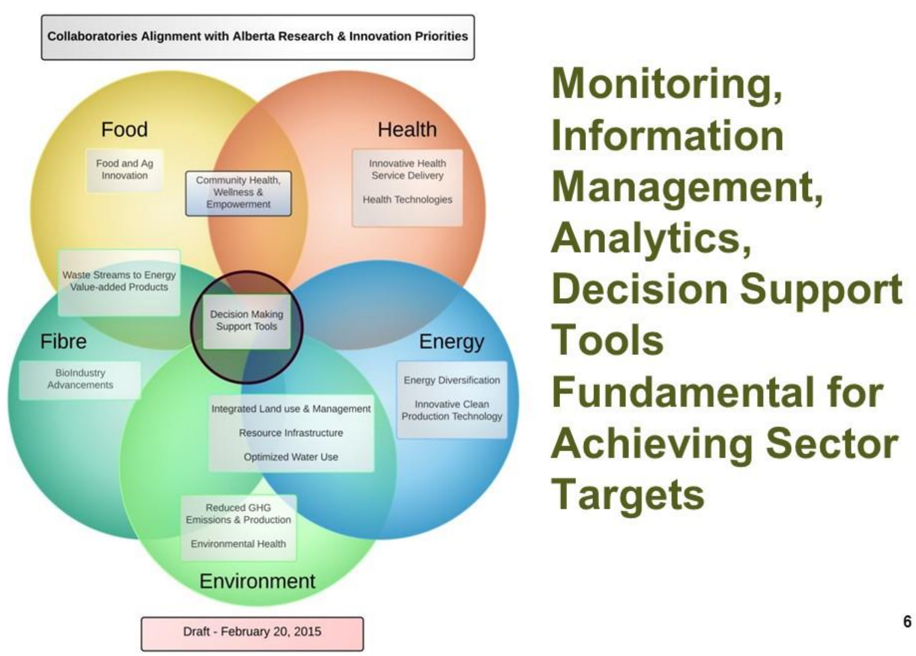
Prior to the Workshop a survey was sent out to gather information on current and future Earth Observation (EO) / Remote Sensing (RS) needs and the perceived impediments to enhanced adoption of EO/RS for environmental management.

2. Workshop Presentations

Each Workshop began with two sets of presentations – the first providing updates of EO/RS needs and perceived impediments from the EO/RS perspective and the second providing insights from government and industry on their current and future needs. The first sessions were common to both Edmonton and Calgary workshops. The presentations are provided in Appendix C.

2.1 Advancing Commercialization of Remote Sensing Technologies

Brent Lakeman, Executive Director, Technology Partnerships and Investments, Science and Innovation, Alberta Economic Development and Trade provided introductory remarks about Alberta's Research and Innovation Framework.



Alberta has established draft 2030 innovation targets for five priority innovation sectors: Energy, Environment; Health; Fibre: and, Food. Innovation collaboratories have been used as the fora for bringing together innovation system players to provide strategic direction and advice on smart, impactful investments of provincial resources.

Examples of focus areas for 2030 Environment innovation targets relevant to this workshop include:

- Species-at-risk detectability, assessment, or recovery
- Remote-sensing imagery and automated sampling devices
- Resource development footprint reduction and increased ecosystem health
- Innovative monitoring systems
- Future water supply and watershed management
- Healthy aquatic ecosystems
- Water quality protection

The government established an Alberta Small Business Innovation and Research Initiative (ASBIRI) pilot program to foster demand-pull innovation, by matching the technologies and expertise of Alberta Small and Medium Sized Enterprises (SMEs) to the critical challenges of large end-users in the public and private sector.

2.2 EO/RS Presentations: Technology and Innovation Focus Area Presentations

Presenters were asked to focus on current market, future outlook and impediments. The presentations are provided in Appendix C. Key points from the presentations are captured below.

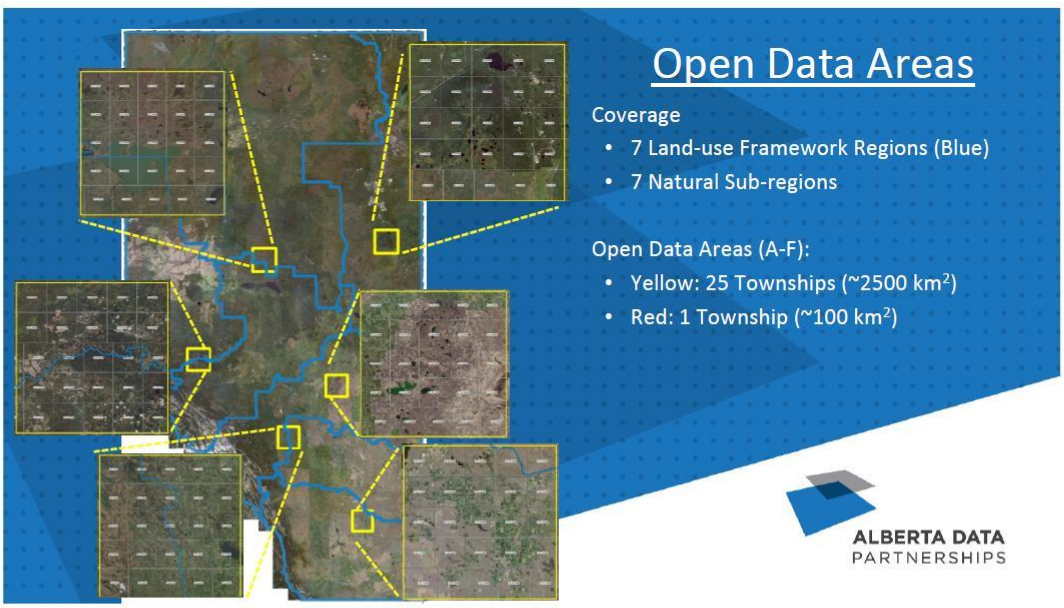
2.2.1 TECTERRA, Jonathan Neufeld, Director, Commercialization Programs: Geomatics Innovation in Alberta

Geomatics can be defined as *the activities involving the collection, management, integration, representation, analysis, modeling and display of geographically-referenced information describing both the Earth's physical features and the built environment*. A less technical description is *knowing where things are, and using this information to solve complex problems*.

Geomatics companies can be categorized as: *Big G* companies that gather and process geomatics information and sell to big customers who need geomatics solutions as well as to *little g* companies who translate the geomatics data into solutions for end users, often consumers who don't necessarily know that the solution is based on geomatics data. TECTERRA has supported 195 Big G and little g companies to date.

2.1.2 Alberta Data Partnerships, Eric Holmlund, Executive Director: Data for Innovation

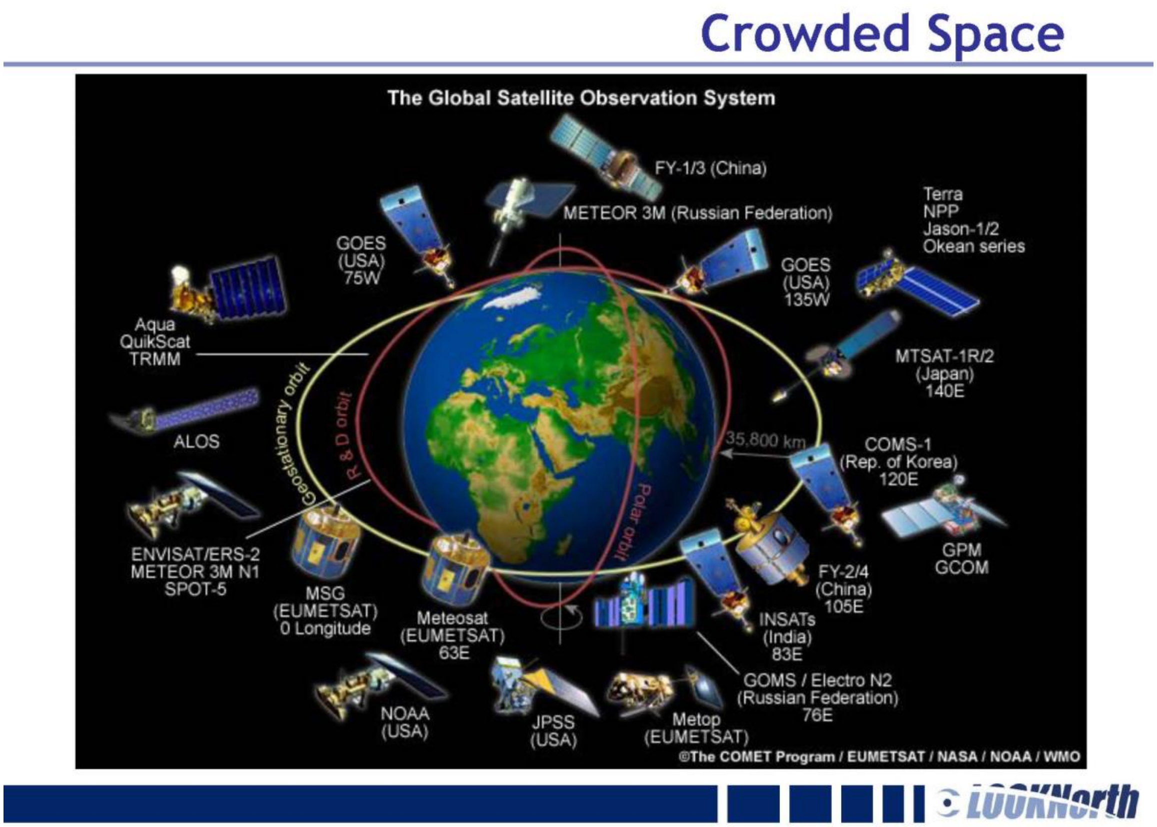
Alberta Data Partnerships (ADP) was formed in 1996 as Spatial Data Warehouse to take over Alberta's digital mapping activities. It is a not for profit, virtual company funded by data sales and focused on data distribution and stakeholder engagement. AltaLIS is a private sector operator who produces and distributes mapping products under license to ADP. ADP is currently exploring opportunities for additional distribution partners.



ADP, in collaboration with the Government of Alberta, is proposing to develop six Alberta Open Data Areas and provide pre-commercialization funding for SMEs. Open Data Areas would be representative of provincial (and global) land cover types and would encompass a range of recreational, commercial, and industrial activities. Funding up to $50K would be directed through a request for proposal process at projects directed at innovative approaches (i.e., pre-commercialization stage) using data provided through the Open Data Areas initiative.

2.2.3 LOOKNorth, Bill Jefferies, Executive Director: Sensors & Systems

LOOKNorth is a non-profit Centre of Excellence that identifies, evaluates, manages and accelerates the development of remote sensing technologies that support sustainable natural resource development.



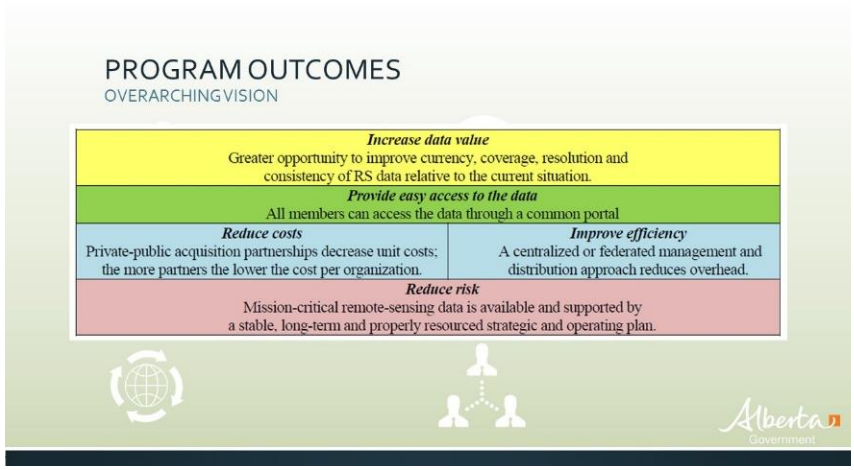
There will be a dramatic increase in EO satellite missions in coming years – the number is expected to double every ten years but will likely be even faster – most of which will be lower-cost and more responsive. There is a trend towards free and open data with near real time capability. Mission features include: constellations, high resolution, hyperspectral and multi polarization/multi frequency sensors, and an emphasis on cloud computing for data storage and processing. The emergence of cubesats allows for lower cost constellations of satellites to be launched more quickly, leading to much shorter temporal resolution (e.g., Satellogic's 300 satellites will allow for 5 to 10 minute repeat passes).

2.3 Edmonton Workshop – Government Presentations

Presenters were asked to focus on government needs and opportunity development. The presentations are provided in Appendix C.

2.3.1 GeoDiscover Alberta, Daryl McEwan, Data Acquisition Services: GoA Remote Sensing Requirements

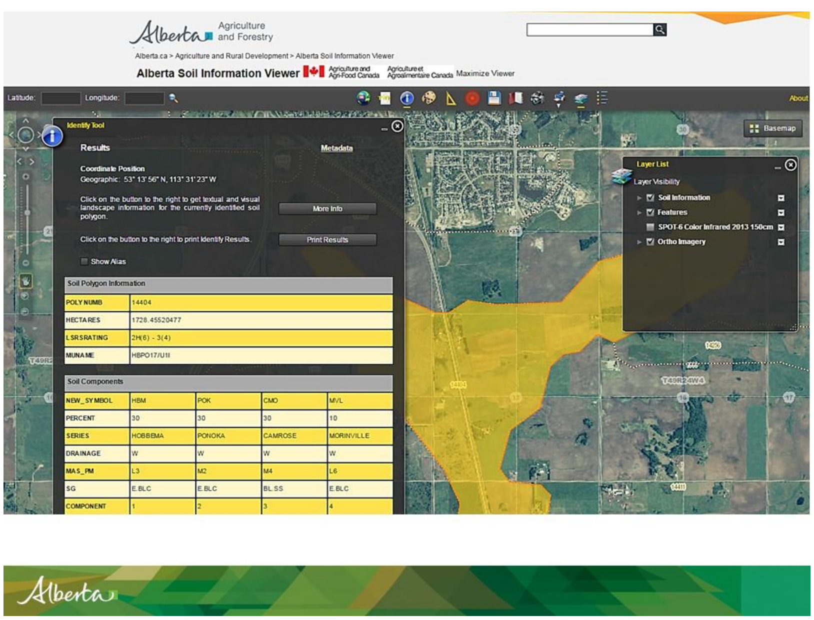
Government undertook a review of remote sensing requirements, driven by concerns about:



- Duplicate purchases and effort;
- Relatively high cost per Ministry;
- Lack of common remote sensing data standards;
- Lack of cross-Ministry knowledge about remote sensing data utility applications;
- Incomplete or inadequate coverage of the province to support province-wide Government of Alberta (GoA) business needs; and,
- Cultural view of remote sensing data as 'Ministry-specific' datasets rather than GoA assets.

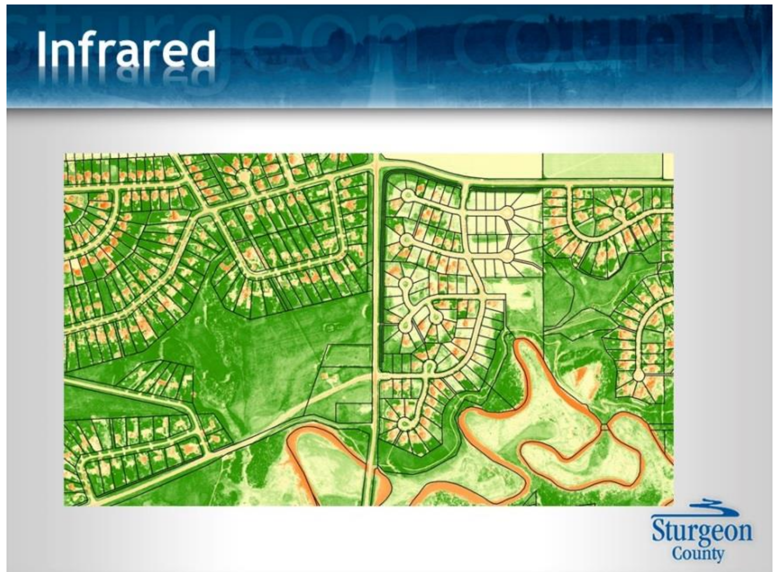
The project identified several critical success factors: Funding, Getting partners; Products; Data management, sharing and access; and, Development of a Steering Committee governance structure.

2.3.2 Alberta Agriculture and Forestry, Tom Goddard, Senior Policy Advisor: Can RS Contribute to Integrated Management Systems in Agriculture?



Agriculture and forestry have a long history of remote sensing use in Alberta (e.g., air photo archives used for farm conservation planning in the late 80's). Precision farming has been enabled by technology and has also helped drive technology enhancements and new technologies (push and pull). There is a trend towards ever more precise deployment of farm management practices – region -> farm -> field -> soil/landform unit -> individual plant – enabled by high resolution sensors.

Alberta Agriculture and Forestry is moving its soils information to the Global Soils Information Facilities (GSIF) open soil database which aims to build cyber-infrastructure to collate legacy (i.e., historic) soil data currently under threat of being lost forever.



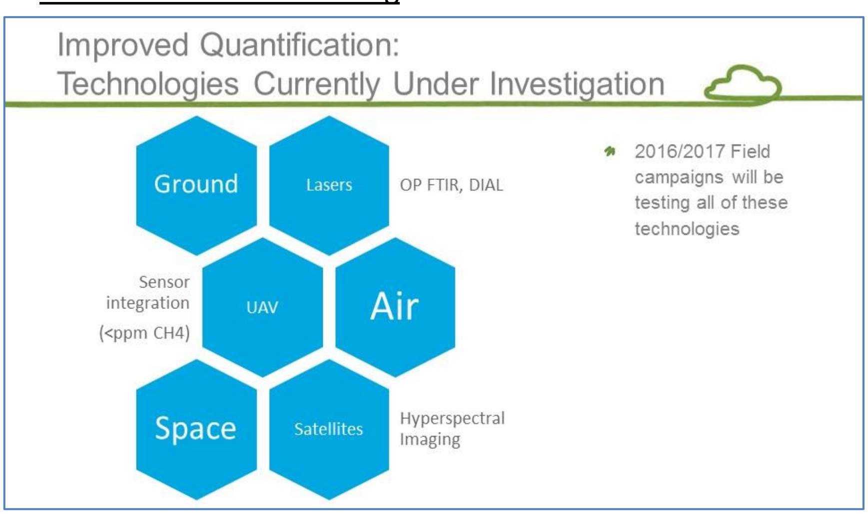
2.3.3 Sturgeon County, Kevin Smiley, GIS Coordinator: Municipal Image and Data Use in the Capital Region

Sturgeon County currently uses digital orthophotos (10 cm and 25 cm) and DEM – LiDAR (AltaLIS 15 m) and plans to use oblique imagery and LiDAR in the future. Remote sensing products are used for: tax assessment, land use planning; disaster response/planning; drainage history/planning; infrastructure assessment/inventory; and, public information. Sturgeon County participates in the Edmonton Regional Joint Orthophoto Initiative (ERJOI), a group effort to acquire orthophotos for the Edmonton region. Currently there are about 1.2M ha at 25 cm resolution and 242,000 ha at 10 cm resolution.

2.4 Calgary Workshop – Industry Presentations

Presenters were asked to focus on industry needs and opportunity development. The presentations are provided in Appendix C.

2.4.1 Suncor, Dan Burt, Team Leader, Air and Climate Change Solutions: Area Fugitive Emissions: Oil Sands Mining



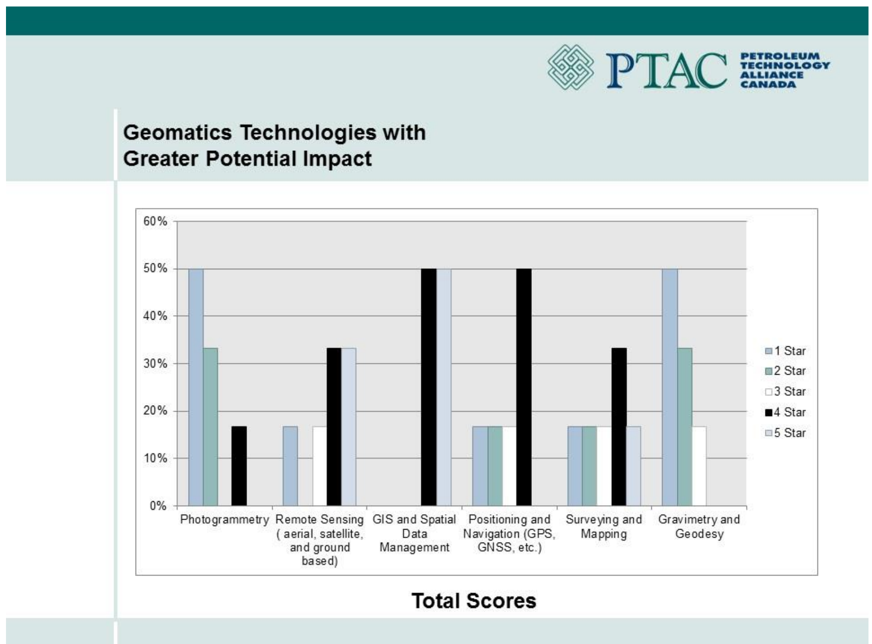
Canada's Oil Sands Innovation Alliance (COSIA) is evaluating the ability of remote sensing to improve measurement of fugitive methane emissions from tailings ponds and mine faces. Current technology involves annual field surveys using flux chambers that take significant time and cost to obtain results that are highly variable and have a high level of uncertainty. Field campaigns to test ground, air and space sensors will be undertaken in 2016/17.

The key attributes of a long term solution:

- Flux rates reliably collected in real time, continuously, with full spatial coverage
- Automated upload, compiling, and configuring of data
- On-demand area fugitive greenhouse gas (GHG) report generation
- Validated (occasionally) by leading technology (e.g., laser, satellite)

2.4.2 Petroleum Technology Alliance Canada, Marc Godin, Technical Advisor: PTAC Remote Sensing Applications

The Petroleum Technology Alliance of Canada (PTAC) is a not-for-profit association with a volunteer board comprised of representatives from producers, technology suppliers, researchers, government, inventors and individuals. PTAC acts as a neutral facilitator or matchmaker for oil and gas innovation, technology transfer and collaborative R&D.

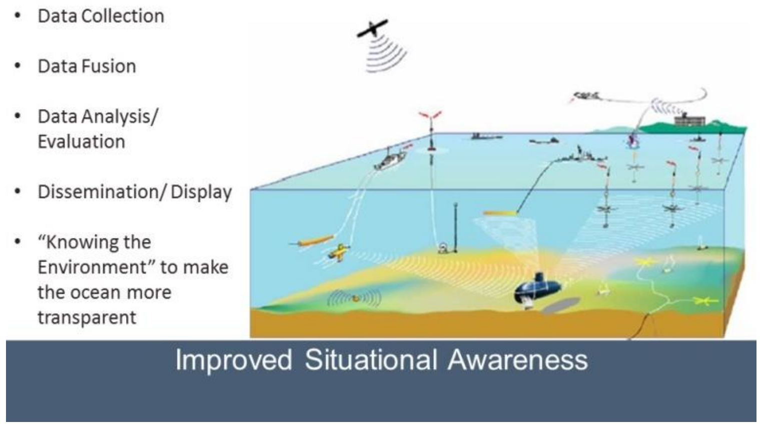


In 2012/13 PTAC developed a Remote Sensing Technology Action Plan (RSTAP). The work identified several remote sensing applications of interest to the industry: environmental monitoring, asset tracking, emergency response management, asset and pipeline integrity and leak detection, and utilization of robots and unmanned vehicles. Focus areas for remote sensing were:

- Water resource monitoring and management: wetlands and hydrological mapping, drainage analysis, etc.
- Detection of leaks and spills from oil and gas storage facilities and pipelines, particularly on water and on ice
- Ground deformation measurement and monitoring

2.4.3 WaVv Strategic Consulting, Kimberley Van Vliet, CEO: ConvergX

ConvergX was formed to create investment and growth opportunities between the Energy and Aerospace, Defence & Security industries, building on commonalities between the two sectors, especially: safety conscious and risk averse; highly regulated; technology-centric; and, need for efficiency and affordability. Under Innovation, Science and Economic Development Canada's Industrial and Technological Benefits (ITB) program there is estimated to be $240B to be reinvested in Canada by 2020 (under the ITB Policy, companies awarded defence procurement contracts are required to undertake business activity in Canada equal to the value of the contract).



Potential investment opportunities under this program include:

- Sensing
- Analytics
- Geomatics to support Environmental Management
- Mobile Asset Tracking
- Data Communications and Analytics

3. Survey Summary

Surveys were sent out March 15, 2016 to Workshop invitees with an encouragement to circulate them to colleagues. Surveys were to be submitted by March 31, 2016; multiple extensions were granted to ensure broader participation. Thirty four (34) survey responses were submitted from government, industry, consultants and academics (Figure 1); 28 of these were received prior to the Workshop and the rest were received by the final cut-off date of April 27. The detailed survey results are provided in Appendix D – a summary of key findings is provided here.

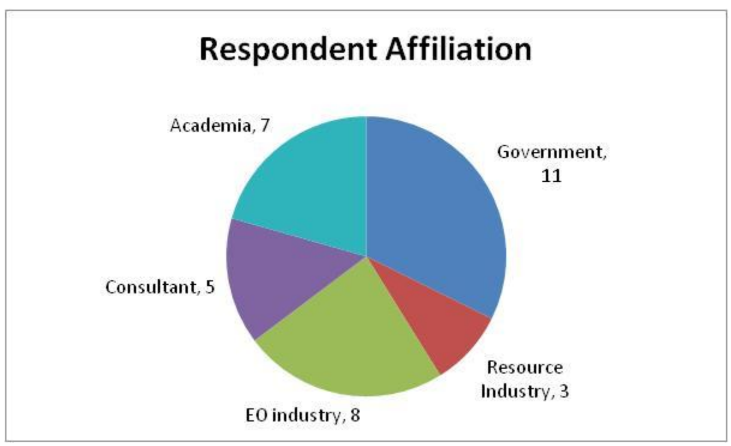


Figure 1. Distribution of survey respondents.

Most respondents indicated that their primary client/user for EO/RS data is internal agency/company, followed by industry to government (Figure 2)[2].

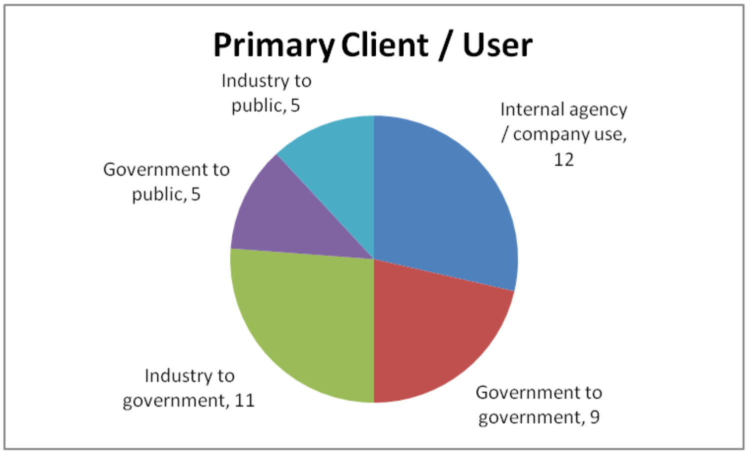


Figure 2. Clients/users for EO/RS data.

3.1 Applications for EO/RS

EO/RS data are used primarily for mapping and change detection (Figure 3). Previous surveys by the Government of Alberta (Figure 4, top panel) and Petroleum Technology Alliance of Canada (PTAC; Figure 4, bottom panel) provide additional insights into potential EO/RS regulatory and industrial applications.

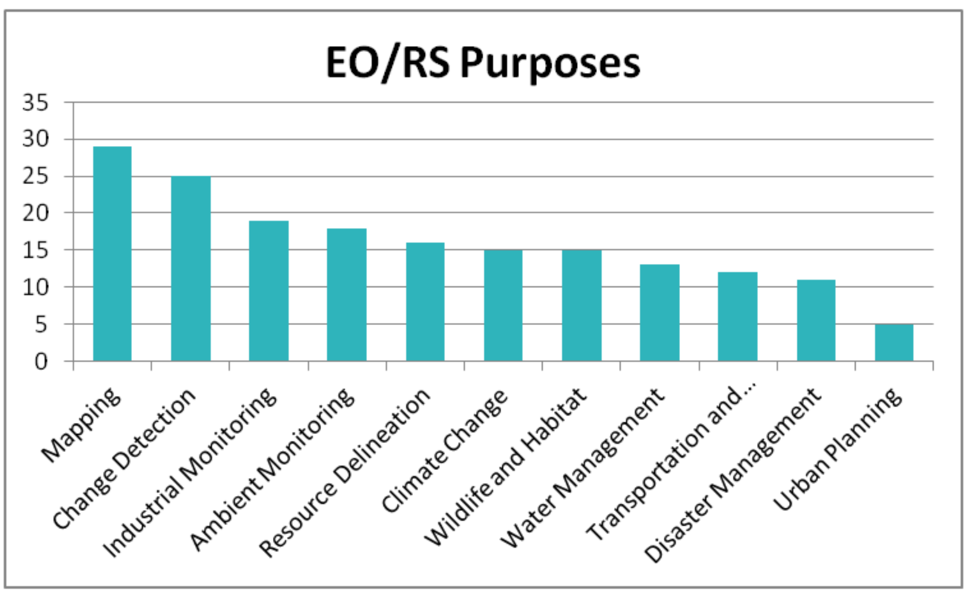
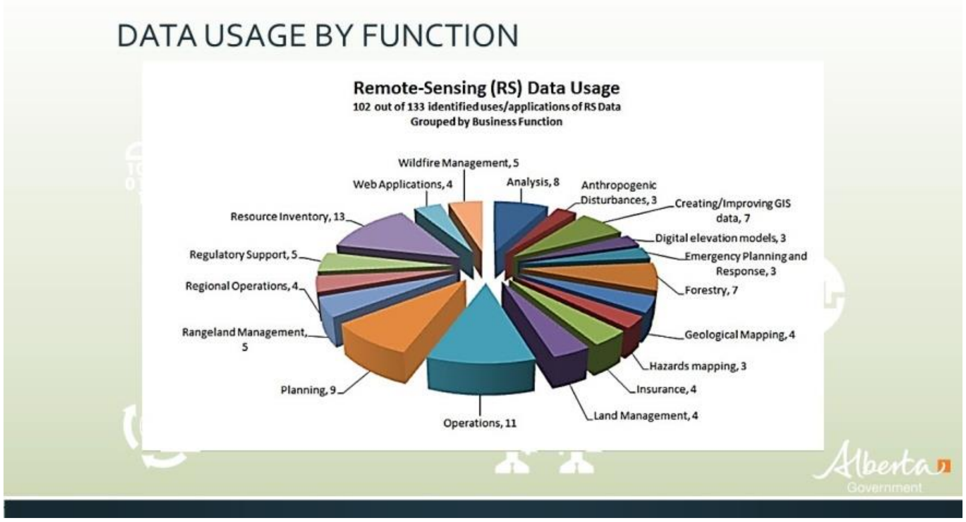


Figure 3. Main purposes for EO/RS data collection.

[2] Many of the questions allowed for multiple responses and some respondents did not answer all questions. Therefore, the results reported will not always add up to 34.



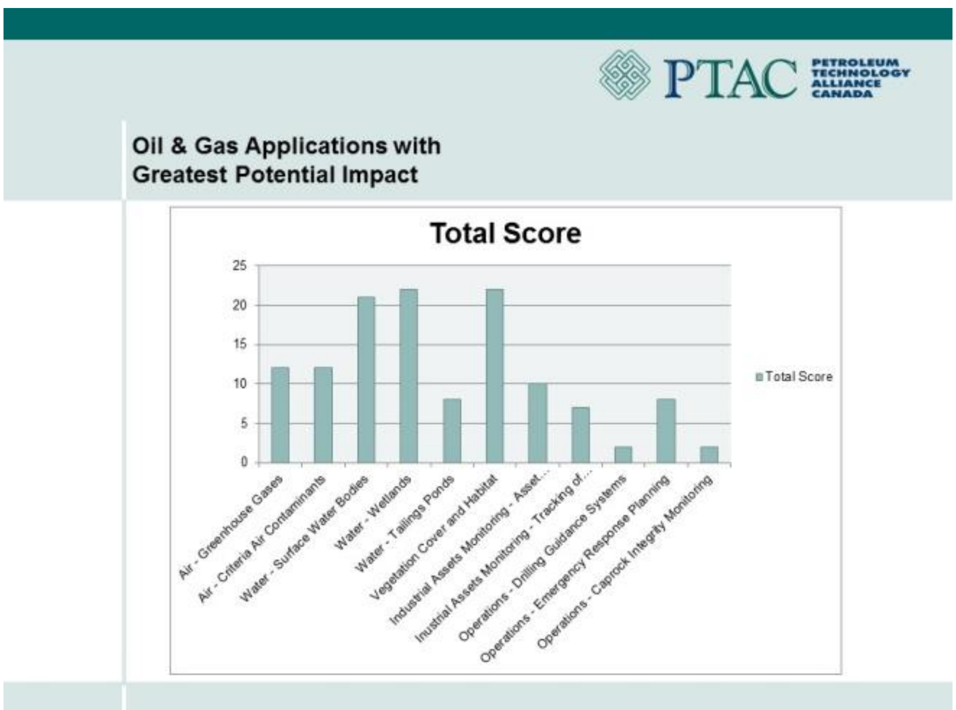


Figure 4. Results of previous EO/RS surveys.
Top panel: Government of Alberta survey (from McEwan presentation).
Bottom panel: Petroleum Technology Alliance of Canada survey (from Godin presentation).

3.2 Data Collection

Satellite imagery is the most frequently used EO/RS data source while respondents indicated limited use of helicopter-mounted sensors (Figure 5). In-field data collection was reported more than all EO/RS sources other than satellites. Respondents noted that currently EO/RS is most frequently used in addition to current field data collection but that they expect EO/RS to allow for reduced field data collection in 10 years (Figure 6).

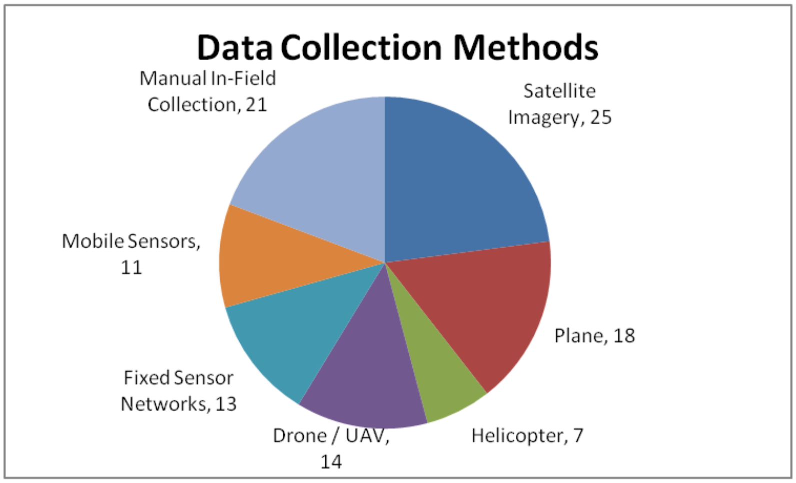


Figure 5. Common data collection methods.

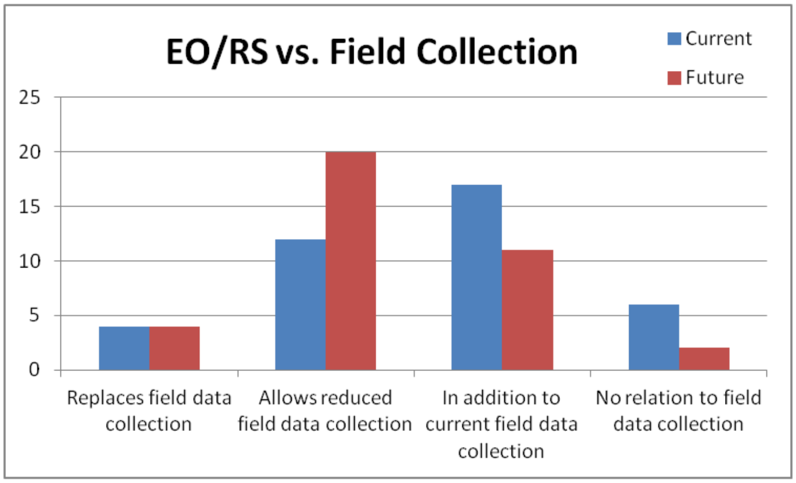
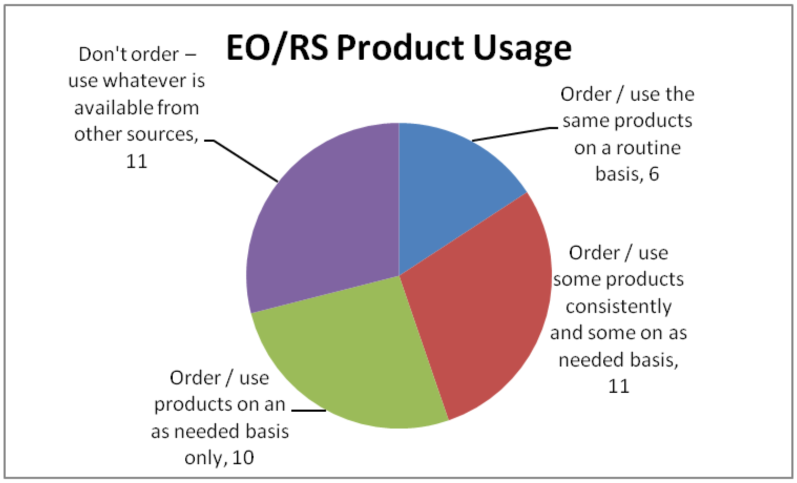


Figure 6. Current and projected use of EO/RS data relative to in-field data collection.

3.3 EO/RS Purchasing

Respondents were less likely to order/use products on a routine basis, instead opting to purchase on an as-needed basis or use whatever was available (Figure 7 – top panel). Most respondents purchase EO/RS data that have been processed to some extent (Figure 7 – bottom panel), though many report purchasing raw data and doing all of the processing and interpretation themselves.



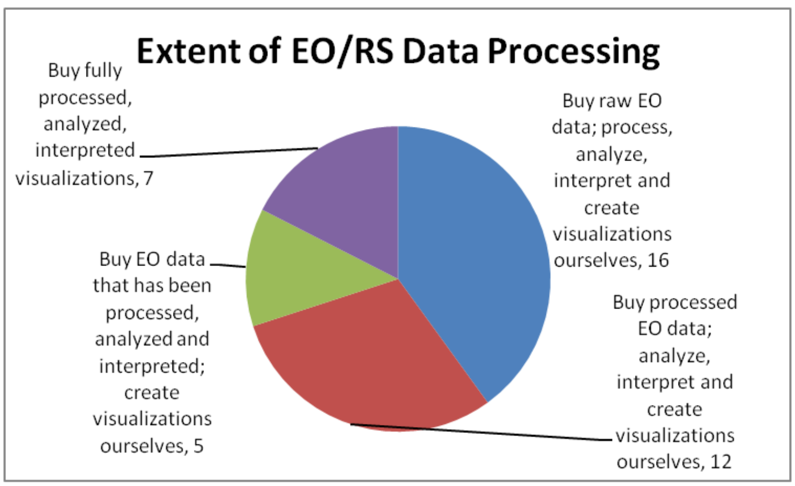


Figure 7. EO/RS purchasing habits.
Top panel: Purchase preferences.
Bottom panel: Extent of data processing.

3.4 Scale and Resolution

Of the 10 options provided in the survey, respondents use multispectral imagery most frequently (Figure 8; data aggregated across all spatial resolutions; see Appendix D for the detailed breakdowns for each data type). Hyperspectral imagery and radar were most often selected as not applicable indicating limited use of these data collection methods; it would be useful to determine if this is due to cost, or a lack of familiarity with the method or its capabilities, or poor experience with them in the past.

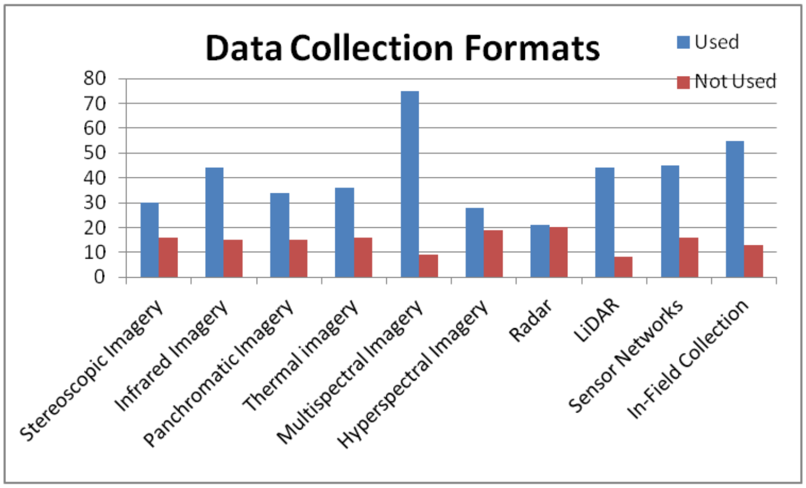


Figure 8. Methods for operational data collection.

Data collection frequently occurs at the provincial- and regional plan-scale on the one hand and the industrial site-scale at the other (Figure 9). There is an indication of increased focus on the county / municipal district-scale in the future.

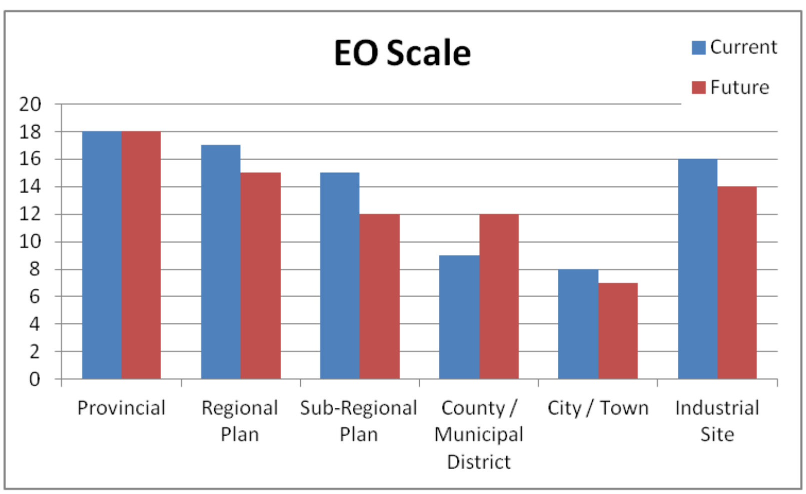


Figure 9. Scale of data collection for current and future operational needs.

When asked about the most appropriate spatial resolution (<2.5m to >1km) for current and future needs most respondents selected <2.5 m (Figure 10; data aggregated across all 10 sensor types).

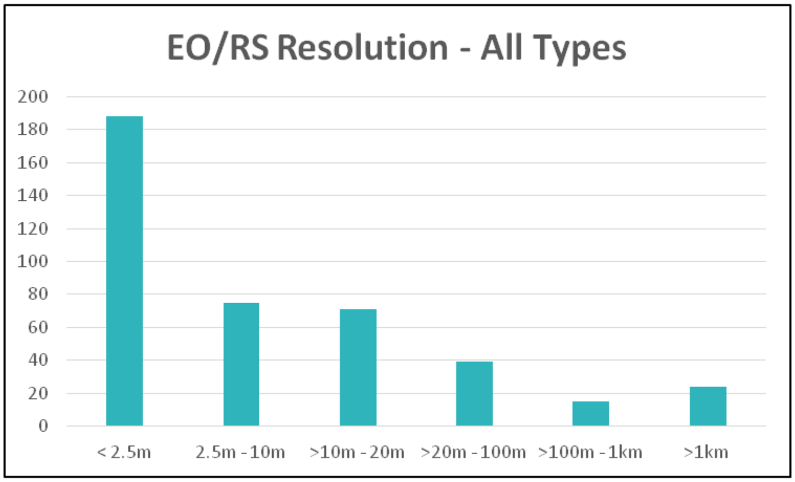


Figure 10. Frequency of responses regarding spatial resolution across all types of sensors.

The majority of respondents noted a current requirement for annual or monthly temporal resolution (Figure 11). There was some indication that more frequent data collection will be done in the future.

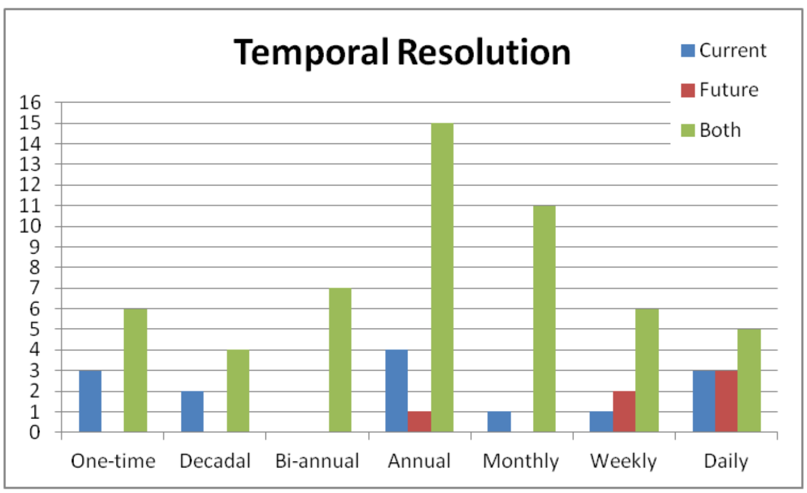


Figure 11. Temporal resolution for current operational needs.

3.5 Data Accessibility

Respondents were asked if government and industry data should be made more accessible or be made freely accessible. They were given the opportunity to identify conditions that would be attached in each case.

Respondents noted a preference for data to be more accessible and more freely accessible (Figure 12), with greater emphasis on government sources being free and freely available. Most conditional access was associated with industry data; common conditions for access included: data confidentiality; context for the data (including appropriate metadata); and, opportunities for cost recovery (a full list of conditions is provided in Appendix D).

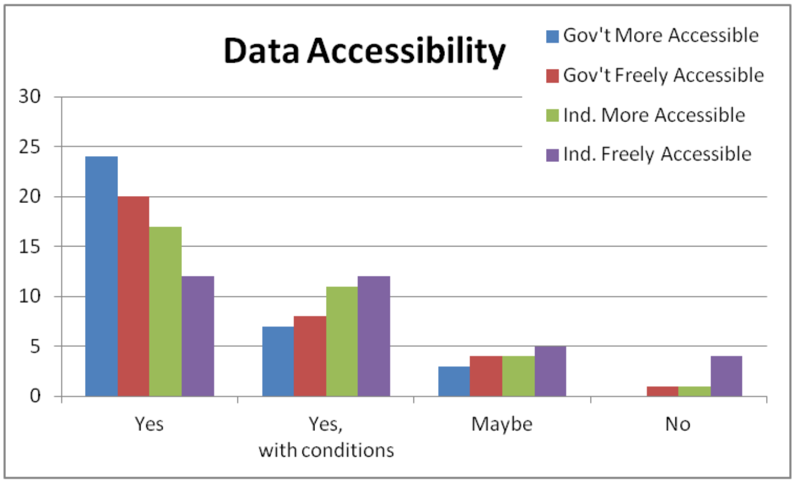


Figure 12. Preferences for access to data.

Respondents felt strongly that there should be not be a cost for access to government data but that industry and third parties should be able to charge for their data (Figure 13).

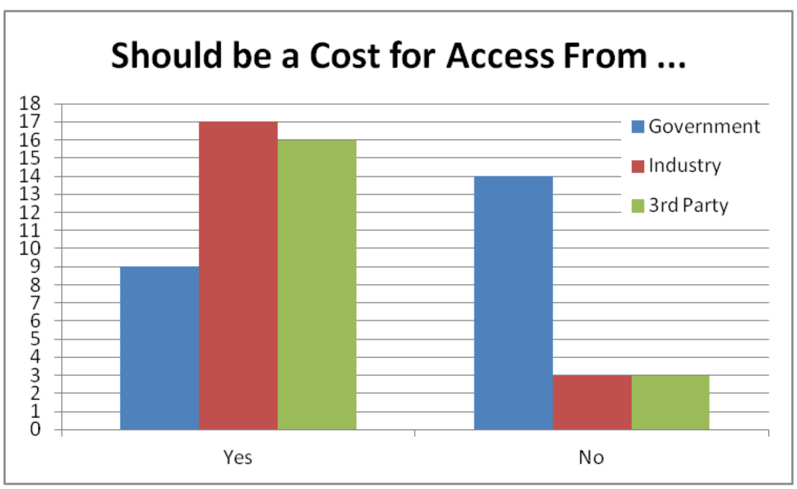


Figure 13. Costs for data access.

The majority of respondents indicated they would use processed data if available, with a slight preference for government sources (Figure 14). There was less interest in using data that included further analysis, interpretation and visualization. Common comments noted were: Nothing is free (needs a sustainable funding model); The quality of the data needs to justify any cost; and, Cost for access depends on data type, acquisition costs, and application (all comments are listed in Appendix D).

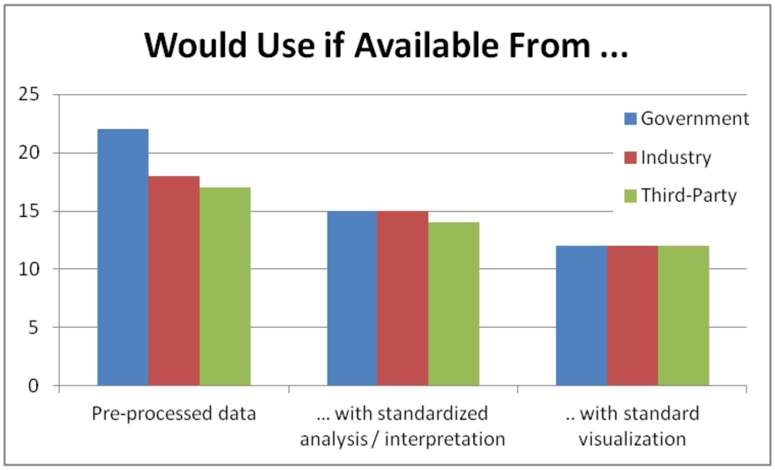


Figure 14. Interest in using processed data from various sources.

3.6 Enablers and Challenges

The biggest EO-related impediment to using EO/RS in respondent's organizations is the cost to acquire imagery (Figure 15).

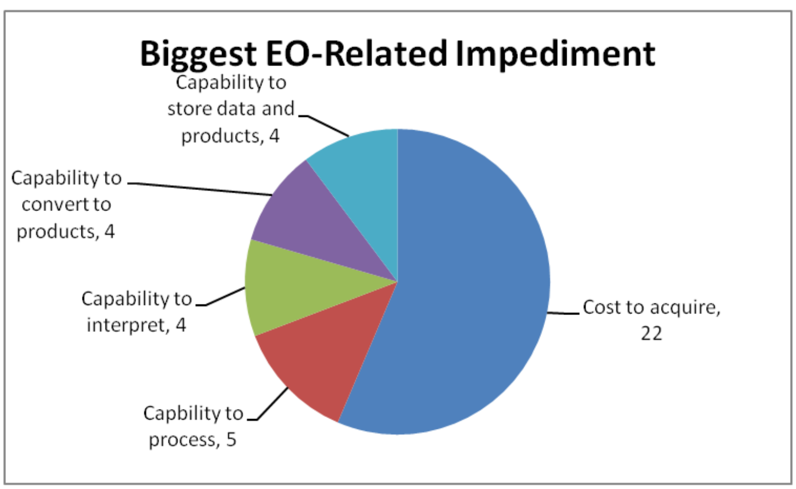


Figure 15. EO-related impediments to using EO/RS.

Respondents were asked to rank five challenges to the increased use of EO/RS products in order of priority (1 = highest; 5 = lowest). Access to data was ranked as the highest overall priority challenge, while regulatory acceptance received the most votes as the #1 challenge (Figure 16). Very few respondents considered EO personnel certification/accreditation as a priority challenge.

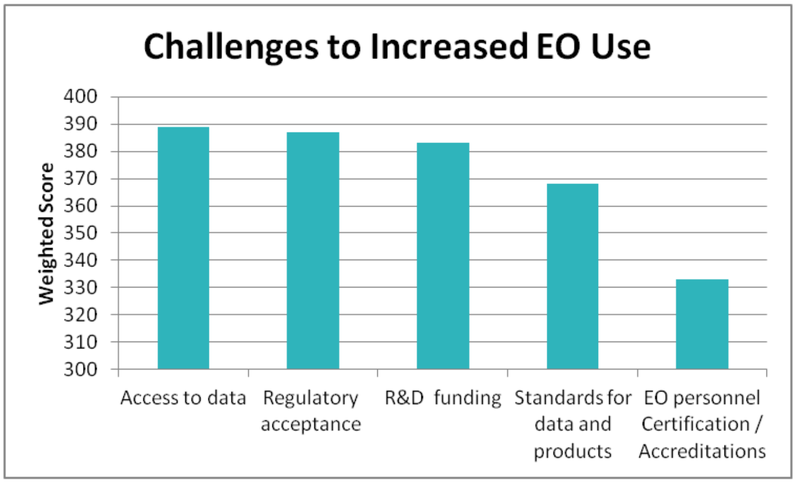


Figure 16. Ranking of challenges to increased use of EO/RS products.

Data analytics was identified by most respondents as being most in need of research and development (Figure 17). No one suggested research was required for data visualization.

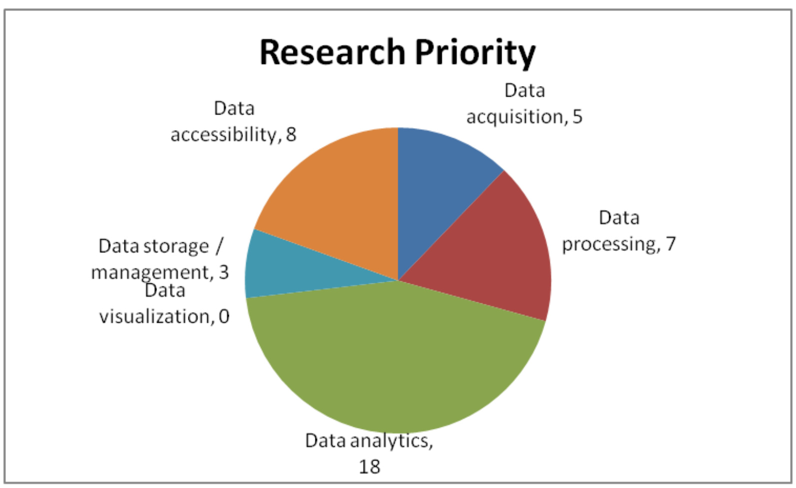


Figure 17. R&D priority areas.

Respondents indicated a strong preference for an organized collaborative effort to develop EO-related products (Figure 18).

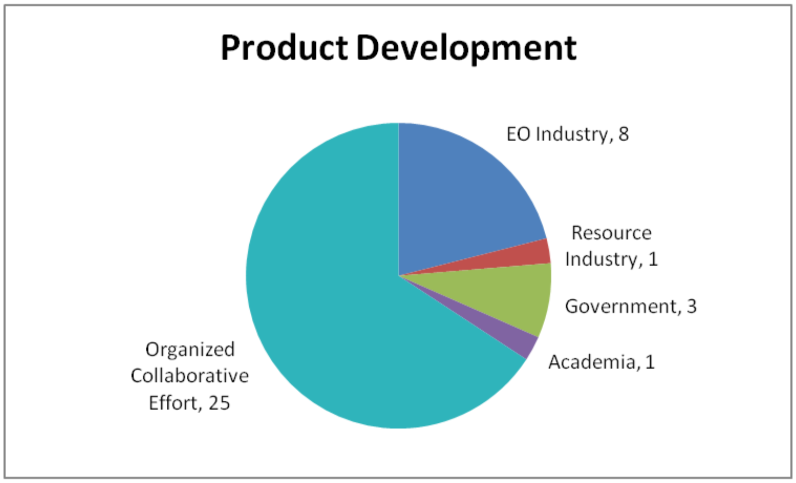


Figure 18. Primary responsibility for product development.

3.7 Future Needs

The majority of respondents indicated that their EO/RS usage would Increase substantially in the next 5 years (Figure 19); no one indicated reduction in use.

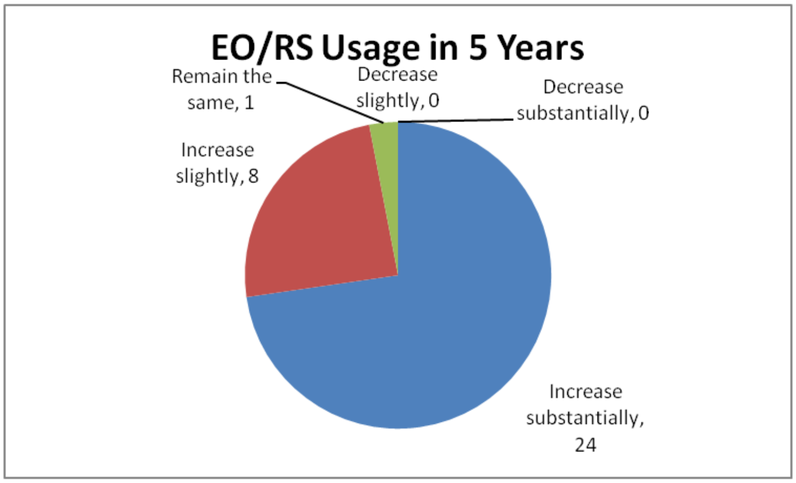


Figure 19. Expected change in EO/RS usage in the next 5 years.

A dedicated site, or set of sites, with free EO data from a variety of platforms for field testing/verifying new EO products and services was seen as very useful (Figure 20).

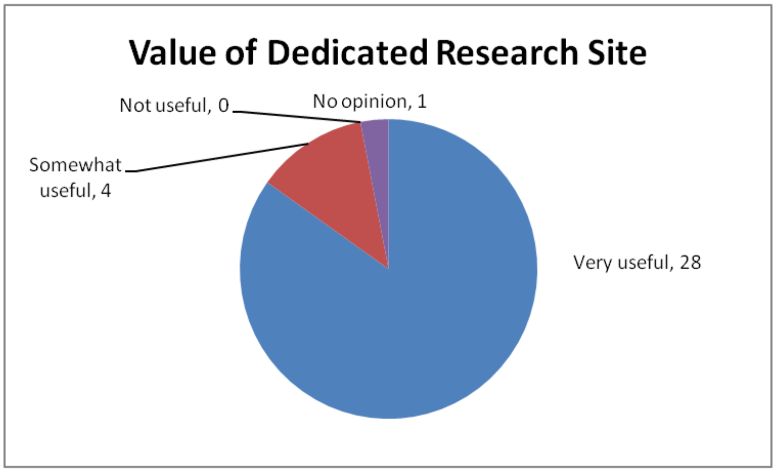


Figure 20. Interest in sites for field testing/verifying new EO/RS products and services.

3.8 Planned R&D Projects

Respondents identified a number of R&D projects planned for 2016 and 2017:

- Environmental site characterization and mapping of oil/gas facilities using a multispectral sensor mounted on an unmanned aerial vehicle (UAV).
- UAV LiDAR, UAV Hyperspectral.
- UAV compatible visible and near infrared (VNIR) Hyperspectral sensor data: agriculture, ecology, water quality, forest health.
- Conducting in house multi spectral LiDAR surveys across Alberta and the Northwest territories.
- Thermal/LiDAR integration and time series analysis of discontinuous permafrost thaw.
- ARTeMiS Lab at U of Lethbridge: multi-spectral LiDAR testing for forest attribute monitoring, C assessment and species delineation.
- Reclamation monitoring using LiDAR and optical data fusion.
- Wetland classification using LiDAR and optical data fusion.
- We have a number of sensor management (IoT) projects coming up. We have platforms that directly manage EO, such as a Cloud UAV platform, as well as platforms that indirectly use EO, as backgrounds for sensor data visualization.
- Combination of oil and gas reservoir hydrocarbon mapping combined with subsurface seismic in 3D presentation.

Trialed Pictometry[3] aerial imagery for 3 months in 1Q 2016.

GHGSat.

Recently initiated project that is developing a web-based system to enable use of remote sensing data to assess reclamation status of disturbed areas.

A web-based monitoring system for enhancing the provincial mapping and monitoring capability - project lead: Nadia Rochdi ATIC/U of Lethbridge.

Long-term watershed ecosystem sensitivity to drought/drying trends in central Alberta using Landsat TM.

Along with a client (Foresight CAC), I will be developing a demonstration project on remote sensing in forestry. The targeted project will be made public in early summer with a call for innovators. This may present a collaboration opportunity between AITF & Foresight based on a collaborative MOU presently being finalized.

AEMERA has identified a need for data quality assurance regarding remote sensing data. Recognizing that this is a fast changing area, AEMERA would like to work with the subject experts to come up with a path forward on establishing initial performance requirements so that remote sending data/products are of good quality. This is important both from scientific point of view and technology commercialization point of view. This issue has been brought to my attention by other parties and I understand that there is an international effort in this area.

In 2016, we are developing web-enabled thermal heat loss maps at the house, community and city level for Calgary, Okotoks, Airdrie, and Edmonton, with the goal in 2017 to complete the top 10 municipal centers in Canada - and make all the residential data freely available to the public[4]. Commercial, Municipal and Government agencies will need to pay for thermal heat-loss results.

Currently evaluating Big Data storage techniques.

Research work South of Fort McMurray in collaboration with the University of Calgary (Greg McDermid P.I.).

4. Workshop Discussions

Workshop participants discussed a series of prepared questions related to the key themes of: Data, Geomatics, and Remote Sensing and Data Analytics. In Edmonton the participants broke into three groups whereas in Calgary the same questions were discussed in plenary. The key points raised in the discussion session are listed here; detailed notes for each question are provided in Appendix E.

[3] See http://www.eagleview.com/Products/ImageSolutionsAnalytics/PictometryImagery.aspx
[4] See https://myheat.ca/

4.1 Data Discussion

It was widely agreed that the future is more data and more complex data. This raises issues of storage and management but provides opportunities for alternative arrangements such as processing data in the cloud rather than buying and storing yourself. Cloud storage and processing raised concerns about security and accessibility (some agencies and companies can't go outside their firewalls).

Government is the *de facto* standard setter by virtue of its data submission requirements and rules. There should be efforts to harmonize with national and industry standards. Concerns about lack of, and quality of, metadata were frequently raised – standards in this area would be very useful.

The idea of a Data Portal to provide access has merit but look to existing portals rather than creating a new one. Datasets submitted to meet regulatory requirements should be reviewed to determine which data could be made readily and freely accessible (e.g., detailed site assessment data used for a reclamation certificate application contained in the Environmental Site Assessment Repository) versus data that might need to be rolled up or made anonymous (e.g., drill core information). All data would need to be accompanied with the appropriate metadata. A number of examples from other jurisdictions (e.g., GeoFoundation Exchange, Vancouver, Saskatchewan) were cited for the concept of free and open data.

Costs are expected to decline but there was a caution about government procurement rules adding costs. Alternatives to free access to recoup costs were discussed. It was noted that open data can enhance overall economic benefits to the province through business growth (i.e., government should look at the bigger picture rather than focus on costs).

After cost, one of the biggest impediments noted to data sharing was restrictive data agreements.

4.2 Geomatics Discussion

Data visualization tells the *story of data* – it is a powerful tool to help people connect with the complex world of data and analysis. The idea of a Chief Storyteller in each EO/RS company to help improve products was raised. The EO/RS industry should look outside their field to find help telling stories (e.g., gaming, flight and military simulators, virtual reality). A current barrier (and therefore opportunity) is the need for specialists to create visualizations.

There was a sense that a catalogue of needs, products and sources might be valuable though no clarity on who should create and maintain it. There was agreement that government and industry need to do a better job of articulating EO/RS needs so SMEs can target product development (the military and COSIA were identified as examples of where this is done well).

The government's shift to outcomes-based (risk-based) regulation and increasing emphasis on regional- vs. site-level monitoring provides support for wider adoption of EO/RS tools. The key is to develop a clear understanding of the capabilities and limitations of EO/RS and the extent to which field validation is required. There is also a need for better understanding of the potential cost savings associated with EO/RS use (i.e., the business case).

4.3 Remote Sensing and Data Analytics Discussion

An approved entity to vet EO/RS technologies and products was identified as one means of improving traction for existing and new technologies. It was noted that in the US the onus is put on the companies proposing the solution to provide this validation to show solution meets regulatory requirements.

A formal mechanism to enable and enhance collaboration was suggested – e.g., a community of practice and/or a Centre of Excellence. Development of Highly Qualified Professionals through University/college educational programs was noted as key to the future use and acceptance of EO/RS and as a means of ensuring Alberta has the capacity to generate local products and solutions.

Education and awareness of EO/RS capabilities and uses need to be increased significantly to facilitate adoption. There is a need for *translators* – specialists who can ensure that all parties understand the complex EO/RS terminology.

Market opportunities exist, in areas like regulatory compliance and data analytics, but again cost is a major barrier.

4.4 Dedicated Research Sites

There was strong interest in the Alberta Open Data Areas proposal. Participants noted a number of data types that would be helpful to have for each area. It was recommended that government develop a strategy and governance system to enable collaboration – several existing collaboration initiatives were noted as potential models. Communication of the goals, data types and accessibility, methods of participation, and results is key to success. The system needs to ensure that SMEs and academia can participate and also provide mechanisms for third parties to contribute data.

5. Next Steps

Based on the workshop discussions and survey responses, the following recommended actions and potential Champion(s) for each are proposed:

1. The Alberta Open Data Areas proposal should proceed and there should be rapid communication of the opportunities associated with the project to ensure the widest possible uptake.
    a. *Champion*: Alberta Data Partnerships.
    b. *Support*: Government of Alberta, Alberta's innovation system, commercialization centres (i.e., TECTERRA, LOOKNorth).

2. Government should collate and publish all existing EO/RS standards associated with regulatory requirements. This will help ensure common and consistent standards, and provide SMEs with targets against which to assess, modify and create products and services.
    a. *Champions*: Government of Alberta (e.g., newly created Monitoring and Science Division, Environment and Parks) and Alberta Energy Regulator (co-leads).
    b. *Support*: Alberta's Innovation System, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).
3. Government should identify all existing public data sources and data collected pursuant to regulatory requirements with an eye towards increasing open, accessible and free data sources. A business case for making data more open and freely accessible should be developed.
    a. *Champions*: GeoDiscover Alberta and Service Alberta (Co-leads).
    b. *Support*: Alberta Energy Regulator, Alberta's Innovation System, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).
4. Government and industry should strive to better articulate and publish EO/RS needs. Ideally this would be made available in the least number of locations practicable and updated on an annual basis.
    a. *Champions*: Government of Alberta (i.e., newly created Monitoring and Science Division within Environment and Parks) and Alberta Energy Regulator (co-leads).
    b. *Support*: Government of Alberta, Alberta's Innovation System, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).
5. Government, the resource industry, the EO/RS industry and academia should work together to develop a formal Community of Practice to enhance communication, education and awareness. Efforts should be made to include broad participation by companies, organizations and individuals with an interest in advancing EO/RS technology development and use in Alberta.
    a. *Champion*: Alberta Innovates.
    b. *Support*: Government of Alberta, Alberta Data Partnerships, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).
6. Government, industry, and academia should work together with the EO/RS sector to explore the opportunity to create an innovation cluster or consortia – exploring different models, and building on the work of existing organizations and centres – to enable and

enhance collaboration across the commercialization spectrum from the support of basic and applied research to aiding in the adoption of EO technologies. A key function of this cluster/consortia may be to facilitate implementation of the other six recommendations.

   a. *Champion*: Alberta Innovates.

   b. *Support*: Government of Alberta, Alberta Energy Regulator, Alberta Data Partnerships, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).

7. Government, the resource industry and the EO/RS industry should explore the concept of an approved body to vet existing and new EO/RS technologies.

   a. *Champion*: Alberta Innovates.

   b. *Support*: Government of Alberta, Industry Associations (e.g., Petroleum Technology Alliance of Canada - PTAC, Canada's Oil Sands Innovation Alliance – COSIA), commercialization centres (i.e., TECTERRA, LOOKNorth).

6. Glossary

6.1 Terms

Many of these definitions are taken from De Abreu et al. (2015).

Analytics

Extracting information from large quantities of scientific data in a systematic way to uncover hidden patterns, unknown correlations, or to extract information in cases where there is no exact formula (e.g., known physical laws).

Earth Observation

Looking down at the Earth from aircraft and satellites using various sensors which make images that are afterwards used to study what is happening on or near the Earth's surface.

Geomatics

The collection, management, integration, representation, analysis, modeling and display of geographically-referenced information describing both the Earth's physical features and the built environment.

Hyperspectral Image

A remote sensing image acquired in narrow contiguous (using a large number) bands (> 20) across the electromagnetic spectrum.

Panchromatic Image

A single band image generally displayed as shades of grey (see https://www.e-education.psu.edu/natureofgeoinfo/c8_p11.html).

Platform

This is what carries a sensor – usually a satellite or an airplane. But a remote sensing platform could also be a hot-air balloon, a tall tower, etc.

Processing

Applying radiometric, atmospheric and geometric correction to remote sensing data to improve data quality and extract information with higher accuracy.

Remote Sensing

Remote sensing is the action of collecting images or other forms of data about the surface of the Earth, from measurements made at some distance above the Earth, processing these data and analyzing them.

Sensor

A device that measures detects and responds to some physical input such as motion, light, heat, pressure, moisture, or other environmental features.

Spatial Resolution

The smallest area on the ground (pixel) that can be resolved by satellite sensor.

Temporal Resolution

Refers to the time needed to revisit and acquire data for the exact same location.

Unmanned Aerial Vehicle (UAV)

An aircraft with no pilot on board. UAVs can be remote controlled aircraft (e.g., flown by a pilot at a ground control station) or can fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems.

Visualization

Using all available visual communication options to make complex and often difficult subjects more rapidly comprehensible, decision-making processes more efficient and knowledge transmission more attractive.

Wireless Sensor Network

A network that comprises of spatially distributed separate sensors to monitor environmental conditions such as temperature, moisture, pressure, etc.

6.2 Acronyms

AAF	Alberta Agriculture and Forestry
ADP	Alberta Data Partnerships
AEP	Alberta Environment and Parks
AGRASID	Agricultural Region of Alberta Soil Inventory Database
AI	Alberta Innovates
AITF	Alberta Innovates – Technology Futures
ARIF	Alberta Research and Innovation Framework
ASBIRI	Alberta Small Business Innovation and Research Initiative
ATIC	Alberta Terrestrial Imaging Center
CGDI	Canadian Geospatial Data Infrastructure
CNC	Cellulose Nano-Crystals
COSIA	Canada's Oil Sands Innovation Alliance
DEM	Digital Elevation Model
EIA	Environmental Impact Assessment
EO	Earth Observation
E-TAP	Environmental Technology Assessment Portal
GENESIS	GENeric Enterprise Spatial Information Services
GFX	GeoFoundation Exchange
GHG	Greenhouse Gases
GoA/GOA	Government of Alberta

GSIF	Global Soil Information Facilities
ICT	Information and Communications Technology
IoT	Internet of Things
IRMS	Integrated Resource Management System
IT	Information Technology
LiDAR	Light Imaging Detection and Ranging
PTAC	Petroleum Technology Alliance Canada
QA/QC	Quality Assurance / Quality Control
R&D	Research and Development
RS	Remote Sensing
RSTAP	Remote Sensing Technology Action Plan
SME	Small- and Medium-Sized Enterprise
TEK	Traditional Ecological Knowledge
UAV	Unmanned Aerial Vehicle
UofA	University of Alberta
UofC	University of Calgary
UofL	University of Lethbridge
US	United States

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APPENDIX A – Workshop Attendees

Workshops were held in Edmonton (April 20, 2016) and Calgary (April 21, 2016). Both Workshops were facilitated by Chris Powter, Enviro Q&A Services.

Edmonton Attendees

Adrian Banica – TEC Edmonton	Andy Robinson – City of Edmonton
Arnold Janz – Alberta Environmental Monitoring, Evaluation, and Reporting Agency	Bill Jefferies – LOOKNorth (presentation by phone)
Bob Morton – Silvacom	Brent Lakeman – Alberta Economic Development and Trade
Brent Scorfield – Alberta Innovates – Technology Futures	Craig Aumann – Alberta Innovates – Technology Futures
Dallas Johnson – Alberta Innovates – Energy and Environment Solutions	Daryl McEwan – Alberta Environment and Parks
David Hildebrand – Alberta Agriculture and Forestry	Derek Peddle – University of Lethbridge
Erik Holmlund – Alberta Data Partnerships	Erin Grass – Alberta Environment and Parks
Gigi Ho - TEC Edmonton	Jahan Kariyeva – University of Alberta
James Freeman – Zedi	Jane Humberstone – Alberta Economic Development and Trade
Jesse Toor – Alberta Energy	Jonah Keim – Matrix Solutions
Jonathan Neufeld – TECTERRA	Kevin Smiley – Sturgeon County
Kyle MacDonald – Boreal Laser	Long Fu – Alberta Environmental Monitoring, Evaluation, and Reporting Agency
Marius Ghinescu – Alberta Innovates – Technology Futures	Matthew Wheatley – Alberta Environment and Parks
Michael Boychuk – City of Edmonton	Michael Snow – Enbridge
Richard Gorecki – TECTERRA	Shane Patterson – Alberta Environment and Parks
Steve Tice – Alberta Energy	Todd Shipman – Alberta Energy Regulator
Tom Goddard – Alberta Agriculture and Forestry	Tom Ogaranko – Tessellate Inc.
Yogendra Chaudry – ECO Canada	

Calgary Attendees

Andrew Pylypchuk – Planet labs	Anil Sharma – AKS Geoscience Inc.
Barb Carra – Cybera Inc.	Bill Jefferies – LOOKNorth (presentation by phone)
Brent Lakeman – Alberta Economic Development and Trade	Brent Scorfield – Alberta Innovates – Technology Futures
Christopher Robson – University of Alberta	Craig Aumann – Alberta Innovates – Technology Futures
Dan Burt – Suncor	Dan Heaney – Farmers Edge
Daryl McEwan – Alberta Environment and Parks	Dason Wells – IBM

David Chan – Cybera	David Hill – University of Lethbridge
Doug Hunter – LiDAR Services International	Erik Holmlund – Alberta Data Partnerships
Geoffrey Hay – University of Calgary	Glen Larson – AKS Geoscience Inc.
Jason Howse – ITRES Research Limited	Jeff Lettvenuk – Saskatchewan Research Council
Jennifer Sylliboy – ECO Canada	Jocelyn Parent – Airborne Imaging
John Molberg – Lockheed Martin	John Orwin – Stantec
Jonathan Neufeld – TECTERRA	Jonathan Wharton – Alberta Innovates – Technology Futures
Jonny Wright – Alberta Municipal Affairs	Kimberley Van Vliet – WaVv Strategic Consulting
Maja Veljkovic – IBM	Marc Godin – Petroleum Technology Alliance of Canada
Michael Kaiser – Innovage Microsystems	Nadia Rochdi – University of Lethbridge
Natalie Arseneau – Innovate Calgary	Richard Gorecki – TECTERRA
Russ Duncan – Sky Hunter Corporation	Sarah Kohlsmith – Suncor
Shane Patterson – Alberta Environment and Parks	Trevor Miller – Intermap Technologies Corp.

APPENDIX B – Recent Needs Assessments and Technology Reports

General Observations

This document provides some background information for the Workshop – it is not intended to be an exhaustive bibliography, rather it represents a quick survey of Alberta-specific information sources that have not been prepared directly by or for the key government agencies or EO sector.

It is apparent that there is considerable effort in academia and the private sector to develop solutions and tools for a variety of problems but it is difficult to find Alberta-focused syntheses of EO user needs; the two workshops and two surveys discussed below are exceptions[5]. In other words, R&D effort may not be focused on the collective highest priority user needs, but rather on a current issue expressed by one user, or a perceived issue or interest of the researcher.

User Needs

De Abreu, R., S. Patterson, T. Shipman and C. Powter, 2015. Earth Observation for Improved Regulatory Decision Making in Alberta – Workshop Report. Geomatics Canada, Ottawa, Ontario. Open File 18. 178 pp. http://ftp2.cits.rncan.gc.ca/pub/geott/ess_pubs/296/296799/of_0018_gc.pdf

On February 26, 2015 researchers from the Canada Centre for Remote Sensing (Natural Resources Canada) presented their research related to earth observation technology in a workshop attended by 57 people from provincial and federal government, academia, resource industry and the Earth Observation / Remote Sensing (EO/RS) service and products industry. Many of these projects were developed as a result of the 2011 workshop in which several project themes were identified; these themes, in turn, led to the development of several pilot projects that were implemented to demonstrate the application of earth observation technologies. This work was carried out over the last 3 to 4 years and involved various levels of collaboration among the Canadian Space Agency, Canadian Forest Service, Canada Centre for Remote Sensing, Government of Alberta, and academia.

The research projects clearly demonstrated EO/RS capability to support key Alberta environmental initiatives, including: energy industry regulation, environmental monitoring, regional planning, and emergency management.

The 2011 Workshop, the research arising from that Workshop, and this Workshop are all part of an ongoing process of deploying EO/RS for environmental management. It is clear that we are at a cross-

[5] Non-Alberta user needs studies are available and may be helpful in focusing future work. See examples at the end of this document

roads – we need to move from research to technology deployment. This will require new partners and a clearly articulated game plan with realistic and achievable end points.

Taken together, the 2011 and 2015 workshops, survey and pilot projects point to the following conclusions:

1. EO has been shown to provide relevant and valuable information to inform and enhance monitoring in support of Alberta regulatory frameworks. Through these pilot projects, AER has begun to invest in EO capacity to further their understanding and use of this technology.
2. Further development of the business case for integration of EO into the regulatory framework is required before EO can play a formal role in IRMS in Alberta. This will require comparing the costs of EO approaches against traditional methods and understanding the value of EO-based information within various business contexts.
3. Although the pilot projects have shown value (and assuming a business case is made), there remain significant steps to operational deployment of any of these techniques within a regulatory context. While commercial remote sensing companies are in place to work with downstream users to deploy identified techniques and methods, Alberta will have to invest in highly qualified EO personnel and systems to advance operational deployment.
4. Relevant EO research and development is occurring within government, academic and commercial sectors. However, there is insufficient means today to integrate these efforts to further the use of EO within Alberta and quite often funding cannot be distributed across sectors.
5. There remains a utility gap between the knowledge products produced by EO scientists and the type of information needed by end user non-specialists who require plain language, simple descriptions, results and cost comparisons of the technology. While the pilot projects and the resultant workshop helped close this gap with Alberta regulators, significant work remains to ensure the value of EO is clearly articulated and understood by users.
6. The strong focus on change detection will place further emphasis on the efficient storage and smart integration of large EO.

It is also clear that we need to continue the dialogue with a broader suite of participants to enhance understanding of the significant role EO/RS can play in environmental management –including supporting regulatory functions, industrial and ambient monitoring, and policy development. A conference on *Application of EO/RS in Environmental Protection* is suggested as a mechanism for sharing knowledge.

Hopkinson, C., 2013. Alberta Airborne LiDAR stakeholder Forum & Questionnaire Report. University of Lethbridge, Alberta Terrestrial Imaging Centre, Department of Geography, Lethbridge, Alberta. http://scholar.ulethbridge.ca/hopkinson/files/ul_2013_lidar_forum_questionnaire_report_0.pdf

The report presents a summary of a questionnaire and a two day forum aimed at better understanding issues of high priority to airborne LiDAR stakeholders in Alberta and ways in which the use and value of LiDAR data holdings could be enhanced. From 62 questionnaire respondents, it was found that three market sectors dominate the Alberta LiDAR stakeholder community (natural resources, environment and energy) with the top three priorities being: i) access to and archival of LiDAR data; ii) development of new applications; and iii) efficient processing workflows.

Almost all respondents indicated that they would consider the use of an online LiDAR data portal to support data access and management, while point cloud processing ranked most highly in terms of existing skill shortages and training needs. There was minor sectoral stratification apparent in some of the responses, with the most notable being that industry and government stakeholder groups both singled out error modeling and acquisition guidelines as high priority needs.

Oil Sands Research and Information Network, 2014. Survey of Oil Sands Environmental Management Research and Information Needs. OSRIN Report No. TR-58. 67 pp. http://hdl.handle.net/10402/era.40128

As one of its last projects, the Oil Sands Research and Information Network (OSRIN) conducted this survey of oil sands environmental management research and information needs. The survey was conducted in October and early November 2014 for OSRIN by the University of Alberta's Population Research Laboratory (PRL). A total of 127 responses were received but only 88 respondents answered all of the questions. Consultants and academics formed the majority of self-identified respondents; approximately 41% of the 88 respondents had more than 15 years combined education and experience.

Respondents were asked how important it is to develop tools, standards and capacity for a variety of tools that support research, monitoring and information sharing. Remote Sensing received the least votes (39) which seems surprising given the level of research effort and piloting work underway to develop applications for this tool.

Research Needs

Using remote sensing to replace Alberta Energy Regulator reporting requirements.

Develop remote sensing tools for tracking reclamation progress and effectiveness.

Use of remote sensing to provide high-level health assessment of oil sands. This remote sensing could track visual disturbances (and bbl/d intensity of disturbance area), GRACE data on water table levels, and be applied to other use cases that be identified in the future.

Priority Information / Data Needs

Independent planning and collection of LiDAR/remote sensing survey of oil sands area – and then GIS-based mapping of current status for each relative to mine plans.

Publicly accessible electronic geospatial database for accessing and submitting environmental impact assessment data, this would also include data from pre-site assessments and detailed site assessments.

Remote sensing data and interpretation tools to support monitoring disturbance and reclamation status in the boreal forest.

Updated, finer resolution footprint inventory.

Updated finer resolution habitat.

Inventory of linear features and associated infrastructures.

Detailed winter exploration footprints.

Detailed land cover / land use footprint.

Mapped quantification of anthropogenic disturbances in oil sands region.

Wetlands and water connectivity mapping.

Ryerson, R.A., 2011. Earth Observation Monitoring of the Oil Sands in Alberta: Report on a Workshop. Prepared by Kim Geomatics Corporation, Manotick, Ontario for Alberta Geological Survey, Energy Resources Conservation Board, Edmonton, Alberta. 69 pp.

This document reports on a Workshop on Earth Observation (EO) Monitoring of the Oil Sands held in Edmonton, Alberta on February 28-March 1, 2011.

Seven simple but important recommendations have flowed from the workshop. The recommendations fall into three categories:

1. Engagement – who else we recommend should be engaged, in what order, and why;
2. Data Assessment, Management and Delivery – the future success of any monitoring program will depend on a foundation of scientifically sound, complete, well managed and easily accessible data; and

3. Organizational Development – details the sort of organizational structure that began to emerge from the workshop.

Engagement

1. The oil sands industry is an important player in the monitoring and stewardship of the oil sands and the industry has already developed some capacity in Earth Observation and remote sensing – we recommend engaging the oil sands industry in the discussion of the use of Earth Observation and remote sensing technologies for monitoring the oil sands region as appropriate using existing engagement linkages.

2. The Earth observation and remote sensing industry is potentially an important player and contributor of technology and there will be many competing interests within this community – we recommend that an open invitation be extended to this industry to participate in a workshop on practical solutions that flow from the suggested pilot and research projects.

Data Management and Delivery Projects

For each of these projects the first step should be the determination of the cost of carrying them out.

3. There is a great deal of information about the oil sands region that is often not well organized, nor easily accessible – we recommend that an EO and Related Meta Data Catalogue be developed to provide (1) An index of what EO and other data are available pertaining to the oil sands, the data's content, where they are, timeframes, and other relevant parameters; (2) A listing of all existing monitoring research as well as the people with experience in the area of monitoring the oil sands region; (3) An assessment of major information gaps; and (4) An approach that would ensure open and efficient access to all available information related to oil sands development activities and the regional area where these activities take place.

4. Open and efficient access to all available information related to oil sands development is required by regulators, policy makers at all levels, NGOs, and the public – we recommend building, maintaining and updating a single online portal to search for and access existing data sets pertaining to the oil sands.

Organizational Development

5. There is no overarching science plan dealing with monitoring of the oil sands with earth observation and remote sensing, and there are gaps in research and knowledge, and there is no single structure coordinating Earth Observation and remote sensing pilot projects and research projects, and there is no organized and systematic approach to provide funding to meet these challenges – we recommend the establishment of a structure or program to track and involve all partners and stakeholders, develop a science plan, and begin to fund pilot and R&D projects.

6. There are concerns about the science underpinning monitoring in the oil sands region and the Governments and the citizens of Alberta and Canada have demanded that monitoring and reporting be

independent, verifiable and believable – we recommend that the structure or program be science-based, similar to the members of the National Networks of Centres of Excellence, focused on remote sensing and EO contributions to oil sands environmental monitoring; have an independent board of directors involving government, regulators, industry, and academe; be subject to international review, and that the Chair of that Board would have to be familiar with remote sensing and Earth observation, industry in the RS/EO field, government programs, and how other networks function.

7. The completion of the data management projects, development of further workshops involving more stakeholders, and development of the science plan and new structure will require funding and the time-horizon is at least in the five- to ten-year range – we recommend the immediate development of a long-term budget for five years, renewable for at least another five years.

PRODUCTS AND TOOLS

Beck, M., T. Blaser and R. Mach, Industry Value and Benefit of Computer Based Visualization of 3D Terrain and Land Use Models.
http://www.machidee.de/pub/Intergeo_feedback_rmtb_060801_red.pdf

A new way to handle complex Geo Data with additional content is the use of Virtual Globes. Virtual Globes may be described as specialized toolboxes for preparing all kinds of data for highly interactive geo referenced use combined with extra 3D information. This article is about Virtual Globes - what they are, where they come from, where their advantage may be found, who is on the market and where we are heading for.

Blade, M. and H. Ziervogel, 2010. The Use of Remote Sensing Technology to Delineate Hydrocarbon Contamination in the Arctic. IN: Proceedings of RemTech 2010, Environmental Services Association of Alberta, Edmonton, Alberta. http://www.esaa.org/wp-content/uploads/2015/06/10-Blade.pdf

Geochemical changes result from PHC degradation in subsurface

- Microbial mat growth with types depending on PHC concentrations
- Use of raster spatial analysis to isolate wavelengths and colour related to vegetation
- Broad applicability for scoping at remote sites and crude delineation

Chen, Y., 2013. Retrieving surface peat moisture in an Albertan bog with Radarsat-2. University of Alberta, Department of Renewable Resources, Edmonton, Alberta.
https://era.library.ualberta.ca/downloads/gb19f593s

To monitor at a large scale, Radarsat-2 was used to retrieve surface (0-5 cm) peat moisture in an Albertan ombrotrophic bog.

Coutts, R., 2014. Aerial Image Acquisition and Processing Services. IN: Proceedings of RemTech 2014, Environmental Services Association of Alberta, Edmonton, Alberta. http://www.esaa.org/wp-content/uploads/2015/06/14-Matrix.pdf

Describes various uses for EO/RS and the benefits and drawbacks of UAVs vs. helicopter vs. fixed wing platforms.

Davidson, D.P., 2002. Sensitivity of ecosystem net primary productivity models to remotely sensed leaf area index in a montane forest environment. University of Lethbridge. Faculty of Arts and Science, Lethbridge, Alberta.
https://www.uleth.ca/dspace/bitstream/handle/10133/155/MQ83748.pdf?sequence=3

Spectral mixture analysis (SMA), accounting for subpixel influences on reflectance, outperformed vegetation indices in LAI prediction from remote sensing. LAI was shown to be the most important variable in modeled NPP in the Kananaskis, Alberta region compared to soil water content (SWC) and climate inputs.

DeLancey, E.R., 2014. Hyperspectral remote sensing of boreal forest tree diversity at multiple scales. University of Alberta, Department of Earth and Atmospheric Sciences, Edmonton, Alberta.
https://era.library.ualberta.ca/downloads/bv73c1280

This research compared the variability/diversity of spectral information captured with spectrometers at the airborne, field, and leaf level to tree species diversity.

Government of Canada, 2009. International GEO Workshop on Synthetic Aperture Radar (SAR) to Support Agricultural Monitoring: Workshop Report. November 2-4, 2009, Kananaskis, Alberta, Canada.
https://www.earthobservations.org/documents/cop/ag_gams/200911_02/20091102_sar_for_ag_monitoring_workshop_report.pdf

This workshop brought together 115 participants from around the world, with some 75 of the experts also participating in the pre-workshop capacity building training session. The participants included experts and managers who map agricultural land cover and land use; monitor changes in the agricultural land base; identify crops and estimate crop area; qualitatively and quantitatively assess crop condition; and monitor properties related to water availability such as soil moisture. The objectives of the workshop were to increase understanding and capacity to use SAR data for agricultural monitoring, and the identify the needs of the agricultural community to space agencies and others involved in the delivery of SAR data and services.

Hassan, Q.K., 2015. Development of a Satellite-Based Forest Fire Danger Forecasting System and its Implementation Over the Forest Dominant Regions in Alberta, Canada. University of Calgary, Geomatics Engineering, Calgary, Alberta.
http://theses.ucalgary.ca/bitstream/11023/2143/2/UCalgary_2015_Chowdhury_Ehsan.pdf

The newly developed 8-day scale FFDFS uses Moderate Resolution Imaging Spectroradiometer (MODIS)-derived 8-day composite of surface temperature (TS), normalized multiband drought index (NMDI), and normalized difference vegetation index (NDVI).

Jahan, N., 2012. Modeling carbon-water-vegetation dynamics using remote sensing and climate data. University of Alberta, Department of Civil and Environmental Engineering, Edmonton, Alberta.
https://era.library.ualberta.ca/downloads/hh63sv96j

In this research, promising techniques for simulating carbon (Gross primary production) and water fluxes (soil moisture and evapotranspiration) were developed using remotely sensed data to overcome our dependence on meteorological data which are often not available with sufficient accuracy for regional scale climate studies. The temporal responses of vegetation to climate were assessed using Artificial Neural Network (ANN) and two remotely sensed vegetation indices (VIs), normalized difference vegetation index (NDVI) and enhanced vegetation index (EVI).

Johnson, R.L., 2000. Airborne remote sensing of forest leaf area index in mountainous terrain. University of Lethbridge, Faculty of Arts and Science, Lethbridge, Alberta.
https://www.uleth.ca/dspace/bitstream/handle/10133/90/MQ49131.pdf?sequence=3

This research examines the effects of mountainous terrain on the radiometric properties of multispectral CASI imagery in estimating ground-based optical measurements of LAI, obtained using the TRAC and LAI- 2000 systems. Field and image data were acquired summer 1998 in Kananaskis, Alberta, Canada. To account for the influence of terrain a new modified approach using the Li and Strahler Geometric Optical Mutual Shadowing (GOMS) model in 'multiple forward mode' (MFM) was developed. This new methodology was evaluated against four traditional radiometric corrections used in comination with spectral mixture analysis (SMA) and NDVI. The MFM approach provided the best overall predictions of LAI measured with ground-based optical instruments, followed by terrain normalized SMA, SMA without terrain normalization and NDVI.

Katsuris, D. and B. Wanless, 2013. Application of UAV Technology for Environmental Lifecycle Monitoring. IN: Proceedings RemTech 2013, Environmental Services Association of Alberta, Edmonton, Alberta. http://www.esaa.org/wp-content/uploads/2015/06/13-Katsuris1.pdf

Describes the use of UAVs for planning and tracking site development and reclamation.

A picture is worth 1000 words …. A mosaic is worth 100's of thousands words …

Lewis, G., 2012. Applications of Unmanned Air Vehicle (UAV) Systems for Remediation Projects. IN: Proceedings RemTech 2012, Environmental Services Association of Alberta, Edmonton, Alberta. http://www.esaa.org/wp-content/uploads/2015/06/12-Lewis1.pdf

UAV – Any fixed or rotary winged aircraft which does not carry any human cargo.

Considerations for use:

- Size of the area to be flown, must be scale appropriate
- Transport Canada requirements (SFOC)
- Training of personal to operate

Li, X., 2009. Neural networks modelling of stream nitrogen using remote sensing information: model development and application. University of Alberta, Department of Civil and Environmental Engineering, Edmonton, Alberta. https://era.library.ualberta.ca/downloads/n009w309g

This study was to develop an artificial neural network (ANN) modelling tool relying solely on public domain climate data and satellite data without ground-based measurements. ANN was successfully applied to simulate N compositions in streams at studied watersheds by using easily accessible input variables, relevant time-lagged inputs and inputs reflecting seasonal cycles.

Marey, H.S., Z. Hashisho and L. Fu, 2014. Satellite Remote Sensing of Air Quality in the Oil Sands Region. OSRIN Report No. TR-49. 104 pp. http://hdl.handle.net/10402/era.38882

The rapid expansion of oil sands activities and massive energy requirements to extract and upgrade the bitumen have led to a need for more comprehensive understanding of their potential environmental impacts, particularly on air quality. There are many oil sands developments and natural sources (point, area and mobile) that generate significant emissions, including nitrogen (NO_2) and sulphur oxides (SO_2), carbon monoxide (CO), and particulate matter. These chemicals are known to affect human health and climate. Thus an environmental monitoring program that measures the ambient air quality is needed to understand air pollutant emissions, their chemical transformation in the atmosphere, long-range transport and subsequent deposition to the local and regional environment. Several studies have been conducted to understand the impact of the oil sands projects on the air quality over Alberta using ground-based measurements. However, data from these measurements are limited in spatial coverage as they reflect local air quality and cannot provide information about the overall regional air quality. A complementary approach to ground-based measurements is satellite-based monitoring which can provide large spatial and vertical coverage and allow monitoring of local and regional air quality.

The objective of this report is to review available remote sensing technologies for monitoring and understanding the tropospheric constituents in the atmosphere, and potential use for monitoring the air quality over the oil sands region. The report includes a summary of the basic principles of remote sensing using satellites for tropospheric composition measurements; a detailed description of the instruments and techniques used for atmospheric remote sensing from space; demonstration of the key findings and results of using satellite data for air quality application; a brief summary of future missions; and, a case study to demonstrate the use of satellite data to study the impact of oil sands and other sources on carbon monoxide levels over Alberta.

The science of atmospheric remote sensing has dramatically evolved over the past two decades and proved to be capable of observing a wide range of chemical species (e.g., aerosols, tropospheric O_3, tropospheric NO_2, CO, HCHO, and SO_2) at increasingly higher spatial and temporal resolution. The integrated use of ground-based and satellite data for air quality applications has proven to be of enormous benefit to our understanding of the global distribution, sources, and trends of air pollutants. Despite the significance of using satellites in characterizations of air quality, there is limited research on using satellite-based remote sensing technology over Alberta. As satellite-based techniques now provide an essential component of observational strategies on regional and global scales, it is recommended to integrate data from satellite, and ground-based measurements as well as chemical transport models for air quality monitoring.

This report provides an in depth review of the developments in the atmospheric remote sensing area that may support air quality management, policy, and decision makers at the national, and regional level to take actions to control the exposure to air pollution.

Parshakov, I., . Automatic class labeling of classified imagery using a hyperspectral library. University of Lethbridge, Department of Geography, Lethbridge, Alberta.
https://www.uleth.ca/dspace/bitstream/handle/10133/3372/parshakov%2c%20ilia.pdf?sequence=1

As a general rule, the larger the number of classes, the more difficult it is to assign meaningful class labels. A fully automated post-classification procedure for class labeling was developed in an attempt to alleviate this problem. It labels spectral classes by matching their spectral characteristics with reference spectra. A Landsat TM image of an agricultural area was used for performance assessment. The algorithm was used to label a 20- and 100-class image generated by the ISODATA classifier. The 20-class image was used to compare the technique with the traditional manual labeling of classes, and the 100-class image was used to compare it with the Spectral Angle Mapper and Maximum Likelihood classifiers. The proposed technique produced a map that had an overall accuracy of 51%, outperforming the manual labeling (40% to 45% accuracy, depending on the analyst performing the labeling) and the Spectral Angle Mapper classifier (39%), but underperformed compared to the Maximum Likelihood technique (53% to 63%). The newly developed class-labeling algorithm provided better results for alfalfa, beans, corn, grass and sugar beet, whereas canola, corn, fallow, flax, potato, and wheat were identified with similar or lower accuracy, depending on the classifier it was compared with.

Patias, P., 2004. Photogrammetry in the Visualization Era. IN: Proceedings: Workshop - Archaeological Surveys, WSA2 – Modelling and Visualization, Athens, Greece, May 22-27, 2004. https://www.fig.net/resources/proceedings/fig_proceedings/athens/papers/wsa2/WSA2_1_Patias.pdf

The purpose of this paper is multiple: First, to present and describe the available techniques and tools. The aim is … to highlight the most important features, which may be useful to the photogrammetrists. Second, to present and analyze the most common and important shortcomings of the current visualization technology, that have an impact on visualization of photogrammetric data. These problems are currently a bottleneck in the photogrammetric visualization "pipeline". Currently, many research efforts are aiming at smoothing out these sharp edges. The proposed (and sometimes implemented and available) solutions are of much importance and interest to the photogrammetric community. Third, a critical survey of the current (during the last three years) visualization efforts and achievements in the photogrammetric community show the current status of achievement and what maybe expected in the future.

Pryor, L.S., 2012. Land-cover mapping in an agriculture zone using simulated Sentinel-2 data. University of Lethbridge, Department of Geography, Lethbridge, Alberta. https://www.uleth.ca/dspace/bitstream/handle/10133/3367/pryor%2c%20logan.pdf?sequence=1

This study simulated Sentinel-2 MSI data from airborne hyperspectral data over an agriculture area in northern Alberta, Canada. The standard Sentinel-2 MSI land-cover product was evaluated by comparing it to one created from the standard Landsat 5 TM and SPOT 5 HRV data products. Furthermore the standard Sentinel-2 MSI water column content band configuration and algorithm was evaluated for atmospheric correction purposes.

Rochdi, N., J. Zhang, K. Staenz, X. Yang, D. Rolfson, J. Banting, C. King and R. Doherty, 2014. Monitoring Procedures for Wellsite, In-Situ Oil Sands and Coal Mine Reclamation in Alberta – December 2014 Update. OSRIN Report No. TR-47. 167 pp. http://hdl.handle.net/10402/era.38742

The scope of the Monitoring Procedure for Reclamation in Alberta (MOPRA) project is to develop a geomatics-based monitoring system to support the Government of Alberta's efforts for monitoring reclamation success. This software will support the decision making process to screen almost all oil and gas wellsites and prioritize those that require immediate intervention allowing an efficient allocation of government resources.

Using remote sensing technologies, the following three types of information were pursued: (1) Baseline maps of the pre-disturbance condition of sites, (2) Vegetation condition related to species, and canopy structure, and vegetation productivity, and (3) Temporal change of land condition in reclaimed areas. The project provided the opportunity to assess remote sensing technologies including optical multispectral, hyperspectral and LiDAR, for monitoring vegetation condition in reclaimed wellsites and mine areas. Three study areas were assessed, sampling both wellsites and a coal mine areas, which cover different landscapes including forested, and agricultural areas.

A set of land products were developed within this project, including baseline land cover, land-cover change, canopy height, fractional cover, tree species and canopy leaf area index (LAI). In addition, multi-year profiles of vegetation index data were examined to assess vegetation regrowth in wellsites in comparison to undisturbed reference areas. Canopy structure attributes, derived from LiDAR data such as canopy height and fractional cover, were also examined to assess differences in vegetation structure between reclaimed wellsites and regenerated burnt/clear-cut areas. In addition, a reclamation monitoring system, composed of a Remote Sensing Data Processing Toolbox and A Stand- Alone Assessment Tool, was developed.

The land products derived from remote sensing data provide information related to some of the landscape and vegetation assessment parameters adopted within the 2010 reclamation criteria document, such as bare areas, vegetation species, land-use change, canopy height, percent canopy cover and vegetation quantity/quality. The achievements of the MOPRA project have highlighted the benefits that remote sensing technologies can provide in support of reclamation monitoring efforts. Having access to a synoptic view of reclaimed lands at the landscape and regional level is of value for assessing land-use cumulative effects and making decisions in line with an integrated resource management system.

While the MOPRA outcomes have shown promise in this direction, there is still a need to test and validate the information extraction approaches adopted as well as the monitoring system developed on various landscapes, such as wetlands, rangelands, agriculture and forested areas. Although, this project has focused on reclaimed wellsites and reclaimed areas within coal mines, the work undertaken can be applicable to natural areas as well as reclaimed lands that have been disturbed by other activities, such as transportation corridors, wind energy, sand and gravel operations, oil sands mines as well as pipelines. To move towards an integration of remote sensing technologies as an operational monitoring tool, the MOPRA monitoring system would require further testing, involving consultants, industry (e.g., oil and gas, coal mine, wind energy farms), and monitoring organizations (Alberta Environmental

Monitoring, Evaluation and Reporting Agency – AEMERA) and regulatory agencies (e.g., Alberta Energy Regulator, ESRD).

Roy, G., 2012. Methodologies for mapping the spatial extent and fragmentation of grassland using optical remote sensing. University of Lethbridge, Department of Physics and Astronomy, Lethbridge, Alberta.
https://www.uleth.ca/dspace/bitstream/handle/10133/3316/roy%2c%20gairik.pdf?sequence=1

This research reports on new methodologies developed for mapping the spatial extent of native grasslands to an unprecedented level of detail and assessing how the grasslands are fragmented. The test site is in the Newell County region of Alberta (NCRA). 72 Landsat and 34 SPOT images from 1985 to 2008 were considered for the analysis. With an airport runway used as a pseudo-invariant feature (PIF), relative radiometric correction was applied to 17 Landsat and 8 SPOT images that included the same airport runway. All the images were classified using the Support Vector Machine (SVM) classification algorithm into grassland, crop, water and road infrastructure classes. The classification results showed an average of 98.2 % overall accuracy for Landsat images and SPOT images. Spatial extents and their temporal change were estimated for all the land cover classes after classifying the images. Fragmentation statistics were obtained using FRAGSTATS 3.3 software that calculated land cover pattern metrics (patch, class and landscape).

Roy, S., 2014. Spectral-spatial approaches for hyperspectral data classification. University of Lethbridge, Faculty of Arts and Science, Lethbridge, Alberta.
https://www.uleth.ca/dspace/bitstream/handle/10133/3757/ROY_SATHI_MSC_2014.pdf?sequence=1

Classification of hyperspectral data is very challenging and mapping of land cover is one of its applications. Improving the classification accuracy and computation time of hyperspectral data were achieved incorporating contextual information in combination with spectral information for correcting classification errors along class boundaries and within class. In the proposed method, the original hyperspectral image was first classified using the Support Vector Machine (SVM) classifier, followed by the Markov Random Field (MRF) approach applied to the boundary areas and Unsupervised Extraction and Classification of Homogeneous Objects (UnECHO) classifier used for the interior parts of regions to produce the final classification map. In this study two agricultural (Hyperion and AVIRIS) and one urban (ROSIS) datasets were used. Investigations of the spectral and various contextual approaches including feature reduction show that the SVM-MRF method with grid search works best for all of the datasets. The highest overall accuracy of 97.35% was achieved for the urban dataset.

Smith, B., 2013. Multi-temporal Remote Sensing of Rangeland Vegetation for Investigation of Fire-related Ecology at Canadian Forces Base Suffield, Alberta. University of Calgary, Department of Geography, Calgary, Alberta.
http://theses.ucalgary.ca/bitstream/11023/735/2/ucalgary_2013_smith_brent.pdf

Used multi-temporal remote-sensing techniques to model plant functional types (PFT; C3 vs. C4 grasses), as an indicator of ecosystem state. The best-performing model (overall accuracy = 74%, weighted kappa = 0.53) was compared against a spatial fire-history database digitized from the Landsat archive (1972 to 2007).

Stoddart, R. and S. Adam, 2012. Arctic Sites Phase 1 ESA & Remote Sensing Pilot Project. IN: Proceedings of RemTech 2012, Environmental Services Association of Alberta, Edmonton, Alberta.
http://www.esaa.org/wp-content/uploads/2015/06/12-Stoddart1.pdf

Imperial Oil legacy sites distributed over 1.5 million km^2

Need to assess many remote Arctic sites in a safe, timely and cost-effective manner

- Chose a modified Phase I approach: traditional file review & remote sensing data in lieu of individual site visits
- Remote sensing as initial review to categorize sites and establish risk based management

Conclusions

- Useful for prioritizing sites that may require future field visits
  - Establishes database of baseline information
  - Potential use as long-term monitoring strategy
  - Advantageous to have an inventory for stakeholder inquiries
- Satellite data proves useful and cost effective vs. hyperspectral
  - Comparable results and more easily acquired
  - Aerial data has detail but expensive and logistically difficult to execute
- Certain site details only acquired by traditional site visit

Suchorolski, J., 2012. Wireless Site Monitoring And Data Collection Environmental Case Application. IN: Proceedings WaterTech 2012, Environmental Services Association of Alberta, Edmonton, Alberta.
http://www.esaa.org/wp-content/uploads/2015/01/WaterTech2012-P54.pdf

Describes wireless sensor network deployed at a golf course to monitor groundwater level, soil moisture and temperature.

Taheriazad, L., C. Portillo-Quintero and G.A. Sanchez-Azofeifa, 2014. Application of Wireless Sensor Networks (WSNs) to Oil Sands Environmental Monitoring. OSRIN Report No. TR-48. 51 pp. http://hdl.handle.net/10402/era.38858

This report presents a comprehensive review of industrial applications of an emerging environmental monitoring technology called Wireless Sensor Networks (WSN). This technology consists of a series of individual wireless nodes that have the capacity to measure different micro-climatic as well as other chemical variables at costs that are significantly cheaper that current wired systems. This review describes monitoring in four main sectors: agricultural, environmental, forest, and industrial. The report reviews publications over the last 13-years; none of the case studies are from Alberta.

The report also provides a description of the establishment of a new Alberta project in which a WSN is used to monitor environmental conditions at a coal mine reclamation site. The WSN is installed at Coal Valley Mine (CVM, Central Alberta), and it represents a collaborative project between the Centre for Earth Observation Sciences (CEOS) at the University of Alberta, Alberta Environment and Sustainable Resource Development, and CVM. The system, logistical needs, and the data management system used to obtain, visualize and analyze the environmental data currently collected at CVM are described.

Given current environmental monitoring needs, plus the large areal extent of the oil sands region, wireless sensor networks have the potential to support traditional monitoring networks. The federal/provincial oil sands environmental monitoring implementation plan specifically mentions the use of remote sensing tools to enhance the monitoring system. More work is required to develop additional sensors specific to chemicals of concern in the oil sands and implement this technology in regional monitoring.

Veiga, V.B., 2015. Use of Remote Sensing and Ground Data in Comprehension of the Flooding in the Bow River Basin, Alberta. University of Calgary, Geomatics Engineering, Calgary, Alberta. http://theses.ucalgary.ca/bitstream/11023/2325/4/ucalgary_2015_veiga_victor.pdf

Landsat-8 imagery used for (i) river flow forecasting at Calgary, (ii) flood extent estimation at Calgary, and (iii) river planform change detection.

Wehlage, D.C., 2012. Monitoring year-to-year variability in dry mixed-grass prairie yield using multi-sensor remote sensing. University of Alberta, Department of Earth and Atmospheric Sciences, Edmonton, Alberta. https://era.library.ualberta.ca/downloads/qf85nc736

NDVI from satellite remote sensing can accurately estimate interannual variation in standing green biomass, and field spectrometry can provide validation for satellite data. These methods can be used to identify the effects of yearly precipitation variability on above-ground biomass in the dry mixed-grass prairie.

Yuen, J.D., 2014. Small Scale Unmanned Aircraft for Environmental Monitoring. University of Alberta, Department of Mechanical Engineering, Edmonton, Alberta. https://era.library.ualberta.ca/downloads/9019s252s

Advances in sensor technology and unmanned aircraft systems (UAS) have created the opportunity for low cost aerial monitoring. As much of this development is not tailored for remote sensing applications, a custom built UAS was used to test the feasibility of inexpensive monitoring over forested and farmland case studies. This system flew autonomously at 50 m altitude above ground level, to create visual wavelength maps with 3 cm resolution and better than 5 m horizontal accuracy. Images were collected with 2 m spot size point spectrometer readings at 4 Hz, for identification of specific compounds. In test runs, approximately 15 acres were surveyed in just over 9 minutes. Methods developed can be applied to industrial monitoring applications such as tailings pond surface moisture content estimation and petroleum leak detection for pipelines.

Felbermeier, B., A. Hahn and T. Schneider, 2010. Study on User Requirements for Remote Sensing Applications in Forestry. IN: Wagner W. and B. Székely (editors). International Society for Photogrammetry and Remote Sensing (ISPRS) TC VII Symposium – 100 Years ISPRS, Vienna, Austria, July 5–7, 2010. International Archives of the Photogrammetry , Remote Sensing and Spatial Information Sciences (IAPRS), Vol. XXXVIII, Part 7B. p. 210-212. http://www.isprs.org/proceedings/xxxviii/part7/b/pdf/210_XXXVIII-part7B.pdf

The data requirements of professional foresters were investigated to derive development goals for remote sensing applications in forestry. A questionnaire was sent to 655 professionals in Southern Germany and answered by 347 of them. Two third describe deficiencies in their forest information and 90 % of them expect improvements by the application of remote sensing techniques. The majority of the professionals want to be supported by a forest information system integrating existing data bases and remote sensing derived information. More than 200 examples were defined for the potential use of remote sensing applications. The majority of the examples are related to the management of natural hazards and the consulting of private land owners.

Green, R., G. Buchanan and R. Almond, 2010(?). What do conservation practitioners want from remote sensing? Cambridge Conservation Initiative, Conservation Futures Shared Challenges Programme, Remote Sensing for Biodiversity Conservation Project. http://www.conservation.cam.ac.uk/sites/default/files/file-attachments/CCI%20Report%20-%20Remote%20sensing%20user%20needs%20-%2011th%20Oct%202012.pdf

This Cambridge Conservation Initiative (CCI) Shared Challenges Programme project aims identify the information that conservation practitioners actually need from earth observation remote sensing data, and, importantly, to increase collaboration between conservation community 'users' and the technical experts. It will also raise awareness across conservation organisations and researchers of the potential for remote sensing to inform their work.

Mondello, C., G.F. Hepner and R.A. Williamson, 2004. 10-Year Industry Forecast Phases I-III – Study Documentation. The American Society for Photogrammetry and Remote Sensing. https://www.uvm.edu/~geosptal/pdfs/10-year-RS-forecast.pdf

This report provides historical, technical and policy context about the nucleus of the research project, the recently completed Ten-Year Industry Forecast Phases I-III. This document summarizes the Forecast's methodology, analyzes its results, and assesses their implications for the industry and for government policy.

The forecast is composed of three phases to date. Phase I, which was completed in December 2000, characterized the industry, and developed a financial and activity baseline and an initial forecast. Phase II, completed in 2002, centered on the identification and as sessment of the end users of remote sensing and geospatial information products. Phase III focused on validating the results of Phase I and II and delivering an updated technology and market assessment, especially given the potential impacts on the industry following the terrible events of September 11, 2001. Post-Phase III (Phases IV and on) activities will center on developing a revised market forecast and standardizing methods for continuing the rolling forecast.

Mouillot, F., M.G. Schultz, C. Yue, P. Cadule, K. Tansey, P. Ciais and E. Chuvieco, 2014. Ten years of global burned area products from spaceborne remote sensing—A review: Analysis of user needs and recommendations for future developments. International Journal of Applied Earth Observation and Geoinformation 26: 64-79.
http://www.geogra.uah.es/images/Documentos/emilio/PDF/Mouillot_et_al_2014.pdf

We surveyed a wide range of users of global fire data products whilst also undertaking a review of the latest scientific literature. Two user groups were identified, the first being global climate and vegetation modelers and the second being regional land managers. Based on this review, we present here the current needs covering the range of end-users. We identified the increasing use of BA products since the year 2000 with an increasing use of MODIS as a reference dataset. Scientific topics using these BA products have increased in diversity and area of application, from global fire emissions (for which BA products were initially developed) to regional studies with increasing use for ecosystem management planning. There is a significant need from the atmospheric science community for low spatial resolution (gridded, 1/2 degree cell) and long time series data characterized with supplementary information concerning the accuracy in timing of the fire and reductions of omission/commission errors. There is also a strong need for precisely characterizing the perimeter and contour of the fire scar for better assimilation with land cover maps and fire intensity. Computer and earth observation facilities remain a significant gap between ideal accuracies and the realistic ones, which must be fully quantified and comprehensive for an actual use in global fire emissions or regional land management studies.

NASA, 2016. National Land Imaging Requirements Pilot Project: Summary of Moderate Resolution Imaging User Requirements. http://landsat.gsfc.nasa.gov/?p=8723

Under the National Land Imaging Requirements (NLIR) Project, the U.S. Geological Survey (USGS) is developing a functional capability to obtain, characterize, manage, maintain and prioritize all Earth observing (EO) land remote sensing user requirements. The goal is a better understanding of community needs that can be supported with land remote sensing resources, and a means to match needs with appropriate solutions in an effective and efficient way.

Parsons, M.A. and R. Duerr, 2005. Designating User Communities for Scientific Data: Challenges and Solutions. Data Science Journal 4: 31-38. https://www.jstage.jst.go.jp/article/dsj/4/0/4_0_31/_pdf

Defining a "designated user community" for a data collection is essential to good scientific data stewardship. It enables data managers to determine what information is necessary to ensure the usability of the data now and into the future. It helps managers present and enable access to the data and may determine the format of the data. However, defining a community is difficult, and it is impossible to predict how the use of a data collection may change over time. This creates a series of data management problems for data stewards that may be mitigated by a set of best practices.

NON-ALBERTA TECHNOLOGY INFORMATION

Smith, S., 2016. Esri Federal User Conference 2016 Kicks Off. http://www10.giscafe.com/blogs/gissusan/2016/02/25/esri-federal-user-conference-2016-kicks-off/

It would seem from the presentations at the Esri Federal User Conference 2016 held in Washington D. C. this week, that the federal government is becoming more "open" on the subject of data, while at the same time protecting the nation's security perhaps more fiercely than ever. Part of the "open" is due to the fact that there is a lot of data to be mined from sources outside the government, and that the need for agencies to work together to solve critical problems has become greater than ever.

For the last seven years, Esri has been building thousands of layers of information in the cloud, many of which are from the government. There are now billions of views per week. Over 2 million people subscribe to this information. Those who are building datasets are influencing users around the world.

Geoanalytics and visualization of massive data can be processed in Hadoop or Elastic Search, allowing spatial operators to handle billions of observations, an aggregated layer of a million records. Geoanalytics will be a new spatial analytics extension that allows you to run aggregations to explore patterns. You can run bigger jobs than ever before. In addition, geoanalytics lets you ask space time questions that you've not been able to do before in multi-dimensional real time spatial analysis.

APPENDIX C – Workshop Presentations

Click on the links to go to each presentation.

Advancing Commercialization of Remote Sensing Technologies

Brent Lakeman, Executive Director, Technology Partnerships and Investments, Science and Innovation, Alberta Economic Development and Trade: Advancing Commercialization of Remote Sensing Technologies

EO/RS Presentations

Jonathan Neufeld, Director, Commercialization Programs, TECTERRA: Geomatics Innovation in Alberta

Eric Holmlund, Executive Director, Alberta Data Partnerships: Data for Innovation

Bill Jefferies, Executive Director, LOOKNorth: Sensors & Systems

Edmonton Government Presentations

Daryl McEwan, Data Acquisition Services, GeoDiscover Alberta: GoA Remote Sensing Requirements

Tom Goddard, Senior Policy Advisor, Alberta Agriculture and Forestry: Can RS Contribute to Integrated Management Systems in Agriculture?

Kevin Smiley, GIS Coordinator, Sturgeon County: Municipal Image and Data Use in the Capital Region

Calgary Industry Presentations

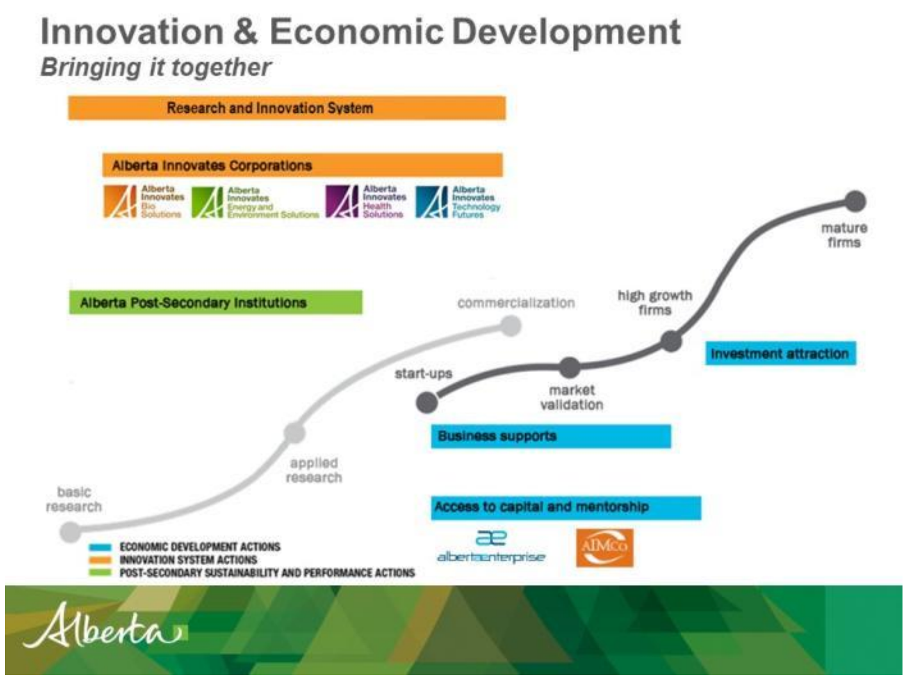
Dan Burt, Team Leader, Air and Climate Change Solutions, Suncor: Area Fugitive Emissions: Oil Sands Mining

Marc Godin, Technical Advisor, Petroleum Technology Alliance Canada: PTAC Remote Sensing Applications

Kimberley Van Vliet, CEO, WaVv Strategic Consulting: ConvergX

Brent Lakeman, Alberta Economic Development and Trade: Advancing Commercialization of Remote Sensing Technologies


Alberta's Priority Innovation Sectors
Energy
Environment
Health
Fiber
Food
Information and Communication Technologies, Nano, Omics – platform technologies
2030 Innovation Targets
Alberta
DRAFT – FOR DISCUSSION ONLY – NOT FOR DISTRIBUTION

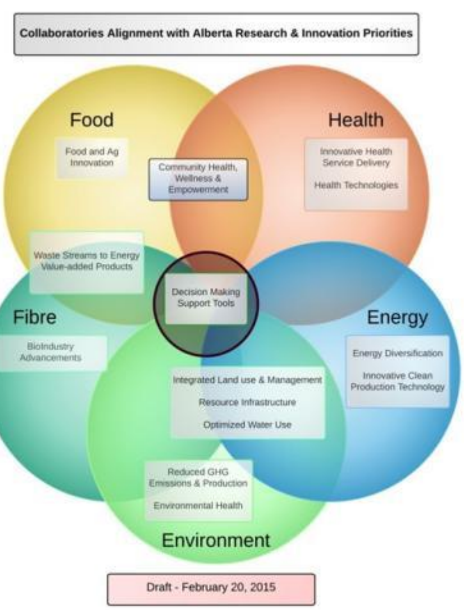

Innovation & Economic Development
Bringing it together
Research and Innovation System
Alberta Innovates Corporations
Alberta Post-Secondary Institutions
basic research
applied research
commercialization
start-ups
market validation
high growth firms
mature firms
Investment attraction
Business supports
Access to capital and mentorship
albertaenterprise
AIMCo
ECONOMIC DEVELOPMENT ACTIONS
INNOVATION SYSTEM ACTIONS
POST-SECONDARY SUSTAINABILITY AND PERFORMANCE ACTIONS
Alberta

Innovation Collaboratories
Purpose and Mandate

To be the catalyst for innovation in Alberta, and to provide strategic direction and advice on smart, impactful investments of provincial resources.

- 2030 Innovation Targets (Long-term, stretch, and aspirational)
  - Focus Areas (specific priority areas for investment)
    - Initiatives (major projects or activities that accelerate innovation toward Targets)

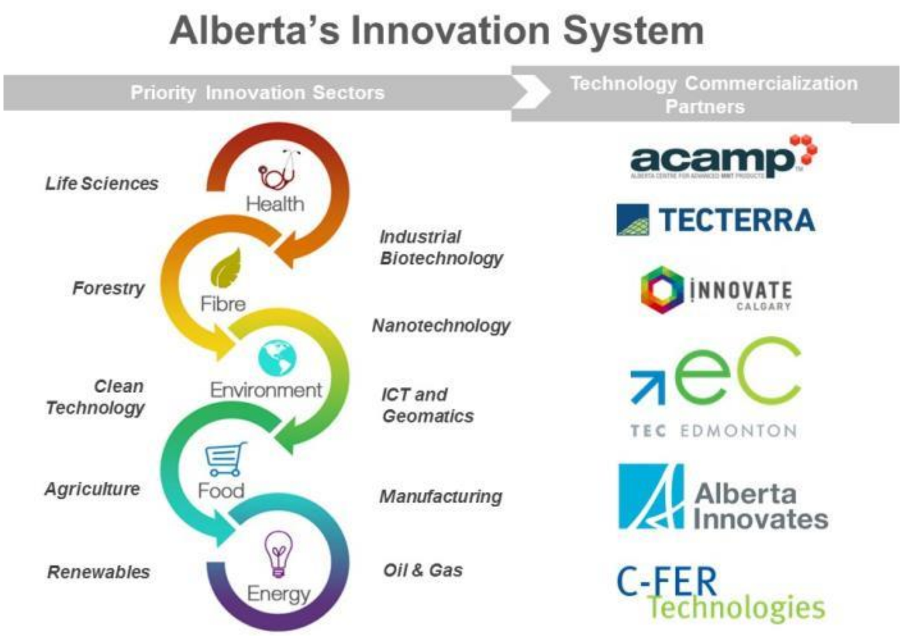
Alberta



Monitoring, Information Management, Analytics, Decision Support Tools Fundamental for Achieving Sector Targets

6

Draft
2030 Innovation Targets
2030 Innovation Target
Focus Areas
Environment
Restoring Alberta's Landscapes
Achieve Alberta's economic and environmental objectives through innovative approaches that reduce landscape disturbance intensity by 20% and accelerate reclamation of disturbed lands to promote the recovery of native habitat and species
Risk assessment, restoration, and remediation
Resource development footprint reduction and increased ecosystem health
Innovative monitoring systems
Fine tailings reclamation
Agriculture
Improve Social Licence
Ensure agricultural, food, and beverage production meets or exceeds public expectations and values by 10% based on 2016 measures
Understand consumer preferences
Validated production processes
Natural resource conservation
Farmer well-being & improved food safety
Energy
Reduce GHG Emissions
Support Alberta's climate change goals by accelerating solutions to reduce methane emissions by 45% by 2025 and ensure a dynamic portfolio of GHG emission reduction technologies
New technologies, processes and design standards to reduce fugitive methane emissions
Carbon utilization solutions for industry sectors
Emerging Technologies
Digital Economy
The ICT industry in Alberta generates more than $20 billion in annual revenues and the province is the best in Canada for digital literacy and connectivity
Data Science: analytics; machine learning, artificial intelligence
Privacy and cybersecurity
Advanced ICT solutions in natural resource management, including sensors, monitoring and decision control solutions
Virtual service delivery, including the last mile
Alberta



Alberta's Innovation System
Priority Innovation Sectors
Technology Commercialization Partners
Life Sciences
Health
Industrial Biotechnology
Forestry
Fibre
Nanotechnology
Clean Technology
Environment
ICT and Geomatics
Agriculture
Food
Manufacturing
Renewables
Energy
Oil & Gas
acamp
TECTERRA
INNOVATE CALGARY
TEC EDMONTON
Alberta Innovates
C-FER Technologies

Monitoring Innovation

- Cross-Department / Agency initiative since 2014
- Ensure access to leading approaches for monitoring
- Understand gaps
- Build on previous workshops
  - Critical enablers for innovation in environmental monitoring (2014)
    - Adaptive management / cumulative effects management
    - Data integration
  - Earth Observation for Improved Regulatory Decision-Making in Alberta (2015)
- Team established priorities for investments in monitoring innovation
  - Remote Sensing
  - In Situ Sensors
  - Citizen Science and Indigenous Wisdom (TEK)
- Ensure linkage to Alberta's Integrated Resource Management System (IRMS)

Alberta 9

Previous Workshops – Key Themes

- Better understand system needs and capabilities
- Develop model for collaboration to support portfolio of projects and greater financial leveraging
- Importance of field sites
- Development of highly qualified personnel
- Effectively utilize existing commercialization mechanisms
- Accelerate operational implementation of technologies

Alberta 10

Other Innovation System Activities

- Alberta Data Partnership – Open Data initiative
- TECTERRA – Understand government resource management needs
- LookNorth – inform development of plans for new remote sensing initiatives
- COSIA and PTAC – determine role for remote sensing, informatics in priority issues (e.g., tailings management, reclamation)

Alberta 11

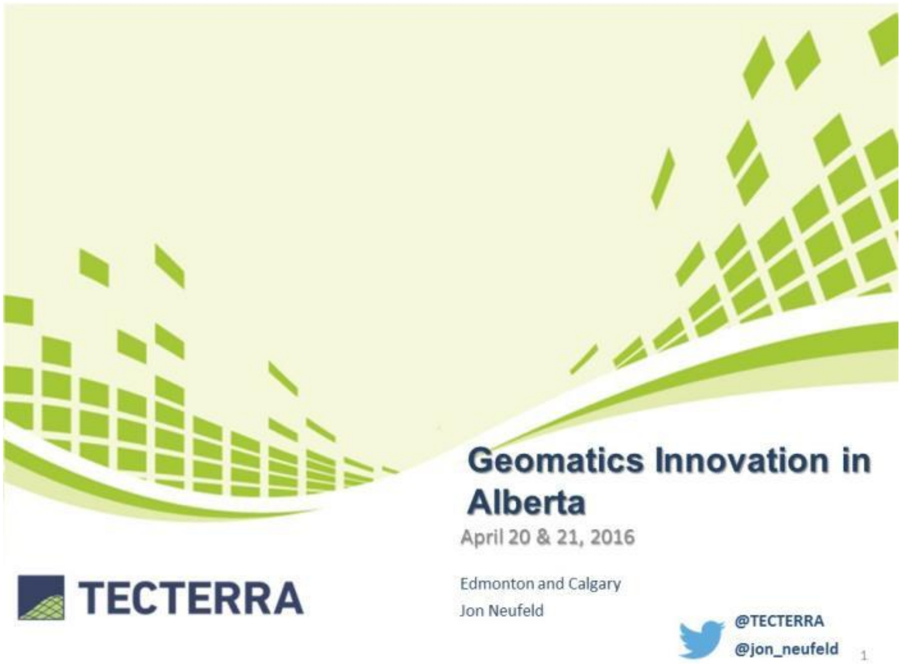
Alberta Small Business Innovation and Research Initiative

- New GOA / Alberta Innovates initiative
- Foster demand-pull innovation, by matching the technologies and expertise of Alberta Small and Medium Sized Enterprises (SMEs) to the critical challenges of large end-users in the public and private sector
- For Alberta SMEs, the program provides funding support, mentorship, and potential first-client opportunities to develop technology solutions with real market potential.
- For end-users, the program mitigates the risk of technology adoption while supporting the development of a solution to a known challenge, by providing them with the opportunity to try and, ideally, procure the resulting solution

Alberta 12


Workshop Objectives
• …Identify the next steps required to commercialize the application of integrated geomatics, remote sensing, data analytics and visualization technologies
Alberta
13

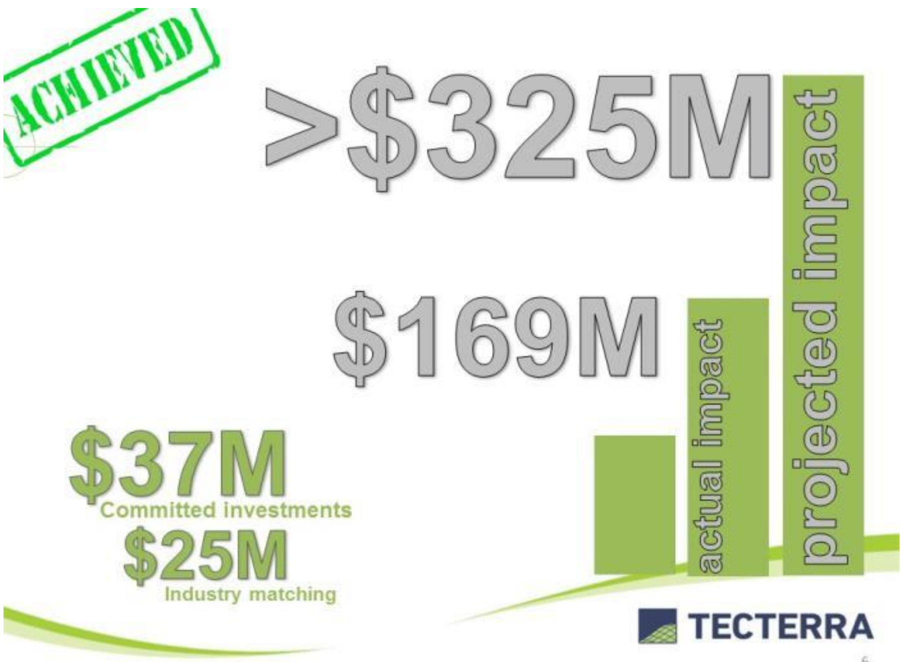
Jonathan Neufeld, TECTERRA: Geomatics Innovation in Alberta

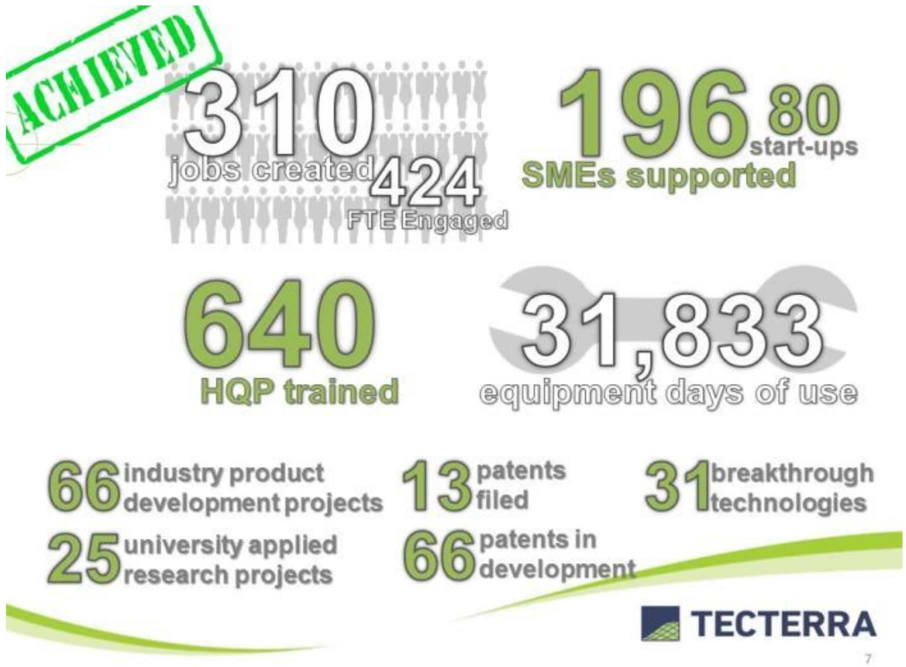


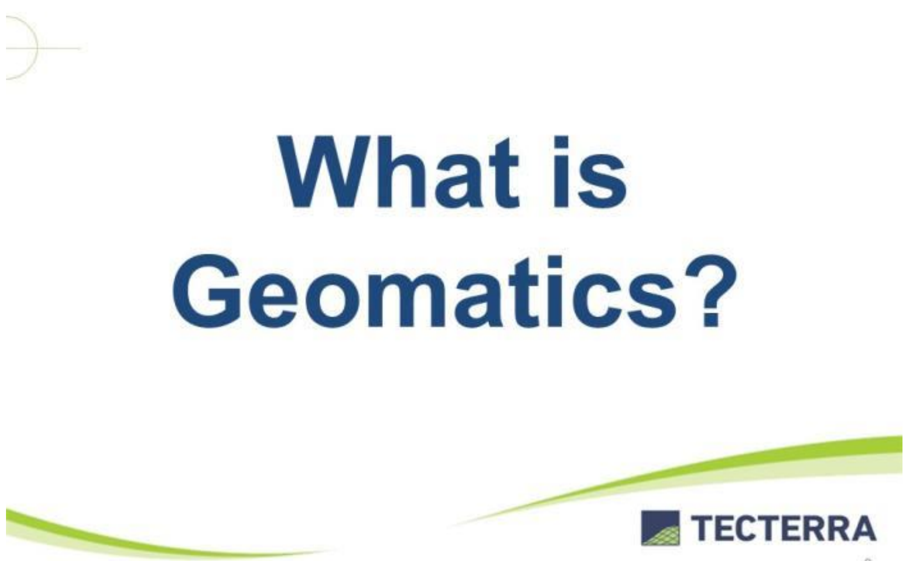

We create prosperity through innovation
TECTERRA
3

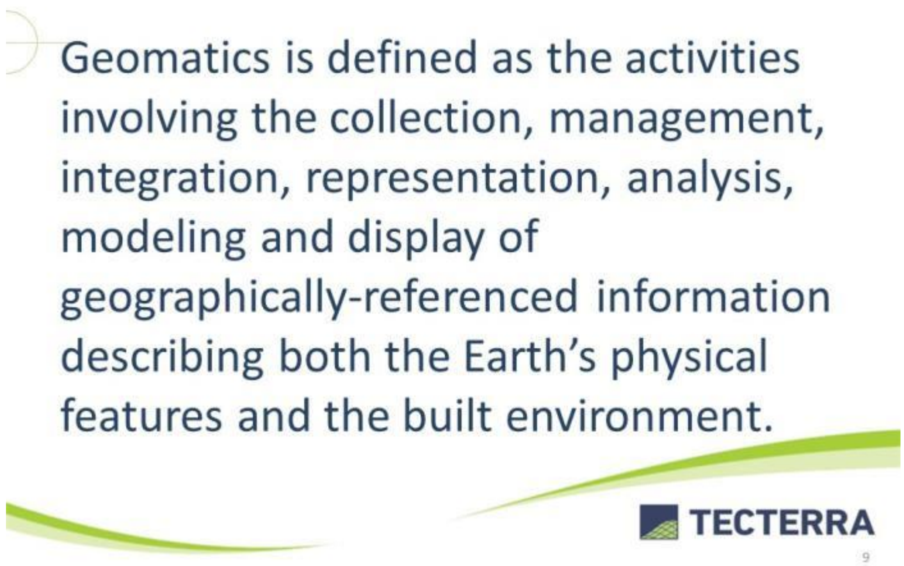

Investing in innovative geomatics technology
TECTERRA
4

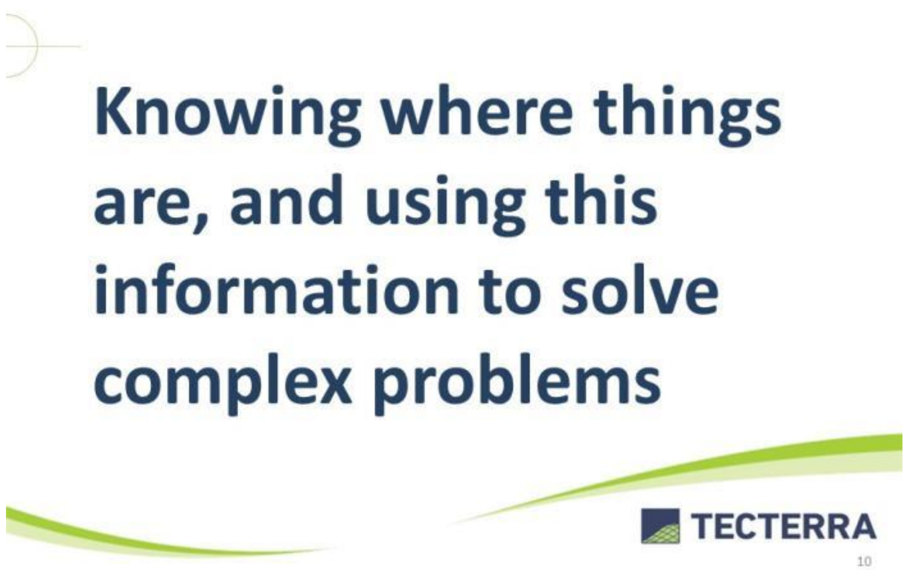

TECTERRA's Portfolio
195
80
start-ups
SMEs supported


ACHIEVED
>$325M
$169M
$37M
Committed investments
$25M
Industry matching
actual impact
projected impact
TECTERRA
6

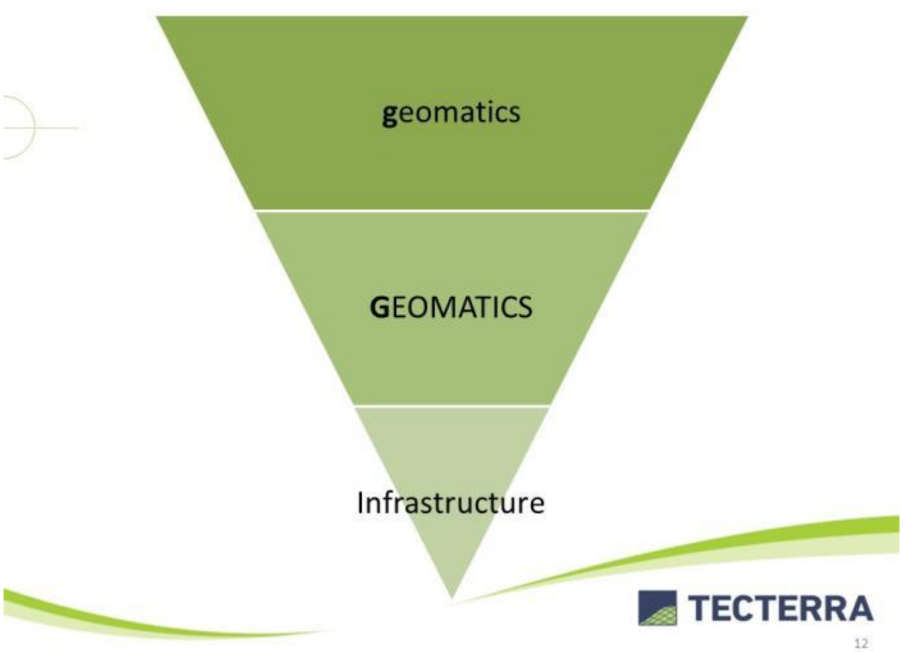

ACHIEVED
310
jobs created
424
FTE Engaged
196
SMEs supported
80
start-ups
640
HQP trained
31,833
equipment days of use
66 industry product development projects
13 patents filed
31 breakthrough technologies
25 university applied research projects
66 patents in development
TECTERRA
7

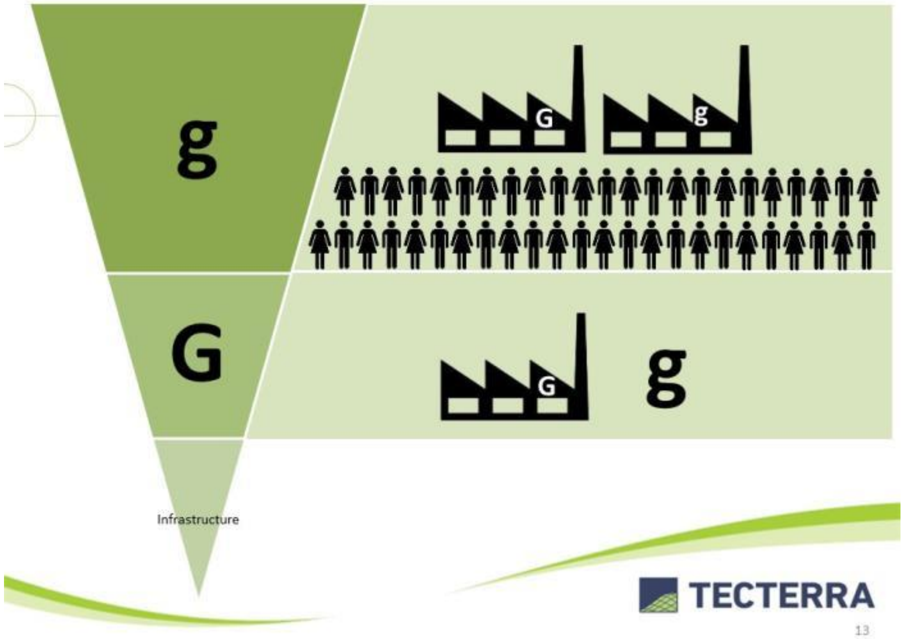

What is Geomatics?
TECTERRA
8

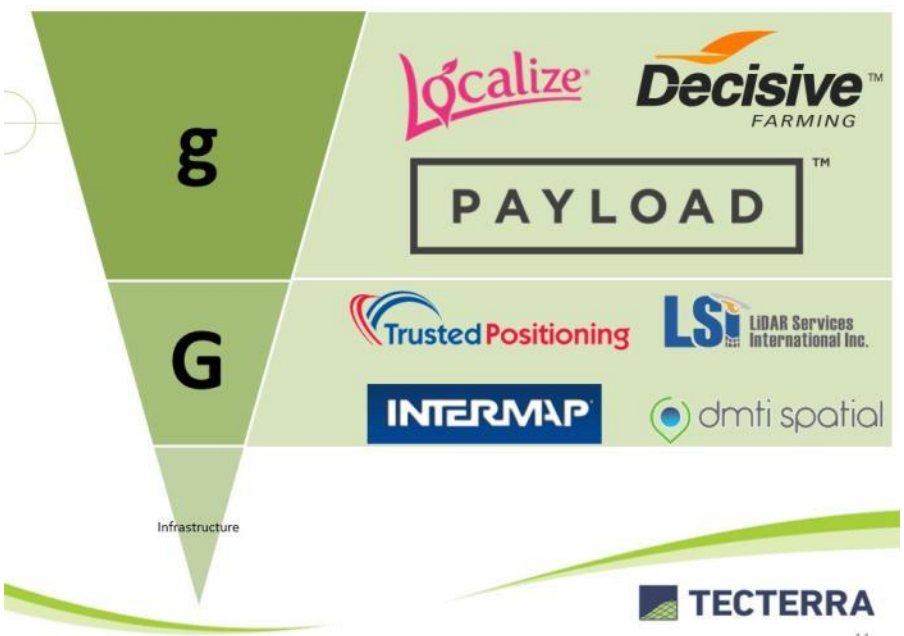

Geomatics is defined as the activities involving the collection, management, integration, representation, analysis, modeling and display of geographically-referenced information describing both the Earth's physical features and the built environment.
TECTERRA
9

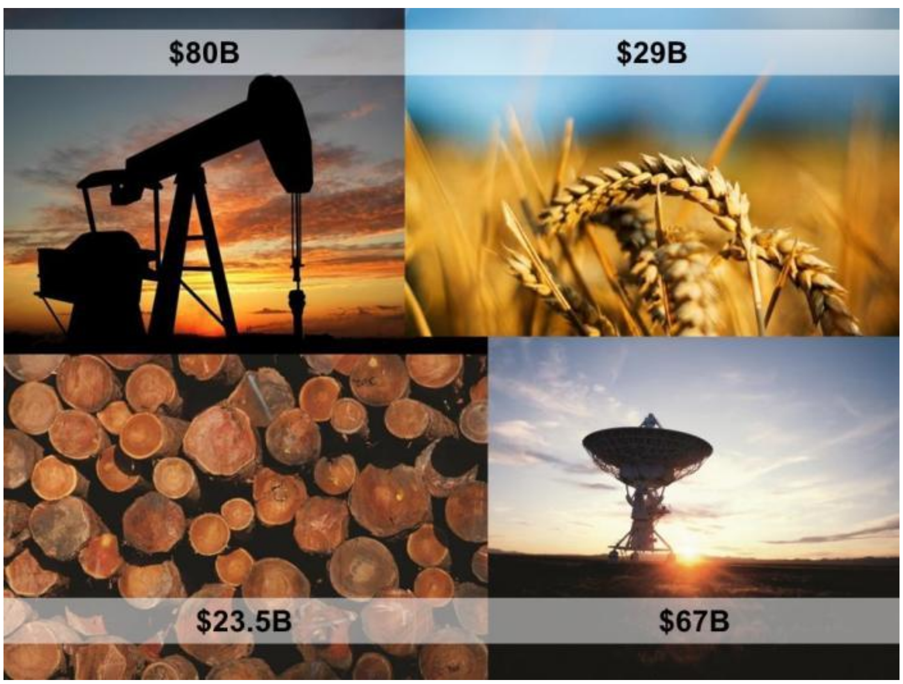

Knowing where things are, and using this information to solve complex problems
TECTERRA
10


"Geomatics" Companies
Trusted Positioning
Trimble.
esri
INTERMAP
BLACKBRIDGE GEOMATICS
Leica Geosystems
LSI LiDAR Services International Inc.
Hemisphere GPS
NovAtel
dmti spatial
TECTERRA
11


geomatics
GEOMATICS
Infrastructure
TECTERRA
12


g
G
G
g
G
g
Infrastructure
TECTERRA
13


g
G
Localize
Decisive FARMING
PAYLOAD
Trusted Positioning
LSI LiDAR Services International Inc.
INTERMAP
dmti spatial
Infrastructure
TECTERRA
14



Alberta Innovates Technology Futures


twelve
Future Markets


$91B
NAVY
502
$1T
$1.5T
$41B


Geospatial Everywhere: Today
Today:
Environment
Forestry
Energy
Wildlife
Agriculture
Location Based Services
TECTERRA
19


Energy
Clean Tech
Unmanned Systems
Location Based
Fibre
Food
Smart Cities
Internet of Things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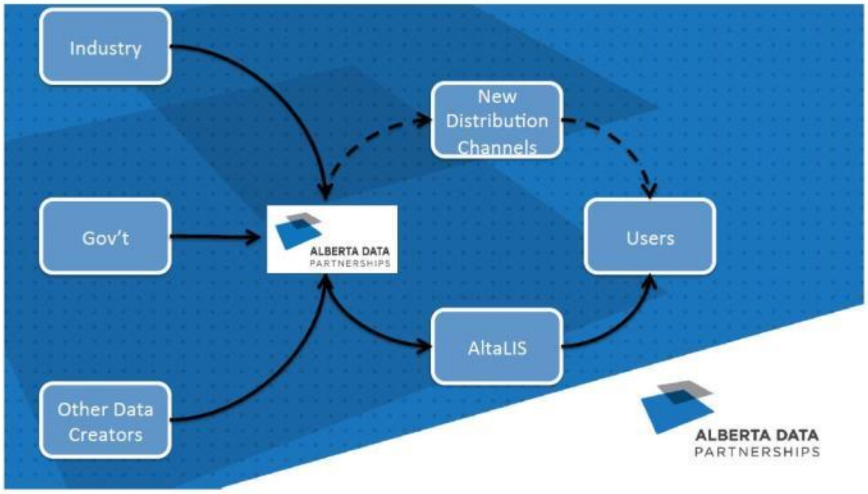
@jon_neufeld
TECTERRA
21

Eric Holmlund, Alberta Data Partnerships: Data for Innovation

AltaLIS Joint Venture

- AltaLIS selected as private sector operator in 1998 to complete Cadastral Mapping and has continued to produce and distribute other mapping products under license to ADP
- In 1999, a JV was signed between ADP and AltaLIS
  - AltaLIS handles day to day updating, sales, licensing and distribution of mapping data to users

ALBERTA DATA PARTNERSHIPS


Industry
New
Distribution
Channels
Gov't
ALBERTA DATA
PARTNERSHIPS
Users
AltaLIS
Other Data
Creators
ALBERTA DATA
PARTNERSHIPS


Towards an Intelligent Community
Value
•Knowledgeable workforce and citizens
•Diversified economy and responsible development
•Government and industry accountability
Coordinated Services
•Resource Regulation, Env. Monitoring, Emergency Response
•Health, Registries
•Land Use Planning
Collaboration
•Transparent processes
•Low cost and sustainable data enabling open communication
•Efficient access to accurate, authoritative data
Infrastructure
•SuperNet
•Public and private IT infrastructure
•Citizen investment
Region
•Alberta
•Large urban regions
•Rural municipalities
PARTNERSHIPS


ALBERTA OPEN DATA AREAS
ALBERTA DATA PARTNERSHIPS


Open Data Areas for Alberta
Alberta Data Partnerships (ADP) in collaboration with the Government of Alberta are proposing to develop Alberta Open Data Areas and provide pre-commercialization funding for SMEs.
Open Data Areas would be representative of provincial (and global) land cover types and would encompass a range of recreational, commercial, and industrial activities
Open Data Areas would contain comprehensive environmental, social and economic datasets consisting of, but not limited to:
– earth observation/remote sensing
– geospatial data
– environmental data (i.e., soils, vegetation)
– social and economic data.
ALBERTA DATA PARTNERSHIPS


Partnership Approach
Alberta Data Partnerships (ADP) is working in collaboration with
• Government of Alberta (GoA),
• provincial regulatory and innovation agencies,
• Canada Centre for Mapping and Earth Observation,
• the Canadian Space Agency, and
• private data providers
ALBERTA DATA PARTNERSHIPS


Stakeholder Observations
Alberta Data Partnerships: 2014 Stakeholder Engagement Sessions
• Included representatives and data users from GOA, Municipal Government, the resource sector, consulting organizations and NGOs
• Need for increased accessibility to more data, especially, data paid for by government
• Need to develop a one-stop shop for data, including a centralized distribution point for the distribution of authoritative spatial data.
• Need to address concerns over the implications of free and open data, such as how do organizations value open data, ensure quality in an open data environment and what are the commercialization opportunities utilizing open data?
ALBERTA DATA PARTNERSHIPS

Workshop Observations

Earth Observation and Remote Sensing: Technologies and Approaches for Informing Policy and Regulatory Decision Making Workshop

- Data policies are moving to cheaper, open data models and coverage is becoming more frequent and reliable.
- Operational use of earth observation data and technology requires a wide variety of skills and competencies
  - *None of which exclusively exist in one sector, be it government, academia or commercial.*
- Operational use of earth observation data and technology to support environmental monitoring and reporting will require unique integrated funding frameworks that allow resources to move easily between government, academia and commercial project partners.

ALBERTA DATA PARTNERSHIPS

Open Data Areas

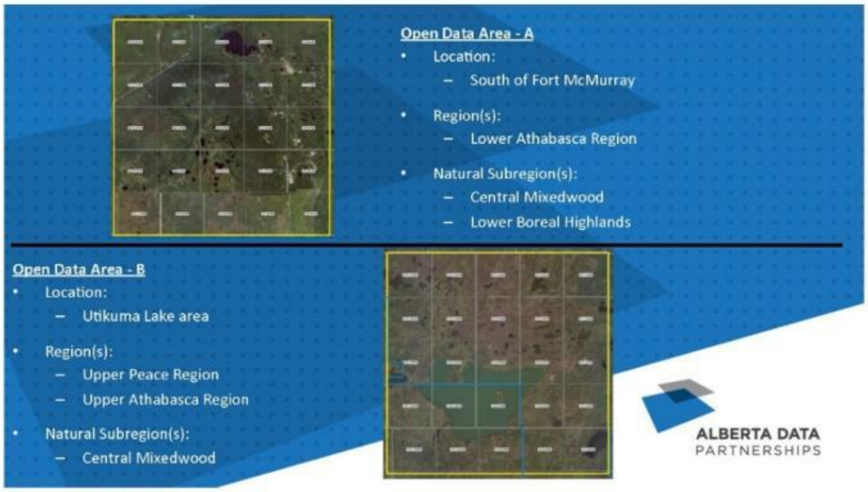
Coverage

- 7 Land-use Framework Regions (Blue)
- 7 Natural Sub-regions

Open Data Areas (A-F):

- Yellow: 25 Townships (~2500 km²)
- Red: 1 Township (~100 km²)

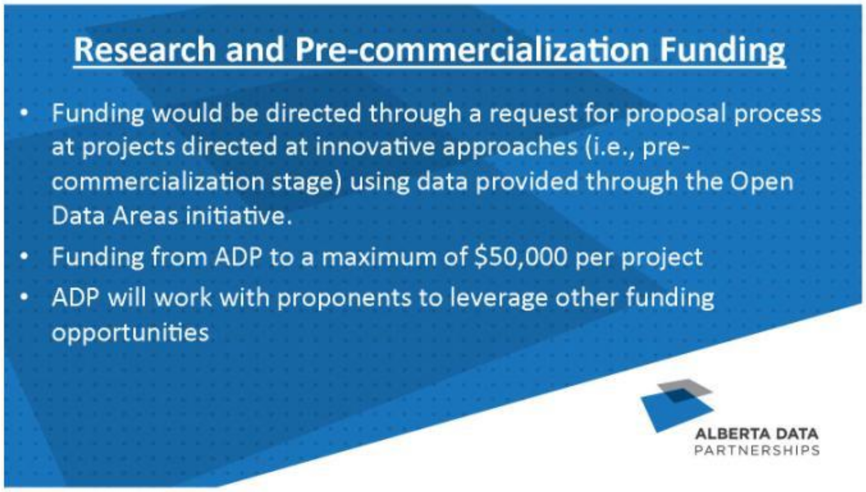
ALBERTA DATA PARTNERSHIPS

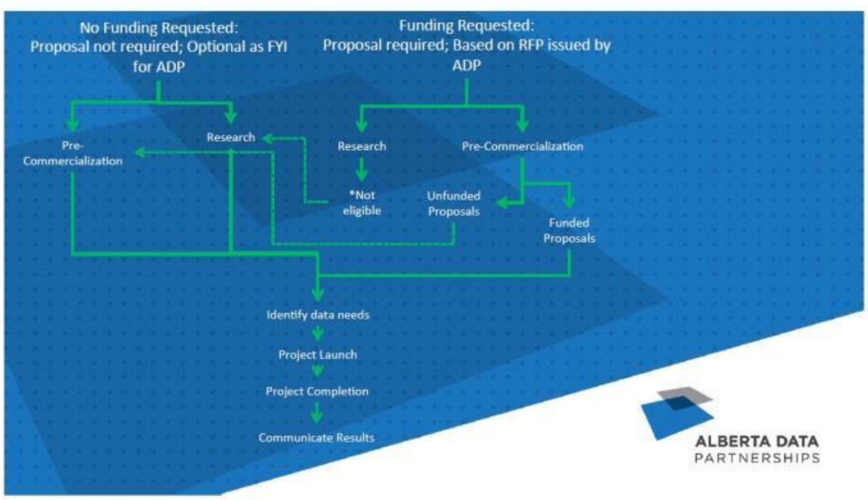

Open Data Area - A
Location:
South of Fort McMurray
Region(s):
Lower Athabasca Region
Natural Subregion(s):
Central Mixedwood
Lower Boreal Highlands
Open Data Area - B
Location:
Utikuma Lake area
Region(s):
Upper Peace Region
Upper Athabasca Region
Natural Subregion(s):
Central Mixedwood
ALBERTA DATA
PARTNERSHIPS


Open Data Area - A
Location: South of Fort McMurray
Region(s): Lower Athabasca Region
Natural Subregion(s): Central Mixedwood & Lower Boreal Highlands
Examples of Collaboration Opportunities:
Academic Project: UofC/UofA/FRI NSERC-CRD
Data: CCRS 2013 Hyperspectral/LIDAR/Ortho flights
GoA/AER: Lower Athabasca Regional Planning
PTAC Project: Removing Wellsite Footprint
Parks: Gregoire Lake; Stoney Mountain Wildland Provincial Park
ALBERTA DATA
PARTNERSHIPS

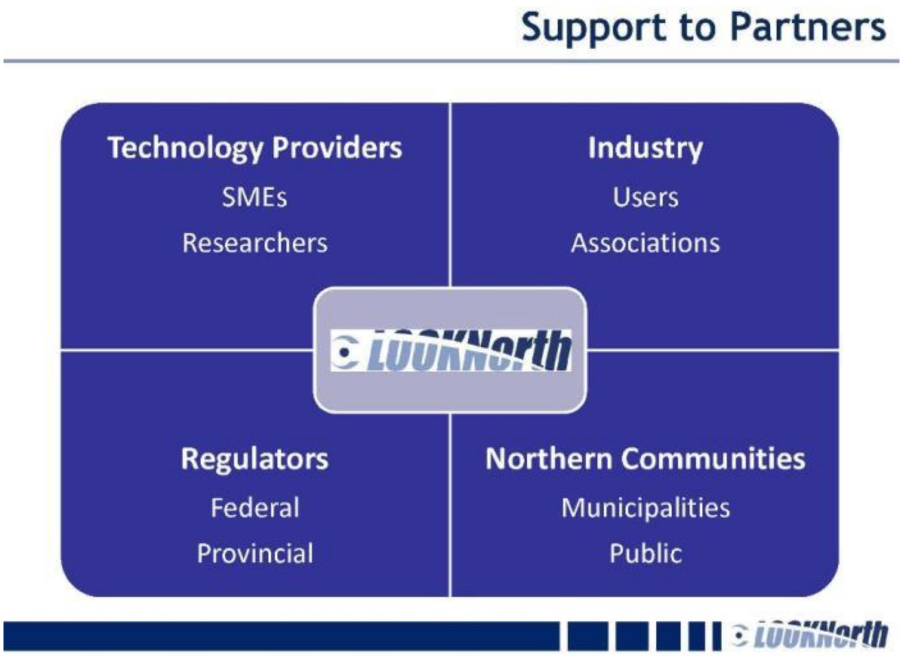

Open Data Area - C
Location:
Southwest of Fox Creek
Region:
Upper Peace Region
Upper Athabasca Region
Natural Subregion:
Lower Foothills
Upper Foothills
Open Data Area - D
Location:
East of Sherwood Park
Region:
North Saskatchewan Region
Natural Subregion:
Dry Mixedwood
Central Parkland
ALBERTA DATA
PARTNERSHIPS

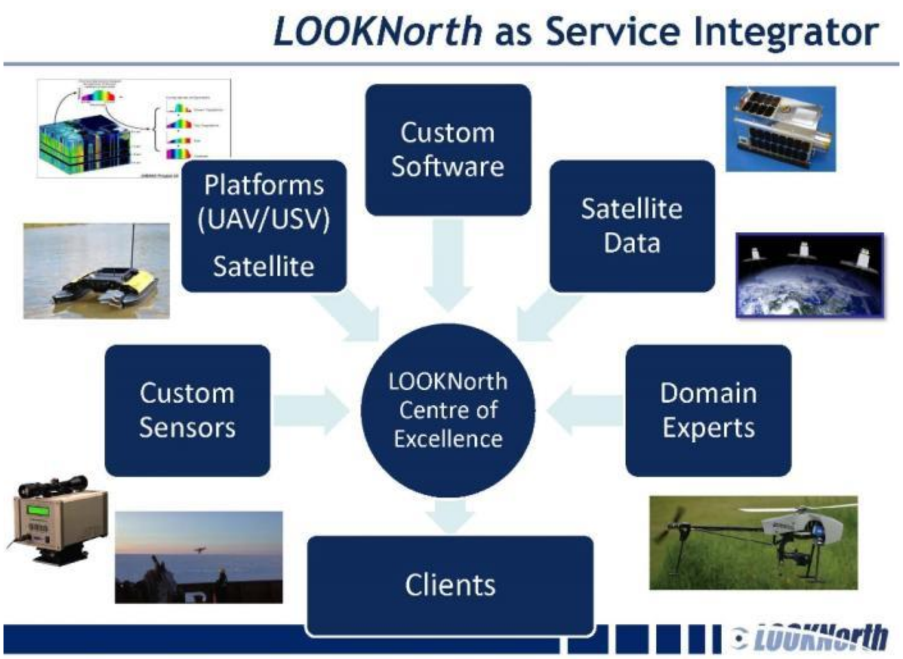

Open Data Area - E
Location:
East of Rocky Mountain House; West of Sylvan Lake
Region:
North Saskatchewan Region
Red Deer Region
Natural Subregion:
Dry Mixedwood
Central Parkland
Open Data Area - F
Location:
Area around Brooks
Region:
South Saskatchewan Region
Red Deer Region
Natural Subregion:
Dry Mixed Grass
ALBERTA DATA
PARTNERSHIPS


Research and Pre-commercialization Funding
• Funding would be directed through a request for proposal process at projects directed at innovative approaches (i.e., pre-commercialization stage) using data provided through the Open Data Areas initiative.
• Funding from ADP to a maximum of $50,000 per project
• ADP will work with proponents to leverage other funding opportunities
ALBERTA DATA
PARTNERSHIPS


No Funding Requested:
Proposal not required; Optional as FYI for ADP
Funding Requested:
Proposal required; Based on RFP issued by ADP
Pre-Commercialization
Research
Research
Pre-Commercialization
*Not eligible
Unfunded Proposals
Funded Proposals
Identify data needs
Project Launch
Project Completion
Communicate Results
ALBERTA DATA
PARTNERSHIPS

Bill Jefferies, LOOKNorth: Sensors & Systems


Support to Partners
Technology Providers
SMEs
Researchers
Industry
Users
Associations
LOOKNorth
Regulators
Federal
Provincial
Northern Communities
Municipalities
Public
LOOKNorth


LOOKNorth as Service Integrator
Custom Software
Platforms (UAV/USV) Satellite
Satellite Data
Custom Sensors
LOOKNorth Centre of Excellence
Domain Experts
Clients
LOOKNorth

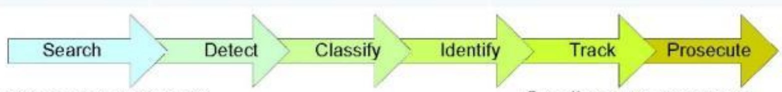
INDUSTRY TRENDS

Crowded Space

The Rise of UAVs

Satellites vs UAVs

	Pros	Cons
UAV	• Flexible missions •Persistent surveillance • Higher Resolution • Measure vertical columns • Multiple vendors •Minimizes atmospheric effects	• Requires field visits • Payload restrictions • Positive control required • Large area surveillance takes time
Satellite	• Broad area surveillance • Site visit not req'd • Repetitive monitoring • Well calibrated & standardized • Open data policies • New missions	• Lower resolution • Operational control • Integrated atmospheric column •Atmospheric effects



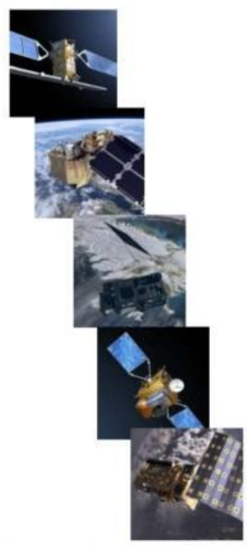
Larger area coverage
Specific locations unknown
Less sensitivity required

Smaller area coverage
Specific locations known
More sensitivity required

SATELLITE TRENDS

Trends in EO Missions

- Dramatic increase in EO satellite missions
  - Number to double from one decade to the next
- Increase of lower-cost and more responsive missions
- EU, Canadian data policy mimicking US
  - Free and open with near real time capability
- New operators with new business models
- Features
  - Constellations
  - High resolution
  - Hyper spectral
  - Multi polarization/multi frequency
  - Complex data
  - Cloud Computing



Issues for EO Missions

- Earth observation now emphasizes monitoring and change detection;
- To be effective missions must address:
  - 3 Rs - Regular, Reliable, Repeatable
  - Calibration
  - Formats
  - Mission planning
  - Data Delivery
  - Cost/Cost Model ($/pixel)
  - Continuity of Mission
  - Interoperability of missions
  - Archives
  - Legislation restrictions

LOOKNorth

Industry Changes

- **Emergence of Cubesats**
  - ***Accelerated development timelines***
    - 1 year cycles vs 5 – 10 years
  - ***High density constellations***
  - ***Flexible price structures***
  - ***New data management approaches, cloud-based access and processing***

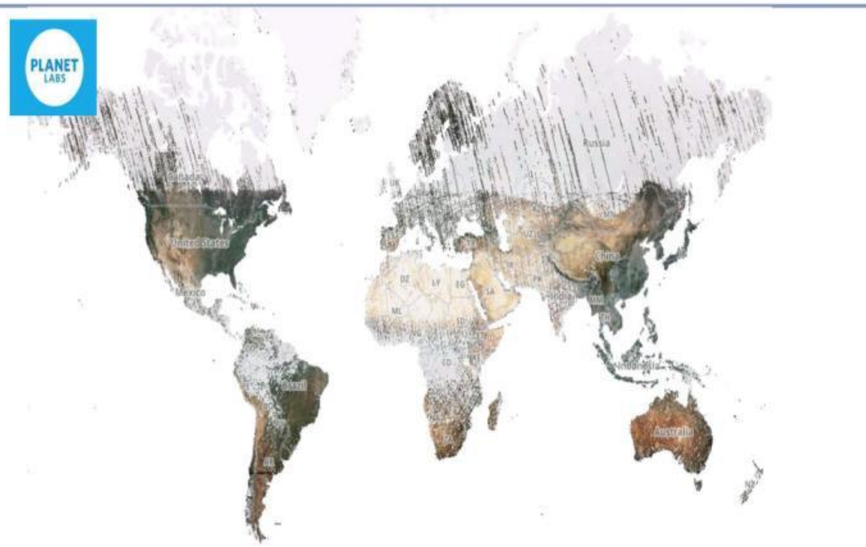
LOOKNorth

Example Missions

Mission	#satellites	Sensors	Revisit	Resolution
Planet Labs	150 – 200	HR EO	Daily, global	5m and lower
BlackSky Global	60	HR EO	70+ daily	1m
Satellogic	300	HR EO, video HS, Thermal IR	5 – 10 min	1m, 30m, 90m
SkyBox Imaging	16	HR EO, video	?	1m
UrtheCast	16	X & L band SAR Video, HR EO		1.5m, 5m 1m

LOOKNorth

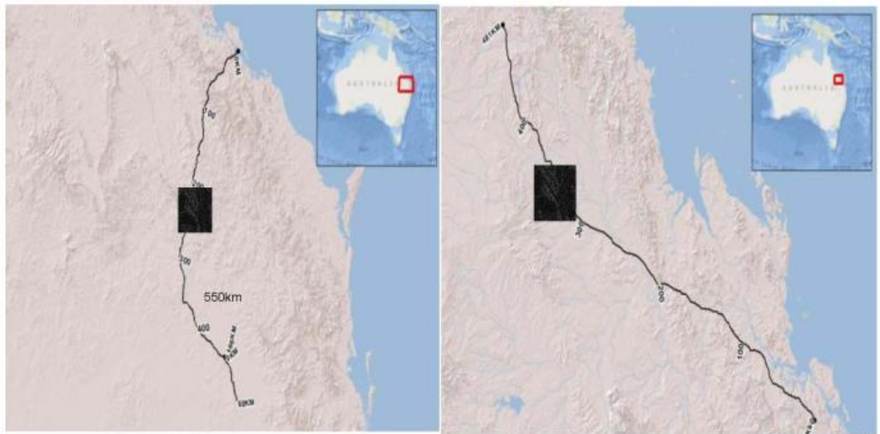
Planet Labs – Mosaic Archive



LOOKNorth

Changing the Business Model

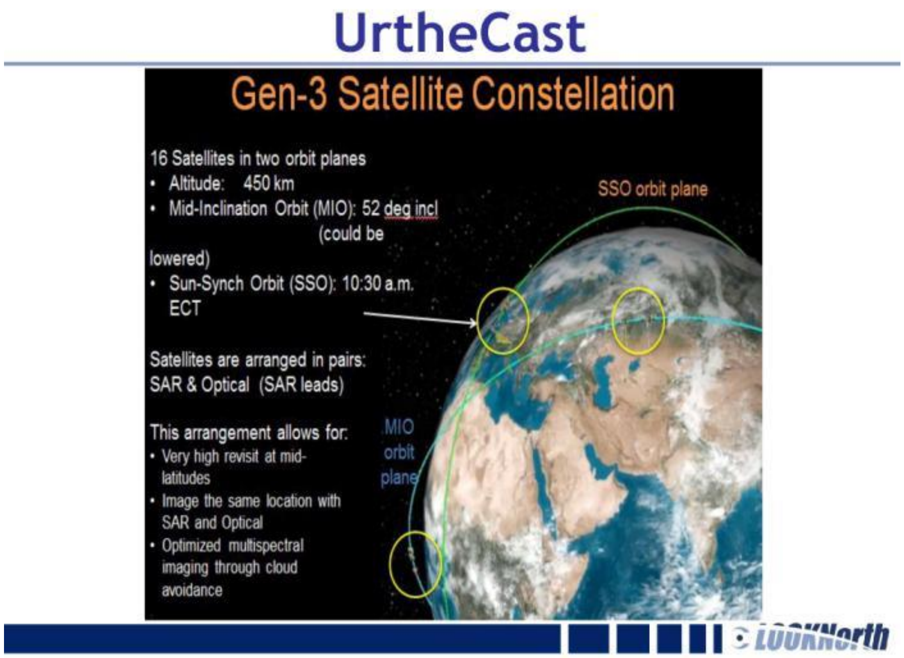
- **Previous scene based data costs**
  - *Covers 50 km x 50 km (2,500 km^2), of a 1,000 km pipeline*



Changing the Business Model

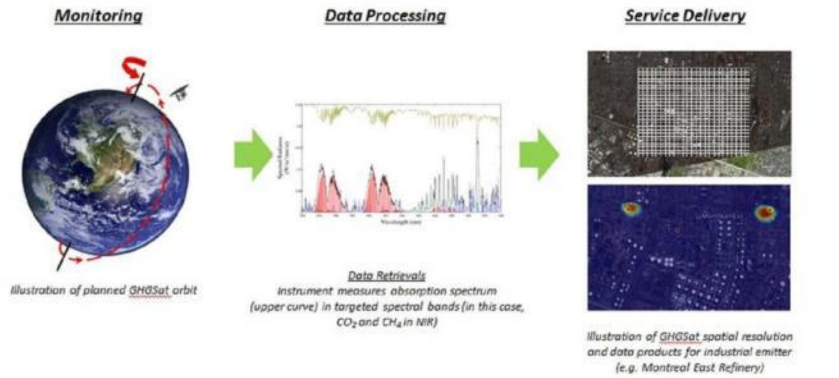
- **Select a 2.5 km strip that follows RoW**
  - *2,500 km^2 of data, daily, over the full length*


SATELLOGIC
ROADMAP
2013-2015
2016-2017
2017-2018
2018-2020
3 Satellites Launched
16 Satellites
2hr revisit times
100 Satellites
15m revisit times
300 Satellites
5m revisit times
Constellation Prototype
Succesful system test
1m resolution MS
30m resolution HySp
90m resolution TIR
1m resolution video
Improved spectral, geometric and radiometric resolutions.
Improved Capabilities
5th Generation


UrtheCast
Gen-3 Satellite Constellation
16 Satellites in two orbit planes
• Altitude: 450 km
• Mid-Inclination Orbit (MIO): 52 deg incl (could be lowered)
• Sun-Synch Orbit (SSO): 10:30 a.m. ECT
Satellites are arranged in pairs: SAR & Optical (SAR leads)
This arrangement allows for:
• Very high revisit at mid-latitudes
• Image the same location with SAR and Optical
• Optimized multispectral imaging through cloud avoidance
SSO orbit plane
MIO orbit plane
LOOKNorth

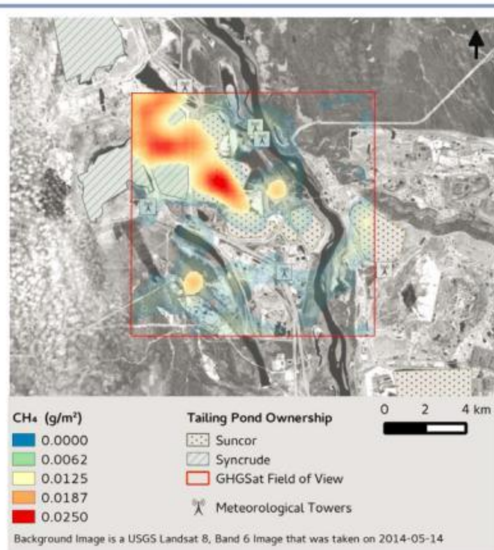
GHG Sat

In 2016 GHGSat, is planning to launch a nano-satellite capable of measuring air quality and greenhouse gas emissions from industrial sites.



LOOKNorth

GHGSat Sensor Validation



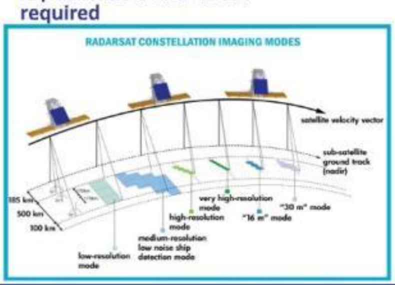
Sensor validation study produced better than expected results for NH4 flux over oil sands tailings facility

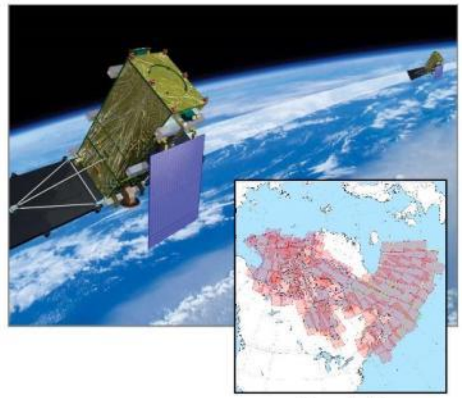
LOOKNorth

RADARSAT Constellation Mission (RCM)

The next generation SAR mission consisting of 3 spacecraft and providing quick revisit, very high collection capacity, and frequent coverage

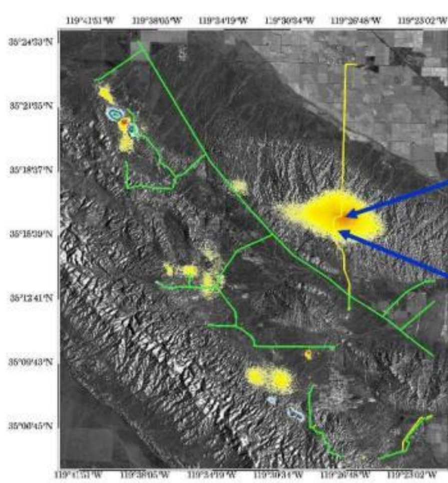
- Daily Coverage of North America
- Polar Orbit: ~2 passes per hour over the arctic
- Rapid satellite tasking and very rapid data / information distribution to end customer
- Enhanced polarization capabilities as and when required

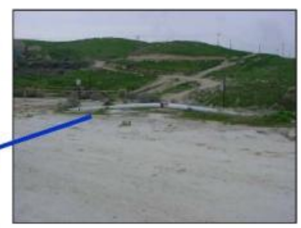




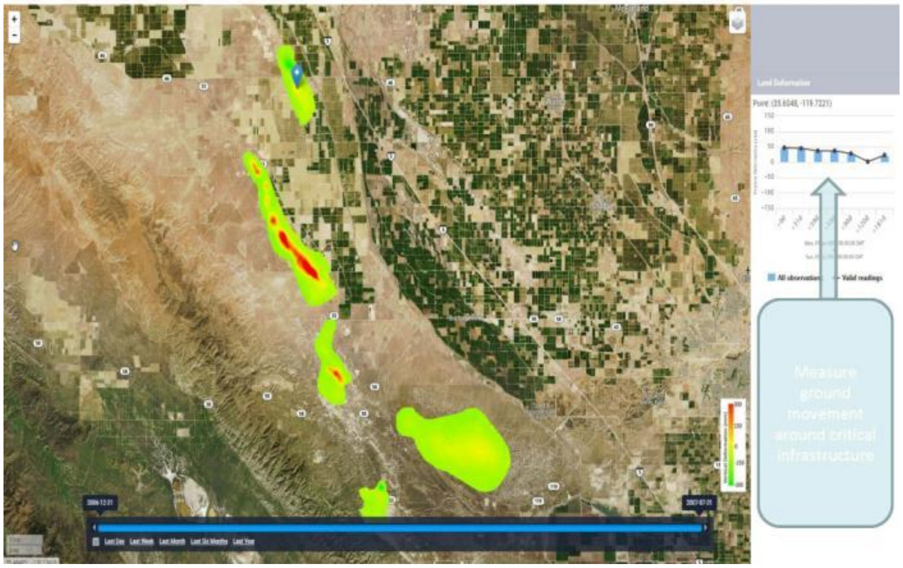
Example daily coverage over DND East Maritime AOI

Ground Stability with INSAR



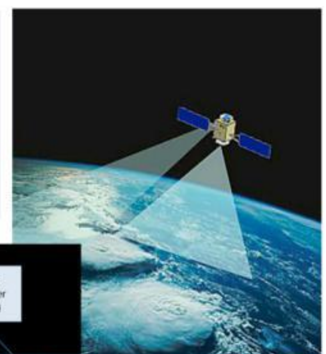


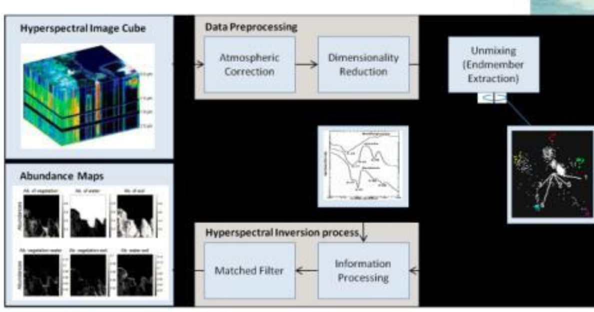
Ground Subsidence with INSAR



NorStar Space Data Inc.

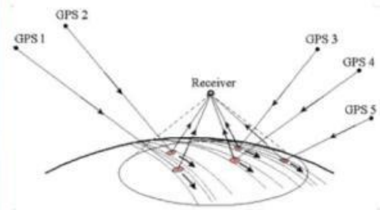
- Constellation of planned hyper-spectral satellite sensors
- Daily revisit in 256+ spectral channels
- Currently validating automatic processing technologies





WatSat Project

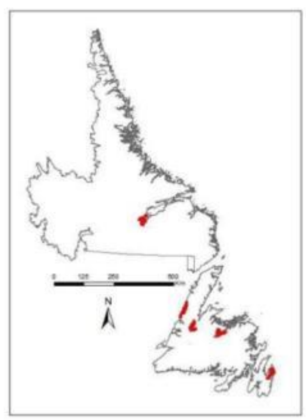
Performing GNSS Reflectometry from a Cubesat to Measure Arctic Sea Ice Thickness



Other potential applications include soil moisture, snow water equivalent

ESA Calibration/Validation Project

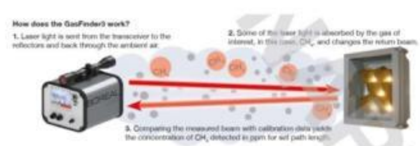
- **Use Canadian northern sites to develop calibration/validation methodologies for Sentinel-2 high latitude applications**
- **Two phased program:**
  - ***Summer 2015 – proof of concept***
  - ***Summer 2016 – multiple validation sites***
- **Current project team:**
  - ***LOOKNorth, NRC, CCRS***
  - ***Others to support field aspects of the 2015 project (McGill University, Agriculture and Agrifood Canada)***
- **ESA Investment:**
  - ***2015 - $500K (estimate $150K through LOOKNorth for internal support, McGill University)***
  - ***2016 – tbd***



UAV TRENDS

UAV Solutions (1)

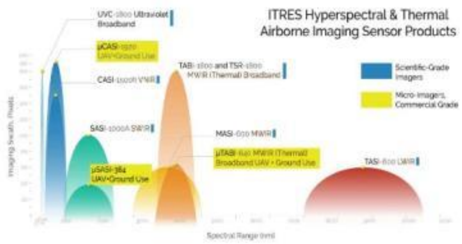
Sensing Technology: **Tunable Diode Gas Absorption Laser**
Sensor Provider: **Boreal Laser (Alberta)**
UAV Provider: **Ventus Geomatics (Alberta)**



- ✓ Operationally demonstrated
- ✓ Independently verified at <1ppm CH_4

UAV Solutions (2)

Sensing Technology: Hyperspectral Spectrometry
Sensor Provider: ITRES Research Ltd (Alberta)
UAV Provider: ING Robotics (Ontario)



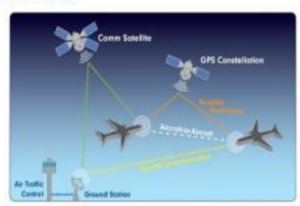
Same Technology as GHGSAT
Claim CH_4 meets sub ppm levels

LOOKNorth

The Regulatory Environment

Objective: to ensure that UAVs meet an equivalent level of safety as piloted aircraft

- ***Special Flight Operating Certificate (SFOC) is required***
  - ***Similar process to balloons, parachute jumps***
  - ***Currently limited to line of sight operation in most cases***
- ***Beyond line of site applications must demonstrate***
  - ***Operational experience***
  - ***Risk mitigation plan***
- ***Ultimately must be able to demonstrate the same detect / analyze /avoid functionality as a piloted aircraft***
  - ***Until then, SFOCs will be granted on a case by case basis***



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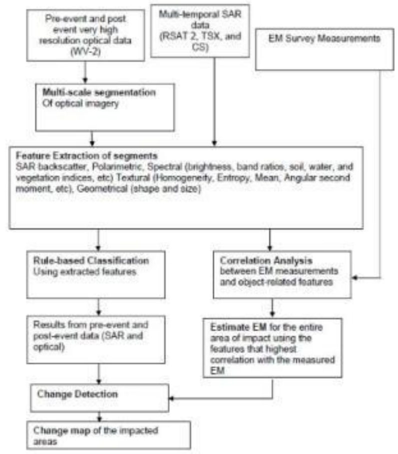
DATA PROCESSING & ANALYTICS

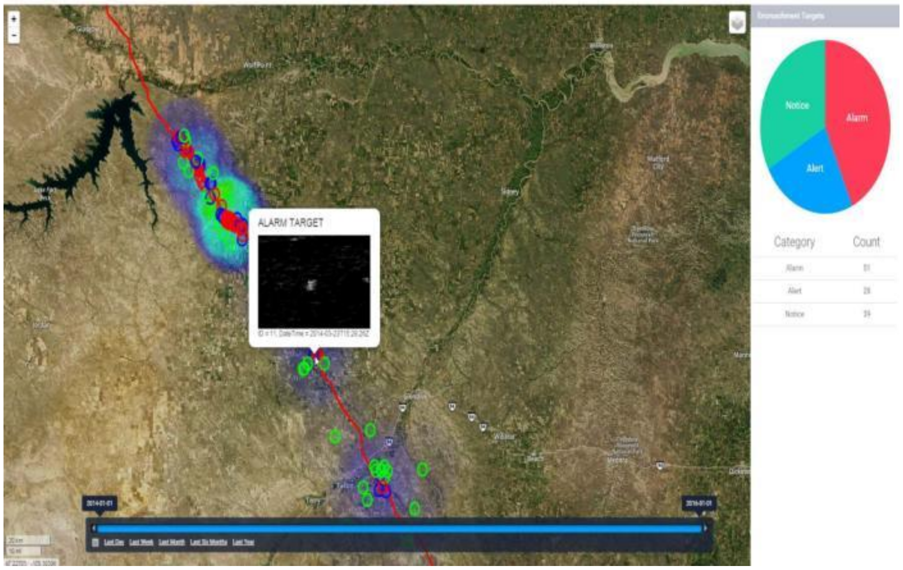
Object Oriented Image Analysis

- Conventional image analysis measures a relatively few parameters (e.g. Tone, texture) on a pixel by pixel basis to classify
- Object oriented image analysis includes:
  - Segmentation into homogenous regions
  - Classification of each region or object
- Each object is defined by a large array of image characteristics derived from both optical and SAR data that distinguish their unique properties. This includes
  - *backscatter polarimetric response, spectral (e.g., brightness, band ratios, and water, soil, and vegetation indices),*
  - *texture (i.e., homogeneity, entropy, mean, angular second moment, etc.), and*
  - *geometry (i.e., shape and size of patches before and after the event) information.*
- From the array of segment features, those that are optimum for characterizing the segment are identified and are utilized for subsequent classification and change detection.



LookNorth

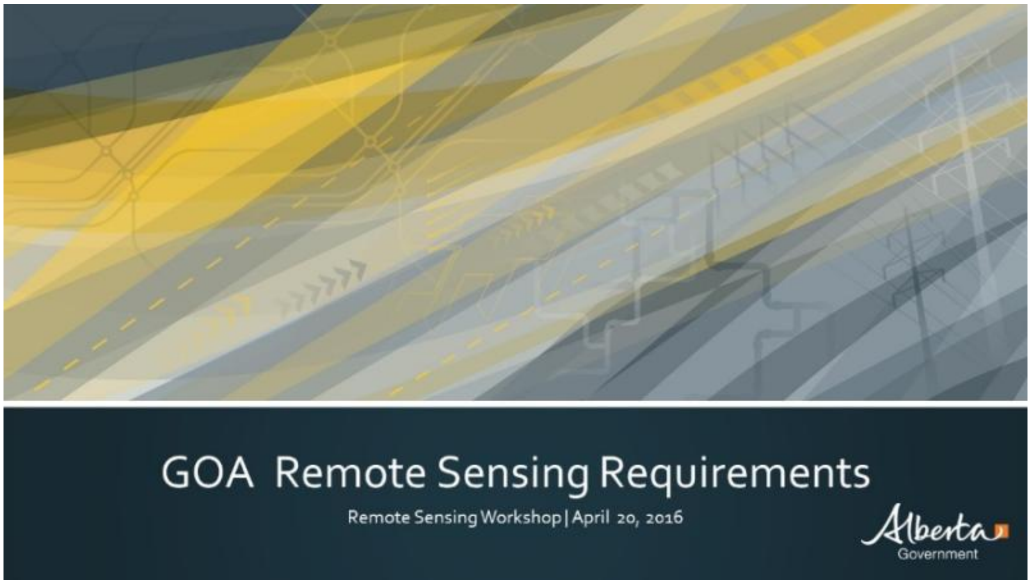
Encroachment Equipment Detection

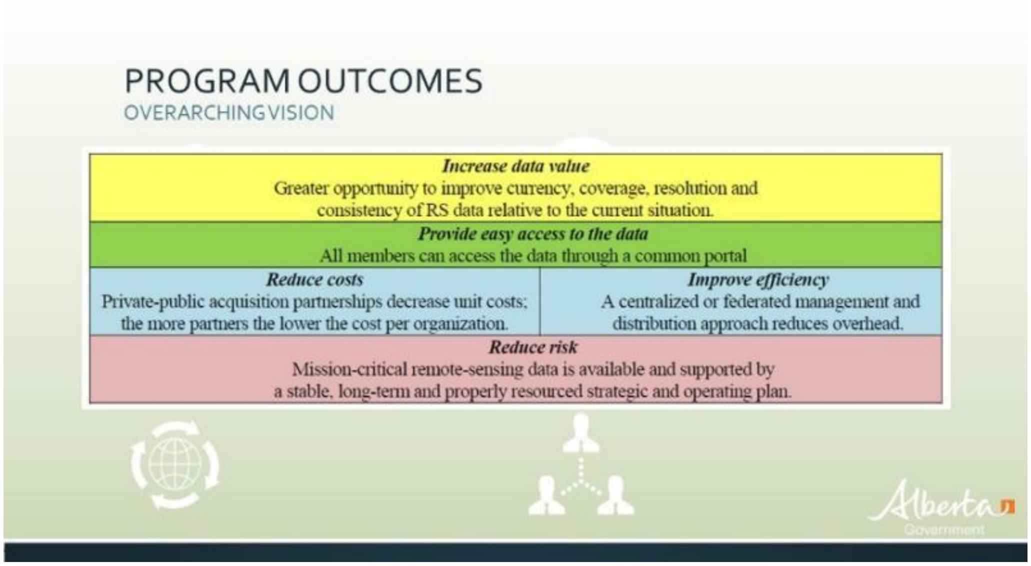


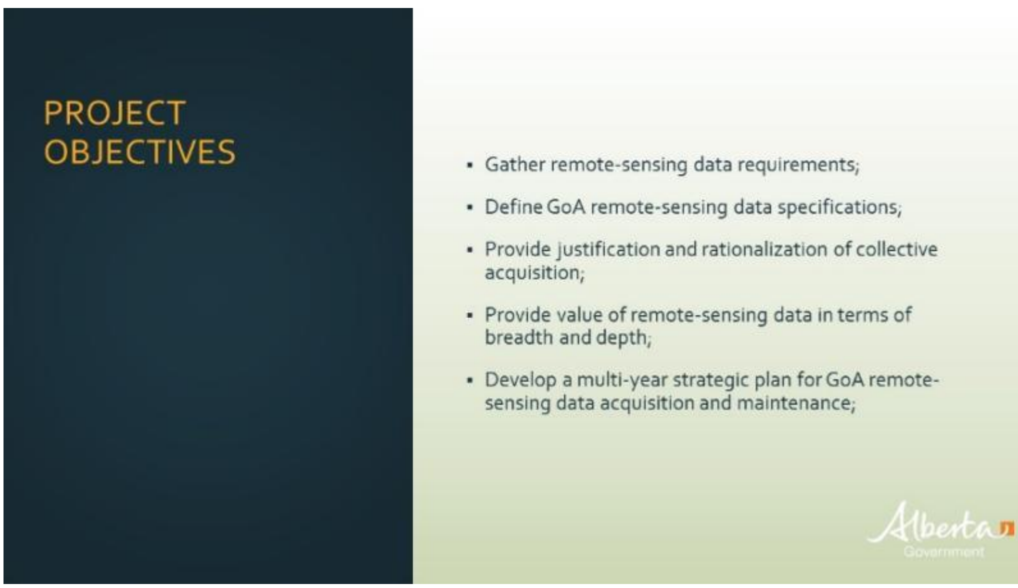
Pipeline Classification Service


Summary
• Rapidly evolving missions fulfill the promise to provide regular, reliable and repeatable monitoring
• Customized products relevant to operators needs are being created

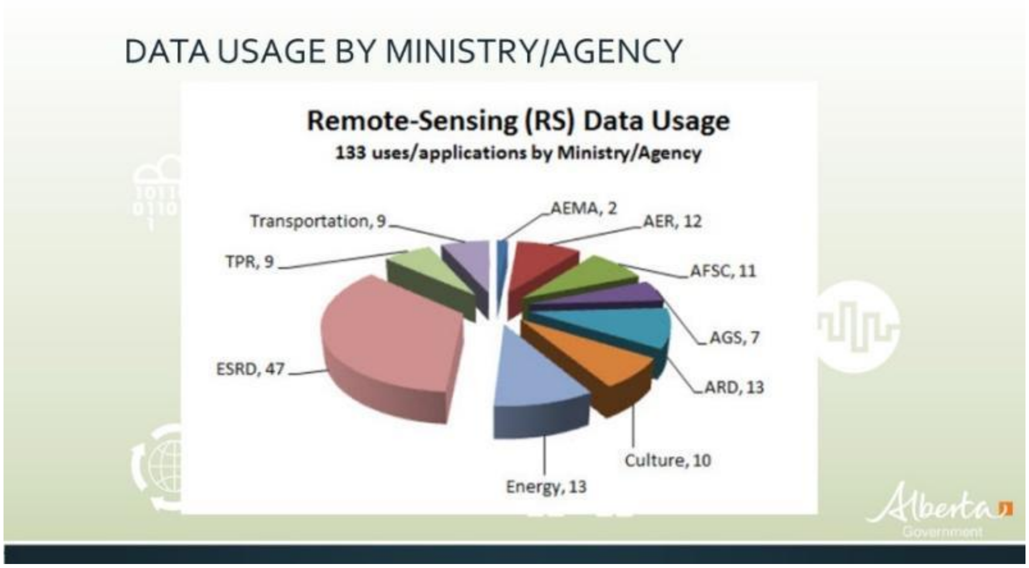
Daryl McEwan, GeoDiscover Alberta: GoA Remote Sensing Requirements



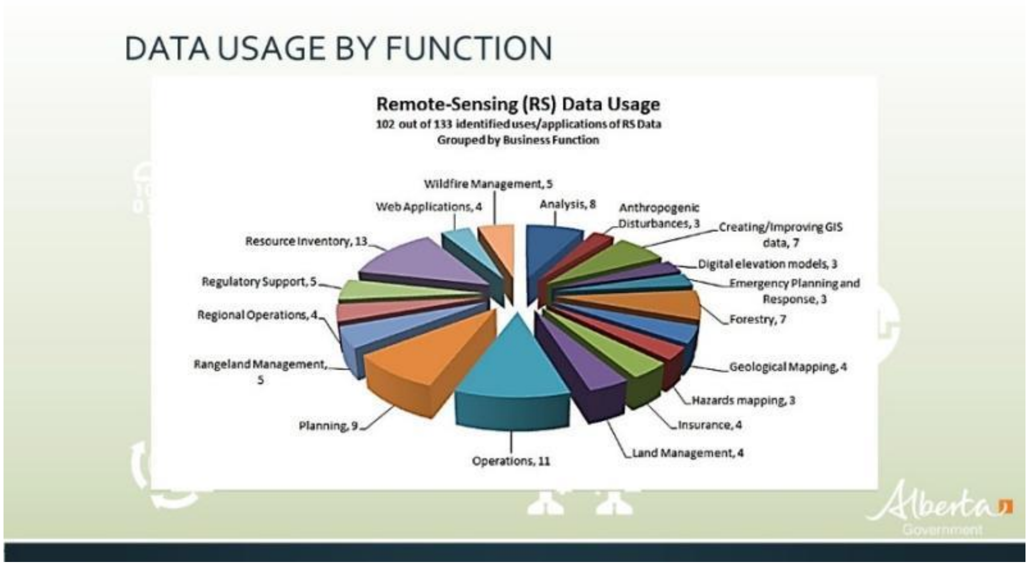

PROGRAM OUTCOMES
OVERARCHING VISION
Increase data value
Greater opportunity to improve currency, coverage, resolution and consistency of RS data relative to the current situation.
Provide easy access to the data
All members can access the data through a common portal
Reduce costs
Private-public acquisition partnerships decrease unit costs; the more partners the lower the cost per organization.
Improve efficiency
A centralized or federated management and distribution approach reduces overhead.
Reduce risk
Mission-critical remote-sensing data is available and supported by a stable, long-term and properly resourced strategic and operating plan.
Alberta
Government

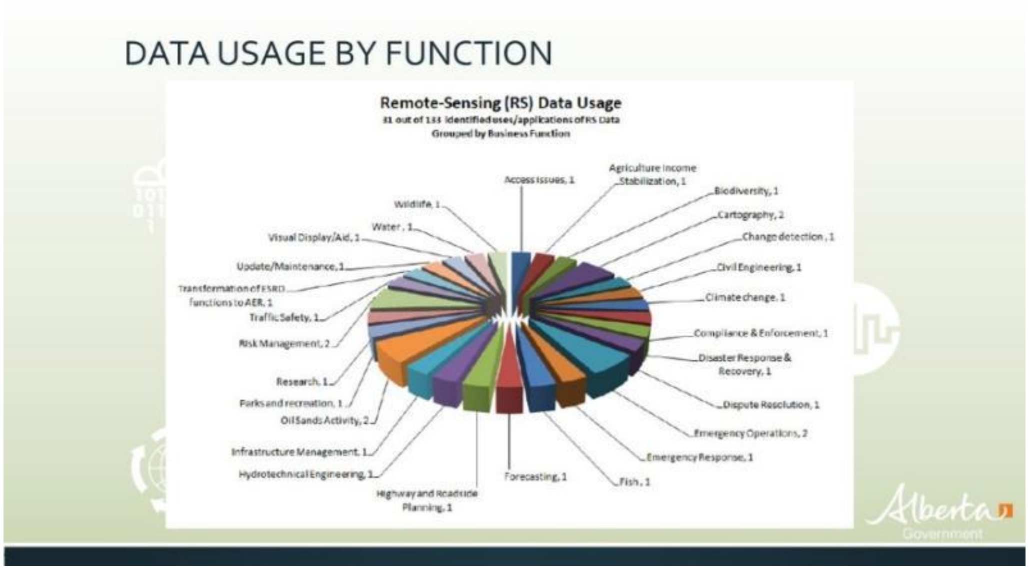

PROJECT OBJECTIVES
Gather remote-sensing data requirements;
Define GoA remote-sensing data specifications;
Provide justification and rationalization of collective acquisition;
Provide value of remote-sensing data in terms of breadth and depth;
Develop a multi-year strategic plan for GoA remote-sensing data acquisition and maintenance;
Alberta
Government

REQUIREMENTS GATHERING
PROJECT TEAM & APPROACH
INTERVIEWS
SURVEYS
DATA ANALYSIS
WORKSHOPS
Alberta
Government

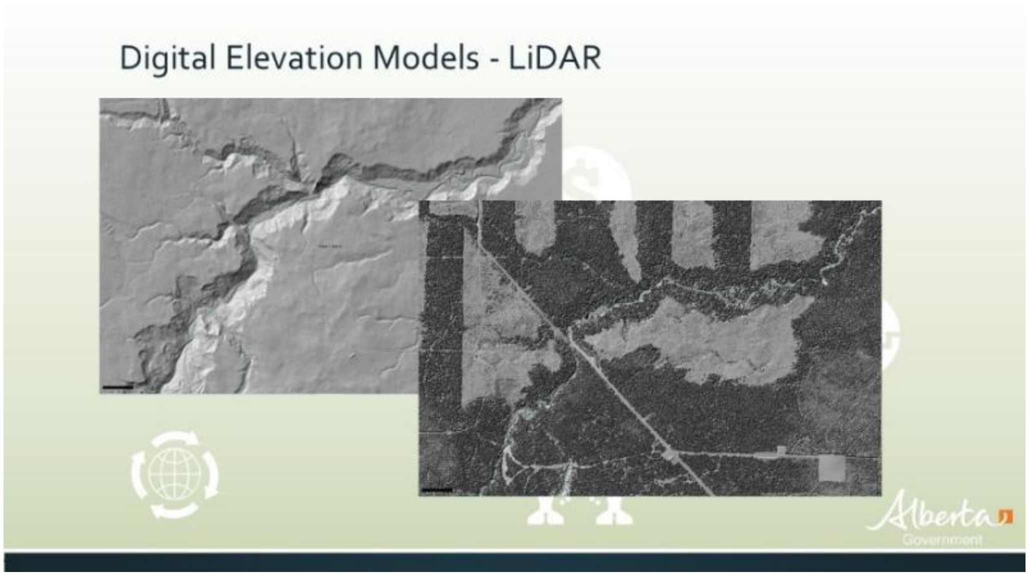


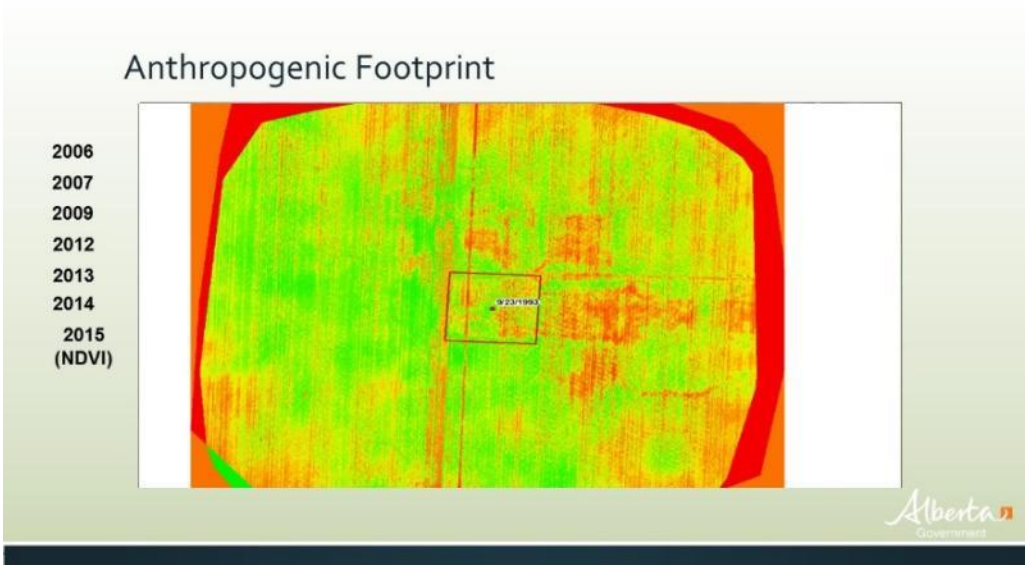
DATA USAGE BY MINISTRY/AGENCY
Remote-Sensing (RS) Data Usage
133 uses/applications by Ministry/Agency
AEMA, 2
AER, 12
AFSC, 11
AGS, 7
ARD, 13
Culture, 10
Energy, 13
ESRD, 47
TPR, 9
Transportation, 9
Alberta
Government

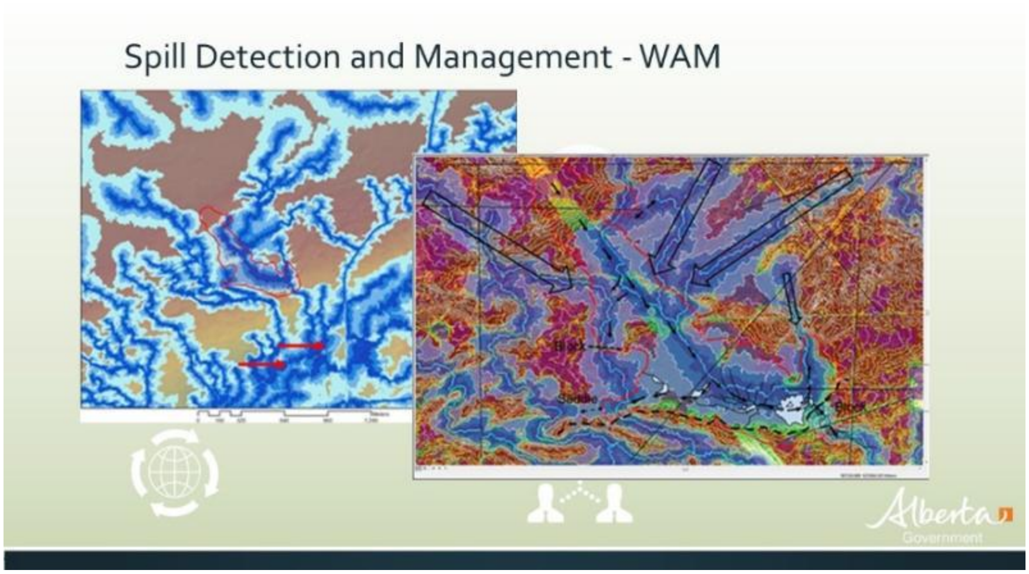

DATA USAGE BY FUNCTION
Remote-Sensing (RS) Data Usage
102 out of 133 identified uses/applications of RS Data
Grouped by Business Function
Wildfire Management, 5
Analysis, 8
Anthropogenic Disturbances, 3
Creating/Improving GIS data, 7
Digital elevation models, 3
Emergency Planning and Response, 3
Forestry, 7
Geological Mapping, 4
Hazards mapping, 3
Insurance, 4
Land Management, 4
Operations, 11
Planning, 9
Rangeland Management, 5
Regional Operations, 4
Regulatory Support, 5
Resource Inventory, 13
Web Applications, 4
Alberta
Government


DATA USAGE BY FUNCTION
Remote-Sensing (RS) Data Usage
31 out of 133 identified uses/applications of RS Data
Grouped by Business Function
Access Issues, 1
Agriculture Income Stabilization, 1
Biodiversity, 1
Cartography, 2
Change detection, 1
Civil Engineering, 1
Climate change, 1
Compliance & Enforcement, 1
Disaster Response & Recovery, 1
Dispute Resolution, 1
Emergency Operations, 2
Emergency Response, 1
Fish, 1
Forecasting, 1
Highway and Roadside Planning, 1
Hydrotechnical Engineering, 1
Infrastructure Management, 1
Oil Sands Activity, 2
Parks and recreation, 1
Research, 1
Risk Management, 2
Traffic Safety, 1
Transformation of ESRD functions to AER, 1
Update/Maintenance, 1
Visual Display/Aid, 1
Water, 1
Wildlife, 1
Alberta
Government


Wildfire Management - Modis
Alberta
Government


Digital Elevation Models - LiDAR
Alberta
Government


Anthropogenic Footprint
2006
2007
2009
2012
2013
2014
2015
(NDVI)
9/23/1993
Alberta
Government


Spill Detection and Management - WAM
Alberta
Government


Critical Success Factors
Funding
Multi-year funding commitment.
Clearly articulating the positive return on investment and value from a membership in the partnership model;
A cost-effective and affordable imagery solution that meets at least everyone's minimum requirements.
Getting Partners
Attracting industry partners in general;
Retaining members in the partnership model.


Critical Success Factors
Product-Related
Defined product or product suite that meets the broadest range of business needs such as:
Agreement on one set of requirements for imagery.
Agreement on one set of requirements for elevation data.
Creation of value-added or derivative products that enable business process improvement or enhancement.

Critical Success Factors

Data Management, Data Sharing and Access

- *Development of a plan that will satisfy all with:*
  - *Active participation by all users;*
  - *Cooperation across various stakeholders;*
- *A clear record of actual data use to help measure the value for the expenditure.*

Data Access and Sharing

- *Ability to share with partners outside GoA.*
- *Publicly accessible imagery.*

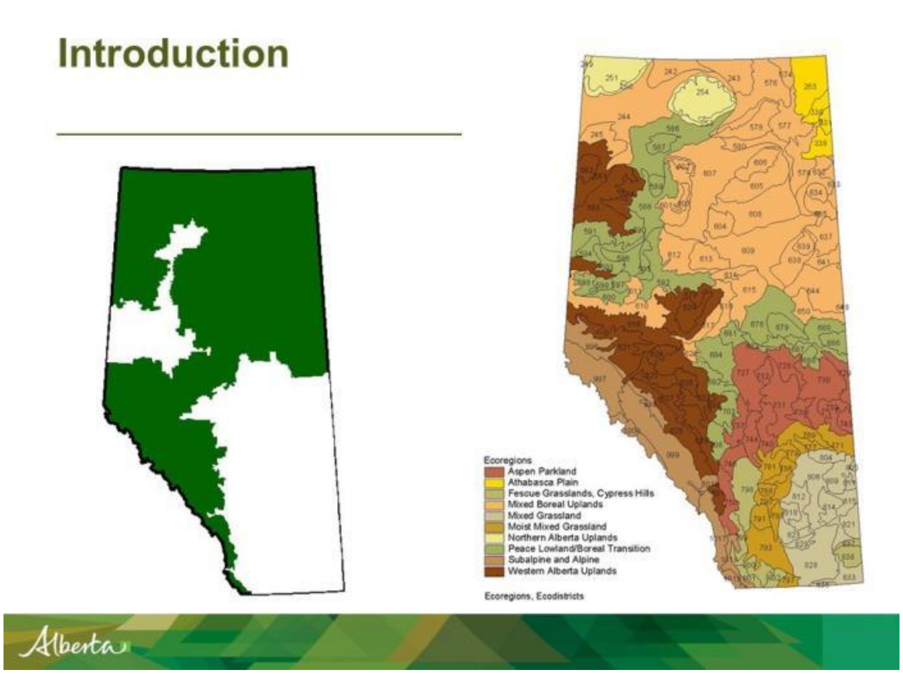
Next Steps

GDA Steering Committee Endorsement

- *Development Program Governance*
  - *Terms of Reference*
  - *Roles and Responsibilities*
  - *Develop Strategic Plan*

- *Are there things you would need from or interact with a GOA Remote Sensing Program?*

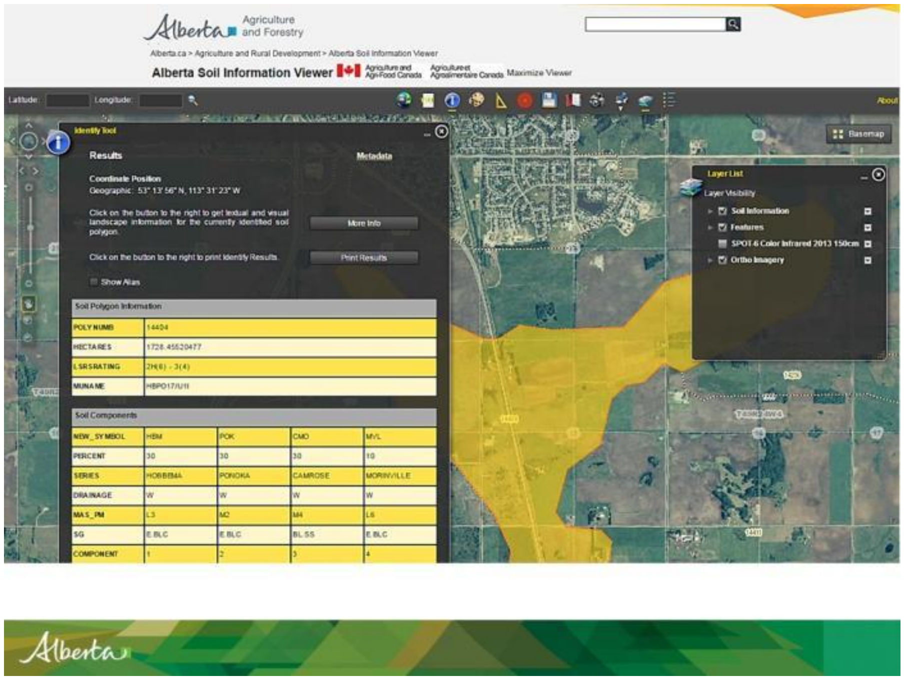
Tom Goddard, Alberta Agriculture and Forestry: Can RS Contribute to Integrated Management Systems in Agriculture?

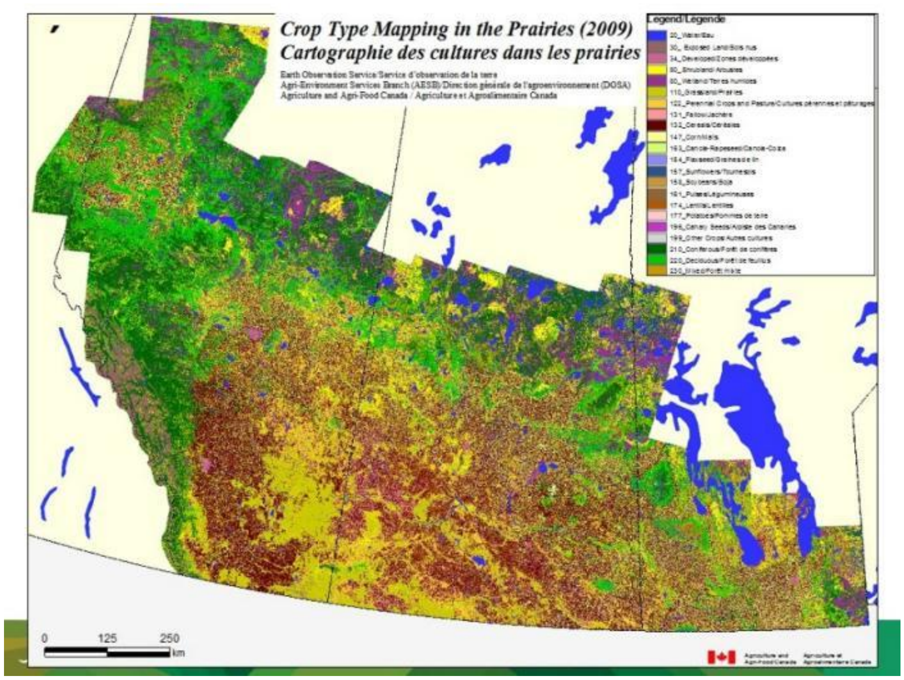


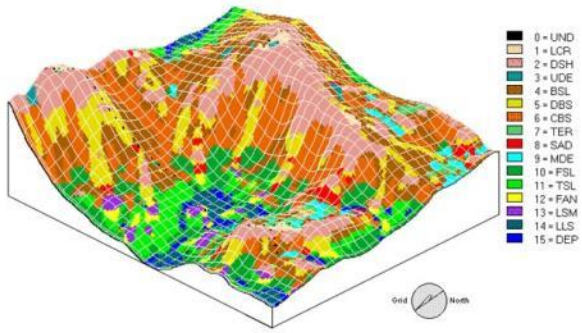
A short Alberta history

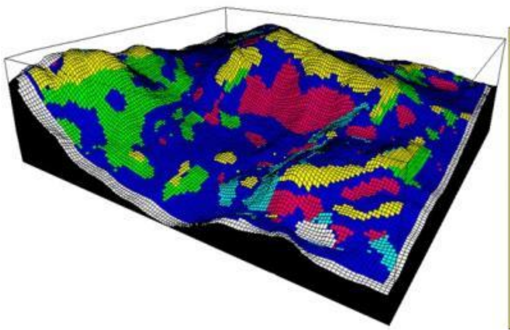
- Air photo archives – farm conservation planning – 1989
  - then Env Farm Plans
- Remote sensing for county level planning – 1989
- GPS for salinity mapping – 1988
- Photo base salinity mapping (? Counties) - 1997
- Precision farming – yield monitoring, variable rate fertilizer, DEM, management zones. – 1993
- Photo base for AGRASID – 2005?
  - Orthophotos (2000), then SPOT (2013?)
  - Vers 3 of viewer now.
- Ag Canada prairie land cover – 2005?

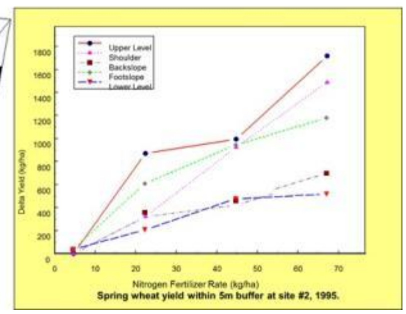
Alberta

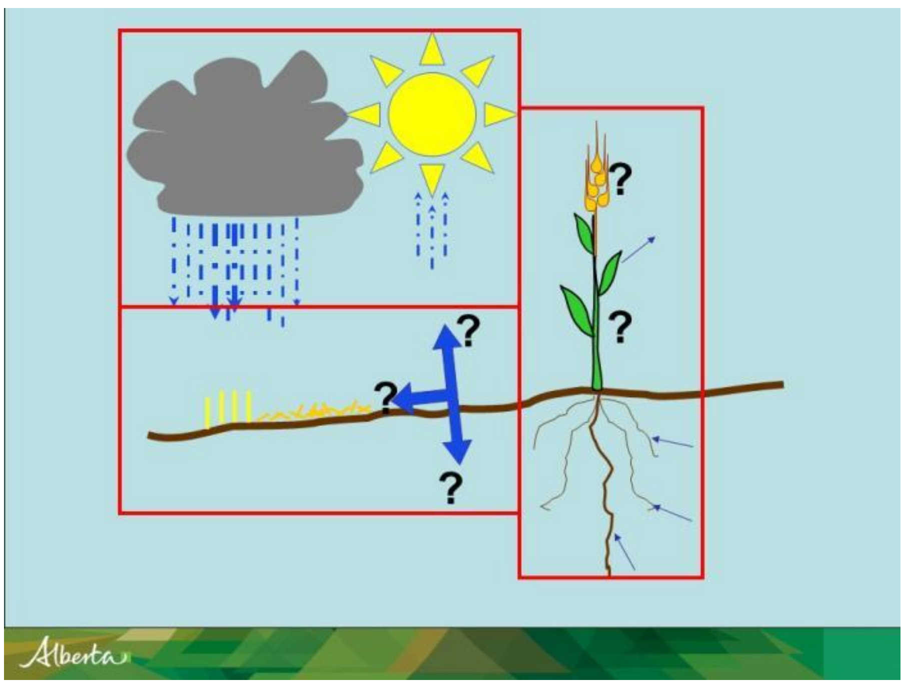

Alberta Agriculture and Forestry
Alberta.ca > Agriculture and Rural Development > Alberta Soil Information Viewer
Alberta Soil Information Viewer
Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada
Maximize Viewer
Latitude:
Longitude:
About
Basemap
Identify Tool
Results
Metadata
Coordinate Position
Geographic: 53° 13' 56" N, 113° 31' 23" W
Click on the button to the right to get textual and visual landscape information for the currently identified soil polygon.
More Info
Click on the button to the right to print Identify Results.
Print Results
Show Alias
Soil Polygon Information
POLY NUMB 14404
HECTARES 1728.45520477
LSRSRATING 2H(6) - 3(4)
MUNAME HBPO17/U1I
Soil Components
NEW_SYMBOL HBM POK CMO MVL
PERCENT 30 30 30 10
SERIES HOBBEMA PONOKA CAMROSE MORINVILLE
DRAINAGE W W W W
MAS_PM L3 M2 M4 L6
SG E.BLC E.BLC BL.SS E.BLC
COMPONENT 1 2 3 4
Layer List
Layer Visibility
Soil Information
Features
SPOT-6 Color Infrared 2013 150cm
Ortho Imagery
Alberta

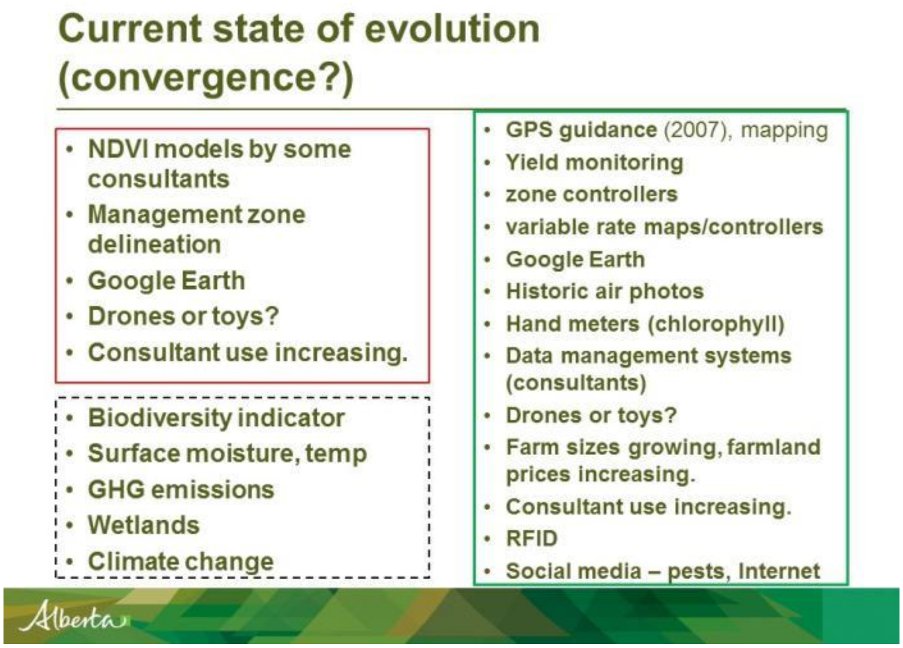

Crop Type Mapping in the Prairies (2009)
Cartographie des cultures dans les prairies
Earth Observation Service/Service d'observation de la terre
Agri-Environment Services Branch (AESB)/Direction générale de l'agroenvironnement (DGSA)
Agriculture and Agri-Food Canada / Agriculture et Agroalimentaire Canada
Legend/Legende
0 125 250
km

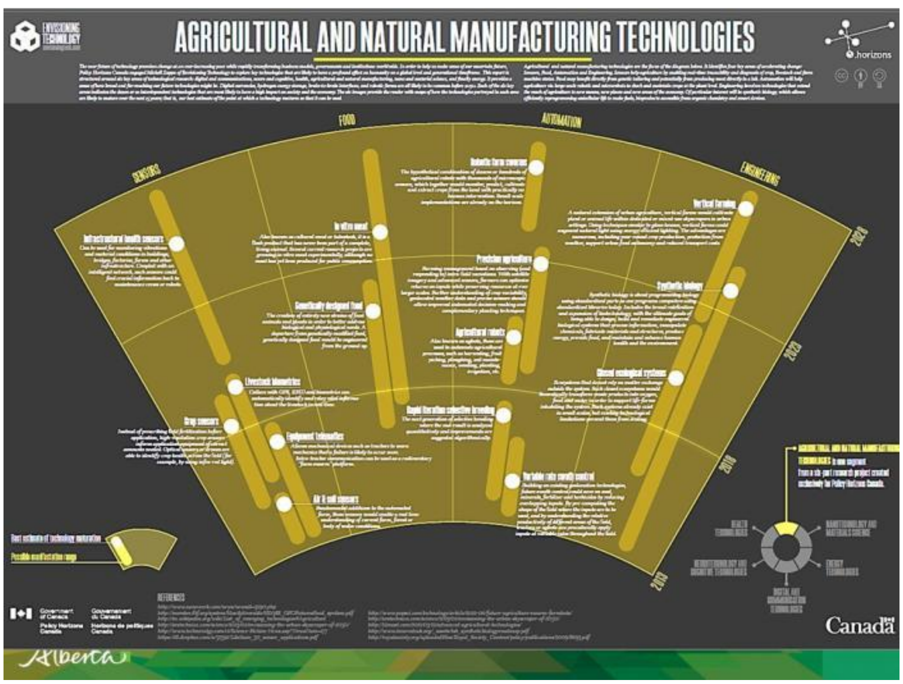

0 = UND
1 = LCR
2 = DSH
3 = UDE
4 = BSL
5 = DBS
6 = CBS
7 = TER
8 = SAD
9 = MDE
10 = FSL
11 = TSL
12 = FAN
13 = LSM
14 = LLS
15 = DEP
Grid
North

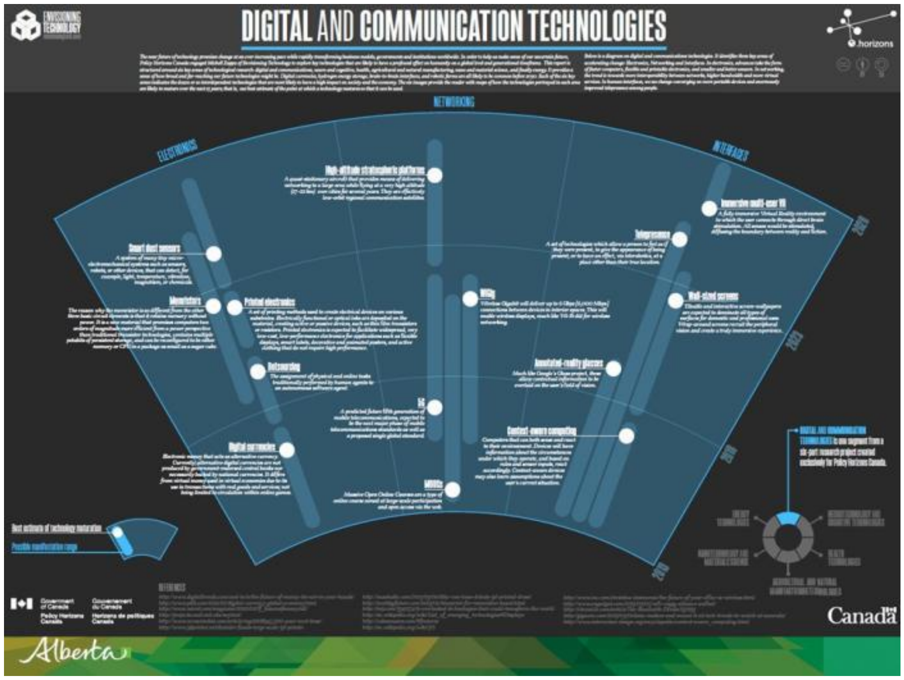



Upper Level
Shoulder
Backslope
Footslope
Lower Level
Delta Yield (kg/ha)
Nitrogen Fertilizer Rate (kg/ha)
Spring wheat yield within 5m buffer at site #2, 1995.


?
?
?
?
?
Alberta


Current state of evolution
(convergence?)
NDVI models by some consultants
Management zone delineation
Google Earth
Drones or toys?
Consultant use increasing.
Biodiversity indicator
Surface moisture, temp
GHG emissions
Wetlands
Climate change
GPS guidance (2007), mapping
Yield monitoring
zone controllers
variable rate maps/controllers
Google Earth
Historic air photos
Hand meters (chlorophyll)
Data management systems (consultants)
Drones or toys?
Farm sizes growing, farmland prices increasing.
Consultant use increasing.
RFID
Social media – pests, Internet
Alberta


AGRICULTURAL AND NATURAL MANUFACTURING TECHNOLOGIES
FOOD
AUTOMATION
SENSORS
ENGINEERING
Canada
Alberta

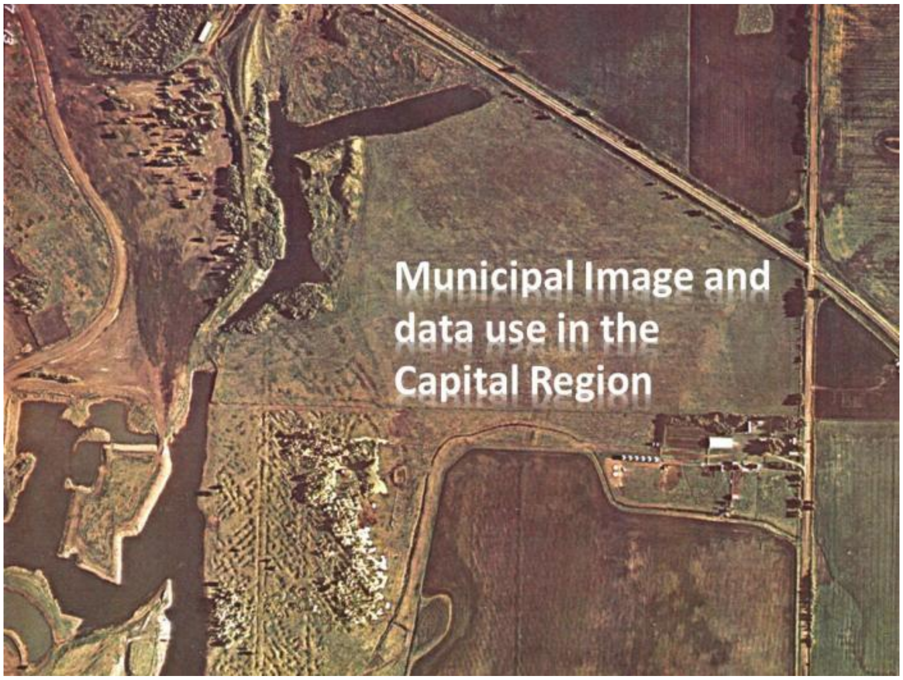


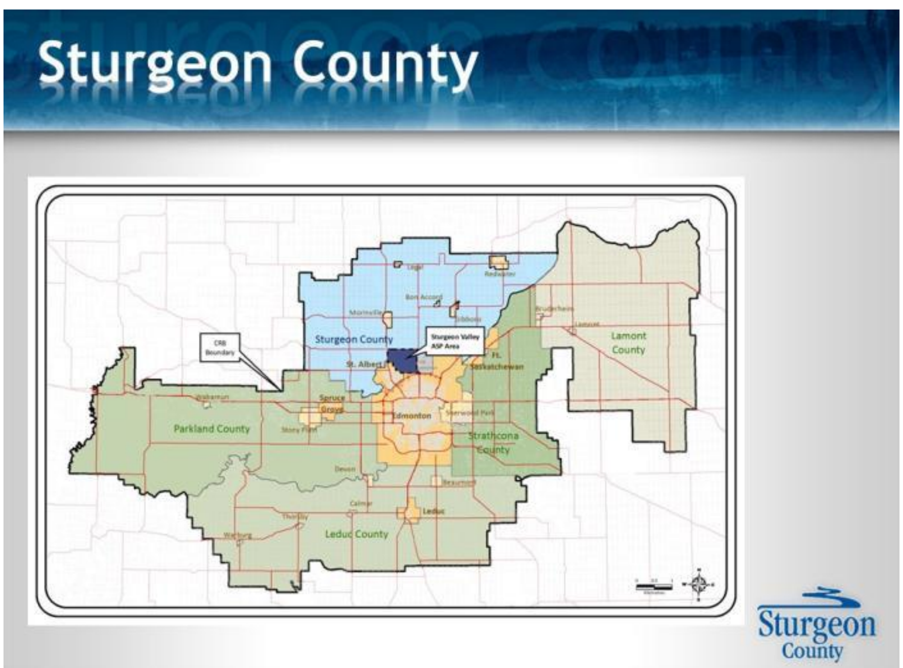
Future potentials

- Higher resolution and sensitivity, density
- Convergence of sensor data.
- Consultant & farmer uses, needs, discovery
- DEM
- Digital mapping technologies – Global Soils Map
- Surface rights, wellsites – baseline and changes.
  - Policy revisions/approaches
- Planning – county, sub region, regions

Alberta

Kevin Smiley, Sturgeon County: Municipal Image and Data Use in the Capital Region





Datasets

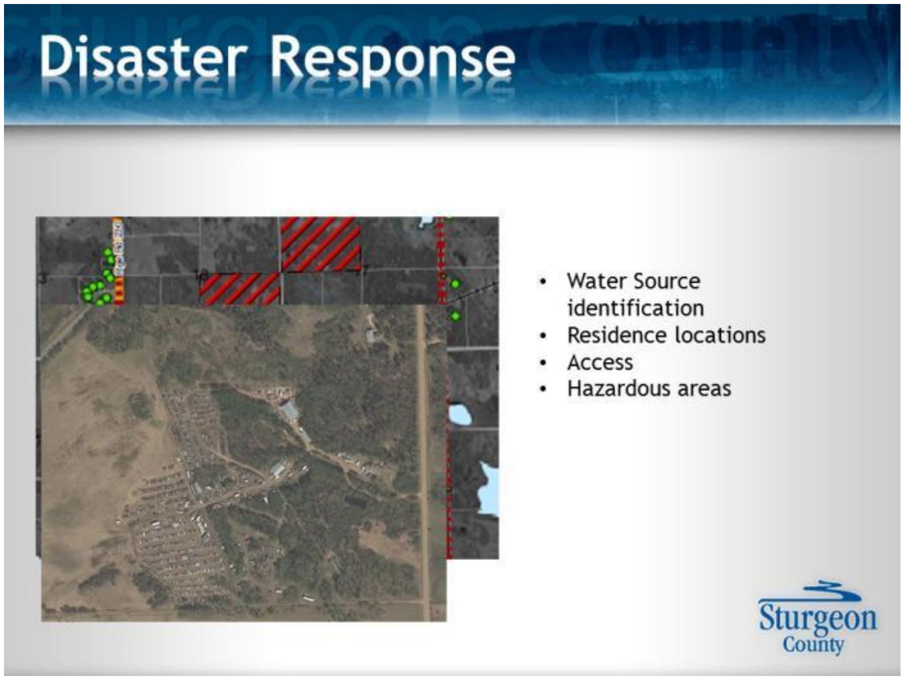
- Current Products
  - Digital Orthophoto 10cm + 25cm
  - DEM - LiDAR - AltaLIS 15m
  - Building footprints
- Future
  - Oblique Imagery
  - LiDAR
- Past Products
  - Contact prints
  - Infrared prints

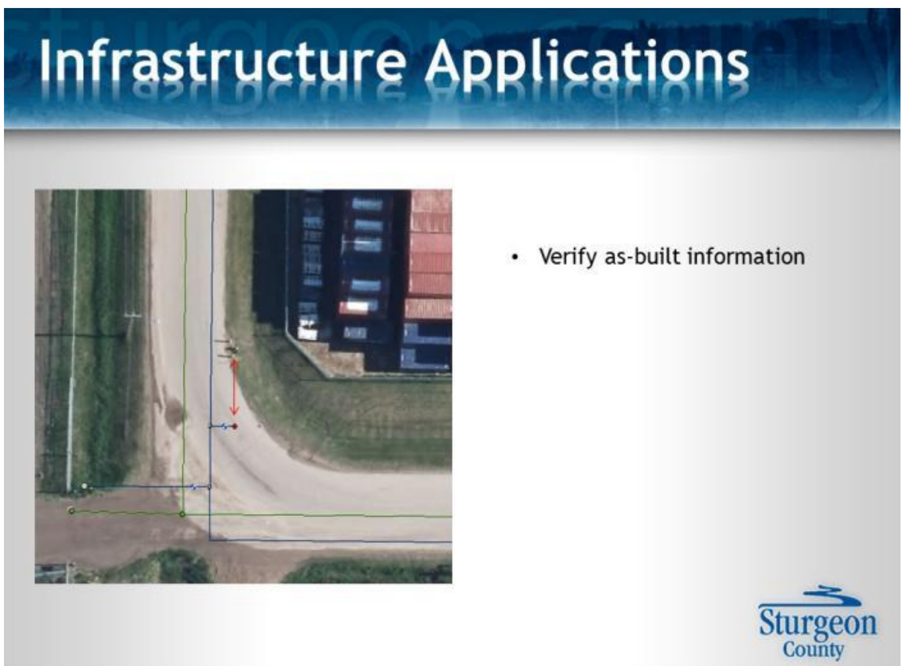
Sturgeon County

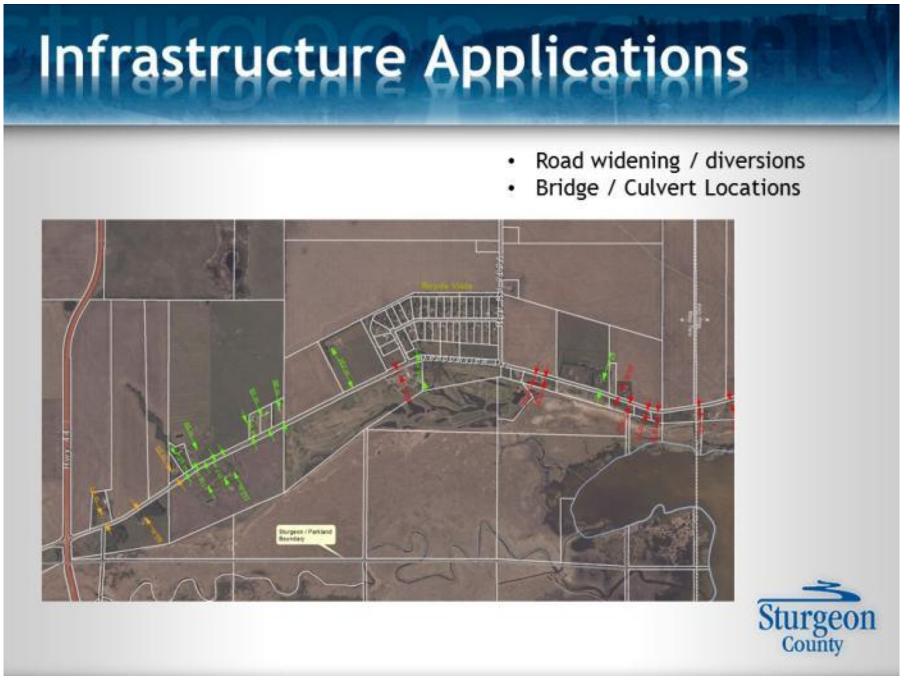
What we use it for

- Tax Assessment
- Land Use Planning
- Disaster Response/planning
- Drainage history / planning
- Infrastructure Assessment/Inventory
- Public Information

Sturgeon County

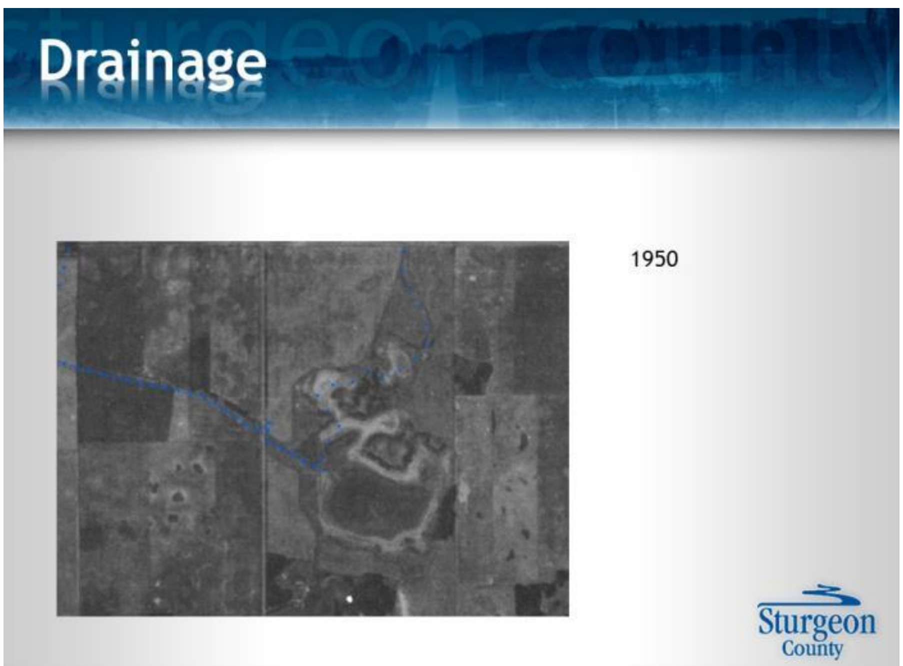

Disaster Response
• Water Source identification
• Residence locations
• Access
• Hazardous areas
Sturgeon County

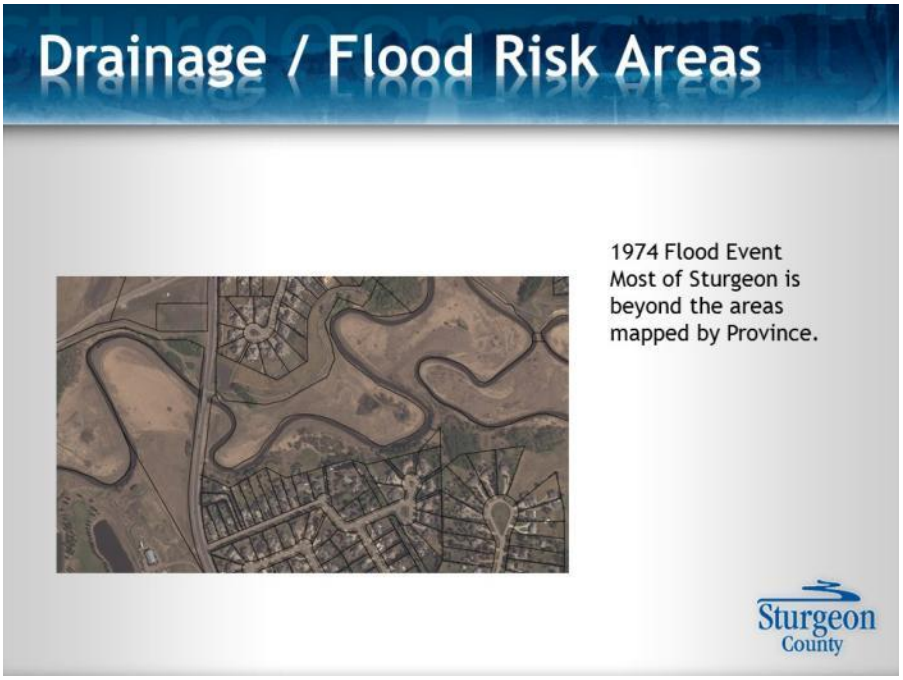

Infrastructure Applications
• Verify as-built information
Sturgeon County


Infrastructure Applications
• Road widening / diversions
• Bridge / Culvert Locations
Sturgeon County


Drainage
• Wetland area?
• Contours from AltaLIS LiDAR 15 product
Sturgeon County


Drainage
2001
Sturgeon
County


Drainage
1950
Sturgeon
County

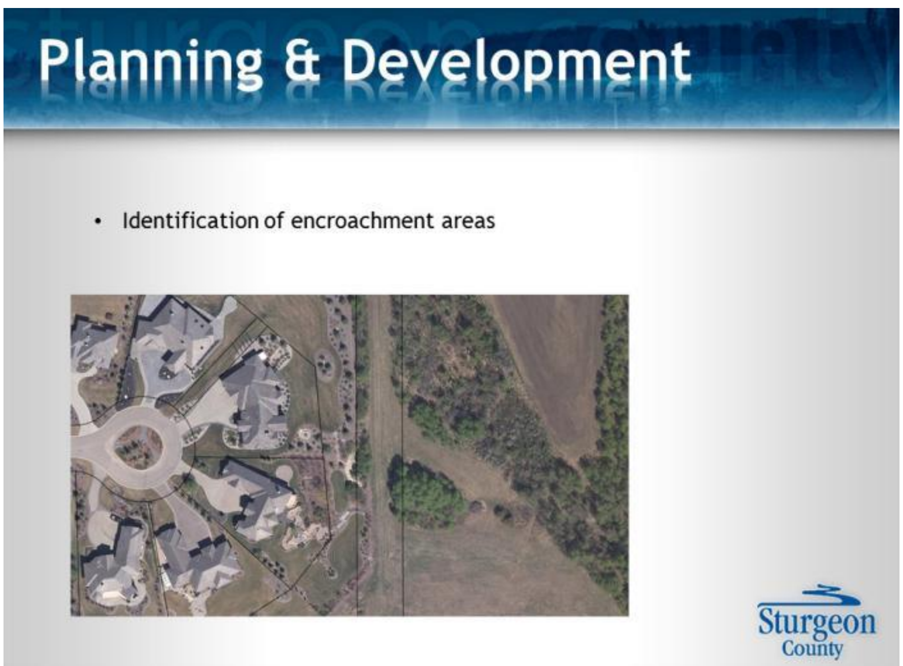

Drainage / Flood Risk Areas
1974 Flood Event
Most of Sturgeon is
beyond the areas
mapped by Province.
Sturgeon
County


Drainage / Flood Risk Areas
1974 Flood Event
Most of Sturgeon is
beyond the areas
mapped by Province.
Sturgeon
County


Planning & Development
• Gravel Pit Development and Reclamation Progress
2005
Sturgeon County


Planning & Development
• Gravel Pit Development and Reclamation Progress
2005
Sturgeon County


Planning & Development
• Setback Compliance
Sturgeon
County


Planning & Development
• Identification of encroachment areas
Sturgeon
County

Assessment

- Large Industrial Sites

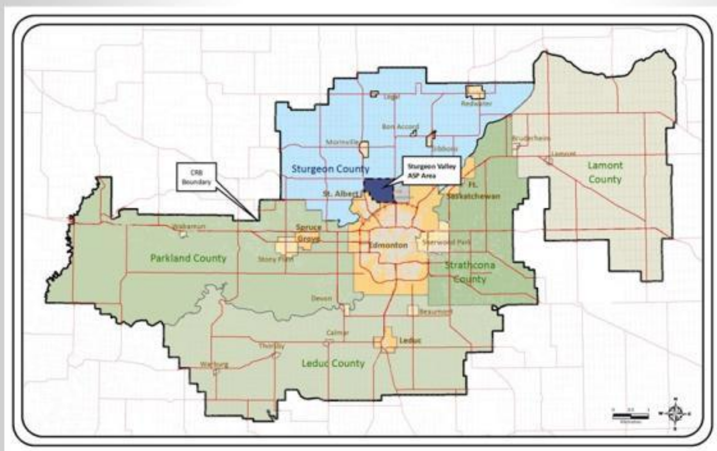
Sturgeon County

Assessment

- Trend towards desktop assessment
- Ortho vs Oblique

Sturgeon County

ERJOI

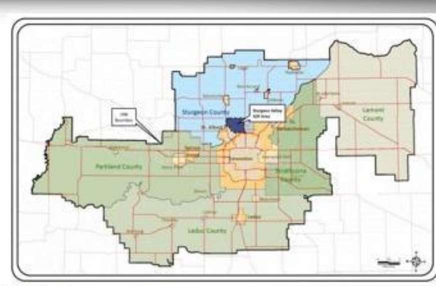


Edmonton Regional Orthophoto Initiative

Sturgeon County

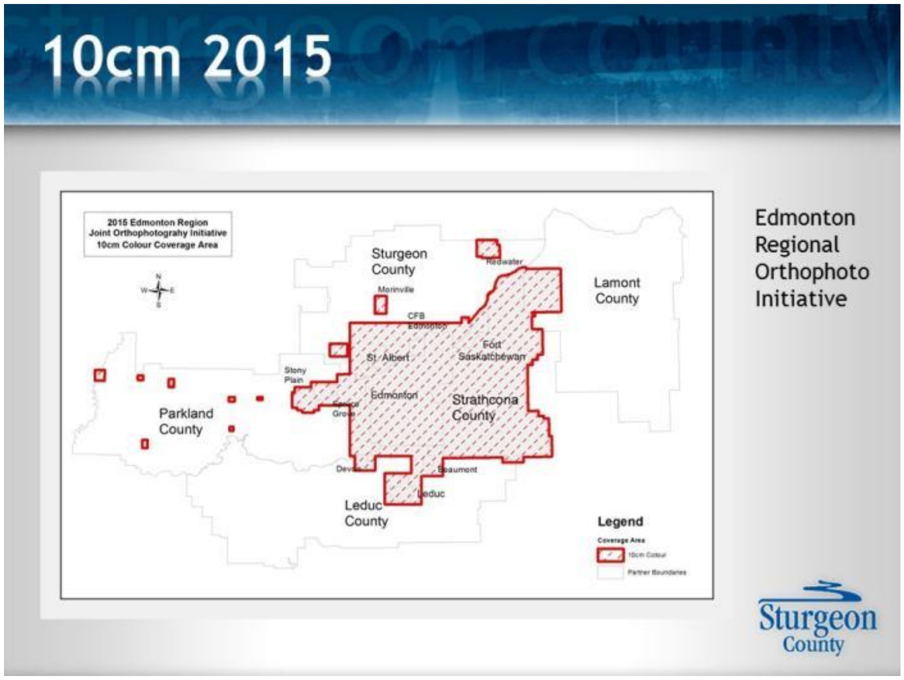
ERJOI - 2015

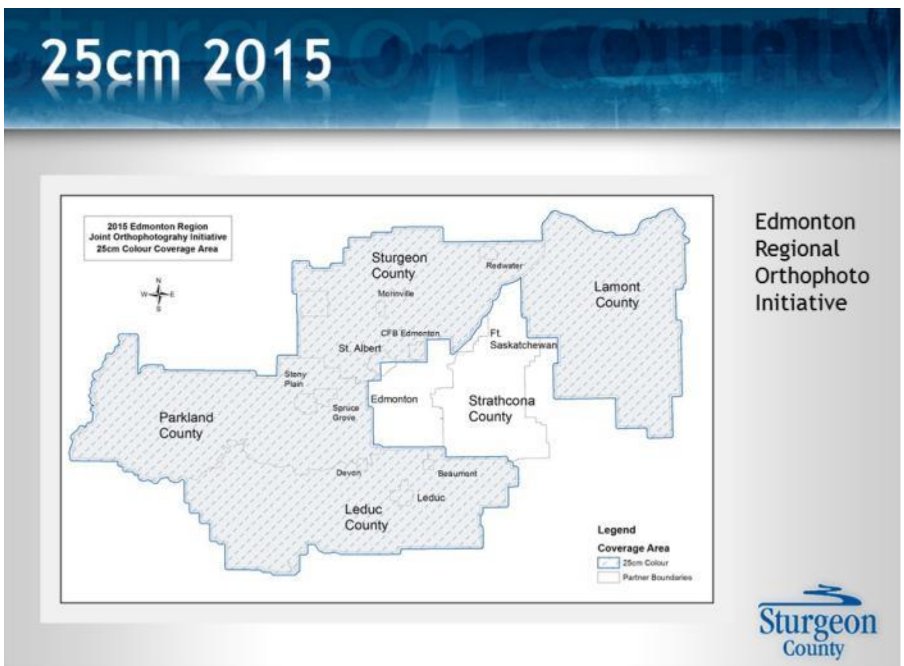
- Group effot to acquire orthophotos for Edmonton region since 2001.
- Started with 25cm + 75cm black and white.
- Urban partners started move to 10cm and colour by 2007 project.
- 2013 was first time the project used a digital camera instead of film.
- 17 partners in 2015
- ~1,200,000ha 25cm
- ~242,000ha 10cm



Name	Hectares	Name	Hectares
Strathcona County	127,028	City of St. Albert	4,974
Leduc County	268,645	Town of Devon	1,199
Parkland County	263,860	Town of Bruderheim	500
Sturgeon County	222,158	Town of Morinville	1,134
Lamont County	252,123	Town of Redwater	708
City of Edmonton	69,969	Town of Stony Plain	2,772
City of Fort Saskatchewan	4,826	Town of Beaumont	1,047
City of Leduc	3,769	CFB Edmonton	2,469
City of Spruce Grove	3,163		

Sturgeon County


10cm 2015
2015 Edmonton Region
Joint Orthophotograhy Initiative
10cm Colour Coverage Area
Sturgeon
County
Morinville
Redwater
Lamont
County
CFB
St. Albert
Fort
Saskatchewan
Stony
Plain
Parkland
County
Edmonton
Strathcona
County
Beaumont
Leduc
Leduc
County
Legend
Edmonton
Regional
Orthophoto
Initiative
Sturgeon
County


25cm 2015
2015 Edmonton Region
Joint Orthophotograhy Initiative
25cm Colour Coverage Area
Sturgeon
County
Redwater
Morinville
Lamont
County
CFB Edmonton
Ft.
Saskatchewan
St. Albert
Stony
Plain
Edmonton
Strathcona
County
Spruce
Grove
Parkland
County
Devon
Beaumont
Leduc
Leduc
County
Legend
Coverage Area
25cm Colour
Partner Boundaries
Edmonton
Regional
Orthophoto
Initiative
Sturgeon
County

2001 Image

- 2001 - Black and White 25cm

Sturgeon County

2015 25cm Image

- 2015 - 25cm - leaf on

Sturgeon County

2015 10cm Image

- 2015 - Colour 10cm - leaf free

Sturgeon County

2011 25cm Image

Sturgeon County


2015 10cm Image
Sturgeon
County


Infrared
Sturgeon
County

ERJOI

Advantages:

- Cost + time savings
- Data Sharing - Each Partner recieves entire area

Challenges:

- Size: 1,200,000 total hectares
  - Short Leaf and snow free window
  - Long Processing time
- Product choice - growing list
  - MrSID (Gen2-4)
  - GeoTiffs
  - Building Footprints
  - DEM Update (for future ortho)
- Spring capture - Construction Season
- File sizes

Sturgeon County

Future

LiDAR

- Currently use Altalis LiDAR 15 product or better.
- Cost

Obliques

- Assessment
- Protective Services

UAV / Drones

- Regulations (ie Airport)
- Gravel Stockpiles

Sturgeon County

Data Sharing

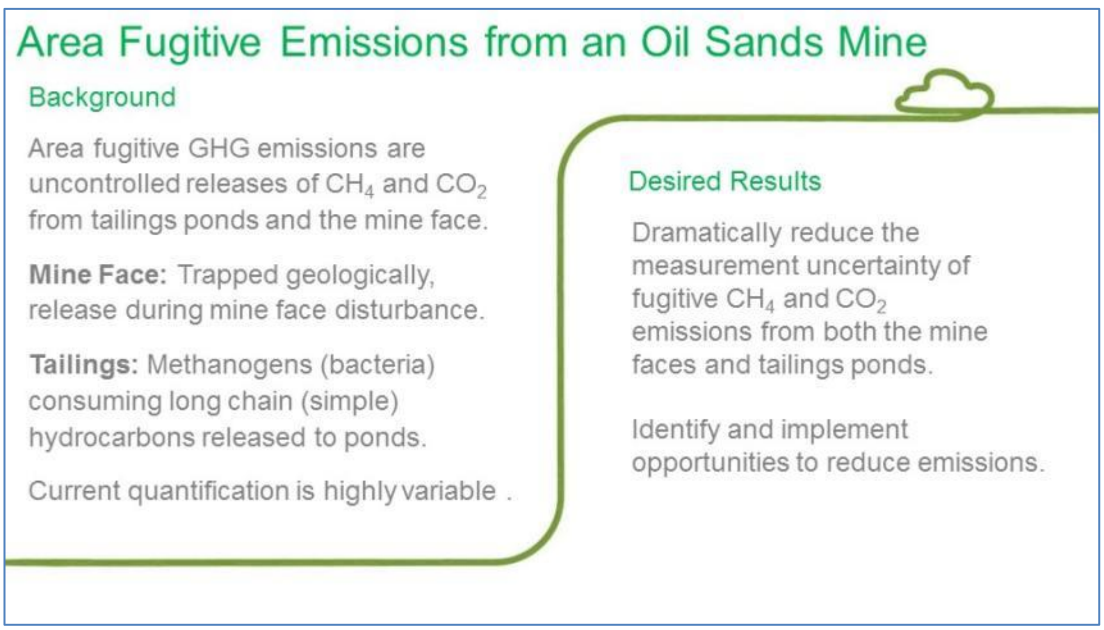
Alberta SRD
Pricing Change
ESRI Community BaseMaps
Municipal Websites

- Property Viewers
- Open Data portals

Capital Region Board

Sturgeon County

Dan Burt, Suncor: Area Fugitive Emissions: Oil Sands Mining



Current Quantification Approach

- Area fugitive emission rates from tailings ponds and mine faces are currently measured using flux chamber technology in "snapshot" measurement campaigns conducted once per year over 2-3 weeks (June-September).
- Annual emissions estimated by extrapolating measured flux rates based on surface areas over the course of the year. Estimates can be based on an area as low as 0.01% of the emission zone: high level of large spatial variability.
- Huge data variability and uncertainty (multiple orders of magnitude identified).
- Issues with measurement itself, including seasonal or operational variability.
- High cost, safety issues and seasonality.

Mine Area Fugitive Emissions: GAPS

Mine Area Fugitives: Gaps

Uncertainty in Quantification

Reduce Emissions from Tailings Ponds

Reduce Emissions from Mine Face

Improved Quantification: Technologies Currently Under Investigation

- 2016/2017 Field campaigns will be testing all of these technologies

Long Term Vision for Quantification

- Key Attributes of a Long Term Solution
  - Flux rates reliably collected in real time, continuously, with full spatial coverage
  - Automated upload, compiling, and configuring of data
  - On-demand area fugitive GHG report generation
  - Validated (occasionally) by leading technology (e.g. laser, satellite)

PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA

Introduction to PTAC

PTAC's vision is to help Canada become a global hydrocarbon energy technology leader through facilitation of innovation, collaborative research and technology development, demonstration and deployment for a responsible Canadian hydrocarbon energy industry.

PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA

Mission, Objectives and Role

- **Facilitate innovation, collaborative research and technology development, demonstration and deployment for a responsible Canadian hydrocarbon energy industry**
- **Improve the environmental, safety, and financial performance of the industry**
- **Facilitate the creation of value through innovation**
- **PTAC is a not-for-profit association with a volunteer board comprised of representatives from producers, technology suppliers, researchers, government, inventors and individuals**
- **PTAC is a neutral facilitator or matchmaker for oil and gas innovation, technology transfer and collaborative R&D**

4/20/2016

PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA

Members

- PTAC's 184 members include those involved in R&D from invention to commercialization including:
  - 22 Producers
  - 3 Transporter / Midstream Processors
  - 126 Service & Supply organizations
  - 15 Research providers
  - 4 Learning Institutions
  - 10 Individuals
  - 4 Government Members

4/20/2016

PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA

How PTAC Works

- Entrepreneurs or researchers may propose projects for funding
- Service/supply firms may request help in testing or commercializing their ideas
- Governments, Regulators, or Producers may invite help in solving problems or sharing on new initiatives
- Technical steering committees may invite proposals for R&D on specific challenges
- Technical Steering Committees, project committees or working groups may provide project direction
- Members assist in planning projects, events and workshops
- Stakeholders provide input at events and workshops on R&D priorities

4/20/2016

Services

- Problem and Opportunity Definition Workshops
- Forums and Conferences
- Technology Information Sessions*
- Launching Projects
- Project Management
- Website – www.ptac.org
- Bi-Monthly Newsletter

** Presentations require an industry or government co-sponsor to confirm content is worthy of consideration by the industry*

4/20/2016

Cultivating a Culture of Innovation Through Technology Networks

- Alberta Upstream Petroleum Research Fund (AUPRF)
- Clean Bitumen Technology Action Plan (CBTAP)
- Phoenix Network
- Pipeline Abandonment Research (PARSC)
- Pipeline Technology Action Plan
- Remote Sensing Network (RSTAP)
- Resource Emission Management Technology Action Plan (REMTAP)
- Support for Small and Medium-sized Enterprises (SME-IRAP)
- Technology for Emissions Reductions and Eco-Efficiency (TEREE)
- Tight Oil and Gas Innovation Network (TOGIN)

PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA

Remote Sensing Applications

- Environmental monitoring
- Asset tracking
- Emergency response management
- Asset and pipeline integrity and leak detection
- Utilization of robots and unmanned vehicles

4/20/2016

PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA

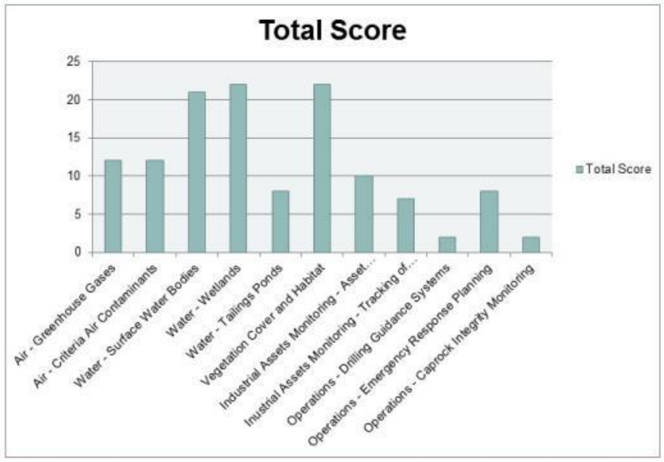
Remote Sensing Focus Areas

- Water resource monitoring and management: wetlands and hydrological mapping, drainage analysis, etc.
- Detection of leaks and spills from oil and gas storage facilities and pipelines, particularly on water and on ice
- Ground deformation measurement and monitoring

4/20/2016

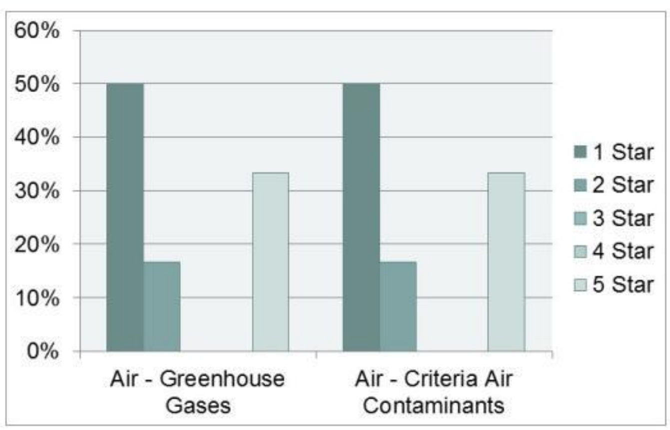
PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA

Oil & Gas Applications with Greatest Potential Impact



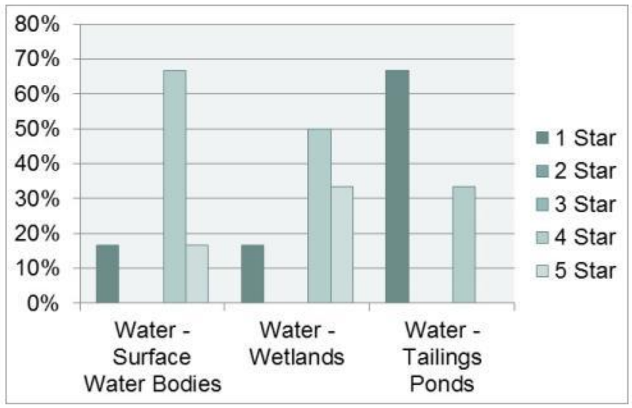
PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA

Air Results

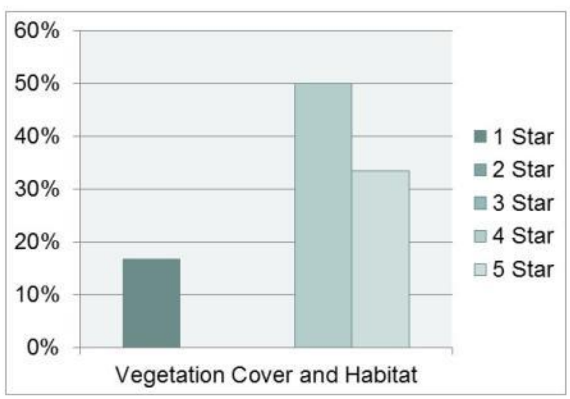


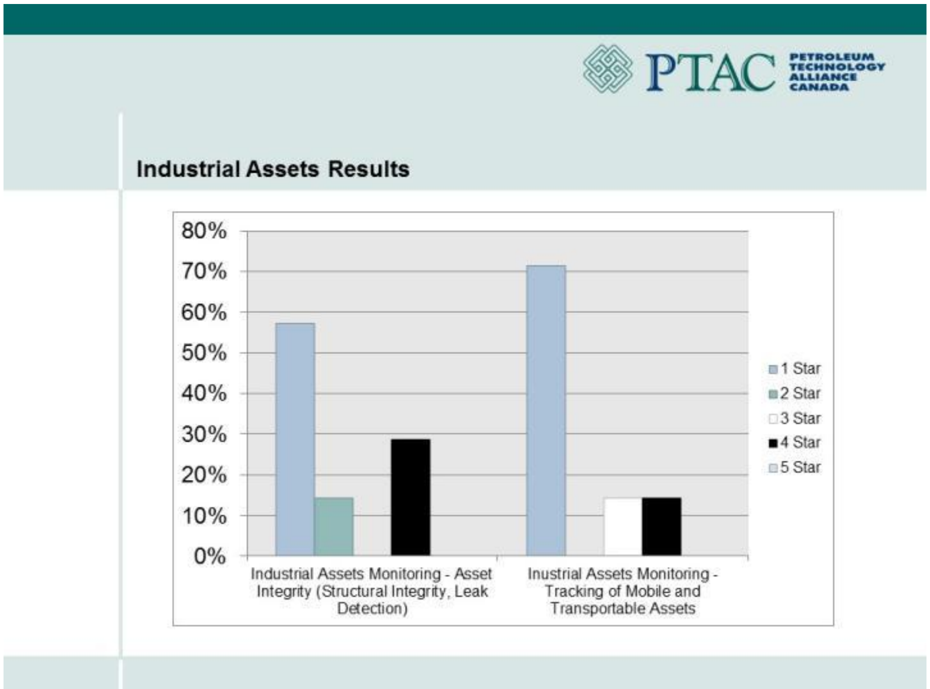
10

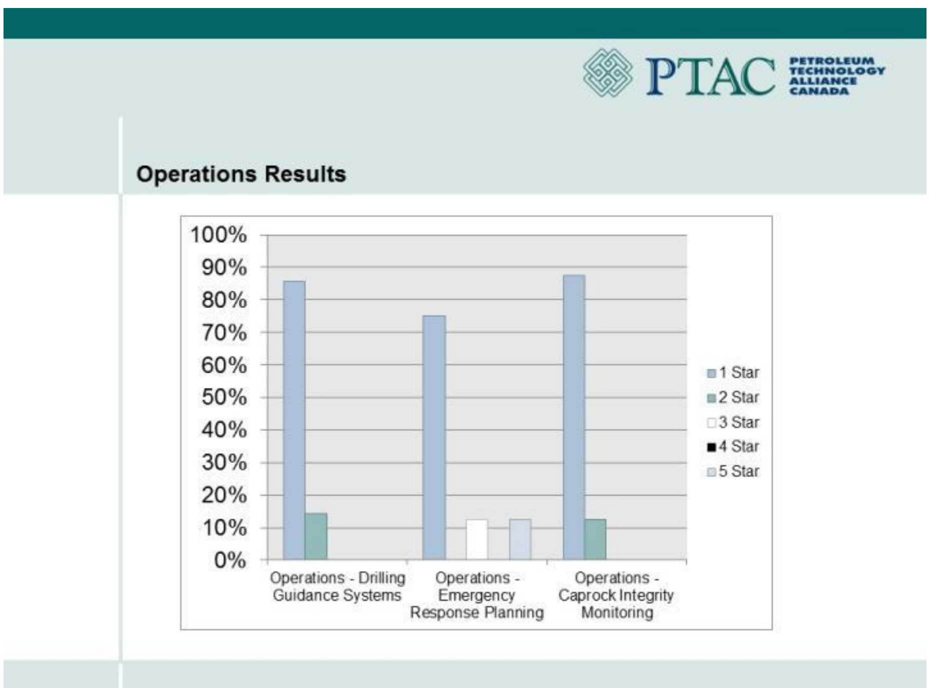
Water Results



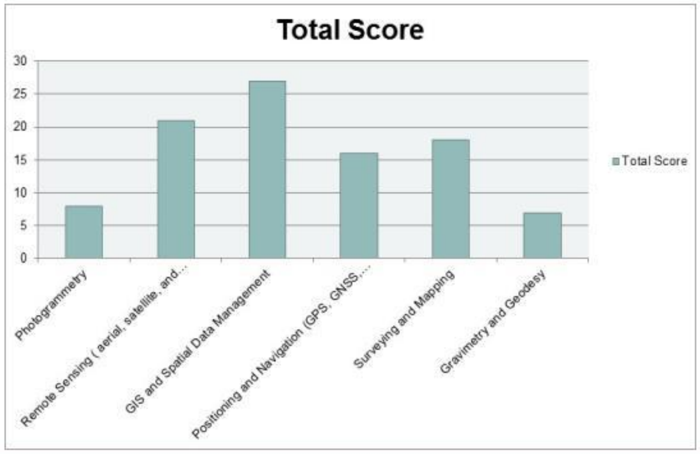
Vegetation and Surface Cover Results



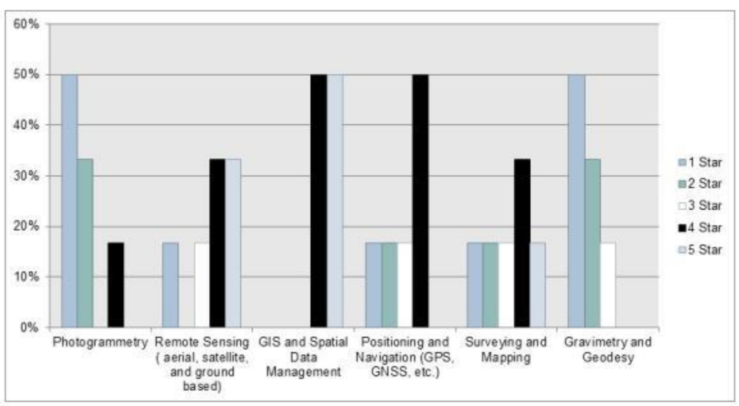

PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA
Industrial Assets Results
80%
70%
60%
50%
40%
30%
20%
10%
0%
Industrial Assets Monitoring - Asset Integrity (Structural Integrity, Leak Detection)
Inustrial Assets Monitoring - Tracking of Mobile and Transportable Assets
1 Star
2 Star
3 Star
4 Star
5 Star


PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA
Operations Results
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Operations - Drilling Guidance Systems
Operations - Emergency Response Planning
Operations - Caprock Integrity Monitoring
1 Star
2 Star
3 Star
4 Star
5 Star

Geomatics Technologies with Greater Potential Impact



Geomatics Technologies with Greater Potential Impact



Total Scores


PTAC PETROLEUM TECHNOLOGY ALLIANCE CANADA
Contact us
We are located at:
Chevron Plaza, Suite 400, 500 Fifth Avenue S.W.
Calgary, Alberta T2P 3L5
For further Information please see our web site at www.ptac.org
Soheil Asgarpour, President
Email sasgarpour@ptac.org, phone (403) 218-7701
For general inquiries please call (403) 218-7700
4/20/2016

Kimberley Van Vliet, WaVv Strategic Consulting: ConvergX

Agenda. . . .

1. Who is WāVv
2. Why and What is ConvergX™
3. Some Numbers
4. Transferable Skills, Technologies and Opportunities

PART ONE

Who is WāVv?

Enhancing your business through adjacent markets and strategic solutions.

The First Global Defence and Energy Conference


PART TWO
??ConvergX™??


SIDE NOTE
To date – 15 deals have either been completed or are in the process of completing between the two industries


PART THREE
Some Numbers. . .


SIDE NOTE
$240 Billion Dollars

What makes up the $240B?

- Fixed Wing Search and Rescue $1.5 Billion, 2014
- Future Fighter Capability $1.5 Billion, 2015
- CH149 Cormorant MidLife Upgrade $500 Million $1.5 Billion, 2015
- Griffon Limited Life Extension $500 Million $1.5 Billion, 2015
- Advanced Short Range Missile $250 Million to $499 Million, 2015
- Medium Range Air to Air Missile Sustainment $250 Million to $499 Million, 2015
- Royal Canadian Air Force Simulation Strategy $250 Million to $499 Million, 2015
- Tactical Integrated Command, Control and Communications $100 Million to $249 Million, 2015
- MultiFleet Air Traffic Management Avionics $100 Million to $249 Million, 2015
- Omnibus Weapon Systems Trainers $100 Million to $249 Million, 2015
- CFFTS Tactical Mission Training System Replacement $50 Million to $99 Million, 2015
- CF188 Defensive Electronic Warfare Suite $50 Million to $99 Million, 2015
- Search and Rescue Mission Management Systems $20 Million to $49 Million, 2015
- CC138 Twin Otter Life Extension Project $20 Million to $49 Million, 2015
- CT114 Life Extension Beyond 2020 Under $20 Million, 2015
- Royal Canadian Airforce Aerial Fire Fighting Vehicle Under $20 Million, 2015
- Land Vehicles Crew Training System $250 Million to $499 Million, 2014
- Airspace Coordination Center Modernization $20 Million to $49 Million, 2014
- Army Heavy Equipment Replacement $250 Million to $499 Million, 2015
- Enhanced Recovery Capability $250 Million to $499 Million, 2015
- LAV LORIT Mobility Upgrade $250 Million to $499 Million, 2015
- Active Protection System $100 Million to $249 Million, 2015
- C6 GPMG Modernization $100 Million to $249 Million, 2015
- Advanced SubUnit Water Purification System $50 Million to $99 Million, 2015
- Common Remote Weapon System $50 Million to $99 Million, 2015
- 84 mm Ammunition $20 Million to $49 Million, 2015
- Close Combat Modular Fighting Rig $20 Million to $49 Million, 2015
- High Risk Search Capability $20 Million to $49 Million, 2015
- LAV OPV Crew Commander Independent Viewer $20 Million to $49 Million, 2015
- New Canadian Ranger Rifle $20 Million to $49 Million, 2015
- Tactical Observer Fire Control System Upgrade $20 Million to $49 Million , 2015
- RDX Replacement Under $20 Million, 2015
- Arctic/Offshore Patrol Ship More than $1.5 Billion, 2014
- Canadian Surface Combatant More than $1.5 Billion, 20142016
- Point Defence Missile System Upgrade $500 Million to $1.5 Billion, 2014
- Submarine Equipment Life Extension More than $1.5 Billion, 2015

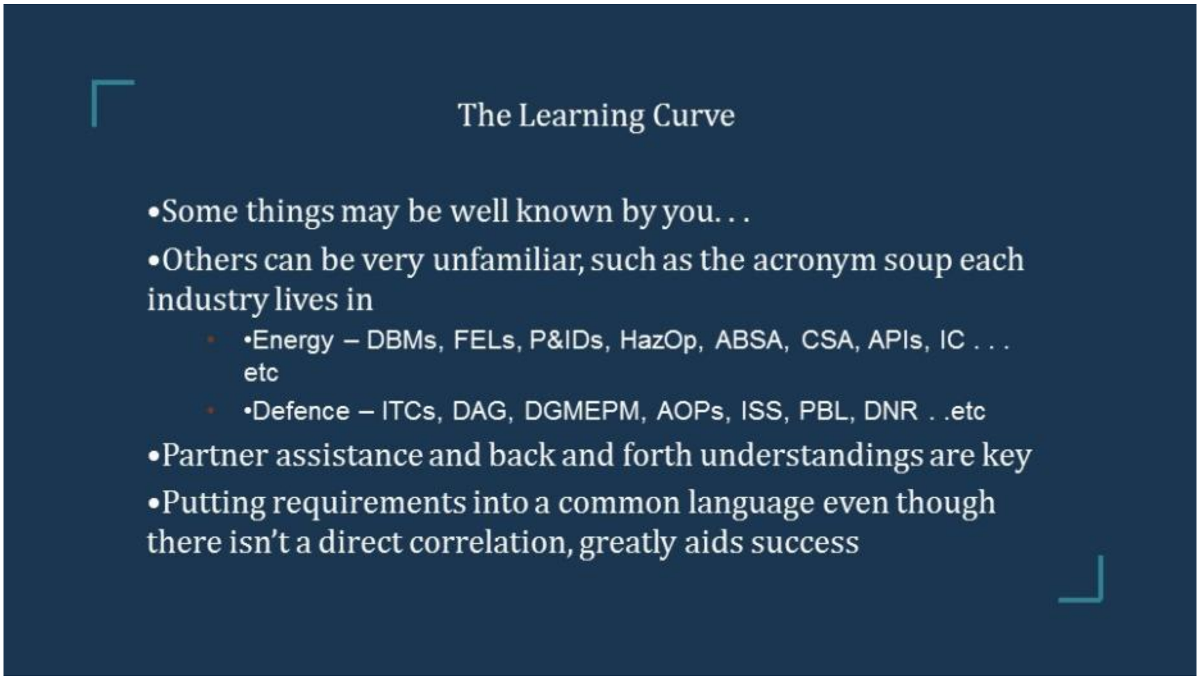
PART FOUR

Transferable Skills, Technologies and Opportunities

Commonalities between the two Industries:

- Scale
- Safety Conscious and Risk Averse
- Highly Regulated
- Technology –Centric
- Harsh Operating Environments
- Both Politically and Environmentally they are under the microscope
- Markets Driving Need for Efficiency & Affordability
- Security Focus

Expanding your view of Key Challenges and demand for new Solutions


The Learning Curve
•Some things may be well known by you. . .
•Others can be very unfamiliar, such as the acronym soup each industry lives in
•Energy – DBMs, FELs, P&IDs, HazOp, ABSA, CSA, APIs, IC . . . etc
•Defence – ITCs, DAG, DGMEPM, AOPs, ISS, PBL, DNR . .etc
•Partner assistance and back and forth understandings are key
•Putting requirements into a common language even though there isn't a direct correlation, greatly aids success


Opportunities
• Sensing
• Analytics
• Geomatics to support Environmental Management
• Mobile Asset Tracking
• Data Communications and Analytics

ARMY – A complete Land EW Capability

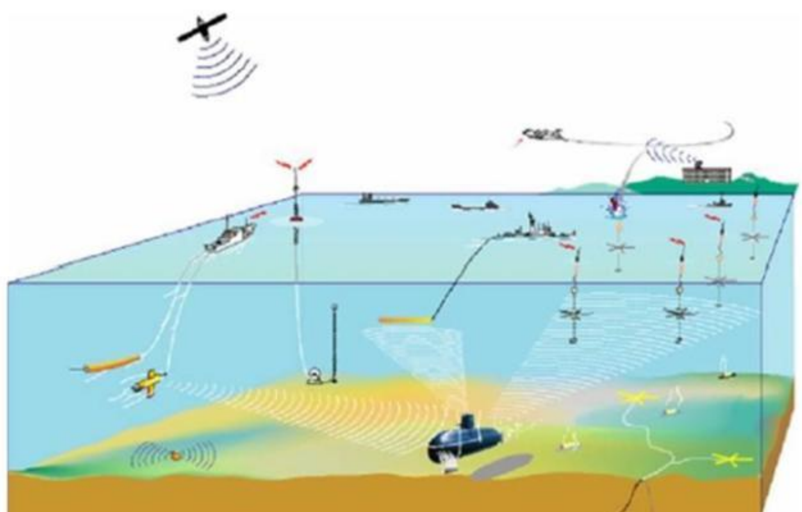
Command

- Planning, Management, Analysis and Distribution
- Electronic Warfare Support (ES) (Surveillance)
- Command and Control Electronic Attack (C2EA) Planning, Management, Analysis and Distribution
- Force Protection Electronic Attack (FPEA)

Sustain

- Transportation and Packaging
- Integrated Logistics Support

- Data Collection
- Data Fusion
- Data Analysis/ Evaluation
- Dissemination/ Display
- "Knowing the Environment" to make the ocean more transparent



Improved Situational Awareness

Emerging Strategic Concerns – Continental Surveillance

- **Technology**
  - New threat vectors: long range, precision, stealth, hypersonic speed, drones.
- **Environment**
  - Unique and changing geophysical conditions, particularly in Northern oceans.
- **Theater**
  - Greater accessibility to and economic activity in the North.
- **Geopolitics**
  - Strategic messaging. Very capable foreign military capabilities going beyond numbers.

APPENDIX D – Survey Results

34 survey responses were received. Results for each question are provided here and summarized in Section 3.

A number of respondents noted that they couldn't fill out the survey or could not fill it out completely for a variety of reasons:

> Please note: Our company provides enabling tools, that is, we enable EO data storage, management, visualization, and analysis. Our clients and partners collect and use the information with our help. So, my answers to these questions are a bit of a proxy for their needs.
>
> I have attached the spreadsheet filled the best I could but a lot of the questions do not apply to what our company does. Many questions are regarding the internal "use" of EO data. Our company is focused on data acquisition and providing data to our clients, not using data.
>
> This is aimed at people who USE satellite data. We PROVIDE airborne data. Not many of the questions apply to us.
>
> I took a look at your survey but given I am in research and developing potential remote sensing products I find the questions somewhat difficult to answer. Many seem to be related to people working in an operational context.
>
> I tried to do this survey last week, and to be honest, it just isn't very relevant to us. Our division is a drone group. We sell drones to do surveying and a variety of other things. We don't so much collect the data ourselves. We would only do it to verify the functionality of our product.

For questions where there were single responses from each respondent we have only shown the summary results; for those where there were multiple answers given by respondents we show the full table to give readers a sense for the combinations of answers individual respondents provided. Additional comments provided by respondents are listed below each question in italics.

1. What is your affiliation?

Government	Resource Industry	EO industry	Consultant	Academia
11	3	8	5	7

Re: Q1 - our organization is better characterized as a not-for-profit

2. Who is your primary client / user of EO data?

Internal agency / company use	Government to government	Industry to government	Government to public	Industry to public
12	9	11	5	5

Re: Q2 - This likely should have also included "Government to Industry" as a primary client/user option. EO data can be used to identify monitoring / compliance / enforcement related items and communicate these between government and industry

3. Which of the following best describes your EO usage?

Order / use the same products on a routine basis	Order / use some products consistently and some on as needed basis	Order / use products on an as needed basis only	Don't order – use whatever is available from other sources
6	11	10	11

4. What are your main purposes for collecting data (check all that apply)?

Ambient Monitoring	Industrial Monitoring	Change Detection	Disaster Management	Water Management	Climate Change	Wildlife and Habitat
18	19	25	11	13	15	15
X	X	X	X	X	X	X
X	X	X				X
X	X	X			X	
X	X				X	
X		X		X	X	X
		X		X	X	
X					X	
X						
X	X	X				X
		X				X
	X	X			X	
X	X	X		X		
X	X	X	X	X	X	X
X	X	X		X	X	X
X	X	X	X	X		X
			X			
			X			
		X	X	X		
	X	X			X	

Ambient Monitoring	Industrial Monitoring	Change Detection	Disaster Management	Water Management	Climate Change	Wildlife and Habitat
	X	X	X			
X	X	X		X		X
		X				X
X	X				X	
X	X	X	X	X	X	X
X	X	X				
X	X	X	X	X	X	X
		X	X	X	X	X
		X				
	X	X	X			
		X				X
X	X	X		X	X	X

Resource Delineation	Mapping	Transportation and Infrastructure Planning	Urban Planning
16	29	12	5
X	X	X	
X	X		
X	X		X
	X		
	X		
X	X	X	
	X		
	X		
X	X		
X	X		
	X		X
	X	X	
	X		X
X	X		
X	X	X	
	X	X	
	X		
X	X	X	X
	X		
	X		
X	X	X	
	X	X	
X	X	X	X
		X	
	X	X	
X	X	X	

Resource Delineation	Mapping	Transportation and Infrastructure Planning	Urban Planning
X	X		
	X		
X			
X	X		
X	X		

4a. Which of these are collected using EO?

Ambient Monitoring	Industrial Monitoring	Change Detection	Disaster Management	Water Management	Climate Change	Wildlife and Habitat
10	13	19	8	11	7	12
X	X	X	X	X	X	X
X	X	X				X
		X		X		
X						
X	X	X				X
		X				X
	X	X			X	
X		X		X		
	X	X		X		X
X	X	X	X	X		X
			X			
		X	X	X		
	X	X			X	
X	X	X		X		X
X	X	X	X	X	X	X
X	X	X				
	X	X	X	X	X	X
		X	X	X	X	X
	X	X	X			
		X				X
X	X	X		X	X	X

Resource Delineation	Mapping	Transportation and Infrastructure Planning	Urban Planning
15	18	7	3
X	X	X	
X	X		
	X		
X			

X	X		
X			
	X		X
X	X		
X	X	X	
	X		
X	X	X	X
	X		
X	X	X	
	X		
X	X	X	X
	X	X	
X	X	X	
X	X		
X			
X	X		
X	X		

4b. List any other purposes for data collection and indicate if EO is currently used.

Urban Energy Efficiency

Wetland Monitoring, reclamation and remediation.

Looking at a diverse source of open data sources with a particular focus on networking data, such as the Mlab speedtest dataset.

Ecosystem health

5. Which of the following best describes the current role of EO in your organization?

Replaces field data collection	Allows reduced field data collection	In addition to current field data collection	No relation to field data collection
4	12	17	6
	X		
		X	
		X	
			X
		X	
	X		
			X
		X	
		X	
X	X	X	
		X	

Replaces field data collection	Allows reduced field data collection	In addition to current field data collection	No relation to field data collection
	X	X	
		X	X
			X
		X	
	X	X	
X			
			X
	X		
X	X	X	
		X	
	X		
		X	
			X
	X		
X			
	X		
		X	
		X	
		X	
	X		
	X		

6. Which of the following best describes your current use of EO data?

Buy raw EO data; process, analyze, interpret and create visualizations ourselves	Buy processed EO data; analyze, interpret and create visualizations ourselves	Buy EO data that has been processed, analyzed and interpreted; create visualizations ourselves	Buy fully processed, analyzed, interpreted visualizations
16	12	5	7
X			X
	X		
		X	X
X	X		
X			
	X		
		X	
X			
X			
	X		
X	X		X
	X	X	X
	X		
X	X	X	X
X			
	X		

Buy raw EO data; process, analyze, interpret and create visualizations ourselves	Buy processed EO data; analyze, interpret and create visualizations ourselves	Buy EO data that has been processed, analyzed and interpreted; create visualizations ourselves	Buy fully processed, analyzed, interpreted visualizations
X			
X			
X			
		X	X
	X		X
X			
X			
	X		
X			
X			
X	X		

Re: Q 6 - we also collect a lot of our own EO data

Re: Q6 - Also collect our own raw EO data from airborne platform

7. Which of the following options does your organization use to collect operational data?

Satellite Imagery	Plane	Helicopter	Drone / UAV	Fixed Sensor Networks	Mobile Sensors	Manual In-Field Collection
25	18	7	14	13	11	21
X	X		X	X	X	X
X	X		X			X
X				X		
X			X	X		X
	X					
X						X
				X	X	X
X				X	X	X
X			X		X	X
X						X
X	X		X		X	X
X	X		X			X
X			X	X	X	X
X	X			X	X	X
X	X	X				X
X	X					
X	X					
	X					
X			X	X		
X			X			X

Satellite Imagery	Plane	Helicopter	Drone / UAV	Fixed Sensor Networks	Mobile Sensors	Manual In-Field Collection
X	X		X	X		X
X	X	X	X			X
	X	X	X			
X		X				
X	X	X	X	X	X	X
X	X	X		X	X	X
	X		X			X
X				X		
X	X				X	X
X	X	X		X	X	X

8. What EO scale best meets your current operational needs?

Provincial	Regional Plan	Sub-Regional Plan	County / Municipal District	City / Town	Industrial Site
18	17	15	9	8	16
X	X	X			X
X	X				
X					
X	X			X	X
X	X	X			
		X			
X					
	X	X			
	X	X		X	X
X	X	X			X
X	X	X	X	X	X
	X	X	X		X
			X	X	X
X	X	X	X	X	X
X	X	X	X		
X					
X					
	X	X	X	X	
X			X	X	X
		X			X
		X			X
					X
	X				
X					X
	X				
X	X		X	X	
X					X
X					X

Provincial	Regional Plan	Sub-Regional Plan	County / Municipal District	City / Town	Industrial Site
X	X	X			X
	X	X	X		

8a. What scale of data collection meets your future operational needs?

Provincial	Regional Plan	Sub-Regional Plan	County / Municipal District	City / Town	Industrial Site
18	15	12	12	7	14
X	X	X			X
X	X				
X					
			X		
X	X	X	X	X	
	X				
X					
X	X	X	X	X	X
				X	X
X	X	X			X
			X		
X	X	X	X	X	X
	X	X	X		X
X	X	X	X	X	X
X	X	X	X		X
X					
			X		
	X	X	X	X	
X					X
		X			X
	X				
					X
X					X
X					
X	X		X	X	
X					X
X	X	X			X
X	X	X	X		

9 What spatial resolution meets your operational needs for the following (Enter C for Current Use; F for Future Use, or B for Both)?

9a Stereoscopic Imagery.

Charts showing each of the 10 EO/RS technology responses are provided at the end of the 10 Q9 tables.

Author's Note: A number of the responses had to be interpreted to fit the intent of the question. Where an X was used in place of the desired C, F or B we opted to replace it with a C. Where a sensor type was left blank we opted to check of N/A.

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
14	3	2	1	0	1	16
B						
B						
						X
					B	
C						
						X
						X
						X
	F	C	C			
						X
						X
C						
C						
						X
B	C	C				
C						
C						
						X
						X
C						
C						
B						
B						
						X
						X
						X
						X
	b					
						X
B						
						X
						X
B						

9b. Infrared Imagery.

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
14	6	6	3	1	1	15
						X
		B				

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
						X
						X
B						
						X
						X
F	F					
	F	C	C			
B	B	B				
						X
C						
C						
						X
F						
C	C	C	C	C	C	
						X
						X
						X
C						
C						
B						
B						
		F				
B						
						X
						X
	B					
						X
F						
						X
						X
B	B	B	B			

9c. Panchromatic Imagery.

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
15	5	2	1	0	0	15
						X
						X
						X
C						
						X
						X
						X
						X
	F	C	C			

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
						X
						X
C						
C						
						X
B	B	B				
C						
C						
C						
						X
	C					
C						
B						
B						
						X
B						
						X
C						
	B					
B						
B						
						X
						X
B	B					

9d. Thermal Imagery.

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
11	5	4	5	1	0	16
B						
		B				
						X
						X
						X
			C			
						X
F	F					
	F	C	C			
F						
						X
C						
						X
						X
F	F					
	C			C		

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
						X
						X
						X
C						
						X
F						
						X
						X
B						
						X
						X
			B			
B			B			
F						
		C				
						X
B	B	B	B			

9e. Multispectral Imagery.

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
17	9	11	6	3	3	9
B						
		B			B	
						X
C						
		B	B			
						X
						X
F	F					
	F	C	C			
F	F	F				
B						
C						
	C	C				
						X
B	B	B				
C	C	C	C	C	C	
						X
						X
						X
C						
C						
B						
B						

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
		F				
B						
						X
C						
			B			
B	B		B	B		
						X
		C				
B	B	B				
B	B	B	B	B	B	

9f. Hyperspectral Imagery.

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
8	6	6	2	0	0	19
	C					
						X
						X
						X
						X
						X
						X
F	F					
	F	C	C			
F	F	F				
						X
						X
C						
						X
		F	F			
						X
						X
						X
						X
C						
						X
	B					
F						
		F				
B						
						X
C						
		B				
						X
						X

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
						X
B	B	B				
						X

9g. Radar.

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
4	7	5	2	0	0	20
C						
						X
						X
						X
	F	F	F			
						X
	F					
						X
	C	C	C			
						X
						X
						X
	C					
						X
	F	F				
						X
C						
	C					
						X
C						
						X
B						
						X
						X
						X
						X
						X
		B				
	B					
						X
		C				
						X
						X

9h. Light Detection and Ranging (LiDAR).

< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
21	5	4	2	0	0	8
B						
						X
						X
C						
B						
			C			
B						
C	C					
	C	C	C			
F	F	F				
B						
C						
C						
						X
B						
C	C	C				
C						
C						
B						
C						
						X
B						
B						
		F				
						X
						X
						X
	B					
B						
F						
						X
B						
B						

9i. Sensor Networks.

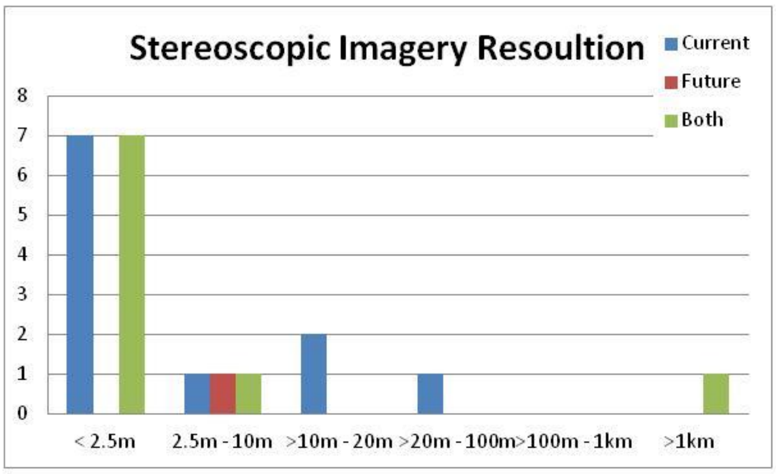
< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
10	4	5	4	2	6	16
B						
					B	
					F	
					C	

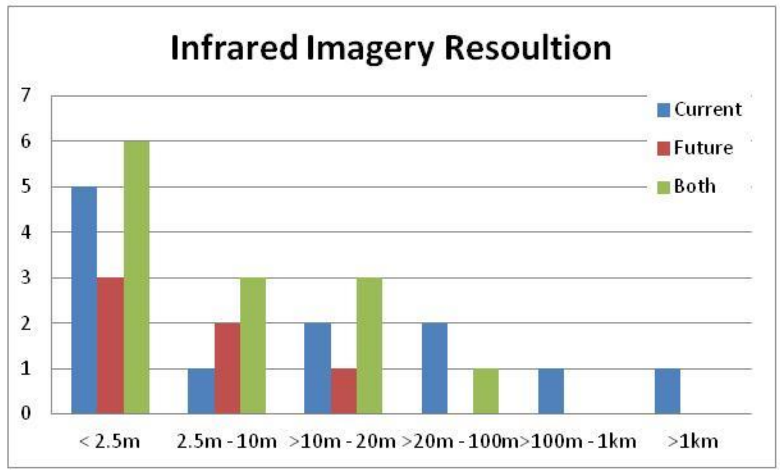
< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
						X
			C			
						X
C	C	C	C	C	C	
	C	C	C			
						X
						X
C						
						X
B	B	B	B	B	B	
B						
						X
						X
						X
						X
C						
						X
B						
						X
		F				
						X
						X
						X
B						
					B	
F						
						X
						X
B	B					

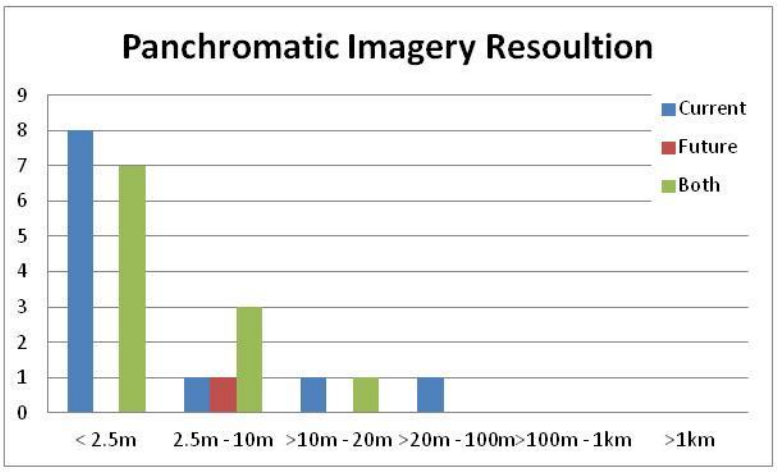
9j. Manual In-Field Collection.

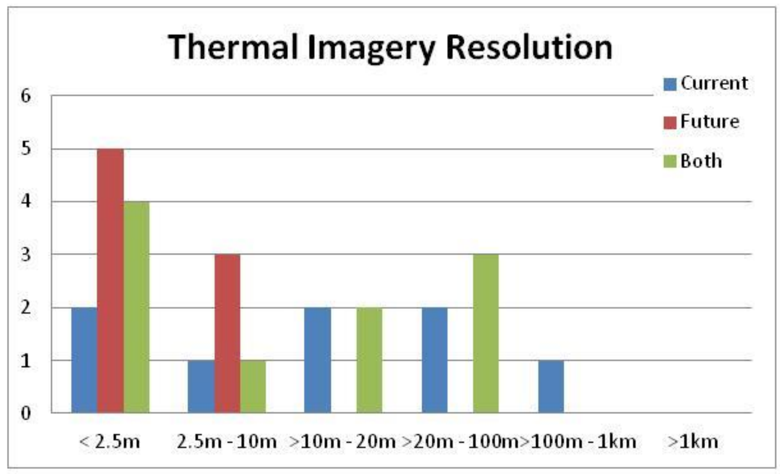
< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
13	5	7	3	4	5	13
B						
						X
					C	
						X
						X
		B				
C	C	C	C	C	C	
	F	F	C	C	C	
B						
B						

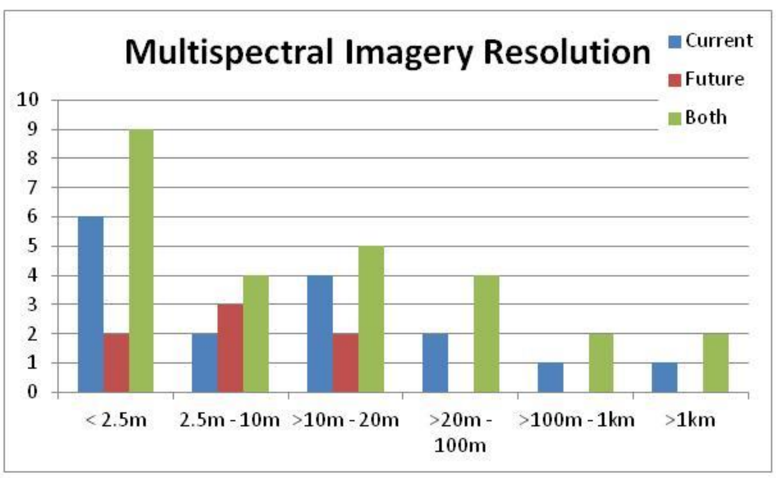
< 2.5m	2.5m - 10m	>10m - 20m	>20m - 100m	>100m - 1km	>1km	N/A
C						
C	C	C				
						X
		B	B	B	B	
						X
						X
						X
						X
C						
C						
B						
						X
				C		
						X
						X
						X
B						
					B	
B						
						X
B	B	B				
B	B	B				

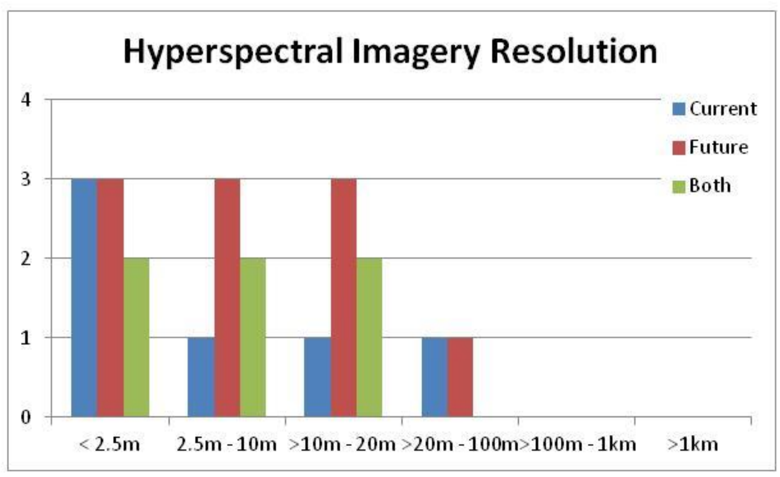

Stereoscopic Imagery Resoultion
Current
Future
Both
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km

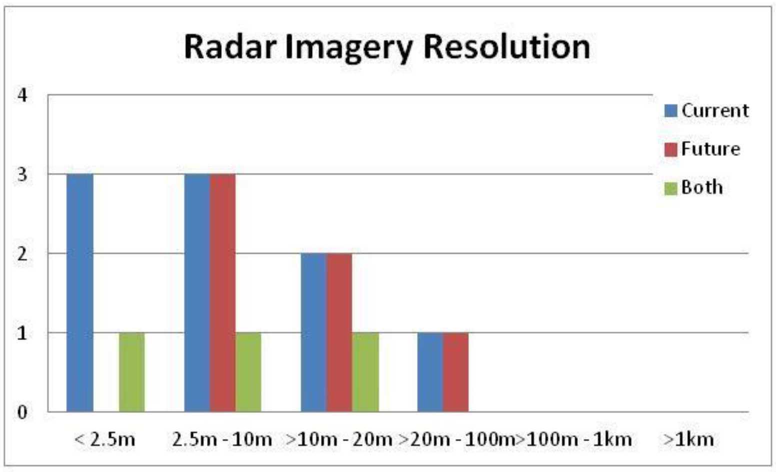

Infrared Imagery Resoultion
Current
Future
Both
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km

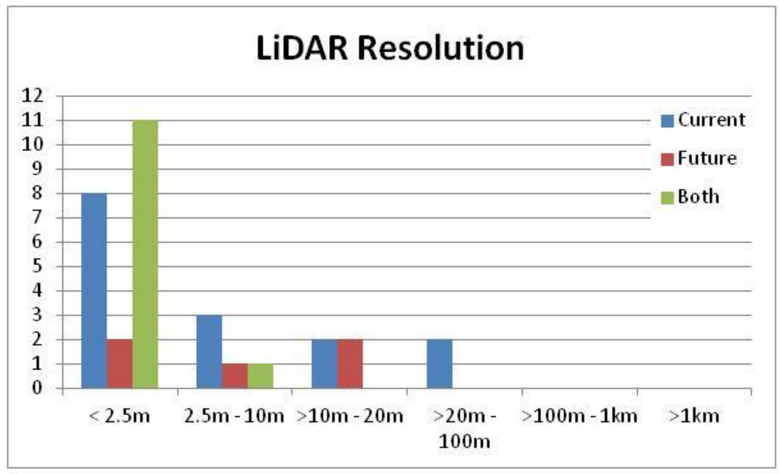

Panchromatic Imagery Resoultion
Current
Future
Both
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km

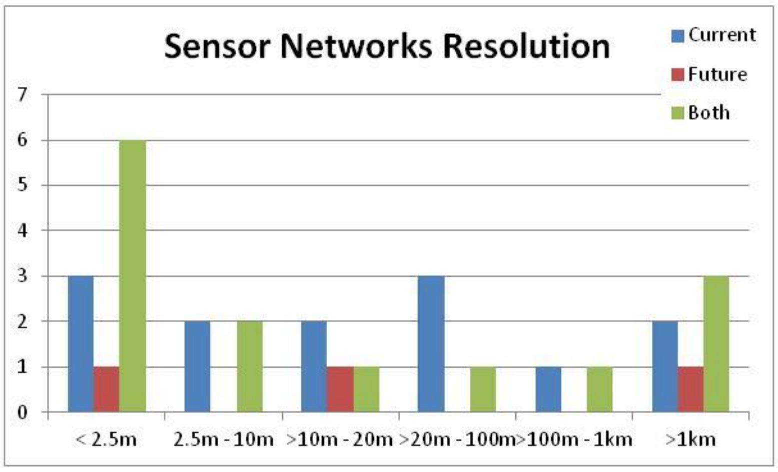

Thermal Imagery Resolution
Current
Future
Both
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km

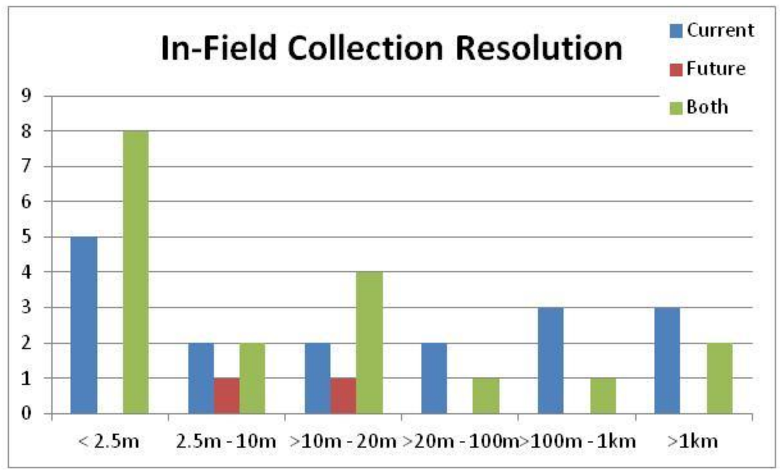

Multispectral Imagery Resolution
Current
Future
Both
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km


Hyperspectral Imagery Resolution
Current
Future
Both
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km


Radar Imagery Resolution
Current
Future
Both
4
3
2
1
0
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km


LiDAR Resolution
Current
Future
Both
12
11
10
9
8
7
6
5
4
3
2
1
0
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km


Sensor Networks Resolution
Current
Future
Both
7
6
5
4
3
2
1
0
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km


In-Field Collection Resolution
Current
Future
Both
9
8
7
6
5
4
3
2
1
0
< 2.5m
2.5m - 10m
>10m - 20m
>20m - 100m
>100m - 1km
>1km

10. What temporal resolution meets your operational needs (Enter C for Current Use, F for Future Use, or B for Both)?

One-time	Decadal	Bi-annual	Annual	Monthly	Weekly	Daily
9	6	7	20	12	9	11
B			B			F
				B	B	B
	B		B			
B	B	B	B	B	B	B
			B	B		
			C			
		B				
						C
						C
			B			
		B	B			B
C			B	B		
				B	B	B
C	C	B	B	B	F	F
B	B	B	B	B	B	B
			B			
C			F	C	C	C
		B		B		
			C		F	
			B			
			C			F
			B			
					B	
B	B	B	B	B		
B	C		C			
			B	B	B	
B			B	B		

Re: Q10 - Daily resolution required in the event of natural disasters

11. Should data collected by government be made more accessible?

Yes	Yes, with conditions	Maybe	No
24	7	3	0
		X	
X			
X			
X			
X			

Yes	Yes, with conditions	Maybe	No
X			
	X		
X			
X			
X			
	X		
X			
	X		
X			
X			
X			
X			
X			
	X		
		X	
X			
X			
X			
X			
	X		
	X		
X			
X			
X			
		X	
X			
X			
X			
	X		

If yes, with conditions (please identify):

Free access

Making it widely available will increase costs to gov, so as a result they will purchase less

Municipal data that is publically collected should be able to be freely reused for value added processing and products - but not resold in its original state.

Internal use cross government

Need opportunity to review, correct errors and provide context first.

NDA for data processing information & limitation of products and authorized samples

Data licensing and sharing agreements; proposal format so that activities and outcomes can be monitored by government and used to support operational guidelines, data acquisitions and policy development now and in the future

Re: Q11 and 12 – Absolutely; should do what the US Federal Government does. All data collected are publically released. It's a massive boon for US.

12. Should data collected by government be freely accessible?

Yes	Yes, with conditions	Maybe	No
20	8	4	1
		X	
X			
X			
X			
X			
X			
	X		
	X		
X			
X			
	X		
	X		
	X		
X			
X			
	X		
X			
X			
		X	
		X	
X			
X			
X			
X			
			X
	X		
X			
X			
		X	
X			
X			
X			
	X		

If yes, with conditions (please identify):

Data is never entirely free. Thus, what is the business model to sustain data collection over the long term?

Confidentiality

No personal information given

Municipal data that is publically collected should be freely able to be reused for value added processing and products - but not resold in its original state

NDA for data processing information & limitation of products and authorized samples

Respecting government requirements & access times

Depends on user. If academic or government, then free use. If industry, then there should be a fee paid for data

Re: Q11 and 12 – Absolutely; should do what the US Federal Government does. All data collected are publically released. It's a massive boon for US

13. Should data collected by industry as part of a regulatory requirement be made more accessible?

Yes	Yes, with conditions	Maybe	No
17	11	4	1
		X	
X			
X			
	X		
X			
X			
X			
X			
		X	
X			
	X		
	X		
	X		
			X
	X		
X			
X			
X			
	X		

Yes	Yes, with conditions	Maybe	No
		X	
		X	
X			
X			
	X		
	X		
	X		
X			
	X		
X			
X			
	X		
X			
X			

If yes, with conditions (please identify):

Free

Security and confidential needs of data providers should be respected, maybe by addressing the resolution under which the data is provided

No personal information given

If regulatory then it requires public scrutiny

Situational - the primary goal would be the regulatory requirement, if it is necessary to collect sensitive information to meet the regulatory requirement, and this can only reasonably be collected if it is not made public, then it may better meet the public's needs if the information is not made public.

Internal appropriate use cross government

Data sharing agreements to reduce levies/fees in exchange for raw or interpreted EO data

Need opportunity to review, correct errors and provide context first.

NDA for data processing information & limitation of products and authorized samples

Remove any sensitive, company specific information

Depending on sensitivity of data. Incentives should be made to encourage industry to share data

Re: Q13 - Yes, I can attest to the amount of time we waste compiling data to submit to the government that was already compiled and submitted to the government as part of a different application.

Re: Q13 - This would be useful. Perhaps provide raw data for future processing/use.

14. Should data collected by industry as part of a regulatory requirement be freely accessible?

Yes	Yes, with conditions	Maybe	No
12	12	5	4
		X	
X			
X			
X			
	X		
X			
	X		
	X		
		X	
X			
	X		
			X
	X		
			X
	X		
	X		
X			
X			
		X	
			X
X			
X			
X			
		X	
			X
	X		
X			
	X		
	X		
X			
	X		
		X	
	X		

If yes, with conditions (please identify):

Security and confidential needs of data providers should be respected, maybe by addressing the resolution under which the data is provided.

I think we have to be careful about not enabling competing jurisdictions to use industry data against us, when such jurisdictions are NOT making their own data available.

Confidentiality.

If regulatory - then oversight is required - however, it cannot be resold in its original state - and cost recovery to the private sector should be considered.

Situational - the primary goal would be the regulatory requirement, if it is necessary to collect sensitive information to meet the regulatory requirement, and this can only reasonably be collected if it is not made public, then it may better meet the public's needs if the information is not made public.

Data needs to be accompanied by appropriate metadata (i.e., context/reason for data collection); subsequent users need to acknowledge the original source for the data.

Remove any sensitive, company specific information.

Respecting industry requirements & access times

Sensitivity of data needs to be addressed. Give and get sharing incentives.

If industry paid for the data, then they should be able to recoup some of the costs associated with data collection. Fees paid for data access should be a fairly small proportion of the original fee paid. Collaboration on data sharing agreements and use could benefit both industry and the new user.

Re: Q14 - If the report is publically available, I can't think of any reason why the data to make up the report isn't freely available.

15. What is the biggest EO-related impediment to using EO in your organization?

Cost to acquire	Capability to process	Capability to interpret	Capability to convert to products	Capability to store data and products
22	5	4	4	4
				X
X				
X				
X	X			
X				
X				
X				
X				
X				
X				
X				
			X	
X	X	X	X	X
		X		

Cost to acquire	Capability to process	Capability to interpret	Capability to convert to products	Capability to store data and products
X				
X				
				X
X				
X				
	X	X		
X				
X				
X				
X				
X				
X				X
			X	
	X	X	X	
X	X			

Re: Q15 – Availability is an impediment.

Re: Q15 - Biggest EO-related impediment to using EO in our organization is availability

Re: Q15 - we can't share raw LiDAR data, only derived products

16. Rank the following challenges to the increased use of EO products in order of priority (1 = Highest, 5 = Lowest).

Access to data	Regulatory acceptance	Standards for data and products	R&D funding	EO personnel Certification / Accreditations
2	1	5	3	4
1	4	2	3	5
2	4	3	1	5
2	1	3	4	5
5	3	4	2	1
4	1	3	2	5
3	1	2	4	5
2	1	3	4	5
2	4	3	1	5
2	4	3	1	5
2	4	3	1	5
1	3	4	2	5
2	1	3	4	5
2	4	1	3	5
3	1	2	4	5

Access to data	Regulatory acceptance	Standards for data and products	R&D funding	EO personnel Certification / Accreditations
3	1	5	4	2
2	5	4	1	3
1	5	4	2	3
3	1	4	2	5
2	1	3	4	5
1	2	3	4	5
5	1	4	3	2
1	3	4	2	5
3	1	4	2	5
1	2	3	5	4
4	2	3	1	5
3	5	4	1	2
1	3	2	4	5
3	1	2	5	4
4	3	1	2	5
4	5	3	1	2

17. Which of the following stages is most in need of R&D?

Data acquisition	Data processing	Data analytics	Data visualization	Data storage / management	Data accessibility
5	7	18	0	3	8
		X		X	X
	X	X			X
X					
		X			X
	X	X			
X					
		X			
		X			
		X			
		X			
		X			
X					
	X	X			
					X
					X
		X			
		X			
	X				
		X		X	
				X	X
	X				
		X			
X					

Data acquisition	Data processing	Data analytics	Data visualization	Data storage / management	Data accessibility
		X			
		X			
		X			
X					
					X
					X
	X	X			
	X				

Re: Q17 - Ranked as follows: Acquisition; Storage/Management; Accessibility; Visualization; Analytics; Processing

Re: Q17 - Ranked as follows: Processing; Storage / Management; Analytics; Acquisition; Accessibility; Visualization

18. Who should be primarily responsible for developing EO-related products and services?

EO Industry	Resource Industry	Government	Academia	Organized Collaborative Effort
8	1	3	1	25

Re: Q18 - EO Industry and Collaborative Effort rated #1, Resource Industry, Academia and Government rated #2.

Re: Q18 - N/A - it depends on so much; this can't be answered as posed.

Re: Q18 - ranked as follows - Organized Collaborative Effort; Government; Academia; Eo Industry; Resource Industry.

19. How do you see EO usage changing in your organization in the next 5 years?

Increase substantially	Increase slightly	Remain the same	Decrease slightly	Decrease substantially
24	8	1	0	0

20. Which of the following best describes the way you see EO used in 10 years in your organization?

Replaces field data collection	Allows reduced field data collection	In addition to current field data collection	No relation to field data collection
4	20	11	2
	X		
	X	X	
		X	
X	X		
		X	
	X		
	X		
		X	
		X	
	X	X	
		X	
		X	
	X		
	X		
	X		
	X	X	
X			
			X
	X		
X			
	X		
	X		
	X		
	X		
			X
	X		
X			
	X		
		X	
		X	
	X		
	X		
	X		

21. Which of the following would you use if available?

21a. through Government;

Pre-processed data	… with standardized analysis / interpretation	.. with standard visualization	Should there be a cost for access (**Y or N**)?	Comments
22	15	12		
				If the process is truly collaborative in nature all of these options would be applicable.
X	X			
X	X	X	N	
X	X	X	N	
X			N	
		X	N	
X	X	X	Y	Nothing is free. Needs a sustainable funding model.
	X			
	X			
X			N	
X	X	X	N	
X	X		N	
X				Re. cost: it depends. For some datasets it may be better to charge a small user fee to offset costs to the tax payer. However, if the dataset could provide a public resource for a broad cross-section of the public, then it would likely be better to make it available at no cost.
X	X	X	N	
X	X	X	N	This is my personal opinion and does not reflect policy
X			N	
X			Y	
			Y	
X			N	
X			N	
X	X	X	Y	The quality of the data needs to justify any cost
X			Y	
X	X		Y	
		X	Y	
X	X	X	Y	Some cost is acceptable
X	X	X		Cost for access depends on data type, acquisition costs, and application. For public interest, government data should be made available
X	X		N	
		X	Y	
X			N	

Re: Q21 - Independent of the source of data, it should always be backed up by lower level data that allows for verification of the conclusions/processed data being provided. The data should be published in a manner that, if users choose to do so, can reproduce the standard analysis/visualization provided.

21b. through Industry;

Pre-processed data	… with standardized analysis / interpretation	.. with standard visualization	Should there be a cost for access (**Y or N**)?	Comments
18	15	12		
X	X			
X	X	X	Y	
X			N	
		X	N	
X	X	X	Y	Nothing is free. Needs a sustainable funding model.
	X			
	X			
X			Y	
X	X	X	Y	
	X		Y	
X				Re. cost: I suppose it depends on their business model.
X	X	X	Y	
X	X	X	Y	
X			Y	
			Y	
X			Y	
X	X	X	Y	The quality of the data needs to justify any cost
		X	Y	
X	X		Y	
X	X		Y	
X	X	X	Y	
X	X	X		Cost for access depends on data type, acquisition costs, and application.
X	X	X	N	
		X	Y	
X			Y	Nominal cost + collaboration with industry

21c. through Third-party;

Pre-processed data	… with standardized analysis / interpretation	.. with standard visualization	Should there be a cost for access (**Y or N**)?	Comments
17	14	12		
X	X			
X	X	X	Y	
X			N	No charge if part of a regulatory requirement. Bespoke acquisition/analysis should be charged for
		X	N	
X	X	X	Y	Nothing is free. Needs a sustainable funding model.
	X			
	X			
X			Y	
X	X	X	Y	How is Industry and 3rd part different?
	X		Y	
X				Re. cost: it depends on their preference
X	X	X	Y	
X	X	X	Y	
X			Y	
			Y	
X			Y	
X	X	X	Y	The quality of the data needs to justify any cost
		X	Y	
X	X		Y	
			Y	
X	X	X	Y	
X	X	X		Cost for access depends on data type, acquisition costs, and application.
X	X	X	N	
		X	Y	
X				This depends on who the third party is

22. How valuable would it be to have a dedicated site, or set of sites, with free EO data from a variety of platforms for field testing/verifying new EO products and services?

Very useful	Somewhat useful	Not useful	No opinion
28	4	0	1

23. Please provide information, where possible, on research or demonstration projects planned for 2016 and 2017.

Along with a client (Foresight CAC), I will be developing a demonstration project on remote sensing in forestry. The targeted project will be made public in early summer with a call for innovators. This may present a collaboration opportunity between AITF & Foresight based on a collaborative MOU presently being finalized.

Combination of oil and gas reservoir hydrocarbon mapping combined with subsurface seismic in 3D presentation.

Recently initiated project that is developing a web-based system to enable use of remote sensing data to assess reclamation status of disturbed areas.

AEMERA has identified a need for data quality assurance regarding remote sensing data. Recognizing that this is a fast changing area, AEMERA would like to work with the subject experts to come up with a path forward on establishing initial performance requirements so that remote sending data/products are of good quality. This is important both from scientific point of view and technology commercialization point of view. This issue has been brought to my attention by other parties and I understand that there is an international effort in this area.

In 2016, we are developing web-enabled thermal heat loss maps at the house, community and city level for Calgary, Okotoks, Airdrie, and Edmonton, with the goal in 2017 to complete the top 10 municipal centers in Canada - and make all the residential data freely available to the public. Commercial, Municipal and Government agencies will need to pay for thermal heat-loss results (see MyHEAT.ca).

We have a number of sensor management (IoT) projects coming up. We have platforms that directly manage EO, such as a Cloud UAV platform, as well as platforms that indirectly use EO, as backgrounds for sensor data visualization.

Currently evaluating Big Data storage techniques.

Trialed Pictometry aerial imagery for 3 months in 1Q 2016.

UAV LiDAR, UAV Hyperspectral.

Environmental Site Characterization and Mapping of Oil/Gas Facilities Using A Multispectral Sensor Mounted on an Unmanned Aerial Vehicle (UAV).

Research work South of Fort McMurray in collaboration with the University of Calgary (Greg McDermid P.I.).

GHGSat.

UAV compatible visible and near infrared (VNIR) Hyperspectral sensor data: Agriculture, Ecology, Water Quality, Forest Health.

Conducting in house multi spectral LIDAR surveys across AB and NWT.

A Web-Based Monitoring System for Enhancing the Provincial Mapping and Monitoring Capability. Project lead: Nadia Rochdi ATIC/U of Lethbridge.

ARTeMiS Lab at U of Lethbridge: multi-spectral LiDAR testing for forest attribute monitoring, C assessment and species delineation.

Long-term watershed ecosystem sensitivity to drought/drying trends in central Alberta using Landsat TM.

Thermal/LiDAR integration and time series analysis of discontinuous permafrost thaw.

Reclamation monitoring using LiDAR and optical data fusion.

Wetland classification using LiDAR and optical data fusion.

APPENDIX E – Discussion Group Notes

E.1 Data Discussion

The Edmonton discussions were led by Alberta Data Partnerships (Erik Holmlund).

E.1.1 Data Access and Cost

Background/Context: The cost to acquire data and access to data are seen as the biggest impediments to usage and yet the majority of respondents felt data should be more accessible (and free, if from government).

Q1) What can be done to address these impediments?

- It would be useful to have an existing portal to work with rather than reinvent a new system as this would take time. Utilize systems that already exist (e.g., GeoDiscover Alberta, Genesis).
- Data Exchange approach.
    - Help to create new products.
- Collaborative, partnership approaches.
    - Identify common data needs.
- There is still more room for reductions in prices and we still may be at the high end of the cost curve. With more data coming, some further cost efficiencies expected.
    - Government costs higher due to contracting / purchasing rules.
- Use "clusters" to create larger demand for data – to help drive down costs further.
- Must show value to industry and government.
    - What is the value proposition for providers?
    - Look at cost to the vendors; concerns about losing market share.
    - Must show added value to industry, government, and the impacts on data providers.
- Need to recognize that data handling will likely represent a new cost that must be factored in.
- Can government make reportable data open?
    - Data submitted to Alberta Energy Regulator should be open BUT make it anonymous.
    - Concerns about competitive advantage being disclosed by data.
    - Need to reduce cost to government to make it open – government not willing to pay to make data open (provider perspective).

- Saskatchewan example – can allow older data to be viewed for free (http://www.opendatask.ca/data/; https://www.geosask.ca/Portal/).
- See Vancouver Open Data example (http://vancouver.ca/your-government/open-data-catalogue.aspx).

- Consider royalty arrangement.
- Open data drives additional economic benefits to the province.
- Impediments.
  - Providers view their data as primary products not derived products.
  - Data agreements are very restrictive (e.g., City licensing agreements – concerns about data being resold) – have not kept up with the times.
  - Can't share data we don't own.
  - Hard to use original data in creating new data products.
- Match the nature of the questions with the resolution of the data.
- Will need to look at it on a case-by-case basis.
- Lots of data filled with errors.
  - Value proposition is to fix data or improve on data from original provider; however example given where this was done and original provider (municipality) wasn't interested in getting the "fixed" data back.

E.1.2 Data Storage and Management

Background/Context: EO/RS usage is expected to increase substantially in the next five years and the emphasis on high-resolution products (i.e., spatial resolution <2.5m; temporal resolution daily to hourly) suggests a massive amount of data will be collected. However, capability to store data and products was not considered to be a major impediment and data storage / management was considered a low priority for research.

Q2a) How can we explain this apparent disconnect?

- Future is lots more data.
  - Issue is ability to analyze the amount of data.
- We have seen costs come down, but this may be more challenging for government users given their needs, and will likely continue to pay more than industry users.
- Enterprise management systems may provide some opportunity to address storage issues.
- New technologies with Enterprise-level capabilities (much cheaper than other approaches).

- Is this more of an area for “innovation” than for “research” – more about the “how” than the “what”.
- Some research into content management and access may be helpful.
- Analytics requires data management and storage.
- People looking for data don’t understand IT and storage.
- Implications of decentralized systems – creates duplications and inefficiencies.
- Issue is not about storage but transporting data between systems.

Q2b) What are the market opportunities for data storage / accessibility?

- More about data management and access.
  - Combine with analytics to see whole spectrum of issues and needs.
- What is ultimate goal – get imagery or get desired product (e.g., notification of incidents)?
  - Issue of being charged for data that you are not using.
- Be able to get data when you need it – must be fit for purpose.
- Security (some cloud storage sites are located in US jurisdictions).
  - Need to ensure company (user) IT systems can work with cloud data.
- Perhaps multi-national enterprise (MNEs) could work with smaller companies in this area.
- Educational component.
  - Overcome cultural and social barriers.
  - Will regulator accept (approve of) products?
- Opportunity for government to learn from other sectors such as defense and aerospace.

E.1.3 Data Processing and Data Standards

Background/Context: Slightly more respondents buy raw data and do all processing themselves than any of the other options yet there was a fair amount of interest in acquiring pre-processed data (especially from government) and to a lesser extent pre-processed data with standard analysis / interpretation.

Q3a) What are the market opportunities for data processing?

- Develop algorithm and analysis services that don’t require user expertise.
  - Need protocols and standards in place so that 3rd parties can ensure data meets standards so 3rd party can deliver instead of government).

- Even if government is the initial provider SMEs can add value and create new products.
- As hyperspectral becomes more common, companies will be able to provide analytical services.
- Discussion between operational products and R&D.

Q3b) Who's responsible for ensuring standards for data quality?

- Alberta is in a good spot because of our existing energy regulatory framework. We should continue to build off of Alberta's framework as it relates to IRMS.
- Government standards around interoperability.
- Government – but challenges associated with just having a government client.
- Need to remember that the buyer will ultimately set the standard. Some standards may also come out of professional associations.
  - Standards are nice but have to realize that you have to supply product based on client needs so you will use whatever is available to meet the needs (even if there are no standards).
  - May be able to meet 4 out of 5 standards but have settle for doing the bets you can with 5^{th}.
  - Good to know minimum requirement, but user will need to be creative (but transparent).
- Better communication around meta data.
  - Should link to national/international industry standards. Alberta can offer a more rigorous approach if needed.
  - Need better (QA'd/QC'd) metadata.

E.2 Geomatics Discussion

In Edmonton the discussions were led by TECTERRA (Jon Neufeld).

E.2.1 Data Visualization

Background/Context: Mapping was the most frequently cited purpose for collecting EO/RS data and yet no one identified data visualization as a research priority.

Q1a) How can we explain this apparent disconnect?

- Data visualization has different connotation than "mapping". Mapping a mature technology.

- Mapping must be accepted by regulatory authorities, but visualization may not necessarily need to be regulated.
- Data visualization (fly through the data) and product visualization (maps, charts, movies, etc.) are different things.
    - Visual and visualization are different things.
    - Data -> 2D map -> 3D picture -> movie.
- Visualization can help in "translating" complex ideas.
    - Visualization helps tell a story – breaks down communication barriers.
    - Helps people connect to results (they understand image not data).
    - A way to message results from analysis.
- Priority is ultimately on analytics but visualization is key for communication.
    - Analytics finds answers – visualization tells the story.

Q1b) What are the market opportunities for data visualization?

- Market opportunities are significant because of the importance of visualization.
    - What the data mean for the decision-maker or stakeholder.
    - Visualization drives ability to influence decision-makers by simplifying complex issues.
- Need to know markets and client to tell the story and determine the appropriate visualization tools.
- Opportunities around high resolution datasets.
    - Look to other industries for solutions (e.g., gaming, simulators, military simulators, virtual reality).
    - Challenge around data set size – downsampling is one option but careful about interpretation.
- Company needs Chief Story Teller.
- Barrier exists as we have to rely on experts to create visualizations.

E.2.2 Catalogue of Needs, Products and Sources

Background/Context: There was an emphasis on ordering/using EO/RS products on an as needed basis or using whatever is available from other sources.

Q2a) Is there value in cataloguing needs, products and sources?

- Yes!
  - Avoids duplication.
  - Creates efficiency and cost reduction.
  - Provides for ease of access.
- Government must get better at clearly articulating its needs.
  - Also what they are willing to spend.
- Government role in understanding what is needed for industry and government users, understand economic benefits and then fulfilling these requirements.
  - US does a good job of this.
- Should look at military approach to identifying needs, COSIA is a good model.
- Should be more than natural resources data – municipal data also very useful.
- Ask developers to identify the data they would like to have – may result in government or industry sharing these data.
- In Saskatchewan, departments and Crowns contribute to geo-levy to provide data for free.
- Need a starting point for the needs/products discussion.

Q2b) Who should develop the catalogue, make it accessible and keep it updated?

- Everyone – users will develop their own catalogue.
- GeoDiscover Alberta.
- Problem now is too many players with no integration.
  - Data are not centralized – this may provide an opportunity.
- Data can be provided in lieu of financial contributions.
- People paying for the data are not the data experts. How to educate the users?

E.2.3 Replacing Field Data Collection

Background/Context: Currently EO/RS data supplement existing field data collection but there was a strong indication that EO/RS will allow reduced field collection in the future.

Q3) What is needed to ensure this transition?

- Understand not just what we are measuring, but why we are measuring and what outcome we are trying to achieve.
  - Don't always have to prescribe the technology to get to an outcome.
  - Regional management questions vs. site questions determine appropriate platforms and sensors.
  - The use of EO/RS as a screening tool to trigger field assessment requires very different sensors and precision than if it is used for regulatory yes/no decisions.
- Need to understand relationship of what we can measure with RS with what we need for field collection and validation.
  - How much or how little field-validation is required to support RS use.
- Need to understand errors associated with the technology, understand the magnitude to which it can impact field collection.
- Understand how well we are measuring things today.
- Need to show how RS can reduce costs while maintaining appropriate level of protection.
- More frequent collection will lower costs of data.
- Need more reliable and accessible data.
- Need regulatory involvement – regulator will need to be outcomes-based not prescriptive – consistent with transition to a risk-based approach.
  - May need to set field verification standards.
- Need to reduce the potential for multiple interpretation of RS data.
  - Use artificial intelligence.
  - Field verification can reduce human bias.
- Technology may have been over-sold in the past – has created some reluctance going forward.

E.3 Remote Sensing and Data Analytics Discussion

The Edmonton discussions were led by Alberta Environment and Parks (Shane Patterson).

E.3.1 Data Analytics Research

Background/Context: Data analytics was identified as the top research priority.

Q1) What research is required?

- Flip question around: What are the best technologies for a particular problem? It is hard for oil and gas companies (for example) to pick the best sensor for their problem.
- How to identify the right question (working with the story-teller).
- Sensors are discussed too amorphously. Hyperspectral could mean many things to different folks.
  - Real challenge is how to adapt sensor to particular problem.
  - Also need integration and interoperability between sensors.
  - Also need to integrate different sensors to make this more useful and impactful.
- Long list of potential needs, but as an SME how do you pick which needs to go after?
  - Problem is that regulator may not accept solutions SMEs put forward, even if the need is addressed.
- Develop a needs repository.
  - System to capture and disseminate needs.
  - Really require a list of remote sensing needs.
- AI Corporations could be involved in:
  - Technology Needs Assessment – to identify the needs
  - Commercialization side (support, engaging regulator).
- Develop vetting group for technologies (COSIA's Environmental Technology Assessment Portal (E-TAP) is an example - http://www.cosia.ca/initiatives/etap).
  - AI Corporations?
  - 3rd parties like PTAC or COSIA?
  - Must be transparent and unbiased.
  - Opportunities for AER to identify third party who is trusted to do complete scientific review of the solutions being proposed.
- US Regulator takes a different approach. In US system the onus is put on the companies proposing the solution to provide this validation to show solution meets regulatory requirements.
- There is a need to identify the current Alberta capacity in this space (academic institutions, labs).
  - Bring together / create directory / metadata around the organizations.

- Also question of how to enable collaboration.
    - Create a provincial community of practice.
    - Need to bring EO and geospatial expertise together.
    - Need to get people together more frequently.
    - Need more ways to connect with industry.
    - Need broader stakeholder engagement during project design with respect to research team.
- Is there a need for a Data Centre?
    - Just a portal would be OK. Really want just a single point of access.
    - Data Lake – could run this as a business. Alternatively as a P3. Main concern is to do this in a way which avoids artificial market closure.
    - Opportunity to use open data areas as good way to translate knowledge to different groups, as this provides a common "sandbox".
- Regulator wants real numbers, not a proxy.
- How to make RS results consistent and repeatable.
- Value in having sites to help normalize the data / test sites for validation.
    - Sites and data should be accessible to the public.
- Transdisciplinary training (math sciences, computer sciences – but they don't always understand the needs).
    - Really about having teams of resources that can mobilize for Alberta challenges.
    - Industry/government need to identify future skills requirements so training can be targeted.
    - Still need subject matter experts (domain expertise).
- Importance of "translators" between industry and researchers.
    - Ensure understanding of the "needs" and the "proposal" – avoid misunderstandings.
- Do we have a good definition of "data analytics".
- Grasslands not good with respect to land cover. Boreal is much more advanced in comparison.

E.3.2 Enhancing Platform and Sensor Usage

Background/Context: There was a wide range in reported usage of various EO/RS platforms, sensors, and resolutions.

Q2a) What market opportunities exist to enhance usage?

- Really need to start with the need, not what sensors can do.
- Regulatory compliance is a huge gap / opportunity.
- Key limiting factor is cost. Seems that cost is greater than the value actually created. Need to focus on how solution fits company's internal value case.
- Data are expensive to:
  - Acquire.
  - Process.
  - Store.
- Bigger issue is how to increase awareness of what others are doing. Is there a need for a consortia approach?
- Need for an EO Institute. Maybe a Western Canada EO Centre of Excellence. This is bigger than University of Lethbridge (ATIC).
  - Maintain the needs and solution database.
  - Facilitate adoption of EO technologies.
  - Also examine how to take subset of platform and apply to new markets.
  - LOOKNorth and TECTERRA – both not good at showing problems.
  - Need Industry associations to help identify challenges (PTAC, COSIA, Environmental Services Association of Alberta).
- "GeoAlliance meeting" recently in Calgary – 69 major players, many more smaller entities, all with similar needs. Education / examples of what industry can do to help users.
  - Importance of geography.
- Data analytics – large market opportunities, but need for both domain expertise and also the computer science side.
- Education and awareness – how technologies can benefit industry.
  - Need to better explain available technologies and what they can do, what their pros and cons are, what value they add, etc.
  - Need samples to showcase products.
- Issue of people doing the same thing for the last 30 years, not willing to change to new way of doing things.
- A strategic sales and marketing plan to facilitate storytelling and education.

Q2b) Is there a need to increase awareness of the capabilities of the platforms (e.g., UAVs, helicopters, planes, etc.) and sensors (e.g., multispectral, hyperspectral, side aperture radar (SAR), etc.) that received lower interest or are there other factors that are restricting uptake?

- Radar products not being sold as "radar" projects – doesn't necessarily get to the remote sensing folks.
- Need to manage expectations – demystify hyperspectral imaging – more of an academic interest.
- Hyperspectral not being used at operational level
    - Costs scare off groups with limited funding.
    - Need to clarify relationship between $$ and product value.

F.3.3 Temporal Resolution

Background/Context: Respondents indicated more frequent use of data acquired on an annual and/or monthly basis compared to data collected on a daily and/or weekly basis. This is consistent with the emphasis on change detection (second most frequent choice) as a primary purpose for data collection.

Q3a) Should SMEs focus on the annual/monthly collection market?

Q3b) Do key market opportunities exist with data collected more frequently?

- Need to decide on a case-by-case basis.
    - Cost.
    - Value created.
- Question of who is aggregating needs (for example, one group needs data at one resolution and frequency, another at another resolution and frequency, how to combine both of these).
- Ensure right temporal resolution for the issue (need drives the solution not resolution-driven).
- Equally important to be able to go back in time to find initial conditions (baseline) from which to assess impacts.
    - Need for collecting and digitizing older RS information with appropriate meta data tro allow for comparison with current technology results.
- Suncor wants to know how much surface water becomes available on the day that the snow melts (want daily for 6 weeks of the year – but not the rest of the year).

E.4 Dedicated Research Sites

In Edmonton, all three groups discussed the following questions as did all participants in Calgary.

Background/Context: Most respondents felt that a dedicated research site, or set of sites, with free data for field testing/verifying new products and services would be very useful.

Q4a) What type(s) of EO/RS data (i.e., platforms, sensors) would be most useful to support such a project?

- Start with data that currently exists for free – validate.
- Foundational (baseline) data.
- Land cover data.
- Data related to urban areas (municipal data – e.g., utility and building locations).
- Census data.
- Subsurface data.
- Wells and well integrity.
- Other environmental data (air quality, biodiversity).
- Agriculture-related data.
- Note that we do need to be targeted so that we don't just get "noise".
- Future development scenarios (e.g., EIAs).
- Future climate predictions.
- Note importance of keeping recent data updated.
- Need for ground validation sites.
    - Also ensure that this field data is available.
    - Look at something like wildfire test site – allow for calibration.
    - Universities would be very interested in using sites for training students.
- Visualization platform.
- Good to have a location that fits with the various potential uses.
    - Ideal would be one location where "everything" could be tested.
- Ideally training people on Alberta-developed technologies, competitions for creating apps.

Q4b) What products and services should be evaluated? How are these needs identified?

- Start with what regulators looking for.
- Needs ultimately will be defined by clients.
- Be clear about the scale of the solution needed – site vs. local vs. regional, etc.
- Look to non-conventional sectors (e.g., educational tools, gaming, tourism, etc.) for solutions.

Q4c) What would an organized collaborative effort look like?

- Develop strategy to enable collaboration desired.
  - Role in operationalization and commercialization.
  - Need partnerships model driven by stakeholder interests.
  - Consider a technical advisory team.
  - Use existing networks through TECTERRA, LOOKNorth, TEC Edmonton, Innovate Calgary, etc. Need to figure out to leverage these better.
  - GeoAlliance Canada may become an umbrella organization for Geomatics.
  - Leverage some previous efforts to build collaborative projects – e.g. WEHUB (Cybera - https://www.cybera.ca/projects/completed-projects/water-and-environmental-hub/); GeoSense. Note WEHUB a "failure" because the projects tackled were thought to be ones that government should really do.
  - Already a federally funded process – GeoFoundation Exchange (GFX), ESRI involvement.
  - Look at what genomics sector has done (http://www.genomecanada.ca/).
- Look at different models.
  - Incubators.
  - Issue big challenges.
  - "Hack-a-thon" type models for challenges.
  - Pilot products that can generate new SMEs.
  - Keep in mind the economic drivers for companies that are in this space (and how to help them grow).
- Need to ensure participation from universities across Canada.
  - Look to UofA, UofC and UofL RS centres.
  - Better support for matching solutions to needs.

    - How to get multinationals to support universities?
- SMEs need a forum.
    - Opportunities to create new industries.
    - But need for business development side as well.
- Need to take 6 data areas and operationalize it.
    - Way to create first customers for companies around the products they have produced.
    - View as Sandbox.
- Agriculture setting sites across the province – willing to share sites under certain circumstances.
- Better communication needed.
    - Need easy method of communication to ensure needs and opportunities are well understood.
    - Need a clearinghouse of information.
    - Ensure visibility of solutions to help create opportunities for SMEs.
    - Workshops on annual/semi-annual basis.
- Need way to dock this back into the AI Corporations, TEC Edmonton and Calgary etc. to move the SMEs through to full commercialization.
    - Need to get policy and regulator flexibility.
    - Centre of Excellence is one option.
- Need to show the detailed economic / environmental / social benefits.
- Need to be careful not to portray geomatics as the only "lens".
- Need good governance systems.
- Need to take out the word *free* as it changes expectations – maybe use *shared*.
- Clients will be the primary users.
- Recognize that some companies will just want to access data.

Q4d) What's missing?

- Need to increase awareness of the demonstration sites.
    - Need good external communication and engagement on the benefits.
    - Ensure there is good communication about results – what worked and what didn't.

- Need to provide context for each area – background information and key questions that can help potential partners/users to decide where they want to participate.
- Need to develop mechanisms for companies (large and SMEs) to contribute data.