SPACEBORNE EARTH OBSERVATION IN CANADA

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Commercial success in Earth Observation from space is contingent on having a supportive technology development and applications environment at home first and foremost. Canada has proven the importance of this principle many times over with its RADARSAT missions, as well as in other space areas such as Telecommunications, Robotics, COSPAS/SARSAT and Space Science.

WHY IS SPACEBORNE EARTH OBSERVATION IMPORTANT TO CANADA?

Seldom has there been such a perfect match of technology with a nation's needs than the one that exists between Canada and Earth Observation (EO) data. With its vast territories, diverse ecosystems, valuable resources, sparse population and its unique geography and climate, Canada benefits greatly from the continuous, widespread coverage of its territories that only spaceborne EO monitoring can provide. No other technology or methods known to mankind can properly address Canada's needs for reliable, all-weather, near real time, wide area reconnaissance data. It was with this understanding and vision that Canada embarked on the development of its RADARSAT Synthetic Aperture Radar (SAR) family of missions some thirty years ago. Over this time, the requirements for the data and services provided by RADARSAT and other EO missions have only grown, as the demands for Canada's resources and the international use of its territories have dramatically increased, while climate change continues to alter its sensitive environments.

As the custodian of many of the world's most unique natural systems, Canada has an obligation to its citizens and the global community to monitor and protect these environments through safe and sustainable use. With an area of 9.98 million square kilometres and a population of 34 million people, Canada is one of the most sparsely populated countries on earth and yet it holds natural resource reserves worth more than $1 trillion and growing at a value of about 10% per year. Some 57% of the country's natural resource reserves are in energy resources, while 24% are in timber and 19% are in mineral resources. In addition to these resources another $1 trillion in wealth exists in land and agricultural value, with more than 60% of Canada's cropland and 80% of its rangeland and open pasture in the prairie region. In spite of its vast expanse, most Canadians (78%) live in urban areas within 100 kms of the U.S. border. More than 42 million people, including 8 million Canadians, live and depend on the Great Lakes and St. Lawrence Basin for their drinking water as well as for transportation, trade, tourism and power. There are more than 2 million lakes and water systems within Canada that contain about 20% of the world's total freshwater resources,

along with 25% of the world's wetlands and with the third largest volume of glaciers. More than half (54%) of the country's land area is covered in forest with 80% of this as boreal forest. The wealth of natural resources in Canada has stimulated the inauguration of massive initiatives such as the James Bay hydro-electric project and the Alberta oil sands development. No better viable means for the monitoring and management of these resources and activities exists than through the use of EO technologies.

Canada's coastline is the longest in the world at over 200,000 kms with most of the coast (80%) in the remote northern and Arctic regions. With increased offshore activities and sensitive coastal areas, Canada has extended its interests to include regions beyond the Economic Exclusion Zone (EEZ) to an outer zone just beyond 1,000 nmi, adding more than 7 million square kilometers to its ocean estate. On average, 1,700 vessels per day are present within Canada's domain of responsibility. With the reduction of the Arctic's permanent ice cover at a rate of about 10% per decade in the past thirty years, there is increasing interest in the international shipping community to consider the use of the Northwest Passage as an alternative for a shipping route between Asia and Europe that could reduce shipping costs by 30%. As a result of the vast regions of Canada's coastal waters and the dynamic nature of its use, spaceborne EO imaging offers the most credible option to meet Canada's surveillance needs.

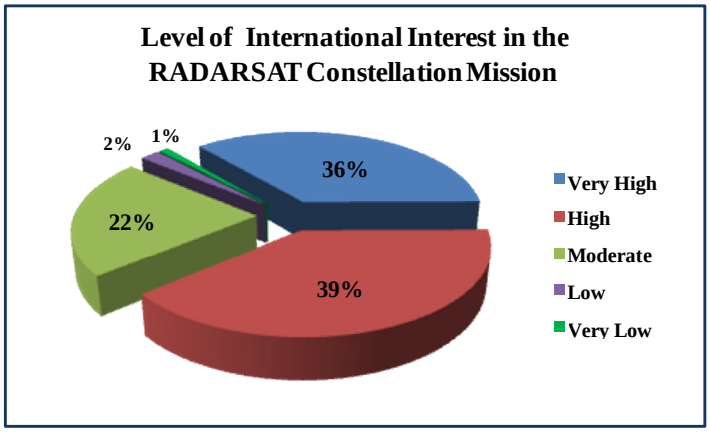
Earth Observation data has also played a very valuable role for disaster management purposes. Canada's disasters are largely (70%) derived from natural causes with the rest (30%) originating from human activity. Disasters result in more than $1 billion in damages per year in Canada, with the most severe being floods and drought, followed by fires, storms and the potential for earthquakes. Through recent research and innovations, Canada has impressively demonstrated the utility of its RADARSAT imagery for many disaster applications including flood mapping, earthquake monitoring and severe storm modelling.

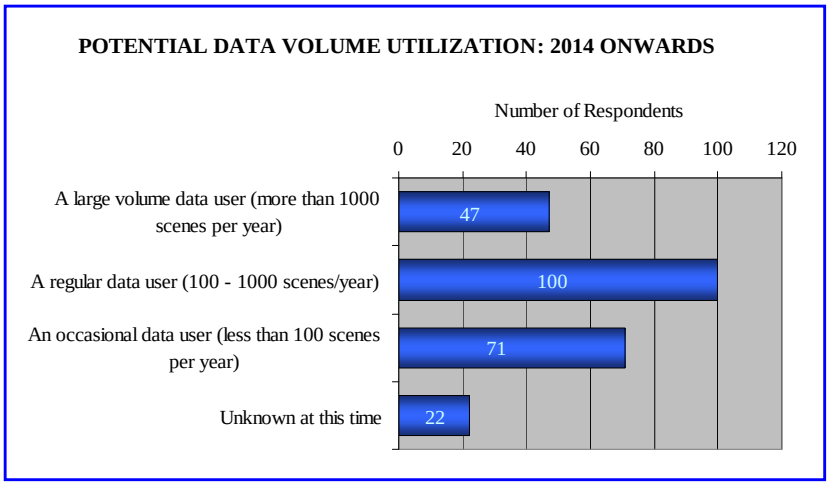
In addition to serving Canada's national needs, EO data and technologies from Canada have been integral in establishing and developing many international collaborative agreements around the world that have resulted in significant new business for its industry, as well as enhanced Canada's reputation as a reliable and capable partner that can be depended upon over the long term for data continuity and creative technology solutions.

WHAT ARE THE FUTURE MAJOR OPPORTUNITIES/CHALLENGES FOR THE CANADIAN SPACE INDUSTRY BOTH IN TERMS OF SPACE ASSETS AND SPACE APPLICATIONS?

The RADARSAT Constellation Mission (RCM) is Canada's single biggest opportunity in EO from space, but it is also its single biggest challenge. Ongoing commercial success for Canada in EO is almost entirely dependent on the continuation of the RADARSAT family of missions, particularly through the implementation of the RCM. Not only would the possible cancellation of the mission be disastrous for the Canadian EO community, but a long delay would irretrievably result in the erosion of the Canadian EO engineering base and the loss of its market position as users turn to alternate data sources.

Previous market research has shown that Canada has positioned itself in a very enviable spot with a high degree of international interest in the RCM concept. (See: *RADARSAT Constellation Mission: International Market Composition, Applications and Utilization*. Final Report for the CSA. Principal author: M. Kirby, 2008). Some 252 spaceborne SAR users from 45 countries provided input and reaction to the RCM concept.





Some 88% of these users foresee an expected increase in the use of spaceborne SAR data in the future. They also suggested that after 2014, subject to the availability of constellation data and cost schedules, their volume of usage could be substantial. In fact, a surprisingly high number of respondents (18%) mentioned that they may expect to use more than 1,000 scenes per year and the largest proportion of the respondents (39%) stated that they could use between 100 and 1,000 scenes per year. Taking these responses a little further, it is possible to calculate the total potential volume of utilization to be in excess of 100,000 scenes per year from this group of respondents alone. However, the availability of other

constellation data has to be factored into these estimates. And even if these figures may seem optimistic to some people, can Canada afford to relinquish its market position and this potential with such a high level of interest in the RCM?

The most important spaceborne SAR technical requirements for the international Earth Observation community, as revealed in the market study, will be met or exceeded by the RCM as summarized in the table below:

REQUIREMENTS AND SPECIFICATIONS FOR SPACEBORNE SAR DATA	
Most Important Technical Requirements of the International Earth Observation Community	**RADARSAT Constellation Mission Specifications**
SAR Frequency: C-Band	Meets Requirement
SAR Data Continuity	Meets Requirement
Full Range of Imaging Modes	Meets/Exceeds Requirement
Spatial Resolutions: 3m – 100m	Meets/Exceeds Requirement
Revisit Capabilities: 5 days or better	Meets/Exceeds Requirement
Data Accuracies: 1:20,000 to 1:50,000 scales	Meets/Exceeds Requirement
Data Turnaround Times: 5 days or better	Meets/Exceeds Requirement
Complete Global Coverage	Meets Requirement

Other Earth Observation opportunities exist for the Canadian EO community, but they are largely based on the success of the RADARSAT legacy and they pale in comparison to the opportunity and challenge currently facing the RCM.

HOW WELL IS THE INDUSTRY POSITIONED TO TAKE ADVANTAGE OF THESE OPPORTUNITIES AND ADDRESS THESE CHALLENGES?

There are two levels of consideration in answering this question with regard to the EO community.

First, for the time being, the Canadian EO community is very well placed to take advantage of the spaceborne SAR business so long as the RCM is supported without significant delays, both in terms of building and operating the mission. Even with the appropriate support, the spaceborne SAR manufacturing base in Canada faces much international competition with a number of countries developing SAR capabilities. In addition, there are new trends in the marketplace which present both an opportunity and a threat:

- **Opportunity:** As SAR technologies become more prevalent, more countries are seeking to have their own SAR missions that they control for their own purposes with the parallel intent of also selling data into the international marketplace. Canada is well positioned to take advantage of this opportunity if support for SAR system development is continued well into the future.

- **Threat:** The creation of SAR constellations, like the RCM, will give our industry a major advantage, leading to the next generation of spacecraft that will likely be smaller and more affordable to a wider group of countries. Canada could be left behind if its SAR manufacturing base is not supported through a delay or cancellation of the RCM.

Secondly, the Canadian value-added (VAR) community currently enjoys a high degree of capability, but it is in a fragile position:

- **Opportunity:** With the proliferation of EO data and a growing international user market, opportunities for services and systems have skyrocketed. In addition, current mission profiles include very complex imaging modes and options, which need new developments for processing, analysis and applications purposes. Canadian industry, with its specialized knowhow, can gain excellent momentum and capture significant portions of these new markets around the world.

- **Threat:** Most of the VAR companies (in Canada and abroad) are small in size (<50 employees) and depend on their national agencies for R&D support and initial market penetration. There are literally thousands of EO VAR companies worldwide and Canadian companies need to be part of a national strategy that ties R&D to its EO missions and trade policies in order to lead in the marketplace.

HOW WELL DO CURRENT GOVERNMENT OF CANADA POLICIES AND PROGRAMS ASSIST THE INDUSTRY TO TAKE ADVANTAGE OF THESE OPPORTUNITIES AND FACE THESE CHALLENGES?

Previously, the Canadian Government had strong policies with regard to R&D, technology transfer and commercialization tied to trade. Over recent decades these policies have become less clear with internal pressures for revenue generating activities, sometimes in competition with industry, and with cost cutting measures that have reduced industrial participation. As we have seen with the latest federal budget and the suspension of the RCM development, there is uncertainty as to the future of Canada's commitment to its national EO initiatives.

Long term success for space technologies and services requires consistency in Canada's policies and programs. The Government that approved the first phases of the RCM initiative in 2010 did so in the context of its Action Plan and Northern Strategy policies, which demonstrated a vision with longevity. The priorities for these policies have not changed and have in fact become more critical to the welfare of the country. Yet, after committing many millions in development funding for the RCM to date, the Government has chosen to suspend further manufacturing activities, which jeopardizes the space industry, undermines Canada's international reputation for continuity of data and partner reliability, as well as reduces the Government's ability to deliver on its own Action Plan and Northern Strategy.

WHAT CHANGES TO POLICIES AND PROGRAMS ARE RECOMMENDED?

There are important recommendations with regard to both the programs and policies for the Government to consider related to spaceborne EO in Canada that will have a significant impact on Canada's EO sector.

Programs:

- The uncertainty around the RCM should be removed immediately and continuation of its development should recommence as soon as possible. Already there are competitive international organizations attempting to take advantage of Canada's delay by highlighting doubt in the RCM's future and Canada's commitment to its EO programs.

Policies:

With regard to strategic EO policies, it is important to:

- Establish and maintain long term consistency in policies that are linked to strategic national objectives and marketplace potential;
- Ensure that there are supportive policies for the development and promotion of space technologies that include the entire value chain to be led by Canadian organizations from the initial R&D sourcing, system design, system manufacturing, operations, applications, to user training and scientific exchanges;
- Link Canadian EO data products, systems and services to trade discussions and international agreements related to natural resources, the environment, safety and security.
- Finish what we start, particularly with regard to the RADARSAT Constellation Mission that is proving to be increasingly necessary with each passing year in meeting Canada's stated national objectives.