Canadian Geomatics Environmental Scan and Value Study

How is Geospatial Information Benefitting Canada's Economy and Society?

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What is the contribution of geospatial information to the Canadian economy?

$21 Billion to GDP

and

$19 Billion to Real Income

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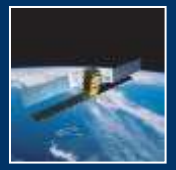
Outline

- About HAL
- Study Concept and Scope
- Sector and Market Definitions
- Modelling Approach for Valuing GI Use
- Study Findings

About HAL

- Hickling Arthurs Low (HAL) Corporation is Canada's premier consultancy specializing in innovation, policy and economics.
- HAL has been conducting socio-economic assessment studies for over 25 years, for clients such as:
  - Natural Resources Canada
  - Canadian Space Agency
  - Industry Canada
  - National Research Council Canada
  - Ontario Ministry of Agriculture, Food and Rural Affairs
  - Ontario Ministry of Natural Resources
  - The City of Guelph
  - Compute Canada
  - National Marine Manufacturers Association Canada



About HAL

- HAL is also a leader of the Polar View network of public and private sector organizations that specialize in providing leading-edge satellite-based information and data services in the polar regions and the cryosphere.
- First organized as a consortium in 2003, Polar View was formally incorporated under the name Polar View Earth Observation Ltd. in the UK in 2011.
- Polar View services include enhanced sea ice information (charts and forecasts) as well as ice-edge, iceberg, lake and river ice, snow cover and glacier monitoring data.

Polar View

Study Context

- The Canadian Geomatics Community Round Table, a forum of geomatics private, public and academic sector leaders, sponsored the development of a **Pan-Canadian Geomatics Strategy** to support, strengthen and guide the sector for years to come.
- Natural Resources Canada offered to undertake this Study, in order to inform the development of the Strategy as well as their own program planning.
- The Strategy is being implemented by a new umbrella organization formed in 2015, **GeoAlliance Canada**, whose members are not-for-profits, companies, educational institutions and government organizations from across the geospatial spectrum in Canada.

Study Scope

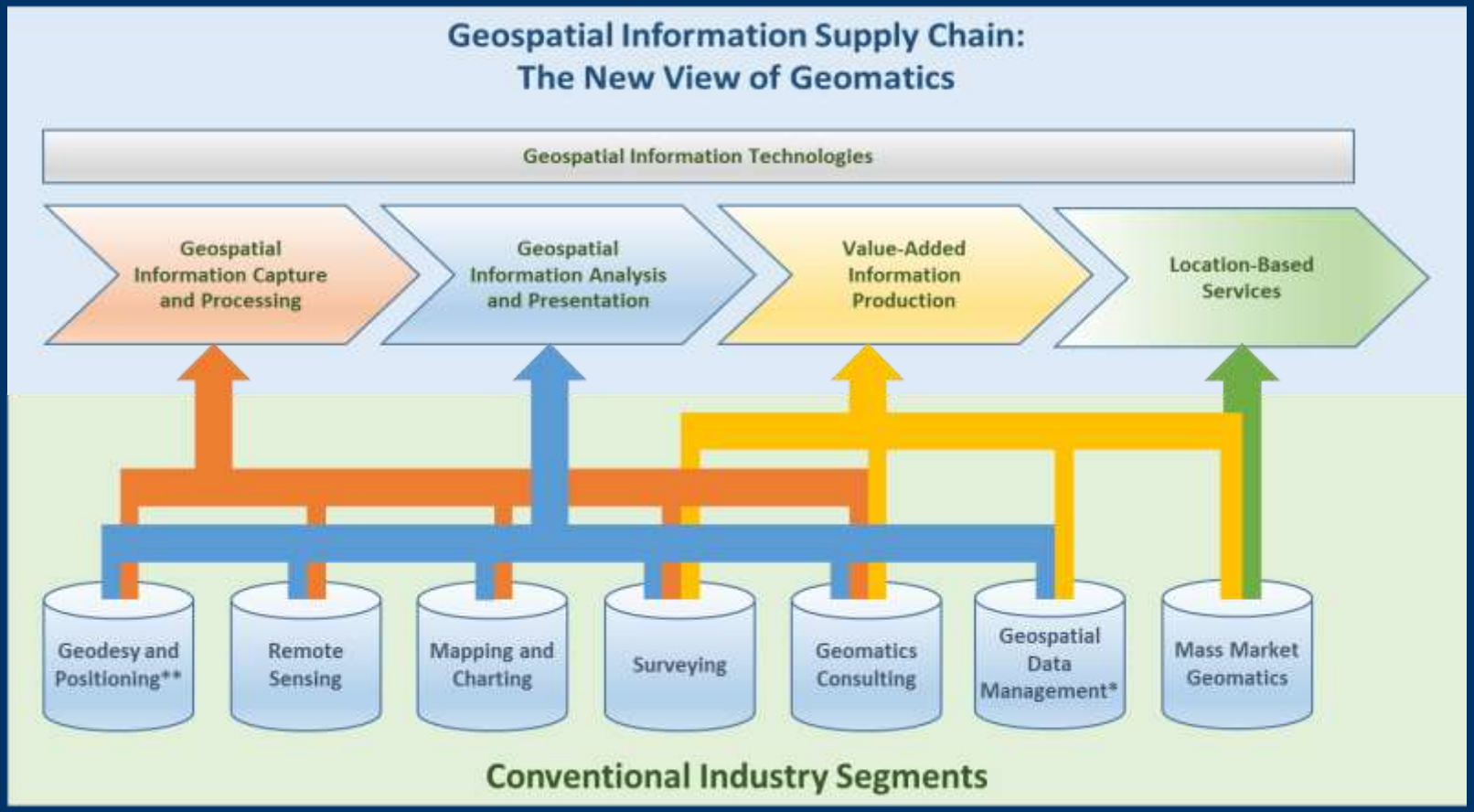
Most comprehensive study in sector's history

- Developed a complete and coherent understanding of the **state of the geomatics sector** in Canada.
- Developed an appreciation of **global geospatial information trends** and Canada's position relative to those trends.
- Developed a better understanding of current, **new and alternative roles for government, industry and academia** in driving, supporting and using geospatial information within the context of the national economy.
- Developed an understanding of the significance and **value of the geomatics sector and geospatial information** to the Canadian economy.

Sector Definition

- Segmentation of the geomatics sector along disciplinary lines has become challenging because
  - many geomatics businesses do not categorize themselves in just one of the disciplines; and
  - the lines between the divisions (e.g., between surveying and positioning, and between remote sensing and mapping) have blurred.
- A segmentation aligned with a modern geospatial information supply value chain seems more logical.

Sector Definition



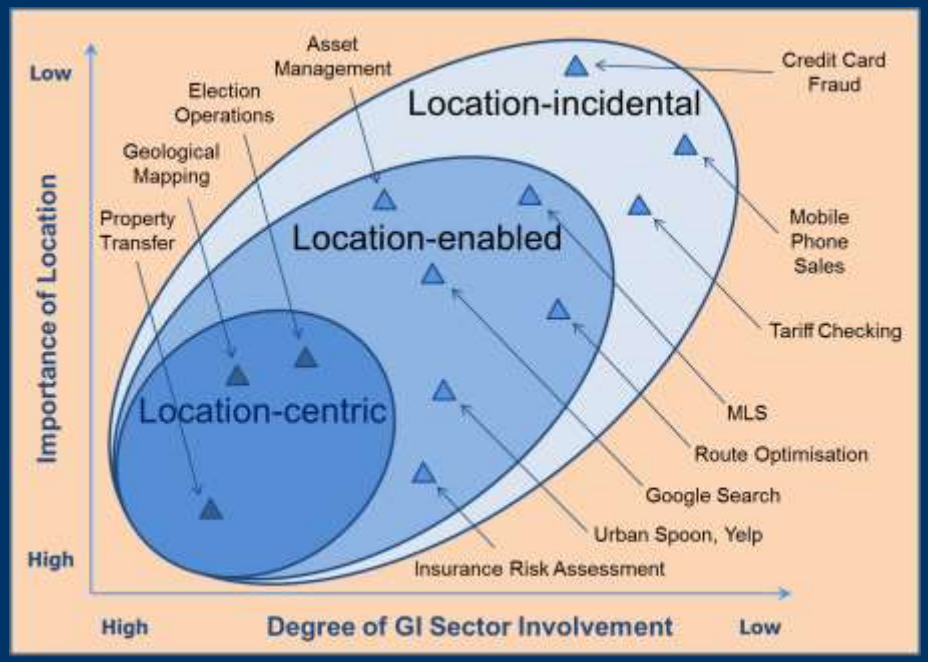
** Includes use of all Global Navigation Satellite Systems
* Includes Geographic Information Systems

Market Definition

- The definition used for the **geospatial information market** is:

  The demand that exists for geospatial information products and services, including those that are location-centric (i.e. products or services that would not be possible without geographical location or position) and location-enabled (i.e. where geographical location or position is an important part of the delivery of products and services).

- The third segment in the diagram – location-incidental (i.e. applications where geographical location or position is not required for the delivery of products or services, but would be nice to have) – was beyond the scope of this study.
- It was recognized that inter-segment boundaries are very fluid.



Components of Value

Geo-Sector

Quantitative description:
- Employment
- Revenue
- Exports
- GDP Contribution

GI Use Economic Benefits

Quantitative CGE modelling:
- Productivity
(Impact on GDP)

GI Use Non-Economic Benefits

Qualitative description:
- Consumer
- Environment
- Health & Safety
- Decisions

Geospatial Information (GI) Use Modelling Approach

Data Sources
Team Knowledge, Literature
Cases Studies & Consultations
Statistics Canada Data

IO Industry Codes Economy Structure

Industries Using GI

GI Use Examples
Application Descriptions

GI Impact Examples
Productivity Estimates

GI Adoption
Adoption Rate

GI Industry Shocks
Productivity

CGE Modelling

Sensitivity Analysis

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Modelling Approach

- Structure of the Economy – The Canadian economy structure was the one used by Statistics Canada for its input-output tables, which breaks the economy into 234 industries.
- Industries Using GI – Only those 60 industries that were found to significantly benefit from geospatial information use were included in the subsequent analysis.
- GI Use Examples – Based on the literature review, consultations, and case studies, examples of how different industries use geospatial information were identified.
- GI Impact Examples – Based on the GI use examples and other data from the literature, consultations, and case studies, estimates were made for the productivity improvements experienced by users.

Modelling Approach

- GI Adoption – The productivity impacts were varied across each industry's early adopters, majority, and laggards, depending on the degree of GI adoption.
- GI Industry Shocks – The impact of geospatial information on an industry is then the product of the productivity estimate times the adoption estimate. These productivity impacts are termed 'shocks' to the economy in economic modelling.
- Initial Impact Estimates – Using the derived productivity shocks and static information on industry GDP, an initial estimate of the economic impact of GI use was made.
- CGE Modelling – Finally, the productivity shocks were entered into the CGE model.

CGE Model

- The impact that GI use had on the Canadian economy was estimated using the Computable General Equilibrium (CGE) model, *Tasman Global*, a large scale, dynamic model of the world economy that has been developed by ACIL Allen Consulting.
- Key advantages of CGE models are that they capture:
  - the expansion in economic activity driven by an investment, and at the same time account for the constraints faced by an economy in terms of availability of labour, capital and other inputs; and
  - a wide range of economic impacts across a wide range of industries in a single consistent framework that enables rigorous assessment of a range of policy scenarios.

The Challenge Process

At each phase of the value study a community of experts examined the work, challenged assumptions, validated results and proposed improvements

Review of the Model	Review of data input matrix	Examination of initial results	Final review
Two reviews - External review committee -GoC economists knowledgeable of CGE modeling	GoC economists familiar with relevant sectors	GoC economists familiar with relevant sectors	**Three reviews** - External Review Committee - Sensitivity analysis carried out by contractor -Project Steering Committee

The mandate

At each stage of the study, ensure that the methods used are consistent with good practice, that the data is the best available and the procedures are free of error.

Economic Value Results

The impact of GI use on productivity is significant in every region of the country…

Region	Real GDP	Changes in Real GDP attributed to GI Use (C$ million)
Atlantic	0.94%	$995
Quebec	0.77%	$2,792
Ontario	0.76%	$5,295
Prairies	2.03%	$8,985
British Columbia	1.02%	$2,457
North	2.38%	$174

TOTAL contribution of GI use to the Canadian economy through productivity improvements:

$20.7 billion in GDP

…at a scale comparable to the forestry sector.

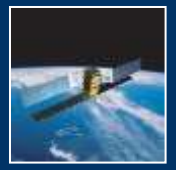
Sensitivity Analysis

- Monte Carlo analysis conducted for the five input variables that had the greatest impact on the results:
  - Conventional and unconventional oil and gas
  - Architectural and related engineering services
  - Other municipal government services
  - Mining
  - Support services for oil and gas and mining

Non-economic Value of GI

- Environmental – improved environmental protection, better compliance with regulatory requirements, better management of resources, and reduced impacts of natural disasters.
- Health – saved lives, improved allocation of resources to manage disease outbreaks and emergency situations, better patient care and lower health risks, as well as better management of health risks.
- Social – more effective communication among governments, business and citizens; increased confidence in services; improved community engagement; and higher customer satisfaction.
- Knowledge – improved presentation and understanding of complex information, increased information consistency, better focus on areas of risk, improved ability to plan, better analyses, improved data integration, increased data confidence, better evidence-based decision-making, and improved citizen literacy.

For Further Information



Canadian geomatics environmental scan findings report

http://ftp2.cits.rncan.gc.ca/pub/geott/ess_pubs/297/297709/cgdi_ip_0047_en.pdf

Value study findings report

http://ftp2.cits.rncan.gc.ca/pub/geott/ess_pubs/297/297711/cgdi_ip_0048_en.pdf

Summary report

http://ftp2.cits.rncan.gc.ca/pub/geott/ess_pubs/296/296426/cgdi_ip_41e.pdf

Supplementary Slides

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Industry Structure

IO Industry Codes

Industries using GI (Industries not using GI are hidden)

Input-Output Industry Codes (IOIC) Detailed level			
Code	Title	NAICS Correspondence	GI Applications
BS111A00	Crop production (except greenh	111	Farm vehicle navigation Crop yield mapping Seeding and variable rate chemical application Agronomic decision-making
BS113000	Forestry and logging	113	Forestry operations planning Harvesting operations Materials transportation Mill operations Reforestation Inventory updating Regulatory compliance reporting
BS114000	Fishing, hunting and trapping	114	Fish finding Monitoring fishing vessels
BS115A00	Support activities for crop and a	115	Aerial Crop Dusting; Forest Fire Fighting & Aerial Pest Control: Aircraft Navigation
BS115300	Support activities for forestry		Mission Planning

NAICS Correspondence (needed to access StatsCan data)

GI Applications (more detail provided on Application Descriptions worksheet)

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GI Application Descriptions

IOIC	Title	NAICS Correspondence	GI Applications
BS111A00	Crop production (except greenhouse, nursery and floriculture production)	111	<u>Farm vehicle navigation</u> This application (often called auto-steer) uses GPS receivers integrated with the farm vehicle's steering system to automatically navigate the vehicle over a field. Typically configured with a touch screen computer in the vehicle cab, the application allows the use of map displays to show the location of the vehicle in the field. The farmer maps the boundary of the field insitu or virtually, and after the first turn the computer figures out where on the field the machine is located and how to steer to complete the field. The operator only needs to monitor the display and check that turns happen in the proper direction (Ref: John Deere Case Study). <u>Crop yield mapping</u> Yield mapping involves collecting georeferenced data on crop yield and characteristics, such as moisture content, while the crop is being harvested sing a range of sensors (e., flow sensors to determines crop volume harvested, moisture sensor to measure crop moisture variability, etc.) (Ref: Yield Monitoring and Mapping http://cropwatch.unl.edu/ssm/mapping). Various methods, using a range of sensors, have been developed for mapping crop yields. Farmers use GPS to map crop yield at harvest time through the technology built into their machinery. Agronomists and soil scientists can then develop prescription maps for the next spring planting season to optimize seed placement and precisely apply pesticides, herbicides and fertilizer (Ref: John Deere Case Study). <u>Seeding and variable rate chemical application</u> GPS technology is integrated with presciption maps and spreading equipment for seeding, and variable rate application of fertilizers, pesticides and herbicides. Typical components of map-based variable rate systems include prescription maps on an in-cab computer, a GPS receiver that provides vehicle position, and an actuator that regulates material rates under the computer's direction (Ref: Agricultural Automation: Fundamentals and Practices). Strategies for varying inputs can be developed based on: soil type, soil color and texture, topography (high ground, low ground), crop yield, field scouting data, remotely sensed images, and numerous other information sources that can be crop and location-specific (Ref: Precision Farming - Variable Rate Application).

Productivity & Adoption Estimates

0.16	0.68	0.16		
Productivity Improvement				
Early Adopters	Majority	Laggards	Industry Applicability	Impact Factor
0.05	0.03	0.01	32%	0.0095
0.05	0.03	0.01	100%	0.0300
0.05	0.03	0.01	97%	0.0292
0.05	0.03	0.01	83%	0.0250

High, medium, and low productivity impact estimates for each industry that uses GI

Impact Factor is the product of the adoption rates and industry applicability

Industry Applicability accounts for industry definitions that include both GI users and GI non-users

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Industry Size Proxy

Proxy for industry size:
Firms x Firm employment

Table 551-0005
Canadian business patterns, location counts, employment size and North American Industry Classification System (NAICS), national industries, by Canada and provinces, December 2
semi-annual (number)

	Total, all sizes	Indeterminat	Total with em	1 to 4 employ (2.5)	200 to 499 em (349.5)	500 and plus e (500)	Industry Size Proxy	Geomatics Applicability
Total, all industries	2,685,366	1,485,009	1,200,357	664,770	6,585	2,731	17,007,815	
Soybean farming [111110]	4,057	3,609	448	372	0	0	1,630	32%
Oilseed (except soybean) farming [111120]	12,300	9,825	2,475	2,208	0	0	8,072	
Dry pea and bean farming [111130]	1,219	968	251	221	0	0	855	
Wheat farming [111140]	9,131	8,010	1,121	1,022	0	0	3,663	
Corn farming [111150]	4,823	3,785	1,038	835	0	0	4,121	
Rice farming [111160]	7	7	0	0	0	0	-	
Other grain farming [111190]	23,649	18,893	4,756	4,094	0	0	17,232	
Potato farming [111211]	1,262	442	820	229	0	0	10,457	
Other vegetable (except potato) and melon farming [111219]	2,162	922	1,240	494	2	0	19,400	
Orange groves [111310]	1	0	1	0	0	0	7	
Citrus (except orange) groves [111320]	12	5	7	4	0	0	31	
Non-citrus fruit and tree nut farming [111330]	4,367	1,907	2,460	1,257	0	1	27,014	
Mushroom production [111411]	174	68	106	31	6	0	4,825	
Other food crops grown under cover [111419]	760	243	517	172	1	0	10,638	
Nursery and tree production [111421]	2,156	945	1,211	584	2	0	16,277	
Floriculture production [111422]	1,669	523	1,146	360	6	1	20,590	
Tobacco farming [111910]	505	222	283	53	0	0	3,228	
Cotton farming [111920]	2	2	0	0	0	0	-	
Sugar cane farming [111930]	2	0	2	2	0	0	5	
Hay farming [111940]	5,908	4,937	971	851	0	0	3,518	
Fruit and vegetable combination farming [111993]	1,238	706	532	304	0	0	5,244	
Maple syrup and products production [111994]	2,501	1,697	804	556	1	0	5,451	
All other miscellaneous crop farming [111999]	9,998	8,245	1,753	1,288	0	0	10,995	

Portion of industry using GI

Some sub-industries do not use GI

Government Structure

StatsCan breakdown of government (federal and provincial) is limited. As a proxy, government productivity impacts have been allocated to departments based on budget size.

GS911A00	Other federal government servi	911A						30,144.0
	Agriculture and food	*Biomass inventory mapping and analysis* *Canada land inventory* *Soils mapping* *Crop inventorying* *Agroclimate impact reporting*	*0.05*	*0.03*	*0.01*	*1*	*0.0300*	*337.4*
	Fisheries	*Habitat mapping and fisheries m*	*0.05*	*0.03*	*0.01*	*1*	*0.0300*	*244.7*
	Natural resources	*Geological mapping* *Storing geophysical data* *Forestry inventorying* *Wildland fire monitoring* *Biodiversity monitoring*	*0.05*	*0.03*	*0.01*	*1*	*0.0300*	*380.4*
	Safety and security	*Search and rescue operations* *Policing operations* *Managing emergencies*	*0.05*	*0.03*	*0.01*	*1*	*0.0300*	*801.7*

Department

Applications

Productivity and Adoption

GDP allocation (see Government Budgets worksheet)

National Initial Impact Estimates

Canada GDP	Canada Impact
15,217.0	**456.5**
3,890.0	**116.7**
1,066.0	**32.0**
2,457.0	**61.3**

National Impact by Industry =
Impact Factor (see Impact worksheet) X
Industry GDP (see GDP Canada worksheet)

Regional Initial Impact Estimates

BC Impact	Prairies Impact	Ontario Impact	Quebec Impact	Atlantic Impact	Northern Impact	Regional Impact Variance
19.3	263.3	88.2	55.6	10.7	-	4%
51.7	13.8	12.4	28.1	11.3	0.0	0%
3.4	0.3	0.9	2.0	26.4	0.1	-4%
16.7	14.1	12.2	11.5	3.5	0.6	4%

Regional Impact by Industry = Impact Factor (see Impact worksheet) X Industry GDP (see GDP Prov worksheet)

Due to data suppression by StatsCan, regional calculations do not sum to the national calculations. The variance is shown here.