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CANADIAN GEOSPATIAL DATA INFRASTRUCTURE
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Assessment Report for the Canadian Geospatial Data Infrastructure - Executive Summary and Case Studies

Goss Gilroy Inc.

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Canada

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[1] The performance assessment of the Canadian Geospatial Data Infrastructure (CGDI) was independently performed by Goss Gilroy Inc. using the CGDI assessment framework developed by GeoConnections and reviewed by international SDI experts.

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Executive Summary

This report presents a performance assessment of the Canadian Geospatial Data Infrastructure (CGDI). As such, it builds on work undertaken by GeoConnections that has resulted in a definition, vision, mission, roadmap and performance assessment framework for the CGDI. The report will be used by GeoConnections and stakeholders to identify gaps and priorities for CGDI investment and to communicate Canada's spatial data infrastructure (SDI) status. This assessment is one step within GeoConnections' five-step CGDI performance project, which will conclude with a CGDI assessment and status report due in 2015.

GeoConnections is a national initiative led by Natural Resources Canada (NRCan). For more than a decade (1999 to present), GeoConnections has coordinated a national effort to build the CGDI, also referred to as Canada's spatial data infrastructure. As the 2012 CGDI Vision, Mission, and Roadmap states, "The CGDI helps Canadians gain new perspectives into social, economic and environmental issues, by providing an online network of resources that improve the sharing, use and integration of information tied to geographic locations in Canada."[2]

The CGDI can be considered "the technology, standards, access systems and protocols necessary to harmonize all of Canada's geospatial data bases, and make them available on the Internet. Geospatial databases include: topographic maps, air photos, satellite images, nautical and aeronautical charts, census and electoral areas, forestry, soil, marine and biodiversity inventories."[3]

The CGDI is characterized in Exhibit 1 below, which illustrates its components and guiding principles. The components of the CGDI are the policies, standards, technologies and framework data. The CGDI is tied together through collaboration and partnerships. The guiding principles of the CGDI are:

- **Open:** To enable better decision making, the CGDI is based on open, barrier-free data sharing and standards that allow users to exchange data.
- **Accessible:** The CGDI allows users to access data and services seamlessly, despite any complexities of the underlying technology.
- **Evolving**: The network of organizations participating in the CGDI will continue to address new requirements and business applications for information and service delivery to their respective users.

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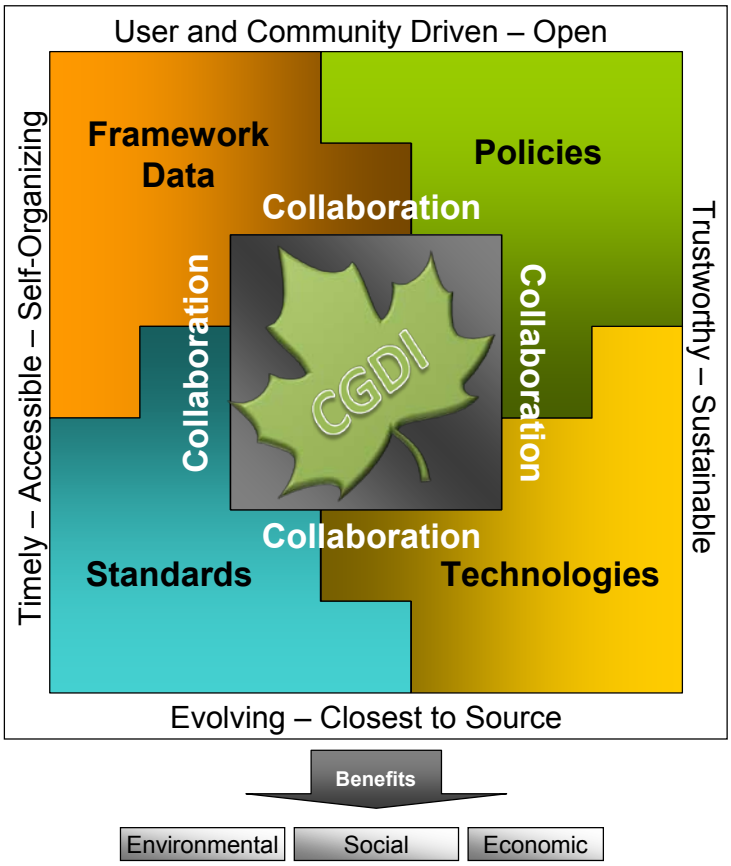
2 GeoConnections. (2012). Canadian Geospatial Data Infrastructure Vision, Mission and Roadmap - The Way Forward.

3 Natural Resources Canada. (n.d.). The Canadian Geospatial Data Infrastructure - Overview.

- **Timely:** The CGDI is based on technologies and services that support timely or real-time access to information.
- **Sustainable:** The CGDI is sustained by the contributions of the participating organizations and broad user community and through the infrastructure's relevance to these groups.
- **Self-organizing**: The CGDI enables various organizations to contribute geospatial information, services and applications, and guide the infrastructure's development.
- **User and community driven**: The CGDI emphasizes the nurturing of and service to a broad user community. These users, including Canadians in general, will drive the CGDI's development based on user requirements.
- **Closest to source**: The CGDI maximizes efficiency and quality by encouraging organizations closest to source to provide data and services. Thereby eliminating duplication and overlap.
- **Trustworthy:** The CGDI is continually enhanced to protect sensitive and proprietary data. The CGDI offers this protection through policies and mechanisms that enable data to be assessed for quality and trusted by users.

Exhibit 1: Components and guiding principles of the CGDI[4]



In 1999, the Government of Canada (GoC) invested $60 million in a five-year initiative (GeoConnections, Phase I), aimed at making the riches of Canada's geospatial information—a public asset—accessible to all.[5] From 1999 to 2005, GeoConnections' partners and stakeholders laid the foundation for the CGDI. The concept focused on the Internet as a platform for sharing geospatial data and creating a distributed network in which each data provider could control and update its own information. High priorities included developing strong partnerships, establishing an inclusive governance structure and promoting the development and adoption of standards that would enable interoperability—the ability to share and compare different data sets.

4 GeoConnections. (2012). Canadian Geospatial Data Infrastructure Vision, Mission and Roadmap: The Way Forward.

5 GeoConnections. (2009). A Framework for the Sustainability of the Canadian Geospatial Data Infrastructure.

Since 2006, the CGDI's backdrop has been changing rapidly. New business models, such as the Wiki or Web 2.0 model, have emerged on the Internet. As well, the explosion of "mass market geomatics"—geomatics-based products and services for consumers, such as Google Earth™/Maps, MapQuest™ and services based on the global positioning system (GPS)—have significantly raised public awareness of geospatial information. This explosion has also increased expectations about the availability, level of detail, currency and ease of use of geospatial information. Governments and other data providers are increasingly challenged to meet these expectations.

In 2005, the federal government renewed GeoConnections' funding for an additional five years. Phase II of GeoConnections promoted the CGDI in four priority areas: public health, public safety and security, sustainable development and the environment, and matters of importance to Aboriginal peoples.

In 2010, the GoC announced a renewed commitment for GeoConnections[6] and provided $11 million in funding over two years. In 2011, the Government extended the original two-year allocation of funding for Phase III to five years (2010-2015) and increased the allocation from $11M to $30M, allowing GeoConnections to continue to "provide consolidated geographic-related information to Canadians via the Internet"[7]. To accomplish this goal, GeoConnections will have to ensure that the CGDI is continually updated to align with the rapidly evolving Internet platform and policies by 2015.[8] GeoConnections believes that it can maintain Canada's international geomatics leadership throughout this period.

By reducing "barriers to using geospatial information so that Canadians can discover, access, visualize, integrate, apply and share quality location-based information and make effective decisions"[9], the CGDI has the potential to significantly contribute to enhanced decision making.

The CGDI is intended to improve decision making within all levels of government, the private sector, non-governmental organizations and academia. The CGDI *enables* users to access and easily integrate the most current and accurate geospatial information in databases distributed across Canada, as well as around the world. The CGDI does not *house or store* this content. Rather, it provides an infrastructure that allows a diverse community to access and share information directly from authoritative sources by capitalizing on common standards.

As part of the CGDI Performance Project, a CGDI assessment framework was completed by NRCan. In preparing the framework, NRCan staff conducted extensive research and reviewed best practices and criteria used to assess other national SDIs. The completed framework was

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6 http://www.GeoConnections.NRCan.gc.ca

7 Canada's Economic Action Plan: Year 2, Budget 2010: Leading the Way on Jobs and Growth (2010), p.119,

8 Please note: 2015 was stated as the original target deadline for the alignment of platforms and policies within the original Treasury Board Submission (2010); however, the date has since changed to *2019*.

9 GeoConnections. (n.d.). Overview / Backgrounder: CGDI Vision, Mission and Roadmap Project.

reviewed by international SDI experts. The completed assessment framework consists of five components:

- Collaboration and leadership;
- Availability and accessibility of policy resources;
- Availability and accessibility of standards;
- Availability and accessibility of technologies; and,
- Availability and accessibility of framework data.

The CGDI Performance Assessment was completed using the assessment framework and criteria developed by NRCan. In all, 47 criteria were assessed. The discussion below summarizes the results for each of the above-noted components. The overall assessment by section is then supported by a more detailed analysis of performance in the annex attached to this Executive Summary. The analysis was conducted using the following levels of the performance assessment framework, namely:

- CGDI components (e.g., collaboration, operational policies, technical and data standards, technology and framework data)
    - Performance results by CGDI components
        - Performance indicator(s) by performance result
            - Criteria by performance indicator

Within the framework, each of the five components are associated with anticipated performance results. Specifically developed performance indicators specify the evidence required to demonstrate how anticipated results are fulfilled. More specific criteria have been identified to demonstrate how these performance indicators were addressed.

A qualitative scorecard rates CGDI performance in terms of three categories:

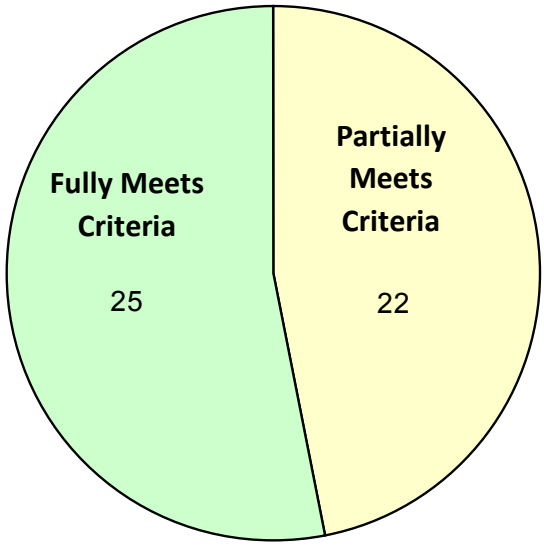
- Fully meets the criteria (green);
- Partially meets the criteria (yellow); or
- Does not meet the criteria (red).

In some cases, qualification has been added by the performance assessment team as to whether gaps are evident (e.g., lack of policies or standards) or whether the response is a matter of improving an existing performance criterion.

The performance assessment was completed based on documents and literature supplied by NRCan and a review of internet information. The information available to analyze each criterion varied significantly. In many cases, the level of evidence was significant, but in others, it was limited.

Overall, of the 47 criteria established in the performance assessment framework, the assessment found that there was evidence to fully meet performance indicator expectations or there was evidence to partially meet performance indicator expectations - with 25 fully meeting the criteria and 22 partially meeting the criteria (Exhibit 2).

Exhibit 2: Number of Performance Assessment Criteria Met or Partially Met



This report is not intended to be a program evaluation. Rather, it is intended to assess progress in the development and use of Canada's SDI. The output will be applied to help identify gaps and priorities for CGDI investment until 2015 and to communicate Canada's SDI status.

Conclusions

The CGDI has met the performance assessment criteria to a large extent, although gaps still remain. The following presents the conclusions of the performance assessment for each of the five expected outcomes by component. Please refer to the Annex entitled *Summary of Performance Assessment for the CGDI* for an overview of the performance assessment. For further details, please refer to the separate report entitled *Assessment of the Canadian Geospatial Data Infrastructure (CGDI)*.

> ***Collaboration and Leadership:*** *Overall, the study concluded that the criteria have been largely met in this area, with some exceptions.*

The study concluded that:

- There is an identified **leader/champion**, GeoConnections. However, although GeoConnections has a documented federal mandate to coordinate the CGDI on behalf of federal stakeholders, no legislative framework supports its role. GeoConnections has promoted the adoption of domestic and international standards, policies, technologies and framework data through its collaboration with and membership in a number of councils and organizations focused on geospatial issues.
- GeoConnections has a clear business model and is in the process of finalizing and adopting a "Vision, Mission and Roadmap" document that is reviewed every five years. It also has sufficient funding until 2015.
- GeoConnections has initiated and promoted many initiatives in the past by funding projects that have promoted the adoption of CGDI policies, standards and technologies.
- The study also concluded that GeoConnections is involved in the promotion and exchange of international experience on behalf of Canadian stakeholders.

However, the study also concluded that:

- Overall governance of the CGDI is unclear and somewhat fragmented in Canada. There are a number of committees and government bodies, but their linkages and authorities are not always clearly specified. The Canadian Council on Geomatics has the clearest role in terms of overall authority for sharing information among the federal and provincial sectors.
- Although much has been accomplished through the efforts of GeoConnections and its stakeholders, gaps exist in the monitoring and reporting of CGDI activities, especially outside the federal sector.
- As geospatial technologies and standards evolve rapidly, the geomatics community will continue to need a coordinating body such as GeoConnections after 2015. However, GeoConnections funding could be discontinued because of changing government priorities and the lack of legislation.

Recommendations for Collaboration and Leadership:

- *R.1: GeoConnections should strengthen its ability to monitor and report on Canadian SDI activities at a detailed level to understand the adoption of policies and standards.*
- *R.2: GeoConnections should work with other CGDI stakeholders to ensure that a coherent governance structure is established and communicated to all stakeholders.*
- *R.3: GeoConnections should seek assurance of adequate funding after 2015, in collaboration with other CGDI stakeholders.*

Availability and Accessibility of Policy Resources: *Overall, the study concluded that the criteria have been largely met in this area, with some exceptions.*

The study concluded that:

- Policy resources have been developed in a number of areas; however, some gaps have yet to be addressed.
- The Government of Canada and some of the provinces have progressed toward establishing portals for access to open data. Likewise, some municipalities have also progressed toward establishing open data portals.
- Many institutions, including universities, show a notable trend toward sharing data.

The study also concluded that:

- CGDI policies align well with international policies.
- There are capacity-development resources (such as training, guidelines, web publications, workshops and webinars) with respect to operational policies.
- There is also some evidence of the use of geospatial operational policy resources.
- Operational policies and guides consider user needs and feedback.

However, the study also noted some criteria weaknesses:

- No overall institutional mechanisms promote and ensure the development, introduction and adoption of operational policies.

Recommendation for Availability and Accessibility of Policy Resources:

- R.4: GeoConnections should strengthen its ability to monitor the adoption of policies and review ways for improving the institutional mechanisms that can promote adoption by users of operational policies and best practices.

Availability and Accessibility of Standards: *Overall, the study concluded that the criteria have been largely met in this area; however, some areas need additional effort.*

The study concluded that:

- Geospatial standards have been adopted in Canada to support geospatial data and service interoperability.
- CGDI standards support application and system interoperability within the Government of Canada, nationally across Canada and internationally.
- CGDI interoperability requirements have influenced the development and setting of international standards by participating in international forums.
- More effort is needed to provide information and implementation guidance on standards.
- Users have provided substantial feedback and input for the development of standards.

However, the study also concluded that:

- There is no overall process to monitor how CGDI stakeholders adopt and apply technical and data standards.
- Although several domestic and international bodies are involved in introducing, developing and reviewing technical and data standards, Canada's process of adopting standards is both unclear and fragmented among a number of entities.

Recommendation for Availability & Accessibility of Standards:

- *R.5: GeoConnections should strengthen its ability to monitor the adoption of standards and review ways for improving the institutional mechanisms that can promote the adoption of standards.*

Availability and Accessibility of Technologies: *Overall, the study concluded that the criteria have been substantially met in this area with some exceptions.*

The study concluded that:

- A number of portals exist for the discovery, access and dissemination of location-based information predicated on an architecture model.
- Tracking of user needs and feedback is ongoing.
- There are efforts to build technology capacity in CGDI stakeholders.
- Guidance documents are available to support the tools available.

However, the study also concluded that:

- There is a lack of mechanisms to monitor the implementation of technology tools.
- While the technology is currently aligned with existing needs, there is a need to adapt and keep up with the rapidly evolving internet and technology environment.

Recommendation for Availability and Accessibility of Technologies:

- R.6: GeoConnections should strengthen its ability to monitor the adoption of technologies. In addition, GeoConnections should ensure that it has the capacity to adapt and keep up with the rapidly evolving internet and technology environment.

Availability and Accessibility of Framework Data: *Overall, the study concluded that the criteria have been substantially met in this area.*

The study concluded that:

- Complete and current data themes are available.
- Spatial data themes are being integrated.
- Suppliers have data sharing agreements.
- There are coordinated data collection, data quality control, and data maintenance and updating processes.

Annex A: Summary Performance Assessment for the CGDI

1.0 Collaboration/Leadership

A: Has an identified leader/champion been identified?

A.1: There is an identified leader and/or coordinating body to coordinate the ongoing maintenance and evolution of the CGDI.	With respect to the federal government, there is evidence of a formal assignment and acceptance of a leadership role by NRCan and GeoConnections in the internal government budget submissions, the NRCan Mapping Information Branch (MIB) operational plan, the NRCan Program Activity Architecture and the GeoConnections business plan. In addition, the Geomatics Accord (2007) accepts GeoConnections as the Secretariat and coordinating body for many of the activities undertaken by the Canadian Council on Geomatics (CCOG). GeoConnections is also Canada's official representative to international bodies dealing with spatial data infrastructures. **Assessment: Fully meets criteria**
A.2: The identified leader and/or champion has a mandate to coordinate via legal instrument (laws, policies, directives).	Canada does not possess a legislative framework governing geomatics, and as a result, no specific legal instruments regulate geomatics activities. Rather, geomatics activities must comply with a number of general purpose laws and regulations. The Canadian Geomatics Accord (2007) coordinates some geomatics activities nationally, and these activities are overseen by the Canadian Council on Geomatics. But no overall governance structure covers all CGDI components and all stakeholders. The lack of legislation makes it difficult to take a standard approach to geomatics, and thus forces agreement through collaboration and consensus. Within the federal sector, geomatics activities come under a number of Treasury Board (TB) policies and standards, notably the Treasury Board Standard on Geospatial Data (2009), which must be implemented by all federal departments and agencies by 2014. **Assessment: Partially meets criteria—gaps evident**
A.3: The identified leader and/or coordinating body initiates, monitors and reports on SDI activities.	GeoConnections has helped initiate a number of SDI activities by funding projects and participating in several domestic committees. The following list includes monitoring activities for the CGDI and GeoConnections conducted throughout the three phases: 1. Annual reporting for GeoConnections programming during Phase I and II; 2. International-level reporting (e.g., the United Nations Committee of Experts on Global Geographic Information Management [UN-GGIM]); and 3. The development of results-based management accountability frameworks. Beyond the noted assessment activities, there is no systematic reporting of all CGDI (SDI) activities in Canada. **Assessment: Partially meets criteria—needs improvement**

A.4: The identified leader and/or coordinating body communicates, engages and promotes the CGDI with stakeholders.	Although recent evaluations and other studies identified communications as an area for improvement, this study observed that CGDI stakeholders have been highly engaged. This engagement is evidenced by the presence of stakeholder committees, including the Technology Advisory Group within Phase I and the management board and thematic advisory groups within Phase II. A documentation review also reveals that a significant number of communication and promotional activities for GeoConnections III and the CGDI are planned. **Assessment: Partially meets criteria—needs improvement**
A.5: The identified leader and/or coordinating body has a budget and clear business model to sustain it.	GeoConnections has a clear business model and funding to sustain the program until at least 2015[10]. The current program vision sees the CGDI completed by 2015, but as technology and user requirements evolve, GeoConnections may need further funding after 2015 to ensure that the CGDI continues to meet new needs. **Assessment: Fully meets criteria**
A.6: There are adequate resources within the coordinating body for the ongoing coordination of the CGDI.	GeoConnections' funding is in place until 2015. There is a risk, however, that the absence of a legislative mandate for GeoConnections could result in funding being cut or eliminated to the detriment of the CGDI. Continued funding may be needed to keep pace with constantly changing user needs and technologies. **Assessment: Partially meets criteria—gaps evident**

B: There is a vision and strategy for CGDI.

B.1: There is a Vision for the CGDI.	Since 2001, the GeoConnections program has had an official vision and mission statement for the CGDI. GeoConnections updated the vision and mission statement in 2005 and did so again in 2012 to reflect the changing demands of and opportunities for the CGDI. **Assessment: Fully meets criteria**
B.2: There is a strategy for the CGDI.	GeoConnections has also developed a strategy for the CGDI, which is included with its Vision, Mission and Roadmap document of 2005. GeoConnections updated this strategy in 2012. **Assessment: Fully meets criteria**
B.3: CGDI stakeholder roles and responsibilities in the SDI are articulated within the vision/strategy.	A number of stakeholders are interested in the CGDI; however, their roles are not explicitly articulated in the vision and strategy. **Assessment: Partially meets criteria—gaps evident**
B.4: The vision or strategy is aligned with federal government priorities.	The CGDI vision and strategy align with federal priorities. **Assessment: Fully meets criteria**

[10] According to the following documents: GeoConnections. (2012). Canadian Geospatial Data Infrastructure Vision, Mission and Roadmap - The Way Forward. http://www.GeoConnections.NRCan.gc.ca; and Natural Resources Canada. (2010). Annex B. Program Design and Governance. GeoConnections Program.

C: Commitment and engagement of stakeholders.

C.1: There is evidence of commitment and engagement of CGDI stakeholders through structured and formalized networks.	Evidence suggests that CGDI stakeholders have been consistently committed and engaged throughout GeoConnections' three phases: **Phase I:** Stakeholders showed commitment by establishing partnerships during the early stages of GeoConnections and the CGDI. **Phase II:** Stakeholders were committed by joining various boards and committees (e.g., Thematic Advisory Boards, Data Management Board and a Technical Advisory Network). **Phase III** (current phase): Stakeholders are currently committed and engaged through structured and formalized networks such as CCOG, the GeoBase Steering Committee and the Federal Committee on Geomatics and Earth Observations (FCGEO). **Assessment: Fully meets criteria**
C.2: CGDI stakeholder strategies align with the CGDI strategy.	CGDI stakeholder strategies align with the CGDI strategy. **Assessment: Fully meets criteria**

D: Linkages to international organizations.

D.1 There is evidence of promotion and/or exchange of experience with international organizations.	Evidence indicates an exchange of Canadian experience with international organizations: Canadian stakeholders are involved in all of the key international geomatics organizations. **Assessment: Fully meets criteria**

2.0 Availability and Accessibility of Policy Resources

A: There are policy resources in place that address common geospatial operational issues within Canada.

A.1: There is operational policy guidance including information on best practices.	The assessment found that policy resources have been developed in a number of areas, listed below. However, a recent study (Operational Policies Needs Analysis[11]) completed by Hickling Arthurs Low in March 2011 and the Geospatial Operational Policy Roadmap Research 2012-2015 [12] both found gaps that have to be addressed. **Assessment: Partially meets criteria—gaps evident**
A.2: There are national open data policies.	The Government of Canada Open Data Portal ((www.data.gc.ca—announced in March 2011) is a collaborative effort that involves Government of Canada departments and agencies. The goal of this portal is to enable citizens, businesses and communities to access and leverage government-managed data. **Assessment: Fully meets criteria**
A.3: There are open data policies within provincial, territorial and municipal jurisdictions.	A number of provinces, territories and municipalities are in the early stages of establishing open data initiatives. Most of the provinces now provide some open access to data. In addition, some municipalities have also developed open data policies. **Assessment: Partially meets criteria—needs improvement**
A.4: There are data-sharing arrangements other than open data policies.	The Government of Canada Open Data Portal is the product of efforts to promote the sharing of data collected once and to make this data available to governments and the public. The GoC Open Data pilot project is meant to enhance access to government datasets by providing a "single-window" to data published by departments and agencies on their public websites. Each province and many municipalities also provide open data policies. The Association of Canadian Map Libraries and Archives reports that while some geospatial data is freely available in Canada, many institutions have entered into agreements with providers of licensed spatial data for academic use at no cost. **Assessment: Partially meets criteria—limited information was available**

B: There are international policy resources that promote interoperability from a policy perspective internationally.

B.1: CGDI policies align with international policies.	International policy resources that promote interoperability are available. Reviews of international operational policy issues and practices conducted by Hickling Arthurs Low (2011 and 2012) found that Canadian operational policies align well with international practice. **Assessment: Fully meets criteria**

[11] GeoConnections and Hickling Arthurs Low. (2011). Final Report: CGDI Operational Policy Needs Analysis.

[12] GeoConnections and Hickling Arthurs Low. (2012). Geospatial Operational Policy Roadmap Research 2012-2015.

C: CGDI stakeholders are able to access and are using policy resources on operational issues.

C.1: There is evidence of the use of geospatial operational policy resources.	Operational policy resources have been developed in Canada since 1999. There is evidence that operational policy resources developed by GeoConnections are being accessed through the GeoConnections website. There is limited indication, however, whether applications developers and geospatial data users are applying operational policy resources and best practices. **Assessment: Partially meets criteria—limited information available**
C.2: There is evidence of availability of capacity development resources with respect to operational policy.	There is evidence that investments have been made in operational policy capacity development resources, such as webinars, seminars, websites and other information sources. GeoConnections has provided much of the capacity development, but universities and private sector entities also provide some capacity development. However, little of this development focuses on operational policy. **Assessment: Fully meets criteria**

D. There are mechanisms and a process established for the introduction and development of geospatial policies that enable the CGDI.

D.1: There are Canadian mechanisms and/or institutional arrangements and a process for the introduction, development, review and adoption of geospatial operational policies.	There is no specific mechanism or institutional arrangements within Canada for the introduction, development, review and adoption of geospatial operational policies. **Assessment: Partially meets criteria—gaps evident**

E: There are mechanisms in place to monitor implementation of the established operational policy resources by CGDI stakeholders.

E.1: Description of mechanisms	There are no formal mechanisms to monitor the implementation of operational policy resources by CGDI stakeholders; however, there is ad hoc reporting at conferences, through webinars and through occasional reports. **Assessment: Partially meets criteria—gaps evident**
E.2: User needs and feedback is integrated into the policy development process.	GeoConnections has made a number of efforts to obtain user needs and feedback for policy development. **Assessment: Fully meets criteria**

F: User needs and feedback are integrated into the policy development process.

F.1: There is a user requirements guide to support the development of policy resources	GeoConnections, on behalf of NRCan, has proactively supported user needs assessments—in particular with regards to needs for operational policies. **Assessment: Fully meets criteria**

3.0 Availability and Accessibility of Standards

A: Common technical and data standards are in place that allow diverse geospatial data sources, services, applications and systems to operate with each other both domestically and internationally.

A.1: There are geospatial standards that support geospatial data interoperability	There is evidence that geospatial standards have been adopted in Canada to support data interoperability. Canada follows the acknowledged international digital mapping standards developed collaboratively by both the Open Geospatial Consortium (OGC) and the International Standards Organization (ISO), as well as by the U.S. Federal Geographic Data Committee (FGDC). **Assessment: Fully meets criteria**
A.2: There are geospatial standards that support geospatial service interoperability.	There is evidence that geospatial standards have been adopted in Canada to support geospatial service interoperability. A key attribute of the CGDI is its set of standards-based services that enable access to geospatially-referenced data. **Assessment: Fully meets criteria**
A.3: There are standards that support application and/or system interoperability • in the GoC; • nationally throughout Canada (i.e., between levels of government or the same level of government); and • internationally.	There is evidence that application and system interoperability are supported by standards in the GoC, nationally across Canada, and internationally. In particular, the Treasury Board Standard on Geospatial Data strongly supports interoperability among federal government departments and agencies. **Assessment: Fully meets criteria**
A.4: There is evidence of CGDI influence on international standards.	There is evidence of CGDI influence on international standards, as Canada is actively involved in international standard setting. **Assessment: Fully meets criteria**

B: CGDI stakeholders are able to access and are using information and guidance on the implementation of the technical/data standards.

B.1: There is guidance documentation and training to support technical and data standards implementation.	Although information and support on standards implementation are available, more could be done to guide CGDI stakeholders about using standards. **Assessment: Partially meets criteria—needs improvement**
B.2: There are capacity development resources available with respect to standards use.	While some capacity building with respect to standards use has been undertaken, more could be done. **Assessment: Partially meets criteria—needs improvement**

C: There is a clear process and institutional arrangements in place for the introduction, development, review and adoption of technical and data standards that enable the CGDI.

C.1: There is a mechanism and a clear process for the introduction, development, review and adoption of technical and data standards.	There is clear evidence of several domestic and international bodies involved in the introduction, development and review of technical and data standards (e.g., TB, Canadian General Standards Board [CGSB], CCOG, OGC, ISO); however, we were unable to identify evidence of and a clear process related to standards adoption. Nevertheless, a number of initiatives encourage adoption of standards. **Assessment: Partially meets criteria—needs improvement**
C.2: Institutional arrangements are in place to manage technical and data standards introduction, development, review and adoption processes.	Evidence suggests that institutional arrangements are in place for the introduction, development and review of technical and data standards and that the federal government plays a key role in these arrangements. However, the process is complex and distributed because various players have specific roles covering certain standards and/or areas of the CGDI. **Assessment: Partially meets criteria—needs improvement**
C.3: CGDI stakeholders are involved in the development, introduction, review and adoption of technical and data standards and processes.	There is clear evidence of CGDI stakeholder involvement in the technical and data standards introduction, development, review and adoption process; however, the communication of standards with stakeholders needs to improve. **Assessment: Partially meets criteria—needs improvement**
C.4: CGDI stakeholders have institutional arrangements in place to integrate standards into their business processes.	There is clear evidence that some CGDI stakeholders have institutional arrangements in place to integrate standards into their business processes. **Assessment: Partially meets criteria—limited information was available**

D: There are mechanisms in place to monitor the implementation of the established technical and data standards by CGDI stakeholders.

D.1: There is evidence of mechanisms in place to monitor the implementation of the established technical and data standards by CGDI stakeholders.	Treasury Board will assess how well federal government departments and agencies comply with its geospatial standard; however, there was little to no evidence that other CGDI stakeholders are monitoring the implementation of technical and data standards. **Assessment: Partially meets criteria—gaps evident**

E: User needs feedback is integrated in standards implementation process.

E.1: User requirements guide the implementation of standards.	There is evidence that user requirements guide the implementation of standards. Standards bodies seek input from users on standards development, and GeoConnections has obtained input on standards from surveying various user groups and commissioning a recent survey related to the 2012 CGDI Vision, Mission and Roadmap. Nonetheless, a number of challenges related to standards will need to be addressed in the near future, due to rapid changes in geomatics and its underlying technology. **Assessment: Partially meets criteria—needs improvement**
E.2: CGDI stakeholders are involved in the standards development process.	There is evidence that CGDI stakeholders are substantially involved in the standards development process. **Assessment: Fully meets criteria**

4.0 Availability and Accessibility of Technologies

A: There are technology tools in place that facilitate the discovery, integration, management, sharing, dissemination and visualization of and access to Canada's location-based information over the internet.

A.1: There are one or more portals for the discovery, access and dissemination of location-based information based on an architecture model.	A significant number of portals exist for the discovery, access and dissemination of location-based information predicated on an architecture model. **Assessment: Fully meets criteria**
A.2: CGDI technology is aligned with emerging internet and technology tools.	Although CGDI technology currently aligns with existing needs, there is a requirement to adapt to and keep up with the rapidly evolving internet and technology environment. **Assessment: Partially meets criteria—needs improvement**
A.3: User needs and feedback are being tracked.	There is considerable evidence of ongoing tracking of user needs and feedback. This evidence includes a number of GeoConnections surveys as well as traffic to the GeoConnections website. **Assessment: Fully meets criteria**

B: CGDI stakeholders are able to access and use information and guidance on the implementation of the technology tools.

B.1: Guidance documents are available to support the implementation of technology tools.	Guidance documents to support the implementation of technology tools are available; however, the withdrawal of the *Developer's Guide to the CGDI* has reduced the information available for developing and publishing geographic information, data and associated services. **Assessment: Partially meets criteria**
B.2: There is evidence of projects that build technology capacity.	Projects are underway to build technology capacity. These projects are being driven by federal government departments, provincial and territorial governments, municipalities and private organizations. **Assessment: Fully meets criteria**

C: There are mechanisms in place to monitor the implementation of the established technology tools.

C.1: The CGDI architecture model and tools are used in specific implementations.	While we found no evidence of monitoring mechanisms, there is evidence that the CGDI architecture model and tools are used in specific implementations. **Assessment: Partially meets criteria (limited information available)**

5.0 Availability and Accessibility of Framework Data

A: Data themes are available that are current and complete with accompanying documentation.

A.1: Data themes are available which are current and complete with accompanying documentation.	Considerable evidence suggests that data themes are available, current and complete and have accompanying documentation. **Assessment: Fully meets criteria**

B: Framework data themes are able to be integrated.

B.1: Spatial data themes are being integrated.	There is considerable evidence that spatial data themes are being integrated by users of geospatial information. **Assessment: Fully meets criteria**

C: There are mechanisms in place for the development and maintenance of national framework data themes.

C.1: There are data sharing agreements between suppliers.	There is evidence that suppliers have data sharing agreements. **Assessment: Fully meets criteria**
C.2: There is evidence of coordinated data collection, data quality control and data maintenance/updating process.	There is strong evidence of coordinated data collection, data quality control and data maintenance and updating processes. **Assessment: Fully meets criteria**

Annex B: Case Studies

Acronyms

AAFC	Agriculture and Agri-Food Canada
AANDC	Aboriginal Affairs and Northern Development Canada
API	Application Programming Interface
CAP-CP	Common Alerting Protocol—Canadian Profile
CCOG	Canadian Council on Geomatics
CCRS	Canada Centre for remote Sensing
CFS	Canadian Forest Service
CGDI	Canadian Geospatial Data Infrastructure
CIDM	Centre for Information Development Management
CIO	Chief Information Officer
CIP	Compliance and Implementation Plans
CISC	Communication Interoperability Strategy for Canada
CoP	Community of Practice
CSA	Canadian Space Agency
CSDGM	Content Standard for Digital Geospatial Metadata
CSS	Centre for Security Science
CTI	Centre for Topographic Information
DDS	Data Discovery Services
DND	Department of National Defence
DODAF	Department of Defense Architecture Framework
EC	Environment Canada
ECVs	Essential Climate Variables
EDXL	OASIS Emergency Data Exchange Language
EMBC	Emergency Management BC
EMO	Emergency Measures Organization
EMP	Emergency Measures Plan
EO	Earth Observation
EOSD	Earth Observation for Sustainable Development of Forests
FGDC	U.S. Federal Geographic Data Committee
GDAL	GeoBase Data Alignment Layer
GIS	Geographic Information System
GML	Geography Markup Language
GoC	Government of Canada
GPF	Geospatial Publishing Facility
GPS	Global Positioning System
GRIP	Government Related Initiatives Program
HTML	Hyper Text Mark-up Language
IACG	Inter-Agency Committee on Geomatics

IM	Information Management
ISO	International Organization for Standardization
IT	Information Technology
ITU	United Nations—International Telecommunications Union
LCCoP	Land Cover Community of Practice
LCCS	Land Cover Classification System
MAF	Management Accountability Framework
MASAS	Multi-Agency Situational Awareness System
MASAS-X	MASAS Information eXchange
MIB	NRCan's Mapping Information Branch
NAP	North American Profile
NFIS	National Forest Information System (Canadian)
NGO	Non-Governmental Organization
NHN	National Hydro Network
NIEM	National Information Exchange Model
NLWIS	National Land and Water Information Service
NRCan	Natural Resources Canada
OASIS	Organization for the Advancement of Structured Information Standards
OGC	Open Geospatial Consortium
SA	Situational Awareness
SAR	Search and Rescue
SDI	Spatial Data Infrastructure
SOREM	Senior Officers Responsible for Emergency Management
TB	Treasury Board
TBITS	Treasury Board Information Technology Standard
TBS	Treasury Board Secretariat
TC	Technical Committee
TNG	Tsilhqot'in National Government
TOGAF	The Open Group Architecture Framework
UN-FAO	Food and Agriculture Organization of the United Nations
URL	Uniform Resource Locator
WMS	Web Map Services
WWW	World Wide Web

1.0 Introduction

This Case Study Annex to the Assessment Report for the Canadian Geospatial Data Infrastructure (CGDI) contains four case studies, which were completed by the assessment team as part of the CGDI Performance Assessment. Highlighting applications, the case studies reveal how the CGDI's components and principles were applied to meet the needs of users associated with four different initiatives:

1. Implementation of the Treasury Board Standard on Geospatial Data
2. DataBC
3. Multi-Agency Situational Awareness System—MASAS
4. Canadian Land Cover Data Project

This document begins by describing how the case studies were developed. Next, it provides an overview of the CGDI components and guiding principles. The four case studies are then presented in Sections 2 through 5 in the order noted above.

Development of Case Studies

Developing the four case studies involved selecting criteria-based projects; reviewing background documents; interviewing project personnel, stakeholders and partners; and preparing case study reports.

The case study selection criteria for CGDI projects were proposed by GeoConnections as part of the Assessment Framework terms of reference. The projects were to be selected to "assess the use and benefits of the Canadian Geospatial Data Infrastructure (CGDI) from both [the] supplier and user perspectives."[13] More specifically, three projects were to be chosen as examples of "spatial data infrastructure usage" (e.g., policies, standards, tools and framework data) focused on key government priorities: federal (e.g., public safety and security) or departmental (e.g., Natural Resources Canada [NRCan]). These priorities include sustainable resource development in the forestry, mineral and energy sectors, as well as sustainable resource development in the North and/or economic benefits.

[13] GeoConnections. (2012). CGDI Assessment Framework Worksheet.

The following case study selection criteria were also established:

1. Two case studies were to be selected from the data supplier perspective including one from a federal government data supplier and one from a provincial/territorial government data supplier. These studies were to highlight the policies, standards and tools used to facilitate sharing geospatial data.
2. One case study was to be selected to demonstrate from the user perspective the data and/or services accessed through the CGDI.
3. The fourth case study was to be selected to highlight an example of "interoperability with international spatial data infrastructures" with a focus on cross-border interoperability, highlighting policies, standards and technology, as well as geospatial data sharing.

Based on the above criteria, GeoConnections selected the following projects for case studies in collaboration with Goss Gilroy Inc. (also depicted within Exhibit 1.1):

1. **Implementation of the Treasury Board Standard on Geospatial Data**
   - Lead organization: Treasury Board of Canada Secretariat
   - Criteria satisfied: "Spatial data infrastructure usage" (e.g., standards) and application of the principles of the CGDI in the federal context, especially using international standards ISO 19115 and 19128 as well as the North American Profile.

2. **DataBC**
   - Lead organization: Government of British Columbia
   - Criteria satisfied: "Provincial/territorial government data supplier which will highlight the policies, standards and tools used in order to facilitate the sharing of geospatial data."

3. **Multi-Agency Situational Awareness System (MASAS)**
   - Lead organizations: Defence R&D Canada – Centre for Security Science, Natural Resources Canada - GeoConnections, Public Safety Canada.
   - Criteria satisfied: "Key government priority such as Public Safety/Security", "interoperability with international spatial data infrastructures", as well as "from the user perspective."

4. **Canadian Land Cover Data Project**
   - Lead organization: NRCan, Mapping Information Branch (MIB).
   - Criteria satisfied: Key priority area for NRCan that includes "sustainable resource development in the forestry, mineral and energy sectors, as well as sustainable resource development in the North and/or Economic Benefits."

Exhibit 1.1: Cross Reference of Selected Case Studies with Established Criteria

Selected Case Studies	Case Study Selection Criteria					
	Spatial data infrastructure usage		Data supplier		User perspective	Interoperability with international spatial data infrastructures
	Federal	Departmental	Federal	Provincial Territorial		
Implementation of the Treasury Board Standard on Geospatial Data	X					
DataBC				X		
Multi-Agency Situational Awareness System (MASAS)	X				X	X
Canadian Land Cover Data Project		X				

Following the selection process, the consultants reviewed relevant project documentation[14], as well as interviewed ten relevant project personnel.

CGDI Components and Guiding Principles

The CGDI is composed of four key components and is governed by nine guiding principles. CGDI's four key components (framework data, policies, standards and technologies) all contribute toward providing Canadians with high quality location-based information, as follows:

1. "**Framework data**: The core data of the CGDI, framework data is the common, up-to-date, and maintained base of quality location-based data for all of Canada. This data provides context and reference to physical features and other types of information linked to geography. These datasets are the base mapping layers required to develop applications and are freely available for reuse. Framework data is the foundation upon which location-based information becomes spatially relevant to users.
2. **Policies**: Operational policies are essential to eliminating barriers and enabling users to exchange location-based information effectively and efficiently. These data policies address topics related to the lifecycle of location-based data (i.e. collection, management, dissemination, use) and make issues such as data access, quality, ownership and integrity easier to manage.
3. **Standards**: Technical and data standards allow diverse data sources, services, applications and systems to operate with each other. The CGDI is built upon international standards that allow it to work with other infrastructures in Canada and

[14] A list of references used to develop the case studies is included with each study.

around the world. This harmonization of standards is fundamental to ensuring the efficient exchange of location-based information.

4. **Technologies**: The CGDI uses a suite of innovative tools to provide a functional and accessible environment, which enables the development of systems and applications that integrate location-based information. The CGDI's open and flexible architecture continually adapts to the rapidly evolving internet. These technologies help users discover, access, integrate, share and disseminate Canada's location-based information.[15]"

The CGDI is defined by the following nine guiding principles:

1. **"Open**: To enable better decision making, the CGDI is based on open, barrier-free data sharing and standards that allow users to exchange data.
2. **Accessible**: The CGDI allows users to access data and services seamlessly, despite any complexities of the underlying technology.
3. **Evolving**: The network of organizations participating in the CGDI will continue to address new requirements and business applications for information and service delivery to their respective users.
4. **Timely**: The CGDI is based on technologies and services that support timely or real-time access to information.
5. **Sustainable**: The CGDI is sustained by the contributions of the participating organizations and broad user community and through the infrastructure's relevance to these groups.
6. **Self-organizing**: The CGDI enables various organizations to contribute geospatial information, services and applications, and guide the infrastructure's development.
7. **User and community driven**: The CGDI emphasizes the nurturing of and service to a broad user community. These users, including Canadians in general, will drive the CGDI's development based on user requirements.
8. **Closest to source**: The CGDI maximizes efficiency and quality by encouraging organizations closest to source to provide data and services. Thereby eliminating duplication and overlap.
9. **Trustworthy**: The CGDI is continually enhanced to protect sensitive and proprietary data. The CGDI offers this protection through policies and mechanisms that enable data to be assessed for quality and trusted by users.[16]"

[15] GeoConnections. (2012). Canadian Geospatial Data Infrastructure Vision, Mission and Roadmap - The Way Forward.

[16] ibid

Case Study Linkages with the CGDI

The four case studies align directly with the CGDI key components and guiding principles. This alignment contributes to the CGDI objective to "reduce barriers to using geospatial information so that Canadians can discover, access, visualize, integrate, apply and share quality location-based information and make effective decisions… within all levels of government, the private sector, non-governmental organizations, and academia."[17]

Each case study describes its linkage to the key components and guiding principles of the CGDI.

[17] ibid

2.0 Implementation of the Treasury Board Standard on Geospatial Data

Introduction

In 2006, the Chief Information Officer (CIO) of Treasury Board (TB) reviewed a number of submissions for geomatics applications from diverse departments. Given the increasing volume of expenditures on geomatics, the CIO asked for a briefing from the Inter-Agency Committee on Geomatics (IACG). In concert with the IACG, Treasury Board decided to support the development and implementation of a standard that would incorporate the the CGDI's principles, which include interoperability and sharing of geomatics datasets.

As a result, in 2009, the Treasury Board implemented the Standard on Geospatial Data for federal departments and agencies. This standard was meant to support the principles outlined in the Policy Framework for Information and Technology and the requirements of the Policies on Information Management and on the Management of Information Technology.

According to the Treasury Board documentation, the rationale for developing a standard was that "The Government of Canada and Canadians have made significant investment in geospatial data, infrastructures and services. To achieve reasonable returns on these investments, the geospatial data created, acquired or used by the Government of Canada needs to be maintained, preserved and made accessible in an efficient and effective manner.

"Standardized data from one source can easily be used with those from another. This interoperability will often produce richer and more useful information than a single data set can provide. The standardization that has been promoted by the GeoConnections program through the CGDI needs to be adopted within the Government of Canada in order to fully realize the benefits of this federally funded program[18]."

Preparing this case study involved reviewing documentation, researching on the Internet, and interviewing individuals at Treasury Board familiar with the development and current status of the Treasury Board standard.

The case study illustrates the application of a key component of the CGDI with respect to standards, i.e., "Technical and data standards allow diverse data sources, services, applications and systems to operate with each other. The CGDI is built upon international standards that allow it to work with other infrastructures in Canada and around the world. This harmonization of standards is fundamental to ensuring the efficient exchange of location-based information.[19]"

[18] Treasury Board Secretariat. (2010). Standard on Geospatial Data, Answers to Policy Suite Renewal Challenge Questions.

[19] GeoConnections. (2012). Canadian Geospatial Data Infrastructure Vision, Mission and Roadmap - The Way Forward.

The case study also illustrates the application of the key principles of the CGDI, which a federal standard is meant to achieve.

Case Study Background

Standard Development

GeoConnections developed the business case for the new TB standard. This standard calls for all departments under the purview of the TB to implement and comply with the International Organization for Standardization (ISO) standards 19115 and 19128.

The purposes of the standard are to:

- Help departments work together efficiently and effectively to manage geospatial data by ensuring that users can discover, evaluate and access geospatial data for sound decision making.
- Support the Government of Canada interoperability goals of "ensuring that digital information is accessible, shareable, and usable over time and through technological change"
- Support the principles in the Policy Framework for Information and Technology.

Departments will be assessed for compliance under their Management Accountability Frameworks (MAFs), Area 12 (information management): Compliance to the Standard on Geospatial Data. An assessment questionnaire assists departments in responding to their MAFs.

The Standard on Geospatial Data was developed and approved through a consultative process. The components of the standard, as well as the compliance and implementation plans (CIPs) for each ISO standard, were developed by the Geospatial Standards Working Group, with NRCan acting as the lead agency. Details about the development process and consultations with government departments, standards groups and external parties were provided in the CIPs.

GeoConnections provided extensive leadership and guidance in the development and implementation of the Standard on Geospatial Data, and a GeoConnections staff member currently chairs the Geostandard Interdepartmental Implementation Committee (GIIC).

Development and Implementation of a Standard

The TB Standard on Geospatial Data was developed over three years, starting in 2006. The following describes the key events in the process:

- A working group, with members from the IAGC, was established in March 2006;
- Subsequently, several working group meetings were supplemented by communications via e-mail and teleconferences;

- The primary working group output was compliance and implementation plans. These plans addressed the scope, phasing of implementation, cost estimates, etc.;
- Twenty-eight departments and agencies were formally consulted through a balloting process under the TB CIO Standards Program (formerly known as the Treasury Board Information Technology Standard [TBITS] process);
- The organizations that responded overwhelmingly supported the Standard on Geospatial Data;
- The working group successfully addressed all issues raised;
- TB and NRCan jointly developed responses to the "Policy Renewal Challenge" questions;
- The Treasury Board Standard on Geospatial Data was approved and became mandatory in June 2009.

The TB Standard on Geospatial Data is meant to help departments efficiently and effectively manage geospatial data and ultimately support program and service delivery. Responsibilities are defined at two levels:

1. ***Responsibilities of Managers and Functional Specialists:***
   - Apply ISO 19115 Geographic Information—Metadata; and,
   - Apply all of the elements of ISO 19128 Geographic Information—Web Map Server to both in-use and new geospatial data exposed as pictorial view via the internet using Web Map Service (WMS) technologies.

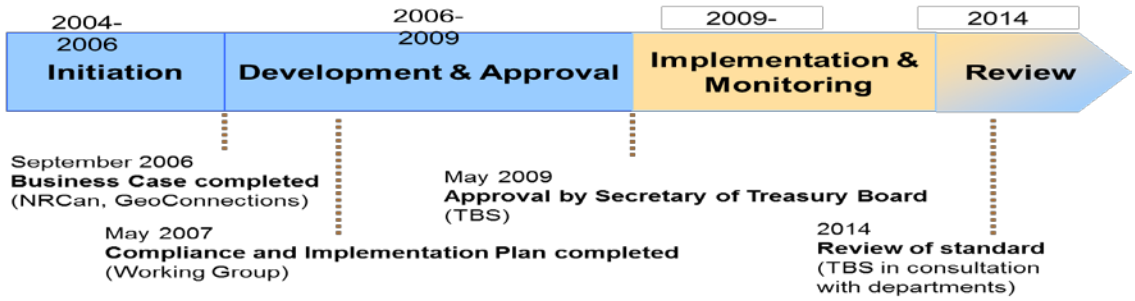
2. ***Responsibilities of Chief Information Officer:***
   - Ensure that geospatial software and systems acquired by the Government of Canada comply with this standard or are modifiable to comply with the standard. Geospatial software and systems are those used to create, edit, generate, parse, harvest, extract, index, browse or display and visualize metadata, maps or pictorial views of geospatial data.

The TB Standard on Geospatial Data was to be implemented over five years. The priorities for application were:

- Newly created data;
- New applications;
- In-use data; and,
- In-use applications.

A GeoStandards Inter-departmental Committee reconvened in the fall of 2009 to discuss and enhance the implementation, as well as to develop and share best practices. This standard represented a transition from previous standards (e.g., U.S. Federal Geographic Data Committee [FGDC] to Content Standard for Digital Geospatial Metadata [CSDGM]). Exhibit 2.1 outlines the implementation timeline for the TB standard.

Exhibit 2.1: Implementation Timeline for the TB Standard on Geospatial Data.



The Standard is issued under the authority of Section 7 of the Financial Administration Act by the Secretary of the Treasury Board, pursuant to Section 3.4 of the Policy on Information Management and Section 3.5 of the Policy on the Management of Information Technology.

In proposing the new standard, the Treasury Board[20] noted in its challenge document that "The Government of Canada and Canadians have made significant investment in geospatial data, infrastructures and services, with estimates amounting to $200 million per year invested by the federal government on geospatial data, infrastructures and services; with similar or greater levels of investment being made by provinces and territories. To achieve reasonable returns on these investments, the geospatial data created, acquired or used by the Government of Canada needs to maintained, preserved and made accessible in an efficient and effective manner."

The Treasury Board note[21][22] also indicated "the importance of the data to social, economic and cultural well-being not only for the Government of Canada, but also for the provinces and territories." TBS emphasized that "Geospatial data is meant to be widely available to support a

[20] Treasury Board Secretariat. (2010). Standard on Geospatial Data, Answers to Policy Suite Renewal Challenge Questions.
[21] Ibid
[22] Ibid

wide range of common public and private enterprises of broad benefit, and in the development, integration, and wide use of value-added innovations and applications."

TBS noted[23] that "To meet the principles of the CGDI, standardization is essential. The CGDI principles suggest that standardized data from one source should be readily usable by another user. This interoperability is a fundamental principle of the CGDI and will often produce richer and more useful information than a single data set can provide."

The Treasury Board also[24] noted that "The standardization that has been promoted by the GeoConnections program through the CGDI needs to be adopted within the Government of Canada in order to fully realize the benefits of this federally funded program."

The Standard on Geospatial Data is an important component of a coordination effort undertaken by the Inter-Agency Committee on Geomatics. This committee produced a Federal Geomatics Strategy[25] in 2007, which indicated that an overall standard would deliver efficiency and cost effectiveness by improving geomatics coordination in operational areas of the Government, including maintenance and standards.

The standards called for are:

- ISO19115 Geographic Information—Metadata comprises structured data about data, which is used to aid the identification, description, location or use of information resources. (Source: Government On-line Metadata Standard);
- ISO 19128 Geographic Information—Web Map Server Interface internet-based service that allows clients to display maps and/or images with a geographic component and whose raw spatial data files reside on one or more remote WMS servers. The WMS conforms to the Open Geographic Information system (GIS) Web Map Server Interface specification; and,
- The North American Profile of ISO19115 Geographic Information—Metadata (NAP—Metadata). The NAP extends standardization across national borders. In addition, the NAP provides the following features:
    - Fewer mandatory elements and more optional elements;
    - Extended elements and new elements to capture more specific information;
    - A hierarchical structure that creates "packages" of metadata that can be reused and combined to form new metadata records;
    - Support for the documentation of new geospatial data topologies and technologies including geospatial databases, web mapping applications, data models, data portals, ontologies, etc.; and,

[23] Ibid

[24] Ibid

[25] The Inter-Agency Committee on Geomatics. (May 2006). Coordinating Geomatics in the Government of Canada—Federal Geomatics Strategy and Policy.

- Suggested best practices for populating metadata elements in a manner that enhances the metadata's quality and usefulness.

Departmental Implementation

The following brief examples illustrate how Aboriginal Affairs and Northern Development Canada (AANDC), Natural Resources Canada, and Environment Canada are working to adopt the Standard on Geospatial Data by Treasury Board's 2014 deadline.

2.1 Aboriginal Affairs and Northern Development Canada

AANDC determined that implementing the TB geospatial standard would do the following:

- Assist managers and functional specialists responsible for creating or using geospatial data or for systems that use geospatial data;
- Support the implementation of the TB standard;
- Assist AANDC to align with the AANDC Geomatics Policy Directive (Centre for Information Development Management [CIDM] IM#27313) to provide reliable and authoritative geospatial information in support of AANDC business;
- Support the entire data management life-cycle; and,
- Lead to proper collection, storage, management, maintenance and dissemination of location-based information.

AANDC Applicability

AANDC decided to implement the TB standard in areas where the department is considered the data authority. Approximately 170 known geographic datasets fell under the criteria[26]. The types of data excluded are as follows:

- Geospatial data used by only one stakeholder and not shared across AANDC;
- All geospatial data provided by an external source such as NRCan; and,
- All geospatial data that is a work in progress or not ready to be available to others.

[26] Indian and Northern Affairs Canada. (2010). TBS Standard on Geospatial Data Implementation at INAC—Project Summary.

Project Approach

The project approach adopted by AANDC required:

- An analysis of the TB standard and its potential impact on AANDC;
- A defined methodology to capture essential metadata to meet TB requirements;
- Creation of a TB compliance strategy, including a short-term work plan to meet the implementation targets; and,
- Cooperative, interactive work with the AANDC Geomatics Community of Practice (CoP) and the AANDC regions.

A CoP web conference and teleconference kicked off the project. The project required a number of prior steps, however, one of which involved a data-gathering stage structured around the following questions:

- What forms and formats exist already?
- What, if any, metadata exist already?
- Who were the subject matter experts, the data authorities, and data custodians?

Once the inventory of data sets was completed, an assessment of available tools was carried out. These tools included GIS software with options for storing metadata in a database. AANDC'S next steps include:

- Improving communication of the TB standard beyond the geomatics CoP;
- Increasing distribution of the Metadata Operations Manual, with support to departmental data producers;
- Integrating the standard into the "Geomatics Directive" and Information Management (IM) Policy within AANDC;
- Reporting through MAF, Self, and peer review; and,
- Producing a Data Discovery and Dissemination Plan.

2.2 Natural Resources Canada

According to Natural Resources Canada[27], the department applies CGDI geospatial data standards in consultation and cooperation with:

- Federal, provincial and territorial governments;
- The private sector and academic community;
- Canadian standards committees (e.g., Canadian General Standards Board Committee on Geomatics and the Canadian Advisory Committee to Technical Committee [TC] 211); and,
- International Standards groups (e.g., ISO/TC 211, Open Geospatial Consortium Inc.).

Several NRCan sectors are involved with geomatics data including Canadian Forest Service, Earth Sciences Sector, Minerals and Metals Sector and Energy Sector.

The NRCan project approach featured a linkage to the NRCan Chief Information Office. It also required aligning with NRCan IM policy and, meeting the TB Standard on Geospatial Data Policy. To complete the work, NRCan had to assess required resources, categorize and specify requirements and conduct an inventory of products, services, tools and other resources.

The following describes the NRCan IM Policy Implementation Plan:

- February–March 2010: Awareness and training on NRCan Policy on IM;
- April 1, 2010: Implementation of the NRCan Policy on IM;
- April 2010–March 2011:
  - Additional guidance to employees regarding how they can implement the policy;
  - IM roles and responsibilities directive or guideline;
  - Registry of departmental classification structures;
  - Independent evaluation of NRCan collaborative technologies to determine if they have advanced NRCan business goals; and,
  - Government of Canada review of departmental libraries (Library and Archives Canada leading with NRCan participation).

[27] Natural Resources Canada. (2010). Treasury Board Standard on Geospatial Data: Overview and Guidance for implementation.

The milestones for NRCan were as follows:

- A detailed project plan was to be completed by June 2010;
- A coordinated approach for communications and change management was to be developed;
- Priority datasets were to be brought in alignment with an existing priority project (e.g., One Stop GeoPortal at the Earth Sciences Sector [on-going]; and,
- Phased implementation was to occur from 2010–2014.

2.3 Environment Canada

Environment Canada's (EC) responsibilities for geomatics data include areas such as

- Water;
- Air and soil;
- Flora and fauna;
- Collaborative work in renewable resources (our lakes, forests and oceans);
- Species at risk;
- Enforcement (environmental and wildlife protection laws); and
- Emergencies (involving a hazardous substance).

Separate geospatial dissemination initiatives do exist, but they presently require multiple servers, uniform resource locators (URLs) and entry points. As well, data discovery is possible, but not well organized. As a result, EC launched a metadata strategy to meet the TB requirements and to improve its management of geospatial data. The strategy objectives are to:

- Increase data interoperability and operations efficiency across and beyond EC;
- Become an efficient service provider of geospatial data via dynamic, "just-in-time" delivery based on international standards;
- Provide one place to find departmental data; and
- Provide the mechanisms for users to discover and departmental geospatial data.

Environment Canada reported that complying with the Treasury Board geomatics standard required the following:

- Approval of the Environment Canada Metadata Strategy in the fall of 2009. EC views standards-based metadata as a strategic resource that must be managed effectively; and
- Creation of an Advisory Committee on Geospatial Data and Tools Management.

Complying with this standard also involves the following ongoing activities:

- Evaluation of metadata creation tools;
- Pilot implementation of GeoNetwork;
- Establishment of a metadata discovery infrastructure; and,
- Establishment of a metadata coordination office responsible for education and training, advice, guidance and coordination.

EC reported improving the handling of its geospatial activities by doing the following:

- Consolidating its desktop GIS software licenses;
- Establishing a list of approved software;
- Establishing a Geospatial Data Repository as of June 2010. The repository enables geospatial practitioners to access authoritative, managed geospatial data collected or purchased by Environment Canada;
- Establishing a Geospatial Publishing Facility (GPF) in 2010/2011. This one-stop, centralized access point aids departmental data stewards in publishing their geospatial data in an easy and user-friendly manner. EC program teams will use the GPF to publish geospatial data to automate the creation of web services. The GPF will ensure integrity of geospatial data and metadata for authoritative publication via web services.
- Implementing a Data Sharing Agreement Repository in 2010/2011.

As a result of these improvements, the following internal guides and standards have also been completed:

- Esri User Guide and Helpdesk Support Guide—June 2009 (final);
- Standard on the Usage of Google Earth—November 2009; and
- Geospatial Discovery Strategy—March 2010 (first draft).

EC reports that future plans include providing:

- More license consolidation activities;
- A data sharing repository for tracking;
- More outreach;
- Education for staff at all levels and enforcing the requirements of the TB standard;
- Implementation of data standards to facilitate the use of data once it is shared
- Standardization of data-use agreements across EC.

Compliance with TB Policies and Standards

In 2011, the Treasury Board surveyed departments to assess progress to compliance with Treasury Board Policies and Standards. One aspect of the survey covered the organizations' planned activities to address requirements as outlined in IM policy instruments, including the Standard on Geospatial Data and the Standard on Metadata.

Nearly half of the 33 departments assessed reported on the degree to which they have adopted the TB Standard on Geospatial Data. Of the 16 departments reporting standard-related activity, only one department was compliant, and three had projects underway. The remaining departments were still assessing their options or had advanced to the planning stages. The Treasury Board will repeat this survey with a view that the departments will have progressed further by that time.

Lessons Learned and Challenges

Interviews completed for the Performance Assessment indicated the following lessons learned.

- ***The process for developing the TB standard and getting approval from TB is lengthy.*** Treasury Board explained that it developed the standard while the organization was reviewing its policies. This review delayed the standard. However, policy development in government inevitably leads to delay because new Treasury Board policies require many levels of approval.
- ***Once a standard is created, modifications or updating can also be lengthy.*** The Treasury Board process for approving a standard in the information management (IM) area requires a number of steps, challenge sessions and approvals. This complexity inevitably will lead to delays in modifying a policy. To get around this issue, TB has suggested having the policy refer to external standards that are not subject to TB review when revised.

The ***challenges*** that departments faced included the following:

- Deciding which holdings would come under the standard; and,
- Deciding what to do with older data assembled earlier and no longer compliant with the standard.

Benefits and Impacts

Standardized data from one source can easily be used with those from another. This interoperability will often produce richer and more useful information than a single data set can provide. The CGDI standards promoted by GeoConnections therefore need to be adopted within the Government of Canada to fully realize the benefits of this federally funded program[28]."

The TB adoption of a standard produced a number of positive outcomes:

- Departments less involved in geomatics became more aware of the tools, technologies and benefits of geomatics. These departments gained this awareness by meeting with more experienced departments—a part of implementing the TB standard;
- The federal government's adopting this standard will lead to users being able to share data easily;
- The standard ensures a common approach throughout government. This consistency should lead to common semantics and definitions; and,
- A standard should also lead to increased data sharing and hence reduced costs as data collection is required only once;
- In addition, once a standard is in place, the implementation tools require less customization.

[28] Treasury Board Secretariat. (2010). Standard on Geospatial Data, Answers to Policy Suite Renewal Challenge Questions.

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3.0 DataBC

Introduction

For more than two decades, the British Columbia (BC) government has ensured that the province's geospatial information remains up to date. Historically, GeoBC has been the governmental organization responsible for collecting and storing provincial geographic data. With the BC government's move to adopt "open data," BC moved the data management and spatial data infrastructure side of GeoBC[29] in July 2011 from the natural resource sector into a new central agency, DataBC[30]. The rationale for this move was that the success of a 'whole of government' open data initiative relied on managing and making data accessible for all ministries. Part of the Ministry of Labour, Citizens' Services and Open Government, DataBC is now the government's single open data portal for geospatial and non-geospatial data.

DataBC (and GeoBC) are an integral part of the CGDI. As a result, DataBC's architecture, standards and policies are consistent with CGDI. DataBC has contributed to the development of numerous complementary tools and technologies, such as Geographic Data Discovery Services, iMapBC, and HectaresBC.

Preparing the DataBC case study involved reviewing documentation, researching on the Internet, and interviewing a representative of the BC government familiar with DataBC and GeoBC.

Context

The BC government recognizes that geospatial information is a foundation for economic growth, public safety and environmental protection, as well for effectively delivering government programs. The province has therefore invested in consistent and reliable geospatial data management and access, starting with the establishment of the provincial base map and the BC Geographic Warehouse—an integrated repository of provincial data and services for data access. Since 2003, BC has provided a spatial data infrastructure (SDI), centered on the BC Geographic Warehouse.

Now part of BC's Integrated Land Management Bureau, GeoBC has been involved in managing the collection of geospatial data, technology and infrastructure to support government priorities largely within the natural resource sector. These priorities include environmental stewardship, emergency response, transportation and infrastructure, natural resources, economic development and land use decisions.[31]

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[29] http://geobc.gov.bc.ca/

[30] http://www.data.gov.bc.ca/

[31] Government of British Columbia. (2011). GeoBC to DataBC and Beyond.

GeoBC has been involved in two streams of activity: 1) base mapping and cadastre, which includes bringing data together to analyze it and create maps of BC's geography; and, 2) decision support, which involves managing the data, ensuring its safety, and making it easy for users to access the data.[32]

Description of DataBC

Structure and Organization

The complementary roles of DataBC and GeoBC are briefly defined below:

GeoBC

Located in the Integrated Land Management Bureau within the Ministry of Lands, Parks and Housing and the Land Acts, GeoBC has statutory responsibility (i.e., adjudications and applications) for geographic and land information under the Land Acts. GeoBC provides the geomatics base data and supports decision making concerning provincial land.[33,34]

A resource for decision support services and land-use planning for the natural resource sector, GeoBC also maintains the authoritative atlas map of BC's geography and key infrastructure such as roads, water resources and place names. In addition, GeoBC maintains maps of land ownership, holds BC's air photos and satellite imagery, and does the research necessary to determine land status, especially of Crown lands."[35]

DataBC

DataBC enables internal government and external users to find data, services, applications and tools to help make informed decisions, inspire change or develop ideas to improve government policies, which includes the *Geographic Data Discovery Service*.[36] DataBC is located within the Ministry of Labour, Citizens' Services and Open Government. DataBC offers all ministries the data management expertise and the spatial data infrastructure that matured in the natural resource sector and provides opportunities to lower data management costs across government.[37]

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[32] Ibid.

[33] Ibid.

[34] Refractions Research. (December 2012). Collaborative Geospatial Architecture External Consultation.

[35] Ibid.

[36] Government of British Columbia. (n.d.). DataBC: About.

[37] Government of British Columbia. (2011). GeoBC to DataBC and Beyond. http://blog.data.gov.bc.ca/2011/10/geobc-to-databc-and-beyond/

Focused on enabling government to use geospatial data and emphasizing the social sector, DataBC maintains a shared data store of geographic data. DataBC supports this role by providing web services, application frameworks and online applications to discover, view, download and analyze data. This SDI encompasses all government sectors, providing hosting, transformation and delivery of data across government and to the public. Used extensively to support government decisions, these systems serve hundreds of thousands of users with 110 legislated and mandated lines of business applications such as land tenure, transportation, public safety and emergency response systems.

DataBC has responsibility to:

- Geographically enable BC public sector content;
- Support strategic geomatics initiatives;
- Encourage effective use and sharing of data and infrastructure;
- Provide an enterprise foundation that allows others to contribute without duplicating effort;
- Expand the public use of geospatial content and services;
- Maximize opportunities to share and innovate; and
- Promote and represent the Province to provincial and federal standards bodies.

The goal of DataBC is to broaden data access as much as possible. In this sense, the data sets can be managed as a portfolio. This portfolio contains three main categories:

- ***Operational data***—acquired, compiled and created by sectors and ministries and used to fulfill the operational requirements of the custodial agency;
    - ***Enterprise data***—a subset of operational data that has sufficient clearance to be shared with other government departments and, under special circumstances, with industry; and
        - ***Open data***—a further subset of enterprise data that can be shared broadly with the public and does not present legal, security and privacy concerns (for example, because it has been aggregated to a level that protects personal identification or because sensitive information has been stripped out of the source data).

To manage data as a key asset, DataBC intends to build on existing geospatial data policies to[38]:

- Establish data governance as a core discipline across the enterprise including:
  - Ensuring a "single version of the truth" in decision making;
  - Ensuring that data is fully leveraged during its entire lifecycle and that the accuracy and lineage of both the data and metadata are established upstream when source data is created; and,
  - Encouraging the implementation of data governance policies including data custodianship.
- Provide some basic analytical capabilities that enable a culture of "timely fact-based decision making" across the enterprise and among the public.
- Provide necessary deliverables and capabilities in support of sector transformation and technology plans as they relate to information access and sharing, e.g., open data.

The BC government considers the management and dissemination of data to be critical to achieving its strategic goals as well as to providing data-driven and fact-based advice to decision-makers over the long term.

Linkage to CGDI Principles and Themes

DataBC with the support of GeoBC contributes geospatial (and non-geospatial) data for all government ministries, although GeoBC performed this function before DataBC's creation in July 2011. This adherence is described below for DataBC but also applies to GeoBC.

In addition, the work undertaken by the provincial government ministries covers the four CGDI themes identified in GeoConnections II (2005–2010), i.e., Environment and Sustainable Development, Matters of Importance to Aboriginal Peoples, Public Safety and Security, and Public Health.[39]

Prior to the advent of DataBC, the GeoBC program contributed to the CGDI through all four themes, as illustrated by the following examples:

- The GeoConnections-funded project *Next Steps Towards Implementing a First Nations Shared Information Service* involved the "…sharing of cultural, land and marine resource information that will facilitate First Nations access to cultural, land and marine resources information held by public governments and third party proponents."[40]

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38 Government of British Columbia. (March 2012). DataBC, Concept of Operations V1.0.

39 DB Geoservices Inc. (2008). GeoBase Land Cover Layer: User Needs Assessment Project Plan. Prepared for Canadian Land Cover Data Project Team, Agriculture and Agri-Food Canada.

40 First Nations Technology Council. (2009). Next Steps Towards Implementing a First Nations Shared Information Service. GeoConnections Final Project Report.

- A contribution was made directly to the development of the First Nations GeoBC Gateway, as well as the First Nation land-stewardship planning portal for the Tsilhqot'in National Government (TNG). This portal provides "end-users with Web-based tools that simplify and accelerate exchanging location-based ("geospatial") data, non-geospatial data, and other land-use planning information."[41] More specifically, "This project is an important part of building this capacity. The portal will combine and extend existing Web-based mapping applications that are compliant with the standards of the Open Geospatial Consortium (OGC), Inc. and the Canadian Geospatial Data Infrastructure (CGDI); and allow users to upload, view, query, edit, download, and print land-use content."[42]
- Another project involved developing the Living Atlas, which has the capability to enable users to explore the Nuu-chah-nulth land and waters of the Clayoquot region by navigating to different places and choosing different themes.[43]
- Under the Safety and Security theme, a contribution was made through BCeMap (i.e., Emergency Event Map Viewer). A Multi Agency Situational Awareness System (MASAS) for BC, BCeMap was a pilot project for the 2010 Olympic and Paralympics Games, funded by GeoConnections. BCeMap was developed by Emergency Management BC (EMBC) and GeoBC to enhance the Emergency Management Information Service (EMIS) implemented by EMBC. BCeMap provides a single resource to aggregate relevant incident data for emergency management and public safety personnel within BC and across Canada.[44]
- In relation to public health, geospatial data facilitated the ability of the province to conduct disease surveillance, specifically through the GeoConnections-funded project *A Spatially Enabled Population Health Framework for Disease Surveillance*. This project developed a "web-based health information tool that supports disease surveillance. Using location-based or geospatial information, this tool will allow BC public health officials to analyze disease and population-health ecology (the interrelationships of the broad range of factors that affect population health)."[45] More specifically, "By incorporating CGDI standards, this project will enable health practitioners to explore the myriad factors that potentially influence diseases—population and demographic structures, housing conditions, health resources, socio-economic status, land uses, water bodies, watersheds, and drinking water systems, to name a few."[46]

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41 GeoConnections. (2011). A Tsilhqot'in Stewardship Planning Portal for Land-stewardship Planning.

42 Ibid

43 http://livingatlas.org

44 Stewart. (2010). GeoConnections: Geospatial Return on Investment Case Study: BCeMap (MASAS).

45 GeoConnections. (2011). A Spatially Enabled Population Health Framework for Disease Surveillance.

46 Ibid.

Application of Standards and Policies

Given the different responsibilities of DataBC and GeoBC, different standards and policies apply. In the case of GeoBC, standards and policies relate to the foundational maps, imagery, etc., while for DataBC, they relate to standards concerning discovery and web mapping. Overall, the architecture, standards and policies are consistent with CGDI.

For GeoBC, the following data standards are in place[47]:

- Base mapping standards and specifications;
- Air photo standards and specifications;
- Trim specifications;
- Geospatial reference standards, specifications and guidelines; and
- Quality standards—based off ISO 9001:2000.

The Geographic Data Discovery Services (DDS), provided on the DataBC portal, allow clients to do the following:

- Easily discover data to use or visualize within DataBC's infrastructure;
- Understand or determine the appropriate use of data; and
- Contact the data provider to ask questions or suggest improvements.

The DDS provides users with access to descriptive information (metadata), "such as the name, location, access and format [which] is available for a wide variety of the provinces' geographically (spatial) referenced data". Metadata accessed through the DDS is compliant with the ISO 19115 Metadata Standards[48] and consistent with the CGDI.

The following standards are also applicable[49]:

- Systems and application technology standards;
- GeoBC file geodatabase standards;
- Physical address and geocoding standards conceptual model;
- Raster data standard; and
- Presentation views and layer file standards.

DataBC is both providing data services to BC citizens and the public sector and helping to manage government data as a strategic asset. Similar to managing other assets, managing data requires a set of organizing principles and governing rules. The DataBC Concept of

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47 GeoConnections. (2012). Internal GeoConnections Survey of Provinces and Territories.

48 Government of British Columbia. (n.d.). Data Cataloging and Metadata.

49 Government of British Columbia. (n.d.). Information Management and Technology Standards and Guidelines.

Operations[50] provides the background, strategic context, operational responsibilities, and overall governance of DataBC. To support its open data mandate, DataBC has in place a policy framework[51] that includes open licensing. This policy framework demonstrates the benefits of CGDI principles.

Application of Tools and Technologies

The DataBC tools and technologies that help users present and consume geographic data[52] are described below.

- ***Geographic Data Discovery Services (DDS)***—This service enables users to discover geographic data from the Province of BC. The service is provided by a web-based software application that permits people to manage and discover ISO 19115 compliant geographic metadata. The metadata database can be accessed using either GIS software or a wide range of tools including DataBC's iMapBC, Data Distribution and Web Content Services. The metadata database content is also indexed by web search engines and, through its Z39.50 protocol, is accessible as a node in the CGDI and the US Federal Geographic Data Committee's (FGDC) National Geospatial Data Clearinghouse network. Metadata Services acts as the DDS custodian by supporting the application and training users.
- ***iMapBC***—This primary map viewer lets users access more than 500 natural resource map datasets hosted by the BC Geographic Warehouse. Users can view the data as interactive maps, put together map layers of interest, upload their own map data and produce maps that can be printed or emailed to others.
- ***HectaresBC***—This map interface employs criteria selected by users to easily display BC data within specific areas. Hectares BC is a collaborative pilot project created under the BiodiversityBC partnership, consisting of Biodiversity BC and the Nature Conservancy of Canada, which is offered as a public service.
- ***Data Distribution Service***—This service allows users to order land and resource data from the BC Geographic Warehouse.
- ***Web Map Services (WMS)***—This service provides access to the BC Geographic Warehouse through connection links such as Google Earth's popular KML and industry standard WMS. This flexibility provides users unprecedented access to provincial geographic information through a single internet gateway.
- ***Geomark Web Service***—This free web service enables users to store an area of interest or shape, called a "geomark." Users can share and retrieve this area of interest across applications, GIS systems and the web in a variety of file formats.

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[50] DataBC, Concept of Operations V1.0, March 2012

[51] http://www.cio.gov.bc.ca/local/cio/kis/pdfs/open_data.pdf

[52] DataBC website, http://www.data.gov.bc.ca/dbc/geo/index.page

- ***Civic Address Geocoding Service***—This service provides standardized, accurate, up-to-date locations for BC civic addresses. The service accepts an input address and returns the coordinates of the location of that address.

Note that while not discussed above, tools and technologies also facilitate data management, provide automation and controls, and enable compliance to standards, policies and procedures.

Lessons Learned and Challenges

A key lesson learned is that custodianship of data is paramount. Data custodians are ultimately responsible for the rules governing the definition, collection, use and disposal of information. Custodians define the information structures (i.e., what information should be collected) and standards (i.e., what level of detail the information should be collected to) within a particular subject area (e.g., theme or geographic region), as well as the frequency of update and other related characteristics.

Establishing a central data agency such as DataBC is a positive step; DataBC is already attracting new data users and creating efficiencies across government. For example, some ministries are using DataBC to host their databases, which reduces the ministries' needs to provide supporting infrastructure.

DataBC is building on the lessons learned by GeoBC in working with geospatial data over the last 25 years. These lessons include a focus on centralized services and standards, a common base and common modeling, as well as recognition of the role of data custodians.

There is considerable pressure to move to open data as part of the BC open government initiative. Nevertheless, data licensing remains a challenge because third parties provide some data, and certain third parties restrict the use of this data. For example, road data more than one-year old can be made available at no cost, but current road data carries a price. There also continue to be some limitations on base maps, foundational data and thematic data. At present, approximately 800 of 3,000 data layers are open, and WMS extracts are available at no charge. DataBC has found that experience with licensing in the United Kingdom has helped address licensing issues in BC.

Another challenge is how to handle licensing for those who use published application programming interfaces (APIs). Once people depend on these APIs for various tasks, users expect the API services to remain available, just as they expect, for instance, GPS services to be available. An open data license does not guarantee that service will continue.

In addition, crowd-sourced data is becoming an issue in the social sector. For example, some 15,000 to 18,000 organizations serve the Ministry of Children and Families, and the Ministry is interested in having them provide local data, such as the location of food banks. The provision of such data represents crowdsourcing at the service provider level, rather than at a public level. An example of public crowdsourcing is emergency management because public input can be potentially valuable in helping prevent or mitigate emergencies. Crowd-sourcing is an emergent area and will need to be addressed further.

Benefits and Impacts

DataBC's centralized approach, involving one set of infrastructure and "one-stop shopping," assists users to access data, services, applications and tools. As a result, DataBC is expected help the BC government cut costs substantially. And as a part of CGDI, DataBC is facilitating straightforward access to pertinent provincial geospatial data. This access is an enabler for many organizations within and outside of the province.

Supported by GeoBC, DataBC is providing an important service within and outside the BC government. As the demand for geospatial data grows, DataBC will play an increasingly prominent role in many government departments and businesses within the province.

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4.0 Multi-Agency Situational Awareness System

Introduction

The Multi-Agency Situational Awareness System (MASAS[53]) was originally conceived during the second phase of the GeoConnections program (2005–2010). Emergency management organizations in government wanted to provide a shared "common operating picture" associated with emergencies or events affecting public safety and security, one of GeoConnections' four priority areas.

Since then, MASAS has evolved to a national priority of federal, provincial and territorial senior officers responsible for emergency management (SOREM).[54] Establishing an enduring national MASAS capability is also a key deliverable within Public Safety Canada's *Communications Interoperability Action Plan for Canada* (April 2012). The core MASAS operational services are centrally managed in Ottawa within the federal government's shared services initiative.

As described below, MASAS demonstrates a comprehensive implementation of the CGDI "spatial data infrastructure usage" (e.g., policies, standards, technology and framework data) in Canada. Further, MASAS is aligned with the CGDI guiding principles and has been successfully used in applications involving cross-border interoperability and geospatial data sharing.

Preparing the MASAS case study involved reviewing documentation, researching on the Internet, and interviewing individuals familiar with the MASAS development and current status.

Context

Canadians face potential natural and intentional threats and hazards, including floods, fires, earthquakes, severe snowstorms, as well as terrorist attacks and criminal acts. Threats and hazards cannot be necessarily prevented, but when they occur, they can be managed to lessen the risks and ensure a speedier recovery.

[53] http://ircan-rican.gc.ca/projects/masas

[54] Natural Resources Canada. (2011). Multi-Agency Situational Awareness System. Information Update: Emergency Management, Security and Business Continuity Planning Committee. PowerPoint Presentation.

Emergency management and response agencies involved in threats or hazards come from the following types of entities:

- police, fire, and emergency medical services;
- emergency measures organizations;
- search and rescue (SAR) teams;
- municipal, regional, provincial, territorial and federal governments, Aboriginal communities;
- non-governmental organizations (NGOs); and
- organizations involved with public health, public works, utilities, transportation, and parks.

Regardless of their focus or interests, emergency management and response agencies must cooperate and share information; effectively managing crises or disasters requires accessing and disseminating incident information in real time.

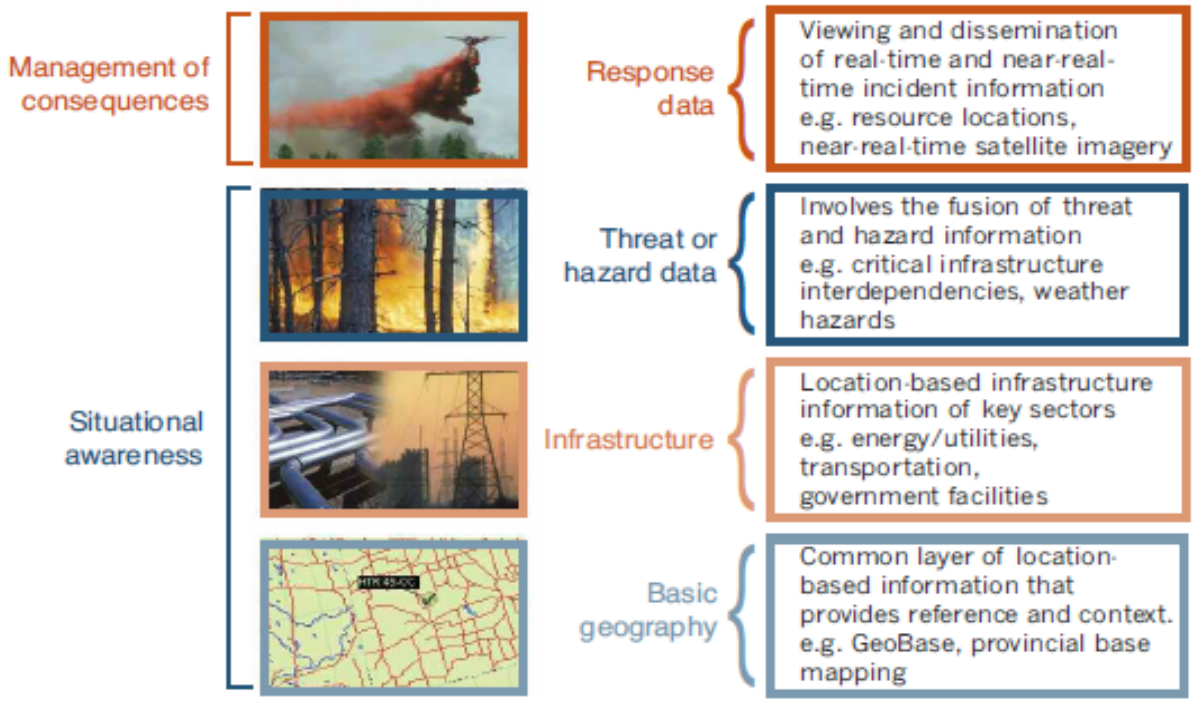
Location-based or geospatial information increasingly plays a key role in managing threats and hazards. "Knowing the geography of a region or disaster, such as a flood, allow officials to better manage incidents throughout the four phases of the emergency management cycle: mitigation, preparedness, response, and recovery."[55]

Situational awareness (SA) is essential for planning and executing emergency responses. In broad terms, SA comes from being aware of what is happening during an incident and understanding these events (now and in the future). Those working in critical environments, like responders, incident commanders or emergency managers, depend highly on SA information to make decisions and perform their duties. SA tools enable these people to access knowledge, share information in real time, and develop proactive solutions.

Several different SA tools are used across Canada. The ability to connect these different tools for shared SA is critical to improving interoperability and to ensuring efficient and effective responses.

[55] GeoConnections. (2007). Public Safety and GeoConnections.

Exhibit 4.1: Key Elements of Building Situational Awareness[56]



Description of MASAS

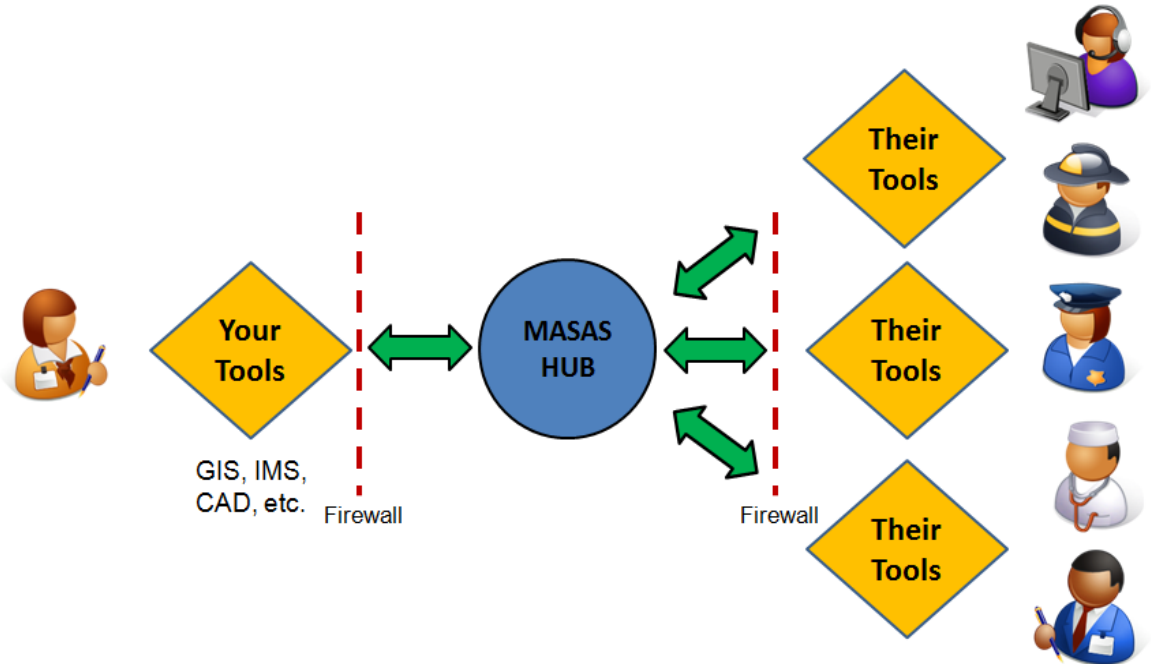
As noted above, MASAS was designed to meet the needs of emergency responders. As such, this multi-stakeholder initiative aims to develop and support capabilities that enable multiple emergency management and response agencies to share real-time, location-based SA information and alerts. MASAS uses open standards, architecture, policies and interoperable technologies based on national geospatial standards—i.e., the CGDI.

According to Stewart (2010), "MASAS aggregates incident information from diverse sources into a consolidated view made available to partners. Information is filtered through a centralized hub. Instead of pushing content to many, contributors publish it once for all. And, instead of pulling information from many agencies, information is pulled from the hub. An envelope can be created for each event so everyone who needs to respond will see the appropriate information"[57] (Exhibit 4.2).

[56] GeoConnections. (2008). Geomatics and public safety and security.

[57] Stewart, M.A. (2010). GeoConnections Geospatial Return on Investment Case Study: Multi-Agency Situational Awareness System (MASAS).

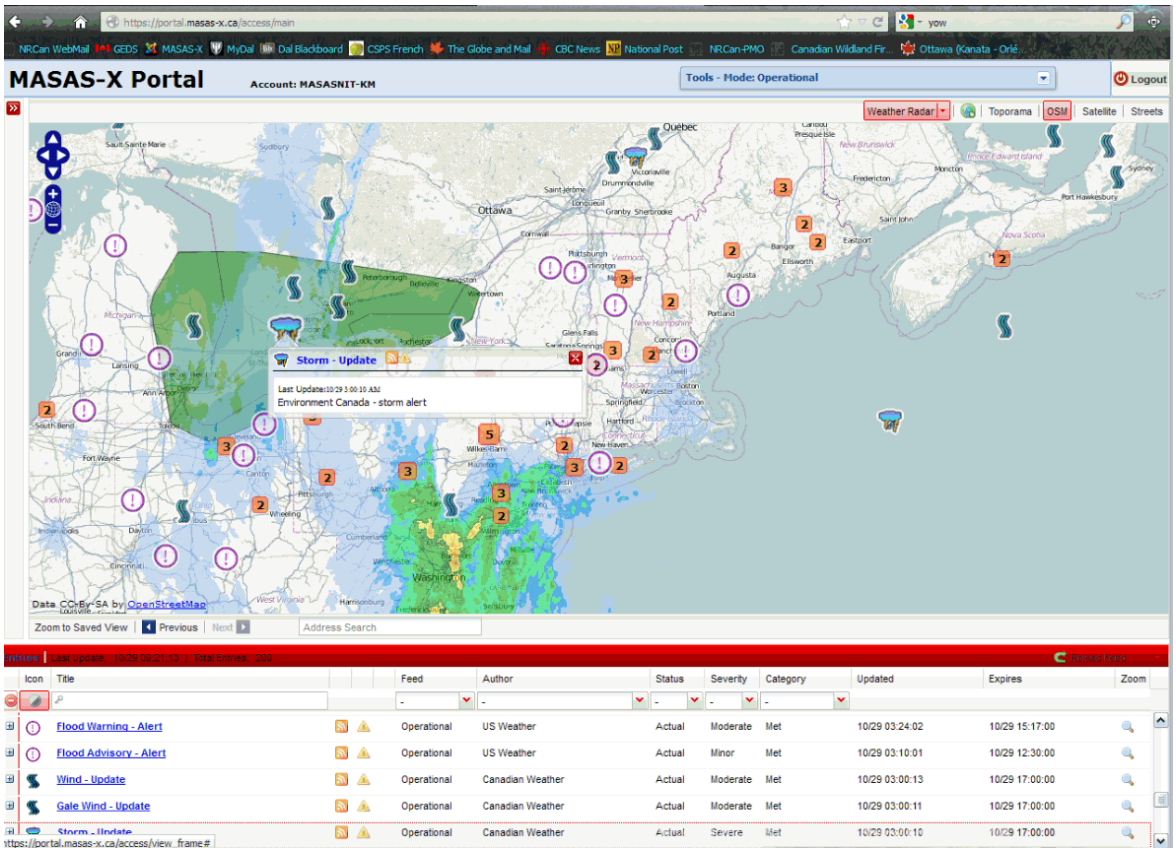
Exhibit 4.2: Model for Alerting / Sharing[58]



The key feature of MASAS is a common geospatial operating picture. Exhibit 4.3 was captured following an exercise in 2009. Each of the items on the map is presented with a symbol associated with the event type. Clicking on any item offers a brief overview, and clicking through provides the complete story. MASAS looks just like an ordinary map but brings together in one place information that decision-makers need in an emergency and makes it available in a variety of mapping formats.

[58] GeoConnections. (2011). Multi-Agency Situational Awareness: MASAS. PowerPoint Presentation.

Exhibit 4.3: Common Operating Picture[59]



Examples of MASAS content include:

- Hazard alerts (e.g., earthquake, tsunami, space weather);
- Water and stream level sensor alerts;
- Current and forecasted weather and other meteorological alerts, warnings and advisories;
- Health alerts and pandemic zone demarcations; and
- Perimeters of wildfires, quarantine zones and events.
- Hazardous materials or incidents involving chemical, biological, radiological, nuclear or explosives agents;
- Road closures;
- Community closures or temporary relocations;
- Search and rescue activity;
- Sandbagging operations, dike construction, pumping stations; and
- Points of interest information (e.g., rest stations, first aid, emergency shelter).

[59] GeoConnections. (2012). Multi-Agency Situational Awareness: MASAS Screen Capture.

According to NRCan, MASAS has achieved the following advances as of 2011:

- **Provincial Systems Operational:**
  - New Brunswick (NB)—NB was an early adopter of MASAS and has achieved interoperability with local NB and Prince Edward Island officials through its systems.
  - Manitoba—Manitoba's Emergency Measures Office and a small number of communities, including the City of Brandon, used MASAS during the major flood of 2011 to share the locations of sandbagging operations and to view road closures across the province.
  - British Columbia—BC developed a MASAS instance within the Flex Viewer application that is interoperable with other MASAS-compliant systems.

- **Exercises:**
  - BC-Washington Cross-Border Earthquake Simulation (CAUSE) (2011)
  - Point Lepreau New Brunswick Nuclear Radiation Leak (2011)
  - Sarnia/Windsor-Detroit Cross-Border Chemical Explosion (2010)

- **Implementation Status:**
  - MASAS is available for operations now and a sustainable operations service model is planned for early 2013.
  - Public Safety Canada is coordinating federal implementation.

Natural Resources Canada Status:

NRCan—Mapping Information Branch is increasing the availability of open geospatial information within the Department including authoritative data layers and real-time data:

- flood information (Canada Centre for Remote Sensing)
- space weather (Canadian Hazards Information Service)
- earthquake locations (Canadian Hazards Information Service)
- wildfire hotspots (Canadian Forest Service)
- infrastructure layers (roads, railways, powerlines, buildings (Mapping Information Branch)
- Canada Transportation BaseMap web service (Mapping Information Branch)
- Emergency Management Map Symbology and taxonomy (Mapping Information Branch)

MASAS can also support the following emergency measures plans (EMPs) within Natural Resources Canada:

- Forest Disturbances (EMP1)
- Geological Hazards (EMP2)
- Space Weather (EMP3)
- Geomatics Support (EMP4)
- Nuclear Explosions Monitoring (EMP5)
- Nuclear and Radiological Incidents (EMP6)
- Medical Isotope Supply Distribution (EMP7)
- Energy Supply Disruption (EMP8)
- Offshore Oil and Gas Incidents (EMP9)
- Non-fuel Mineral and Metal Commodities and Production Shortages Support (EMP10)
- Influenza Pandemic Plan (EMP11)[60]

Structure of MASAS

MASAS is a system of systems based on standards, which enables each participant to:

- Publish information for other participants to consume;
- View information across agencies in a predictable and reproducible manner, where each agency:
  - Controls what they share;
  - Decides what information from other agencies is relevant to them; and,
  - Uses their existing systems to publish and consume information; and

- Integrate information from external sources into the local emergency operations system.[61]

The hub of MASAS is a software system, hosted on a network of servers designed to allow multiple agencies to access real-time information from the system and feed information into the system, MASAS acts as an information broker. In this role, MASAS enforces a standard for structuring and packaging data to ensure interoperability between agencies. It also acts as information filter, enforcing access rights and levels of information to ensure confidentiality and meet possible security restrictions.

[60] Ibid.

[61] Based on presentation of CGDI Standards for the Public Safety and Security Community, M. Habbane, NRCan, Nov. 4th 2009.

Only the public safety and security community has access to MASAS, a condition that preserves data integrity. For response agencies without situational awareness tools, MASAS provides free, basic web-hosted tools for both posting and sharing information and alerts and viewing information posted from other sources.

Organizations must be registered to participate in MASAS, and currently, approximately 250 organizations are registered across Canada. Information stored in MASAS is non-sensitive and available to all participants, although MASAS may provide links to sensitive information and, in future, may include sensitive data restricted to certain users.

MASAS consists of core software and a set of interfaces and software development tools that public agencies use to build interfaces and software systems which connect to MASAS. Third-party software vendors, IT consultants and technology system vendors also have access to these tools to assist their development effort.

MASAS uses open source software, which means its source code is available to the public. As such, MASAS opens itself to community-based development in which users are encouraged to further develop the core software.

Evolution of MASAS to Date

Conceived by GeoConnections, MASAS was identified as a priority area by the GeoConnections II (2005–2010) Public Safety and Security Committee, comprising federal and provincial representatives. NRCan and GeoConnections led MASAS's developed from 2005–2010. GeoConnections helped fund a number of projects that have led to emergency responders having national MASAS capability. These projects included a number of MASAS systems, as well as a number of building blocks (e.g., Emergency Mapping Symbology and the Canadian Profile of the Common Alerting Protocol standard). The following section provides a few highlights from this period.

MASAS Highlights during GeoConnections Phase II (2005–2010)

Numerous provincial governments identified the need for interoperability of SA tools following catastrophic flooding in Saskatchewan and New Brunswick. For example, in 2005 and 2006, Saskatchewan floods affected 90 communities and caused estimated tens of millions of dollars in damage. Yet the public safety community had only limited access to geospatial data and interactive emergency mapping systems. "Paper maps, cellular telephones, conference call interlinks, and daily incident reports were the main means of communication, coordination, and information shared across several provincial departments and between local, provincial, and federal authorities."[62]

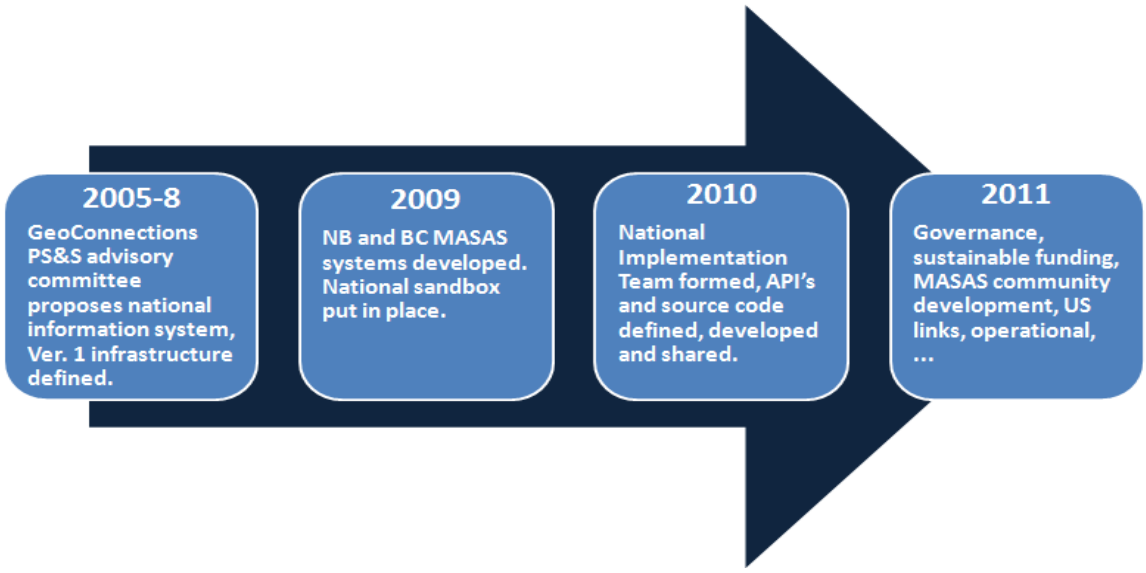
[62] GeoConnections. (2008). GeoConnections 2006–2007 Annual Report.

To better prepare themselves for future floods and other emergencies, the provinces approached GeoConnections. Saskatchewan Corrections and Public Safety received funding from GeoConnections in 2006–2007 to develop a spatial system that would improve decision making during emergencies, both "vertically through different levels of government and horizontally across each of those layers of government."[63] The developed system used CGDI-endorsed standards and a similar distributed architecture.

GeoConnections also funded a Government of New Brunswick project in 2006–2007 entitled "Decision Support for Flood Event Prediction and Monitoring." The project capitalized on the CGDI "to overlay web-based maps with transportation networks, property boundaries, municipal infrastructure (e.g. power lines, natural gas lines), contour lines, as well as the flood-risk mapping database and a digital elevation database." The project goal was to provide the "public and emergency response organizations with near real-time information about the potential for and extent of flooding in their areas."[64] In addition, GeoConnections also funded the New Brunswick MASAS project in 2009–2010. The primary motivation for NB MASAS was the 2008 spring flooding that involved numerous municipalities along the Saint John River. Other provinces and the State of Maine were also involved.

The above-noted projects identified the need for a national situational awareness system because no agency or government in Canada possesses the authority and expertise to act unilaterally. Consequently, the MASAS development initiative followed, as illustrated in Exhibit 4.4.

Exhibit 4.4: MASAS Timeline[65]



63 Ibid.

64 GeoConnections. (2012). Decision Support for Flood Event Prediction and Monitoring (FEPM).

65 GeoConnections. (2011). Multi-Agency Situational Awareness: MASAS. PowerPoint Presentation.

Further, in January 2011, a federal, provincial and territorial committee - Senior Officials Responsible for Emergency Management (SOREM)[66] identified MASAS as a national priority. Following this step, the Centre for Security Science (CSS) within Defence Research and Development Canada of the Department of National Defence (DND) assumed leadership of MASAS and began to support making the system available operationally. GeoConnections continued (and continues) to be a key player, providing the "plumbing" for MASAS, consisting of the underlying geographic context and standard symbology.

In 2011, CSS funded a study to define concepts of operations and is currently funding the two-year MASAS-X (MASAS Information eXchange) pilot project, in conjunction with NRCan and Public Safety Canada. The pilot began in November 2011, and the project is intended to move to full implementation when the pilot completes in March 2013. MASAS-X focuses on operationalizing the pan-Canadian system that will provide a communications link between stakeholders. MASAS-X is considered to be both the first step in building an enduring national MASAS capability and a deliverable under Public Safety Canada's *Communications Interoperability Action Plan for Canada* (April 2012).

[66] Natural Resources Canada. (2011). Multi-Agency Situational Awareness System. Information Update: Emergency Management, Security and Business Continuity Planning Committee. PowerPoint Presentation.

In addition, MASAS was recognized as a deliverable of the Beyond the Border (BTB) Action Plan: A Shared Vision for Perimeter Security and Economic Competitiveness signed by United States President Barack Obama and Canadian Prime Minister Stephen Harper. Through the Communications Interoperability Working Group, MASAS and supporting spatial data infrastructure components will be developed, tested and demonstrated in preparation for a real cross-border disaster that requires shared situational awareness.

MASAS services offer a stable, reliable, resilient, and long-term shared situational awareness capability within the Canadian public safety (and critical infrastructure) community. These core operational services are managed through a hub in Ottawa within the federal government's shared services initiative. The MASAS hub comprises three smaller hubs: 1) supporting operations, 2) training and 3) exercises.

Governance and Collaboration

With MASAS leadership now assumed by the Defence R&D Canada—Centre for Security Science, MASAS illustrates how other agencies are building on GeoConnections' efforts to develop and sustain CGDI applications. In the MASAS-X pilot project described above, CSS is partnering with NRCan's Mapping Information Branch (MIB), Public Safety Canada's Interoperability Development Office, and industry professionals. In addition, other federal departments and, provincial, territorial and municipal governments are contributing to the project.

The roles and responsibilities for the MASAS-X project are as follows:

- CSS is leading the core technology development, architecture development and system implementation;
- Public Safety Canada is leading strategic policy development, the governance framework and partner engagement; and,
- NRCan MIB is providing location-based knowledge to CSS and Public Safety Canada and leading the production and dissemination of open geographic data for the emergency community.

Linkage to CGDI Principles and Themes

MASAS is aligned with the nine CGDI principles as follows:

1. **Open**: For emergency responders, MASAS offers open, barrier-free data-sharing services with interoperable standards for information exchange. While MASAS is limited to the public safety and security community to ensure data integrity, MASAS is designed to allow multiple agencies to log into the system and both access real-time information from the system and feed information into the system.

2. **Accessible**: The hub of MASAS is a software system, hosted on a network of servers exposed (securely) to the Internet. This combination helps emergency responders access MASAS using a variety of systems.
3. **Evolving**: MASAS continues to evolve to meet the needs of the emergency responder community.
4. **Timely**: MASAS provides the sharing of authoritative location-based information, in near real-time, to emergency responders.
5. **Sustainable**: MASAS is sustained through the contributions of the participating organizations and through its relevance to these groups.
6. **Self-organizing**: MASAS enables various levels of participating organizations to contribute geospatial information, metadata, services and applications.
7. **User and community driven**: One of MASAS's keys for success is for the user community (i.e., the public safety and security community) to drive future CGDI development by openly providing information and data. The MASAS project's open source software encourages this kind of involvement and impact. Without user cooperation and participation, the MASAS project would stagnate.
8. **Closest to source**: Information provided by the public safety and security community has equipped its members to respond effectively and efficiently to natural and intentional threats and hazards by eliminating duplication of information during events. Data is supplied from the authoritative source thereby supporting a trusted environment for decision-making.
9. **Trustworthy**: The information available to the user community is limited to the public safety and security community, thereby preserving data integrity.

Moreover, MASAS directly aligned with the GeoConnections II goal to make CGDI products, services and applications relevant to decision makers in public safety and security. In addition, MASAS contributes to GeoConnections III and CGDI 2015 goals by "fulfilling the need for documentation in Canada related to operational policies and standards for implementation and use of spatial data infrastructures within the context which they are most advantageous; that is within situations where multiple, diverse agencies with differing responsibilities must coordinate information and actions for a single common good."[67]

Furthermore, the MASAS-X project is considered by MIB to be a "Pathfinder project due to its current and future implementation of 'federated' infrastructure between multiple levels of emergency management organizations by means of the application of leading-edge IM and geospatial standards, and its alignment with the current CGDI vision, roadmap and architecture and potential contributions to the evolving CGDI vision."[68]

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[67] Natural Resources Canada. (2012). Mapping Information Branch Project Management Framework Project Plan: MASAS.

[68] Ibid.

Application of Standards and Policies

At the core of MASAS is its open standards and architecture. MASAS adheres to CGDI principles and is essentially a complete implementation study of CGDI operational policies and standards within a complex governance and organizational structure.

MASAS is based on common layers of location-based information that provide reference and context—e.g. GeoBase and provincial base mapping. In turn, these layers use national standards for metadata, framework data and thematic data. By encouraging interoperability, these standards help users share geospatial data.

The Canadian Council on Geomatics (CCOG) is a major federal-provincial-territorial consultative body for geographic information management. The CCOG endorses standards used by its members, and these standards have been employed in the GeoBase Portal and other member geospatial data sources. In terms of thematic data, GeoConnections sponsored the development of a symbology set for this application. The Emergency Mapping Symbology project developed national symbology to ensure a common understanding of emergency situations across Canada, with over 200 mapping symbols created for geospatial products.

In addition, the underlying layers conform to published web services architecture to leverage the internet's IT and infrastructure. This IT and infrastructure includes generic IT services such as user authentication and e-commerce, along with web service technology.

MASAS stakeholders have identified existing and emerging operational policy issues (e.g., crowd-sourcing, mobile applications, sensitive information sharing, etc.) as prime candidates for further investigation. Operational policy and standards will be a community-specific contribution to the knowledge to be maintained in the CGDI Resource Centre.

In addition to geospatial standards and policies, MASAS uses the Canadian Profile of the Common Alerting Protocol (CAP-CP[69]). The GeoConnections Program funded development of a 'location event reference layer' in order to position CAP-CP events in a geospatial context. The Canadian profile complies with the Common Alerting Protocol (CAP) of the Organization for the Advancement of Structured Information Standards (OASIS). In addition, the MASAS initiative is investigating emerging standards, particularly the OASIS Emergency Data Exchange Language (EDXL) suite. The CAP is also recognized by the United Nations—International Telecommunications Union (ITU)[70] and complies with the National Information Exchange Model (NIEM).[71] Further, MASAS is near to aligning with the Emergency Management Systems Interoperability Framework, including consideration of the Department

[69] http://capan.ca/index.php/en/cap-cp/

[70] ircan-rican.gc.ca/attachments/1858/MASAS_110204.pdf

[71] Public Safety Canada. (2011). Public Safety CIOD. Interoperability and Portfolio Management. PowerPoint Presentation.

of Defense Architecture Framework and The Open Group Architecture Framework.[72] Operating policies will evolve as MASAS moves through the pilot to operation.

Application of Tools and Technologies

As shown in Exhibit 4.2 and Exhibit 4.3, MASAS is built on common base layers of CGDI location information that provide reference and context—e.g., GeoBase and provincial base mapping. These layers include infrastructure information on key sectors, such as transportation, utilities, government facilities, etc.

For the MASAS-X project, MIB and GeoConnections of NRCan are providing the "production and dissemination of open infrastructure geographic data (via the existing GeoBase 2 project), providing existing NRCan public safety/security content as open geographic data, and advancing geographic standards/operational polices for the Public Safety/Security community."[73]

MASAS allows users to add threat and hazard data to these common base layers. MASAS also equips users to add, view and disseminate real-time and near real-time incident information that all participating emergency organizations can use.

Lessons Learned and Challenges

One of the most important lessons learned from the MASAS initiative to date, according to GeoConnections (2011), is that the "vast majority of information that needs to be shared during major events, and in daily use, has little to no redistribution restrictions." In addition, it was stated that "We also learned quite quickly that if we move up the scale of sensitivity, the number of issues rise and escalate into a paralysing freeze on activities. While we study how to navigate above a certain line, we are staying below a threshold where we can keep all stakeholders at the table." As a result of the noted challenges, MASAS is *not* emphasized as a "public" notification system, as strict rules govern providing information to the public.[74]

Another lesson learned concerned the lack of early federal support. Due to the grassroots beginnings of MASAS in 2006, entities such as Public Safety Canada and SOREM took significant time to gain interest and offer support. In retrospect, demonstrating the value of the MASAS concept earlier may have accelerated MASAS's availability.

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[72] Marshall, K. (2011). Multi-Agency Situation Awareness System: The Current State. PowerPoint Presentation.

[73] Natural Resources Canada. (2012). Mapping Information Branch Project Management Framework Project Plan: MASAS.

[74] GeoConnections. (2011). Multi-Agency Situational Awareness: MASAS. PowerPoint Presentation.

A number of challenges have been identified for MASAS:

- Operational policies, particularly data sharing agreements, are an ongoing barrier to information sharing and interoperability. Agencies that have the potential to contribute information to MASAS need specific details on their responsibilities and potential liability.
- Community-driven specifications (de facto standards) (i.e., Emergency Mapping Symbology) require maintenance and ongoing change management. Many community standards (e.g., symbology) need future standardization. However, according to GIS User, "Future plans for the Emergency Mapping Symbology are to establish a formal standard, and to set up a change-management process to guide the continued development of new symbols and enhancement of the existing symbols and taxonomy."[75]
- With an ongoing shared national system, there remains the issue of who pays for the supporting infrastructure—i.e., how will participating organizations pay for sustainable hosting, maintenance, and operations plans or resources?
- A good operations team is needed, as emergency organizations will have to be extensively trained in using MASAS.

Benefits and Impacts

"In all aspects of emergency management, geospatial data and tools have the potential to contribute to the saving of lives, the limitation of damage, and the reduction in the costs of society of dealing with emergencies" (The U.S. National Research Council, 2007).

MASAS's broad applicability may well generate far-reaching benefits. By significantly reducing duplication of effort, MASAS has the potential to assist emergency response agencies to manage disasters and crises much more cost effectively and efficiently than they can today. In particular, MASAS has the ability to "reduce the time lost to making information requests, sharing information with individual agencies, relaying information of other agencies, and sifting through situation reports."[76] As MASAS is further refined, government departments at all levels are expected to incorporate MASAS concepts, components and models into their existing systems. For example, the National Search and Rescue Secretariat is reportedly implementing MASAS's open standards, architecture, policies and interoperable technologies.

[75] http://www.gisuser.com/content/view/20655/2/

[76] Stewart, M.A. (2010). GeoConnections Geospatial Return on Investment Case Study: Multi-Agency Situational Awareness System (MASAS).

MASAS also has the potential to be an invaluable planning tool as the system incorporates more information and makes this information available. Such information includes topographical maps, satellite images from the Canada Centre for Remote Sensing, and Environment Canada's weather data. It would be extremely advantageous to "be able to replay an entire emergency timeline, which would make the MASAS an invaluable planning tool."[77]

The *GeoConnections Geospatial Return on Investment Case Study for the New Brunswick MASAS* report (Stewart, 2010) further illustrates MASAS's potential benefits. The NB MASAS project was developed by New Brunswick Emergency Measures Organization (EMO) and funded by GeoConnections, with the intention of deploying MASAS nationally. The NB MASAS was developed after severe flooding in 2008 resulted in damage claims in excess of $22 million and New Brunswick required support from outside the province. According to the report, "Forward-looking five-year analysis of New Brunswick MASAS: Cumulative benefits are $1.006M. Cumulative costs are $552,000. Net present value (benefits minus costs in 2008 dollars) is $454,000 with an annualized return on Investment (ratio of net present value to cumulative costs) of 16.42 percent. Payback period is three years, showing a break-even point in 2011."[78] In addition, other potential benefits included enhanced efficiency, improved decision making and increased availability of reliable information.

[77] Natural Resources Canada. (2011). GeoConnections helps provide a clearer picture of Manitoba flood response.

[78] The figures take 'benefits to health staff' into consideration. When omitting benefits to health staff, "Cumulative benefits are $668K. Cumulative costs are $481K. Net Present Value is $187K with an annualized Return on Investment of 7.76%. Payback period is four years, showing a break-even point in 2012."

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5.0 Canadian Land Cover Data Project

Introduction

Context and Rationale

Land cover classification categorizes land into themes such as forests, wetlands, crops and pasture, snow and ice, rock, and urban development. People use land cover data in a wide variety of applications to make crucial decisions about the environment, natural resource management and urban development. Land cover is identified as one of the five highest priority essential climate variables (ECVs) within the *Global Terrestrial Observing Systems* (2000) report to the United Nations Framework Convention on Climate Change Subsidiary Body for Scientific and Technological Advice. The ECVs are critical, when used with other measurements and observations, for enhanced reporting on climate change impacts.

Multiple federal and provincial agencies have mapped land cover data to meet their needs. As a result, land cover data exists in various vintages, using different legends and different scales and representing different geographic areas. Many of the recently completed land cover projects in Canada addressed differing sector-based information needs. For example, the Canadian Forest Service (CFS) and Agriculture and Agri-Food Canada (AAFC) have been working together since 2003 to produce land cover with sector-specific legends and classification methodology, with compatible resolutions and spatial and temporal extents.

While the quality and consistency of the maps are high, considerations remained for merging differing map products to create a comprehensive national land cover map. One consideration was the lack of a contiguous depiction of land cover for the entire land mass of Canada at high resolution.[79] A nationally contiguous, higher resolution, wall-to-wall depiction of land cover was required to meet a broad range of user needs, as well as to provide a consistent national standard to address regional needs.

In response, the Canadian Land Cover Data Project was launched under the leadership of AAFC with a primary objective of using existing land cover data from provincial and federal organizations to produce a harmonized database consistent with international standards, namely, to add a "land cover map layer" to the GeoBase portal.

A land cover community of practice (LCCoP) was formed in 2005 by the Inter-Agency Committee on Geomatics. This community of practice comprised federal agencies mapping land cover, as well as organizations that require land cover maps to meet their business needs. The Canadian Land Cover Data Project Team was then formed from members of the LCCoP and the GeoBase program. The team's objective was to meet user needs by integrating land cover maps

[79] DB Services Inc. (July 2008). GeoBase Land Cover Product User Needs Assessment Report.

from provincial and federal organizations into a harmonized database consistent with international standards. Furthermore, the team also intended to recommend and promote national standards for developing land cover information. The team's mandate was to:

- Provide a common technical response to national earth observation (EO) strategies and policies from a land cover perspective;
- Promote and facilitate the sharing of knowledge and data, working towards integrated national land cover products for Canada;
- Improve the availability, quality and extent of land cover information; and,
- Support common infrastructure to develop and share land cover information and supporting data.

Description of the Land Cover Project

The Mapping Information Branch of NRCan, through the GeoBase program, led the collection and integration of land cover data from various classified satellite data. GeoBase land cover was built from classified satellite ortho-imagery as a result of collaboration between Agriculture and Agri-Food Canada, Natural Resources Canada (Canada Centre for Remote Sensing, Canadian Forest Service and Mapping Information Branch), the Canadian Space Agency and Canadian provinces and territories. The challenge for the Canadian Land Cover Data Project was to reconcile the various classifications and semantics into one consistent set of classes that meets national needs.

This reconciliation was made possible by the collaborating agencies developing a harmonized legend (describing the land cover classification) for the GeoBase land cover layer. The objective was to preserve as much thematic class detail as possible, while creating a national coverage for Canada.

The Canadian Land Cover Data Project adopted a phased approach:

- Phase 1: User needs assessment;
- Phase 2: Data product definition; and,
- Phase 3: Implementation.

GeoConnections funded Phase 1, asking a wide spectrum of users about their short- and long-term needs for land cover information. In 2008, Phase 1 was completed and a report, *GeoBase Land Cover Product: User Needs Assessment* (DB Services Inc., 2008), was prepared for the Canadian Land Cover Data Project Team and AAFC.

Technical work for Phase 2, *Data Product Definition*, involved developing the specification for the land cover layer that is aligned with international standards. This phase was completed by the Mapping Information Branch of NRCan, in collaboration with AAFC and CFS, with partial

funding from the Government Related Initiatives Program (GRIP) of the Canadian Space Agency (CSA).

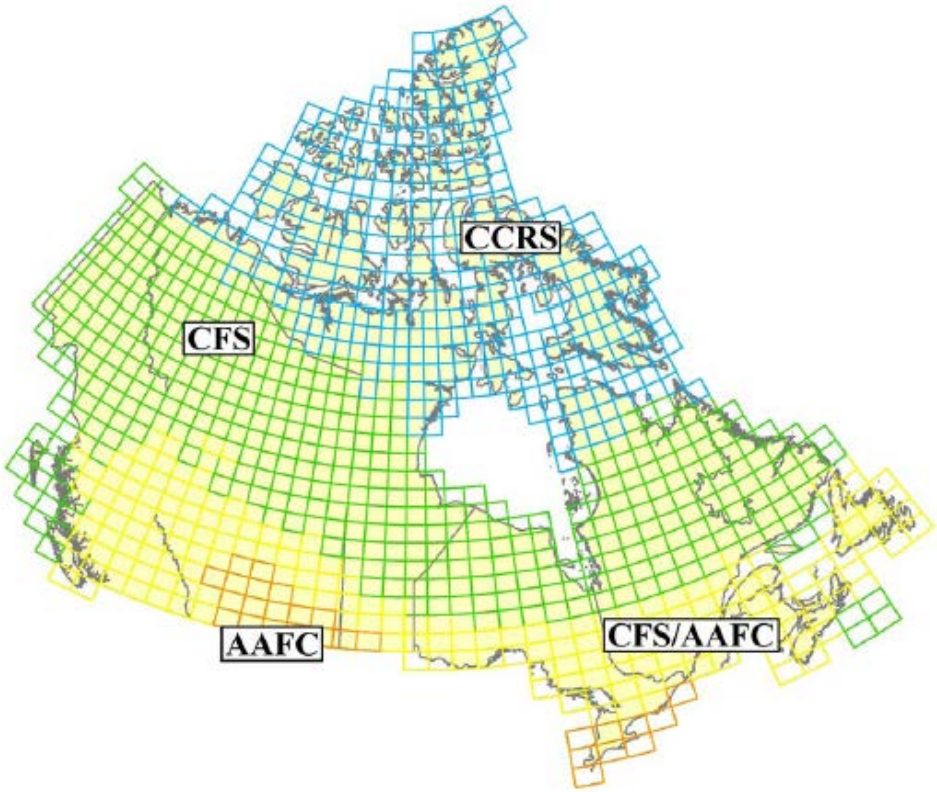
During Phase 3, *Implementation*, integrated data products were developed. NRCan integrated and converted sectoral land cover data into data that align to international standards. These data can be accessed through the GeoBase portal via: http://GeoBase.ca.

Three sources of data, derived from Landsat satellite imagery, were integrated:

- AAFC: Land Cover for Agricultural Regions of Canada, circa 2000, available via: http://geodiscover.cgdi.ca/web/guest/home.
- Canadian Forest Service (CFS): Earth Observation for Sustainable Development of Forests (EOSD) project, available via Canada's National Forest Information System (NFIS) website: https://ca.nfis.org/index_eng.html.
- Canada Center for Remote Sensing (CCRS): Northern Land Cover of Canada, circa 2000, available via: http://www.geogratis.gc.ca/geogratis/en/index.html

The NRCan EOSD dataset (CFS in Exhibit 5.1) covers the forested areas of Canada, and the NLWIS dataset (AAFC in Exhibit 5.1) covers the agricultural extent of Canada. Neither dataset covers the north. Completion of the land cover product for northern Canada (north of the forested and agricultural zones) was realized by NRCan Canada Centre for Remote Sensing (CCRS in Exhibit 5.1).

Exhibit 5.1: "Land Cover data coverage according to providers (data producers)"[80]



Prior to this project, two major land cover products had been created to meet specific sector needs:

1. In cooperation with provincial governments, CFS created Earth Observation for Sustainable Development to satisfy forest sector requirements.
2. Agriculture and Agri-Food Canada completed a land cover product as part of the National Land and Water Information Service (NLWIS) program in March 2009 to meet the agriculture sector needs, again in collaboration with provincial governments. AAFC builds on the major crown project NLWIS completed in 2009, which delivers geomatics services, geospatial decision tools and agri-environmental information to support local and regional land-use planning and management.[81]

[80] Natural Resources Canada, Centre for Topographic Information. (2009). GeoBase Land Cover, circa 2000-Vector Data Product Specifications Edition 1.0.

[81] Agriculture and Agri Food Canada. (2008). About Agri-Geomatics Programs and Services.

NLWIS integrates land cover data with provincial inventories, principally for agricultural purposes. Offered at no charge to users, the NLWIS land cover product is complete and available for the agricultural regions of Manitoba, Saskatchewan, Alberta and the Peace River district of British Columbia. NLWIS is to cover all agricultural land in Canada.

Other agencies are also working on operational land cover projects. For example, Environment Canada is leading a team with the goal of creating a Canadian wetland inventory, and CCRS is advancing techniques for land cover mapping in urban environments and also north of the tree line.

Together these agencies have produced, are producing or will produce land cover mapping for the majority of the country. The active mapping agencies have worked internally and with the provinces to meet land cover data needs specific to their sectors.

Governance and Collaboration

The team members and their roles in the Canadian Land Cover Data Project were:

- Agriculture and Agri-Food Canada
  - Project leadership
  - Agricultural mapping
- Natural Resources Canada—Canadian Forest Service
  - Forest mapping
  - Project coordination and logistical support (Land Cover Community of Practice Secretariat)
- NRCan—Mapping Information Branch
  - Geospatial data product definition and product development
- Ontario Ministry of Natural Resources
  - Provincial Coordination Advisor
- Canadian Space Agency
  - GRIP funding for map product development
- NRCan—GeoConnections
  - Funding of the user needs assessment

Linkage to CGDI Framework Themes

During its second phase, GeoConnections concentrated on four themes: Environment and Sustainable Development, Matters of Importance to Aboriginal Peoples, Public Safety and Security, and Public Health.[82] As a result, GeoConnections requested that the user needs assessment for the Canadian Land Cover Data Project include representatives from these four themes. The Survey of Geographic Information Decision-Makers conducted by Environics (2006) highlighted that the environment and sustainable development user-community identified land cover as a priority data set, whereas the other three user communities felt that land cover data was not as important as other types of data. Despite the survey findings, the Canadian Land Cover Data Project Team decided to include the Safety and Security and Public Health user-communities within the user needs assessment phase.

Application of Standards

The land cover application complied with the following ISO standards to the extent feasible:

- ISO 19144-1 Geographic Information—Classification Systems Part 1: Classification System Structure, and;
- ISO 19144-2 Geographic Information—Classification Systems Part 2: Land Cover Classification System (LCCS).

The ISO standard is represented by the Food and Agriculture Organization of the United Nations (UN-FAO) Land Cover Classification System (UN-FAO, 2005). The LCCS was developed as a comprehensive, standardized, *a priori* classification system, designed to meet specific user requirements. The LCCS is categorically exhaustive and can be employed to classify land cover anywhere in the world. LCCS users follow diagnostic criteria that allow for correlations with regionally or nationally developed classifications and legends. The CFS and AAFC land cover legends have already been correlated to the LCCS.

The Land Cover Data Project created its own framework data standards and model and adhered to the following CGDI standards:

- Data Alignment: Land cover mapping was aligned using the GeoBase Data Alignment Layer (GDAL).
- Metadata: The GeoBase National Land Cover data was ISO-19115 compliant.
- Accuracy Assessment: The Canadian land cover community continues to work with the international community to develop standards for accuracy assessment.

[82] DB Geoservices Inc. (2008). GeoBase Land Cover Layer: User Needs Assessment Project Plan. Prepared for Canadian Land Cover Data Project Team, Agriculture and Agri-Food Canada.

- Future Classification Work: In the future, the sectoral land cover work will be able to use the LCCS *a priori*. [83]

Application of Tools and Technologies

To exploit recent sectoral initiatives and make the results accessible to the broadest set of stakeholders[84] in the quickest, most affordable way, the GeoBase National Land Cover Product[85] was based on integrating federal mapping products.

The source data for the GeoBase land cover product is satellite imagery (Landsat, circa 2000[86]). GeoBase land cover was produced by vectorizing classified raster data. Tied to the GDAL, the land cover data is aligned with other GeoBase data layers such as the National Road Network and the National Hydro Network (NHN). It can also be used in combination with both the GeoBase Landsat and SPOT orthoimagery layers.

The data is distributed in 1:250,000 National Topographic System tiles through data formats provided via the GeoBase portal. GeoBase also allows for visualization of data layers through freeware viewers available from a variety of sources[87]. As with all GeoBase products, the following key principles are being observed:

- Compatibility with GDAL;
- Adherence to international standards (product specification, classification system, collection metadata, product metadata);
- Provision of data closest to source;
- Maintenance of data;
- National coverage; and,
- No cost and no restriction for users.

The legends of the EOSD and NLWIS products were harmonized to allow for the compilation of single coverage of Canada. The intent is to preserve as much thematic class detail as possible. The initial source data for the land cover theme will be converted to vector format to be geometrically adjusted with the GDAL. Exhibit 5.2 shows the proposed integration of EOSD and NLWIS.

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[83] Agriculture and Agri-Foods Canada. (2009). Canadian Land Cover Data Project: GeoConnections Final Project Report.

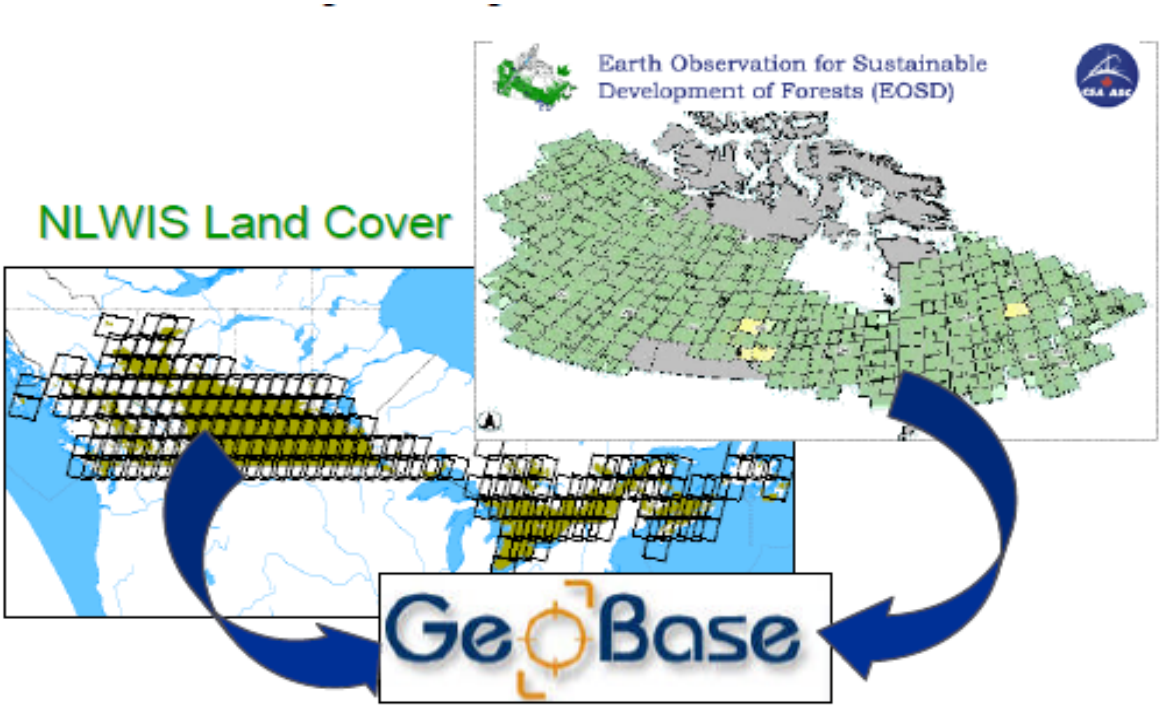
[84] DB Geoservices Inc. (2008). GeoBase Land Cover Product: User Needs Assessment. Prepared for Canadian Land Cover Data Project Team, Agriculture and Agri-Food Canada.

[85] GeoBase. (2012). Land Cover, Circa 2000 – Vector.

[86] Natural Resources Canada, Centre for Topographic Information (2009). GeoBase Land Cover, circa 2000-Vector Data Product Specifications Edition 1.0.

[87] http://geobase.ca/geobase/en/data/landcover/csc2000v/utilisation.html

Exhibit 5.2: Integration of NLWIS and EOSD[88]



Legend classes from both products were integrated and preserved as best possible; in other words, detailed agricultural classes and detailed forest classes as each appear in the regions and areas where they are mapped.

GeoBase portal allows for visualization of data layers through freeware viewers available from a variety of sources[89]. The following freeware viewers are offered for users wishing to display downloaded GeoBase National Land Cover Product:

- **ArcExplorer** distributed by ESRI: http://www.esri.com/software/arcgis/explorer/arcexplorer.html
- **Caris Easy View**: http://www.caris.com/products/easy-view/.
- **Geomatica** provided by PCI Geomatics: http://www.pcigeomatics.com
- **Map Maker Gratis** provided by Map Maker: http://www.mapmaker.com/
- **Quantum GIS**: http://www.qgis.org.
- **Udig**: http://udig.refractions.net/confluence/display/UDIG/Home.
- **gvSig**: http://www.gvsig.org/web/home/gvsig-en/view?set_language=en." [90]

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[88] DB Geoservices Inc. (2008). GeoBase Land Cover Product: User Needs Assessment. Prepared for Canadian Land Cover Data Project Team, Agriculture and Agri-Food Canada.

[89] http://geobase.ca/geobase/en/data/landcover/csc2000v/utilisation.html

[90] http://geobase.ca/geobase/en/data/landcover/csc2000v/utilisation.html

Lessons Learned and Challenges

The Canadian Land Cover Project demonstrates the value of collaborating to develop multilayered mapping capabilities with GeoBase. CGDI standards and policies were followed to the extent possible. Through the Canadian Land Cover Data Project, the LCCoP furthered coordination and work with stakeholders beyond their sectors to determine land cover requirements and to develop integrated products to meet broad community needs. In doing so, the project addressed the need for a framework land cover data layer.

In developing land cover data, the project team faced the following mostly technical challenges:

- The Canadian Landsat ortho-imagery was incomplete;
- There was a discrepancy between the GeoBase layers and land cover maps that were compiled, which required adjusting some data;
- The national hydrological GeoBase layer was not finalized;
- The different source imagery and differing classification schemes were also classification schemes remains a challenge;
- The developers of the land cover layers reported that the most challenges were presented by the data processing requirements to engineer a consolidated data set; and,
- Priority setting presented a challenge due to the range of needs and perspectives. At times, the LCCoP had to give greater priority to mapping needs than to user needs, which sometimes caused conflicts. The needs of the broad array of users must be reasonably balanced with the mapping community's capacity to address those challenges in the development phase. Coordinating the forestry and agriculture

As well, according to members of the project team maintaining the GeoBase Canadian Land Cover layer, the following future challenges will be faced:

- With federal funding cuts, no additional work has been undertaken. Funding additional development work and ensuring that land cover imagery is consistently updated will be a challenge due to insufficient funding;
- As the major task has been completed, the LCCoP has stopped meeting, and the member departments are proceeding with their ongoing work. There is no federal driver to continue developing the product;
- There is a need for a sustained national mapping strategy. At present, none exists, and there is no incentive to continue developing integrated joint products, as each mapping agency has its own priorities.

Overall, the Canadian Land Cover Data Project illustrated how a range of mapping agencies could work collaboratively. However, it also illustrated the need for a forum to develop, express and negotiate national priorities among key federal agencies.

Benefits and Impacts

The project benefits reported so far are as originally anticipated:

- The Canadian Land Cover Data Project was an example of effective collaboration among a range of mapping agencies;
- The project provides a common technical response to national Earth Observation (EO) strategies and policies from a land cover perspective;
- It promotes and facilitates the sharing of knowledge and data—providing an integrated national land cover product for Canada;
- It improves the availability, quality and extent of land cover information; and,
- There is a common infrastructure to develop and share land cover information and supporting data.

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