Lessons Learned from OOS in Canada: Preliminary Assessment of OOS Value

by
Ocean Science and Technology Partnership (OSTP)

for

Fisheries and Oceans Canada
and
Canadian Space Agency

March 31, 2011

Executive Summary

A preliminary assessment of the environmental, economic, and social value of Ocean Observation Systems (OOS) was carried out in conjunction with an inventory of OOS in Canada conducted by the Ocean Science and Technology Partnership (OSTP).[1] The main objective was to identify actual cases of added value from existing OOS, rather than potential value. The highlights of this short study, in terms of lessons learned, are presented below.

1. ***Positive Benefits:*** OOS in Canada have demonstrated many positive benefits, although rarely quantified. These include:
   - demonstration of innovative technologies;
   - improving co-ordination and collaboration among diverse data sources;
   - development of export opportunities for expertise and technology;
   - economic and safety efficiencies in transportation;
   - improved access to information;
   - data support for a wide variety of applied and theoretical research efforts to better understand, monitor, and manage the marine environment;

2. ***Need for an Effective National Strategy and Governance Structure to Maximize Benefits of Investments:*** To date, the various OOS activities represent isolated, regional, and often technology driven projects. No national framework exists for developing long term, coordinated objectives and for sharing expertise. This fragmented approach decreases the potential value, at a national level, of the investments made and it decreases Canada's potential effectiveness at the international level. Canada has a rich opportunity to use its unique regional differences to maximize its OOS capabilities and expertise, but to truly capitalize on this requires national coordination, leadership, and accountability.

3. ***Need to Measure and Communicate Benefits of OOS:*** Many of the major efforts, such as Neptune, Venus and Ocean Tracking Network (OTN), and even the American Great Lakes Observatory are in their formative stages. Others such as SmartBay and the St. Lawrence Global Observatory (SLGO) have begun to have an impact, however, even then quantifiable benefits are difficult to estimate. To obtain long-term continuing political, financial, and user support there is a need for all of the OOS efforts to focus more on who the end users are, what do they require, and how well the systems contribute to tangible added value. Many system managers had difficulty identifying specific examples of benefits to individual users. Canada needs to move beyond the published lists of possible benefits and now start to track real economic, environmental, and social impacts.

[1] OSTP [2011]. *Canadian Survey of Atlantic, Pacific, Arctic, and Great Lakes Observing System.* Report prepared for Fisheries and Oceans Canada and the Canadian Space Agency, March.

Introduction

The purpose of this study was to identify and quantify, where possible, tangible benefits that have actually been achieved by OOS in Canada, as an indication of the environmental, social and/or economic value of these systems. The study found that many of the OOS efforts are in the initial development stage and nearly all OOS have limited tracking of actual use and benefits other than web site traffic. In fact, a major finding of this study, supported by the parallel inventory of OOS[2], is that for the most part the OOS efforts have been driven by demonstrations of technology and large investments in either academic or government research. While these are important goals, the actual value to end users of the technology, data, and research is difficult to estimate.

Little attention to date has been given to identifying actually achieved direct and indirect benefits of the data. While users and system managers could cite many examples of the potential OOS value, there is little documentation of actual use of and value of the data collected and distributed. The result is that this current study is very much a preliminary assessment of value, using examples where information was available. The focus is more on highlighting some of the lessons learned and barriers facing OOS today from a value perspective.

Current and planned OOS initiatives in Canada already illustrate that there is a great potential for more consistent and comprehensive monitoring of the oceans, Great Lakes, and the related watersheds. In various projects, Canada has already demonstrated that OOS are:

- essential in supporting environmental monitoring (including adequate baseline studies) and marine conservation;
- composed of innovative technologies and research that provide an opportunity to solve specific Canadian issues, such as collecting data in the vast areas of Canadian waters and for a wide diversity of resources and resource uses;
- providing opportunities for export of technology and expertise;
- the basis for Canada to meet its global responsibilities in ocean and environmental management;
- demonstrating efficiencies and safety in marine transportation;
- providing a focus for co-ordinating diverse public, private, and academic sector and organizations who collect, manage, distribute, and/or use data;
- improving access to information for the public, communities, governments, and both fundamental and applied academic research.

To date, however, the efforts have been mainly isolated from each other and primarily region and/or purpose specific. The actual value of these OOS investments could be enhanced greatly by more national co-ordination to build on the collective expertise and technologies.

---

[2] Ibid.

Measuring Value

This study was not intended to be a comprehensive economic analysis of OOS benefits. The purpose was to gather information available from interviews and information available that could include examples of OOS. These range from informal volunteer data collection and provision by small organizations to the much more sophisticated systems developing in the Atlantic, Pacific, Arctic and Great Lakes regions. During the interviews, various OOS managers and OOS users, who were identified by the managers, were asked to consider:

Economic Benefits, such as:

- reduced transportation (shipping) costs
- reduced risk to infrastructure
- avoidance or mitigation of disasters (e.g., by identifying hazards)
- co-existence of potentially competing economic activities (e.g. aquaculture and traditional fishery)
- opportunities for industry growth (collaboration within Canada and abroad)

Social Benefits, such as:

- improved school/university curriculums or learning experiences
- protection of heritage/culture
- community/school participation in collecting local knowledge
- security and public safety
- making resources safely available for activities (such as public swimming, jobs in areas of high unemployment)

Environmental Benefits, such as:

- public safety
- identification of contaminants or other hazardous conditions
- establishment of baseline data for long term monitoring
- monitoring of development impacts to identify threats or compliance

Any quantification of the benefits was based entirely on what users or system managers quoted and are rough estimates at best.

A general conclusion of the study is that, while OOS managers and users could provide potential benefits, few could identify actual benefits that have been achieved. In fact, in some cases, OOS managers had difficulties identifying specific users beyond “academic or government researchers”. Tracking down the value chain of these uses was beyond scope of this study, but the general uses are reported.

Examples of OOS in Canada

The short studies that follow vary in depth based on the information that was able to be collected in this preliminary study. The two major OOS investigates were SmartBay and the St. Lawrence Global Observatory, in part, due to their active participation, assistance, and therefore interest in this study, but also because the are relatively well established with active users. Others are only highlighted here to show the wide variety of sizes and purposes. The Great Lakes Observation System (GLOS) was included to illustrate the potential for Canadian participation.

SmartBay

This first case study primarily demonstrates the benefits of OS in marine transportation both for shipping and fishers, although the use and potential of the system is broader. SmartBay began in 2004 as the Placentia Bay Information Seaway Pilot Project by Canadian Center for Marine Communications (CCMC).

Governance and Funding

An initial investment in SmartBay of two million dollars was made under the Oceans Action Plan through the Atlantic Canada Opportunities Agency (ACOA). Since 2006, SmartBay has continued with support from various stakeholders including federal and provincial government, industry and the Marine Institute at Memorial University.

Currently SmartBay is under the management of the School of Ocean Technology (SOT) at the Fisheries and Marine Institute (MI) of Memorial University. SmartBay industry partners include AMEC Earth and Environmental, International Communication and Navigation (ICAN) and Earth Information Technologies Ltd. In August 2009, the Government of Newfoundland and Labrador recognized the importance of SmartBay OS technology and experience in the provincial “Oceans of Opportunity” strategy over the following 5 years.[3]

SmartBay is an example of the challenges in obtaining long term funding commitment. However, the provincial government is now recognizing the importance of SmartBay as a demonstration of ocean technology that provides real time meteorological and oceanographic data to both communities and the marine transport industry. The latter industry is estimated to be worth $7 billion annually.[4]

In January 2011, additional funding for operational support for 2 more years was provided through ACOA. In March 2011, SmartBay received additional five million dollars in federal-provincial funding as part of the Atlantic Gateway. This is funding for infrastructure but long term operating costs were not included. [5]

[3] Government of Newfoundland and Labrador Press Release, August 9, 2009. [See http://www.smartbay.ca/news.php?id=5] Accessed January 4, 2011.
[4] Government of Newfoundland and Labrador Press Release, August 9, 2009. [See http://www.smartbay.ca/news.php?id=5] Accessed January 4, 2011.
[5] R. Newhook and B. Carter, Telephone Interview, March 28, 2011.

Infrastructure

SmartBay consists of a series of sensors and a gateway portal to related information sites for Placentia Bay, one of the major shipping routes in Canada. A major concern is the potential conflict between traditional fisheries, marine transportation supporting offshore drilling, ecotourism, and environmental goals. The heart of SmartBay is the array of buoys which provide environmental information for marine transportation, weather forecasting and other uses.

The main thrust of SmartBay is to provide an environment where *"data is collected once, maintained close to the source, and available for use by many"* [CCMC, 2004]. The primary sources of data are three on-line meteorological/oceanographic buoys within the Bay. Additional sources of information include the 3-D ocean mapping data available through the Geological Survey of Canada (NRCan) and Bedford Institute of Oceanography. The SmartBay portal (http://www.smartbay.ca/) provides access to real time weather and tide data, as well as linkages to related government, industry, and community sites.

User Requirements, Benefits, and Value

SmartBay began with a series of meetings with industry, government, and community groups including local fishers. This was a high level assessment of user requirements. Potential benefits identified in this study included the following:[6]

- Catalyst for developing new technologies for Canada and export
- Safety and efficiency of marine transportation
- Improved (smart) fishery, minimizing by-catch and habitat harm
- Infrastructure for rapid response to emergencies and potential disasters

These benefits have at least been partially realized, especially in the marine transportation sector. In an article by Safer,[7] it is pointed out that the major beneficiaries are the savings and safety provided to marine pilots and the shipping industry. In the article, Ivan Lantz the Director of Marine Operations of the Shipping Corporation of Canada estimated the following savings in Placentia Bay [Safer, 2010]:

> *five to seven times a year, a large crude oil tanker is delayed from entering or leaving Placentia Bay; he figures SmartBay could reduce the delay time on average by six hours at a daily vessel cost of $75,000.*

Again in this same article, the Atlantic Pilotage Authority explained their cost-saving[8]:

---

[6] CCMC [2004]. *Placentia Bay Information Seaway Pilot Project-Stakeholder Workshop.* [See www.**smartbay**.ca/.../User%20Workshop%20Report%20-%20March%2028.pdf] Accessed January 5, 2011.
[7] A.Safer [2010] http://www.progressmedia.ca/article/2010/06/beam-me. Accessed January 5, 2011.
[8] Ibid.

> *When the Atlantic Pilotage Authority determines the weather and sea state conditions are unsafe for a pilot to board or disembark, the shuttle tankers either remain at anchorage or stay at sea. The pilot boarding station (PBS) is 27 nautical miles from the pilots' home base, and weather conditions at the two locations often differ considerably. With SmartBay, pilots can remotely assess the boarding conditions at the PBS, eliminating the need to steam out there to determine if it's safe to board. That keeps them out of harm's way and saves three to four hours of their time and between $1,000 and $1,500 in fuel costs per trip.*

Safer [2010] also points out that pilots estimate SmartBay reduces vessel delay time by 25% and improved safety and say that and that a similar system is needed for areas such as the Bay of Fundy.

When further provincial funding was granted to the project in 2010, Captain Anthony McGuiness, Chief Executive Officer, Atlantic Pilotage Authority said

> *having the availability of 24-hour 'real-time' weather information has increased* ***one-hundred fold*** *[emphasis added] the safe transfer of pilots and movement of vessel traffic within Placentia Bay.*[9]

From the community perspective, SmartBay provides real-time information for fishing and a platform for managing other marine activities such as aquaculture, eco-tourism, and hazardous waste sites [e.g., Placentia Bay had been a disposal site for the US army in Argentia]. Direct access to the buoy information is obtained by the Canadian Coast Guard and an estimated 6800 to 7000 accesses are made to the buoy information page each month.[10] One fisherman from Placentia Bay was supplied with an Automatic Identification System (AIS) similar to those used on larger vessels. Mr. Fudge made the following comments after his experiences of having ships "see" his boat and thus avoid accidents:

> *This is the best system ever created since radar; there should be a law that all small boats carry this system to avoid accidents and to communicate with other vessels…. I can get weather data from buoys…. SmartBay has made this a possibility"* [Fudge, 2011]

A more comprehensive study of benefits was conducted by ACOA in 2008 (based on 45 user interviews). [11] Some of the highlights of this analysis include:

- estimated savings of nearly 1 million dollars annually for fishers and large vessel operators having better access to sea-state information;
- more efficient major environmental assessments as a result of access to oceanographic and water quality information, including partnership with

---

[9] Ibid
[10] R. Newhook and B. Carter [2011]. Telephone Interview, March 28, 2011.
[11] D. Hogan [2008]. *Assessment of the SmartBay Technology Demonstration Project.* ACOA, St. John's, Newfoundland. (See: *aczisc.dal.ca/54SBAssessRpt.pdf)*

Newfoundland and Labrador Refining Corporation resulting in $63,000 for a wave-capable Acoustic Doppler Current Profiler;
- catalyst for ocean technology development in the province;
- use of the technology infrastructure by other companies;
- enrichment of information for integrated resource management.

The marine Institute also notes that communities in the Bay, such as Argentia, are using SmartBay as a marketing tool for industrial development.[12]The ACOA assessment also provides details on estimated benefits for marine transportation such as:

- annual savings of $225,600 in fuel costs for fishers who chose not to sail based on weather and sea state;
- pilotage, fuel, and demurrage savings of approximately 1 million dollars annually for shipping.

Internationally SmartBay has attracted attention that indicates increased potential for exporting Canadian technology and expertise. Both in New England and Ireland co-operative initiatives have been implemented based on the SmartBay model and on sharing of expertise and technology. A Newfoundland and Labrador Government press release on March 1, 2007 announced signing of an MOU with Ireland.

> *As both regions are leaders in ocean technology and boast strong ocean technology clusters, the MOU will encourage further collaboration, particularly in the area of ocean observing, between business, academia, and governments in both jurisdictions. In 2006, Newfoundland and Labrador signed an MOU with the State of Rhode Island to collaborate on ocean technology. The MOU with Ireland will complement work being done with New England… Collaboration on ocean technology is already underway. Ireland is launching its own SmartBay project this year, modeled after the SmartBay project underway in Placentia Bay… This will be a pilot project for an ocean observation system in Ireland.* [13]

Summary:

SmartBay included an initial exploration of user requirements, but basically has been a test of technology and potential uses. The fact that it has continued to attract funding from government and industry, even if in a slightly discontinuous manner, demonstrates that partners and users find the system an asset. SmartBay has also attracted international attention in, for example, Ireland and Rhode Island as a model for OOS. The main benefits that have been specifically identified are associated with efficiency of marine transportation, improved weather forecasting, safety for coastal fishers, and export.

[12] R. Newhook and B. Carter [2011]. Telephone Interview March 28, 2011.
[13] Government of Newfoundland and Labrador Press Release, March 1, 2007 (http://www.releases.gov.nl.ca/releases/2007/exec/0301n04.htm)

St. Lawrence Global Observatory (SLGO)

This second example describes a more complex OOS that is evolving as a co-operative effort, mainly involving government and universities, to improve access to and distribution and use of integrated data. SLGO covers the St. Lawrence River and Estuary, the Gulf of St. Lawrence, and watersheds through a number of joint initiatives. The initial business plan focused primarily on data producers. Now it is also including industry and organizations such as the Green Alliance (a network of shipping companies promoting green navigation) and other users of ice, oceanographic and environmental information.[14]

Governance and Funding

The SLGO is designed to be a neutral body that can avoid some of the complicated legal and jurisdictional issues that affect ocean spaces. SLGO is a corporation made up of both producers and users of ocean and coastal data. Headed by a Board of Directors, it has members from primarily three levels government and academia/research institutes, but also from community groups and information technology organizations. The Scientific Advisory Committee focuses on the priorities for data dissemination projects.

Formal membership agreements between the SLGO Corporation and members also define such arrangements as member rights and responsibilities, intellectual property, and standards. There are now at least six people managing the design and development of the web portal, the financial arrangements and partnerships. This staff is funded through membership agreements.

The members collect, store, and manage the ocean data and the selected data is made available on the web through the gateway between the member and SLGO. Collaborative projects and expertise have allowed the Observatory to grow and move from a focus mainly on data producers to one that engages a wider potential user group.

Infrastructure

The wide variety of active members provide access to data via SLGO. The collective infrastructures include: fixed monitoring instruments (e.g., tide gauges); submerged sensors, remote sensing imagery (e.g., ice conditions and water temperature); seabed mapping; buoys which monitor oceanographic and meteorological data, shipboard and field surveys; and research platforms for specific projects. SLGO provides real time access to some of this data; other data is historical, modeled, or interpretive. The web portal (http://www.slgo.ca/en.html) provides standardized access to this data for a variety of applications.

User Requirements, Benefits and Value

The goal of the SLGO is to democratize and add value to scientific information and make it available for users. A user needs assessment was not carried out specifically by SLGO, but in

[14] J. Hamel [2010]. Telephone Interview December 7, 2010.

2006 the first business plan was compiled based on the combined assessments of user requirements from member organizations. SLGO is today involved with a number of strategic networks, such as NavEcoNet representing science, engineering, and transportation sectors together for green/sustainable navigation and a Community-University Research Alliance (CURA) project involved in adaptation to climate change. This helps to connect SLGO with communities and various user sectors and their requirements.

From Dec 15-2009 to Dec 15, 2010, SLGO notes the following access statistics: [15]

- there were 36, 680 visits to the Observatory
- 100,422 pages were reviewed
- 50% of the visitors were new visitors
- the average time on site was 2:27 minutes

Canadian Hydrographic Service (CHS), Tides and Water Levels, is an example of a member service through SLGO. CHS (Quebec Region) provides tides and current information, as well as ice cover, primarily for sailors, transportation and other navigators. Current data, for example, can be displayed directly on the ships Electronic Chart Display Information System (ECDIS). Forecasting water levels 30 days in advance help organizations such as the Port of Montreal which provides information to shipping entities to manage the risk of cargo loading. As an SLGO member, CHS is also developing applications for CHS service upgrading.

> *During the storm surge of December 22, 2010 the (Quebec Region) CHS measured approximately 12,000 hits on their web service for water level observations. These would include householders, communities, emergency measures organizations, etc.*[16]

SLGO [2010] points out the following added value of the corporation [emphasis added]:[17]

- easier **access** to collective wealth of information about the St. Lawrence ecosystem;
- increased **collective capacity** to deliver mandates through collaboration, sharing &improved relations between data producers;
- **savings** & better return on investment through sharing means and expertise identification of information **gaps** & reduction of **duplication**
- development of **joint monitoring & research** initiatives
- potential for development of a variety of **value-added** data products and services by **private & public sectors**
- global vision facilitating **integrated management** & ecosystem-based approach
- opportunities for making **academic data** available, accessible and reusable
- increased **visibility** for member community, national & international **exposure.**

With respect to the last point, SLGO made it possible for companies in Quebec to participate in a similar development in Argentina.

---

[15] Supra Hamel [2010]
[16] Durais [2011]. Telephone Interview January 8, 2011.
[17] SLGO slide show summary, December 2010.

> *One aspect of the project …is the added-value that SLGO brings to regional industry. While SLGO was providing advice and expertise in terms of implementing an inter-jurisdictional governance structure and interoperable data access mechanisms, the Observatory project with Argentina brought opportunities for contracts for 2 Rimouski companies, one that sold oceanographic buoys to Argentina, the other that sold data management solutions.*[18]

Summary

SLGO, as an organization provides access to information from a wide variety of ocean, coastal, and watershed data collected and managed by members. It is also financially sustained by members and therefore relatively less susceptible to funding discontinuities. Continuing support and growth indicate that members see benefits in the initiatives. No real user needs assessment was compiled; the assumption being that knowing user requirements is the responsibility of member organizations.

SLGO has achieved benefits in transportation efficiency and in providing wide public access to information in a variety of applications. SLGO provides for example environmental data for critical applications such as long term climate analysis, public safety, and emergency measures. One key benefit of SLGO has been co-ordination and standardization of data sources and data management, i.e., a stronger data infrastructure to support future needs and opportunities. This cooperative effort should provide long term benefits to the member associations as a 'consortium' and the increased potential for exporting of Canadian technology and expertise.

[18] Supra, Hamel [2010].

Examples of Other Initiatives: Atlantic, Great Lakes, Pacific, and Arctic

Ocean Tracking Network (OTN)[19]

OTN is a global OOS pilot project of the Global Ocean Observing System and is designed specifically to monitor and track movements of marine animals and their environment. This project is an international collaboration led by Dalhousie University and funded by the Canadian Fund for Innovation (CFI), the National Science and Engineering Research Council (NSERC) and the Social Science and Humanities Research Council (SSHRC). The Canadian agencies have provided approximately $45.5 million dollars and OTN expects to leverage in excess of $100 million (in kind and financial) from its partners, including ACOA and DFO. All of the equipment used is Canadian.[20]

OTN began deploying in April 2008 with a listening line of sensors in the Halifax region, however the major CFI funding was only realized in March 2010 and there is a 7 year plan for the project. Among the current activities are:

- development and deployment of lines of acoustic arrays of sensors to monitor species;
- development and use of satellite linked ocean gliders;
- links to other networks to provide other oceanographic data;
- provision of a data warehouse for ocean tracking data;
- tagging of grey seals, salmon, bluefin tuna, and eels for example for monitoring;
- development of visualization tools.

Among the major beneficiaries are DFO and other fisheries agencies, commercial fishers, researchers in Canada and around the world. Besides being a major support for species management and international cooperation, OTN is also a vehicle for development, demonstration, and potentially export of Canadian technology.

Conservation Ontario

Conservation Ontario, consisting of a network of 36 Conservation Authorities, is an example of an organization involved in the Great Lakes region. In 2006 the *Ontario Clean Water Act* established (water) Source Protection Regions (SPR) which are legal entities at the watershed level with a primary concern municipal water supply from both surface and ground water.[21] They are both collectors and users of information related to water and other natural resource management. Currently there is no co-ordination with the American Great Lakes Observing System.

Conservation Ontario does not 'monitor' water quality. They use existing information, as well as periodic samples. These are limited by SCR capacity. Capacity for sample analysis is also related to provincial lab resources.[22]

---

[19] See http://oceantrackingnetwork.org/ Accessed December 17, 2010
[20] [2011] Telephone Interview.
[21] See http://www.conservation-ontario.on.ca/ Accessed December 14, 2010.
[22] M. Millar [2010]. Telephone Interview December 16, 2010.

US Great Lakes Observation System (GLOS)[23]

GLOS is included here to illustrate an international OOS that directly challenges Canada to improve its international cooperation. GLOS is a regional node of the US Integrated Ocean Observing System (IOOS). On March 24, 2009 the US House of Representatives authorized the IOOS as part of the National Ocean and Atmospheric Administration (NOAA). GLOS is a non-profit regional association funded by NOAA but not a federal entity. It currently has 2.5 employees.

The main purpose of GLOS is to provide wide internet access to real-time and historic data on the hydrology, biology, chemistry, geology and cultural resources of the Great Lakes, its interconnecting waterways and the St. Lawrence River. In 2008 it deployed 5 marine observation buoys to monitor near shore regions and initiated the Great Lakes Modeling and Assessment Center. It is planned that GLOS will eventually provide[24]

- *a complete inventory of federal, state/provincial and municipal observation and monitoring activities;*
- *spatial density of basic observations across the system;*
- *coverage over varying time scales (real-time to historic) and over space (site-specific, watershed and regionwide);*
- *uniform monitoring protocols;*
- *broad availability of information on Great Lakes conditions and trends for managers and other stakeholders***.**

Although much of the efforts have focused on environment and water quality, GLOS is now initiating work to support recreational and commercial navigation with an on-line decision-support tool (HarbourView) which allows access to Great Lakes observation data.

NOAA has done extensive work on measuring the economic impacts of its activities. Estimates for the potential benefits of IOOS have been compiled on a regional basis.[25] GLOS is also looking at benefits that include, for example, determining when water supplies should be shut off to avoid contamination. If GLOS can more closely observe when an event occurs and its extent, then public health can be protected and better water management decisions can be made potentially saving money by not shutting down supplies unnecessarily.

As pointed out by the Executive Director of GLOS[26] and echoed by a former Canadian member of the Board of Directors, Canada has not stepped up to the challenge of making this a comprehensive bilateral effort. [27] Canada does not have a co-ordinated OOS in the Great Lakes, despite efforts to promote this in the past. Similar problems related to the lack of Canadian resources and international co-operation exist in Atlantic, Pacific, and Arctic Oceans.

---

[23] See http://glos.us/
[24] ibid.
[25] See: www.economics.noaa.gov/?goal=weather&file=obs/info/ioos&view=benefits
[26] J. Read [2010]. Telephone Interview, December 10, 2010.
[27] H. Shearer [2011]. Telephone Interview, January 8, 2011.

MORSE- An Arctic Coastal Initiative[28]

MORSE is a joint initiative of the Canadian Space Agency (CSA) and the European Space Agency (ESA) to better use satellite imagery to meet the needs of a wide variety of users in the Arctic. In November 2008, a user consultation workshop was held to collect input on the potential use of satellite imagery for the following broad themes:[29]

- ***Mapping, Characterization and Changes with Time of Arctic Coastal Areas***
  This theme encompasses cartographic information in Arctic coastal areas, where up to date cartography is often scarce. It will also address characterization and physical changes with time due to coastal processes and dynamics.
- ***Environmental Monitoring of Land, Water and Air in Arctic Coastal Areas***
  This theme includes environmental monitoring of land, water and air in the Arctic coastal transition zone. Environmental monitoring covers physical, chemical and biological issues, and usually implies revisits with sufficient frequency to detect trends and short-term changes.
- ***Sustainable Economic Development of Natural Resources in Arctic Coastal Areas***
  This theme addresses mapping and monitoring of Arctic coastal regions to support economic activities including the exploitation of natural resources and also transportation, by land, water and air.
- ***Safety and Emergency Response in Arctic Coastal Areas***
  This theme covers aspects of monitoring in order to improve safety in the coast zone and to support emergency response to both natural and man-made conditions.
- ***Security and Sovereignty in Arctic Coastal Areas***
  This theme covers monitoring in Arctic coastal areas to support the protection of humans, wildlife and property and the terms of the United Nations Convention on the Law of the Sea (UNCLOS).

In April 2009, a summary of user requirements from this workshop was published.[30] Targeted end users include national, territorial, and provincial governments in Canada and Europe; northern communities; universities, research institutes, and knowledge networks; industry; and NGOs. A very significant aspect of MORSE is that it can demonstrate how satellite imagery can augment a variety of OOS activities in other Canadian waters.

---

[28] See: http://www.morsearctic.net
[29] http://www.morsearctic.net/thematics.php accessed March 29, 2011
[30] CSA and ESA [2009] *MORSE User Requirements Document, Version 1.1* April 25, 2009 See: http://www.morsearctic.net/links.php

Venus and Neptune[31]

Neptune and Venus represent the greatest investment Canada has made in OOS. Capital funding of $110M was provided by the federal (NSERC, CFI, and others) and British Columbia government in 2007 for five years, which is primarily dedicated to construction. This is viewed as an initial investment to install the first underwater arrays and to develop *"the world's first regional scale underwater ocean observatory network connected to the internet."* [32] Venus is a set of cabled ocean observatories in two sites of the Pacific coast and began operations in 2006. Neptune is a much larger array of sensors located in the British Columbia offshore.

The major purpose of Neptune and Venus is to provide the latest in ocean observation and communication technologies to monitor the earth's crust, the seafloor and water column. It is a platform for fundamental and applied research with a wide range of potential benefits from earthquake prediction and environmental management to providing curriculum content for science in schools.

In 2007 the Ocean Networks Canada (OCN) was established to oversee both projects with the aim of *"supporting transformative ocean science; contributing to public policy; creating commercial opportunities; and promoting public education and outreach."*[33]One of the issues is that despite the initial commitment of funding, on-going operational and maintenance costs are estimated to be approximately $15M per year.[34] Without this funding over the projected life of the science plan (25 years) the potential benefits of the initial investment will not be achieved. OCN is partnering collaboratively with Canadian and international organizations (e.g., in US, Japan, and Taiwan).

[31] See: http://www.neptunecanada.ca/news/multimedia-gallery/video/onc-video.dot (accessed March 14, 2011.

[32] Ibid.

[33] M. Taylor [2008]. "Supporting the Operations of Neptune Canada and Venus Cabled Ocean Observatories." In *Proceedings of Oceans 2008 – MTS/IEEE Kobe Techno Ocean Conference,* April 2008.

[34] Ibid.

Surfrider Foundation (Vancouver Chapter)

In contrast to the sophistication and complexity of Neptune and Venus and other OOS described above, there are a large number of informal and formal organizations who monitor the coasts and oceans and provide important local and traditional knowledge. These organizations include traditional fishers, commercial transportation, Inuit, Inuu, and First Nations, and a wide variety of NGOs.

The Surfrider Foundation is an example of a small NGO that monitors water conditions and quality, beach access, and other coastal zone management indicators (e.g., air quality) affecting the use of the coast in specific areas.[35] Their web site[36] provides water quality information published on a weekly basis from the Greater Vancouver Regional District Laboratory. The benefit of the website is that this information can be accessed by the general public for recreational purposes, as well as Surfrider members. Compiled assessments of coastal conditions are also published annually, however the organization notes that due to the lack of co-ordinated coastal management activities in British Columbia, standardized indices and information is not as readily available as in the USA. [37]

[35] Haggerstone [2011] Personal communication by e-mail February 2011.
[36] Seehttp://www.vch.ca/your_environment/water_quality/recreational_water/beach_water_quality_report/beach_water_quality_report. (accessed February 18, 2011)
[37] See http://www.beachapedia.org/State_of_the_Beach/State_Reports/BC (accessed Dec 9, 2010)

Lessons Learned: Barriers to Maximizing the Benefits of OOS in Canada

This section draws on the OOS examples presented in Section 3, interviews with government, academic, and private sector OOS stakeholders, and the insights provided by the team members of the OSTP Inventory of OOS in Canada.[38] The focus is on some of the barriers that OOS in Canada that prevent achieving maximum benefits from the investments that have and are being made.

Project Oriented, Technology Driven Approaches

OOS in Canada have developed to meet specific regional needs or issues or to demonstrate particular technologies with no overall national vision of how all of the isolated efforts fit together. This has led to a project driven approach by both funding sources and the OOS with the resulting uncertainty about how the initial investments will be maintained operationally or how demonstrations can be applied in other regions.

There is unevenness in terms of availability of resources, sustainability, and support. In some cases, such as the Great Lakes there is no real counterpart to GLOS. In other regions, such as the Arctic, the multitude of current scientific projects involving the coasts and oceans need overall co-ordination nationally as well as internationally if data is to be used more than once and by more than one specific project. There is an opportunity in Canada to demonstrate OOS in a variety of environments and for a wide range of purposes. However, the current approaches represent lost opportunities for an integrated and long term return on investments.

Lack of Effective Governance Structures at a National Level

Directly related to the current isolated, project driven approaches is the lack of a national framework for OOS, including overall governance, co-ordination and management. This will require leadership and a national vision, as well as co-operation, and collaboration, instead of focusing on competition for scarce resources.

Without a national approach many of the potential benefits of OOS in Canada cannot be achieved. Examples of the issues that will probably persist without a national framework include:

- inconsistent, discontinuous, and incomplete monitoring of the oceans and Great Lakes resulting in further environmental, economic, and social costs;
- lack of strategic investment objectives;
- lack of a strong pan-Canadian approach to marketing OOS technologies and expertise;
- short term projects without sustainability and minimal ability to leverage investments because of fragmentation;
- inability to meet international responsibilities such as security and environmental protection which depend on common standards and integrated data for joint decision making;

[38] Supra, OSTP.

- unevenness in the focus on beneficiaries where some systems focus entirely on research and others focus more on commercial or public applications.

Canada's lack of a national framework has led to fragmented, sporadic, and isolated data much of which will never be used outside the specific project or even known about by potential users. This represents lost opportunity costs and significant costs of duplication. A major issue in this respect is the lack of policies and standards for data management. This has already resulted in lost opportunities and duplication of efforts. Examples of the impact of these costs include:

- costs of duplicate data collection efforts due to lack of continuity, lack of trust, or lack of knowledge of the data's existence;
- inability to integrate and use all available data effectively for decision making;
- missed opportunities to use existing technologies such as satellite data;
- inability to provide the flexibility in providing data at appropriate scales for multiple users, including lack of effective and cost efficient processing of end products.

Lack of Identification, Tracking, and Communication of Benefits

As shown in the few interviews conducted for this study, little attention has been focused on measuring the actual value of the OOS. Although many of the systems are in their formative stages, there has been a lack of rigorous evaluation of potential user requirements. Such user assessments are considered standard in land based resource information systems and have been supported by programs such as GeoConnections. Yet in the oceans, the systems have been focused on the system provider/manager, i.e., "how will my proposed system give you potential benefits?" rather than "what information do you need, how will it be used, and what is the best strategy for providing that information?"

Therefore the emphasis across Canada has been the potential benefits of the system. Aside from tracking web page usage, few assessments of benefits achieved have been conducted. Perhaps more disturbingly, most OOS managers are not really aware of who the end users are or how to monitor and evaluate any benefits achieved. In reverse, there is little knowledge in many of the regions of the OOS activities that are undertaken. How many OOS have even thought of mining local knowledge to complement scientific observations?

Without this information on achieved value, there is little accountability for the investments made. In addition, each OOS project needs to make a special case for its funding. Politicians and funding organizations need to know that OOS is moving beyond demonstration and beyond potential value if there is to be sustainable and sufficient support in the future. Potential partners need to know what has been achieved before collaborating.

Recommendations

1. ***Canada needs to build a national vision and governance structure with effective leadership to capitalize on the large investments made in OOS in Canada.*** This is essential in, for example:

    - providing the information required to implement the Oceans Act provisions more effectively and efficiently, including improving the availability of reliable baseline data and improving the continuity and completeness in long term monitoring;
    - promoting common standards and policies to minimize downstream costs of data management and use;
    - sustaining and expanding existing OOS within an integrated framework;
    - providing a more balanced approach to investment across regions, user groups, and specific applications or issues;
    - enhancing the ability to commercialize and market Canadian technologies and expertise by demonstrating a integrated approaches for a wide variety of marine environments;
    - enabling Canada to meet its international responsibilities in terms of environmental management, public safety and security.

2. ***OOS initiatives in Canada need to identify, measure, and communicate benefits actually achieved.*** This involves two thrusts: a) more focus on the user community on the front end; and b) methodologies and commitments to tracking the use and value of OOS.

    When there are new or expanded initiatives, a more comprehensive approach of evaluating user requirements will help to build that link between the system and end user. User requirement studies help to:
    - identify potential stakeholders/users/actors;
    - increase stakeholder involvement and thus support;
    - streamline potential data collection, processing and dissemination;
    - provide more concrete indicators of success.

    Tracking and better communicating achieved benefits will assist in:
    - evaluating system performance;
    - ensuring accountability to the public and investors;
    - providing information for continuing support.

    Without a new focus on accountability and value, it will be increasingly difficult to gain the political support and financial resources to develop and sustain OOS in Canada. As the existing OOS mature, Canada needs to move beyond the published lists of possible benefits and now start to more rigorously measure real economic, environmental, and social impacts.