Ocean Networks Canada's Smart Oceans™ Initiative

Institution	Institute for Studies and Innovation in Community-Based Research/Ocean Networks Canada
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Location	Coastal British Columbia, Cambridge Bay, Nunavut
Dates	April 2013—March 2006
Partners	IBM Canada, University of Victoria (Office of Indigenous Affairs, Institute for Studies and Innovation in Community-University Engagement)
Funders	Western Economic Diversification, Canada Foundation for Innovation, Province of British Columbia
Methods	Community consultation on environmental concerns; Installation of community observatories in coastal and northern locations; development of educational resources in collaboration with community educators to integrate local knowledge with observatory data; ongoing engagement through data sharing and environmental monitoring; joint development of data products and services according to community needs.

Project description

Ocean Networks Canada (ONC), an initiative of the University of Victoria, operates, maintains and develops cabled ocean observatory systems in all of Canada's oceans. The world-leading NEPTUNE and VENUS cabled observatories supply continuous power and Internet connectivity to a broad suite of subsea instruments from the coast to the deep sea, supporting research on complex ocean and Earth processes. This Internet connectivity permits researchers to operate instruments remotely and receive data on their computers anywhere on the globe, in real time.

Through the Smart Oceans™ initiative, Ocean Networks Canada is deploying instrumentation in coastal communities in British Columbia (BC) and the Canadian Arctic. Coastal communities are facing a wide range of rapid changes due to a changing environment. Lack of up-to-date scientific data limits community members in their ability to make informed decisions about their own coast.

The goals of the project are to improve community access to local, relevant environmental data which will support applications in several areas, including:

- Marine safety (by monitoring and providing alerts on sea state and ship traffic)
- Public safety (through natural hazard warning for earthquake ground-shaking, underwater landslides and near-field tsunamis)
- Environmental protection (by gaining a baseline of critical areas, and providing real-time environmental observations for managing operations and accidents should they occur)
- Science-based decision-making (by leveraging the observatories to help support decision-making
- Education and outreach (by providing students, teachers and community members access to locally relevant data and support in analyzing and utilizing the data)

Background on Ocean Networks Canada

ONC, an initiative of the University of Victoria, operates the world's most advanced cabled ocean observatories off the BC coast for the advancement of science and the benefit of Canada. The NEPTUNE and VENUS cabled observatories supply continuous power and Internet connectivity to a broad suite of subsea instruments from the coast to the deep sea, supporting research on complex ocean and Earth processes in ways not previously possible. This Internet connectivity permits researchers to operate instruments remotely and receive data on their computers anywhere on the globe, in real time.

With an operational life of more than 25 years, Ocean Networks Canada provides essential data required to address pressing scientific and policy issues. Real-time flow of data to on-shore laboratories and data centres permits rapid analysis of information on natural hazards such as earthquakes, tsunamis, storm surge, and underwater landslides.

NEPTUNE and VENUS share the same data management and archive system called Oceans 2.0. It provides users with open access to real-time and archived data and supports a collaborative work environment.

Funding for Smart Oceans™ BC

Western Economic Diversification is providing ($9,127,000) over 3 years to assist with the purchase and initial installation of the initial infrastructure required to deliver Smart Oceans™ BC.

IBM Canada (http://www.ibm.com/ca/en/) is providing significant investments to enhance the data analytics capacity required to support Smart Oceans™ BC.

Ocean Networks Canada was recently awarded a CANARIE grant to develop fast event detection and enable a mobile Oceans 2.0 for use in geographically remote sensor locations. This will also enhance the data analytics capacity to support Smart Oceans™ BC.

Smart Oceans™ BC is built upon the existing ONC infrastructure and operations, developed over the past 10 years through investments by:

- Government of Canada
- Canada Foundation for Innovation
- Natural Sciences and Engineering Research Council of Canada (NSERC)
- Centres of Excellence for Commercialization and Research (CECR)
- Government of British Columbia
- Canada's Advanced Research and Innovation Network (CANARIE)
- University of Victoria
- Industry partners such as IBM Canada, Ocean Works International, International Submarine Engineering Ltd. and ASL Environmental Sciences Inc.

It represents over $200 million in capital investment and has an annual operating budget of $16 million per year. In 2012, Ocean Networks Canada was selected as one of only four Major Science Initiatives eligible for funding under the Canada Foundation for Innovation Major Science Initiatives Program.

Ocean Networks Canada also represents a consortium of 12 member institutions from across Canada and harnesses, through collaborative relationships, the capacities in Ocean Tracking Network, ArcticNet and MEOPAR. In addition, Ocean Networks partners with NRCan, Fisheries and Oceans Canada, and Environment Canada to deliver observatory information aligned with their current priorities.

The community observatory

A cornerstone of the planned installations under Smart Oceans™ is the community observatory. These scaled-down observatories leverage the technologies developed for the larger observatories to implement smaller environmental monitoring platforms which are suited to shallow water coastal deployments. As in the case of NEPTUNE and VENUS, the information collected from community observatories is sent to the University of Victoria where it is managed, archived and made freely available to anyone with Internet connection.

- Typical equipment deployed on a community observatory includes:
- Water property sensors (to measure such things as temperature, oxygen, salinity, chlorophyll)
- Underwater microphone (called a hydrophone, to detect marine mammal vocalizations and other sounds)
- Underwater video camera (to monitor the diversity and behaviour of sea life)
- Above-ground weather station (to provide information on atmospheric conditions)
- Stationary shore camera (to support weather station data)
- Optional instruments to suit the location (such as an ice profiler for the Arctic)

In addition to community observatories, other instrumentation to be deployed where appropriate as part of the Smart OceansTM initiative includes coastal radar systems (for measuring waves and currents),

Figure 1: The Cambridge Bay Community Observatory before deployment.

Automatic Identification System antennas (for vessel tracking) and seismic sensors (for detecting earthquakes).

Community involvement

Benefits to communities through Smart Oceans™ can only be achieved if the data collected is relevant to community members and contribute to research priorities identified in the community. The data must be easily accessible and complement existing research and environmental monitoring initiatives. In addition, community members must possess the knowledge and tools to analyze and interpret the data for their purposes. For these reasons, community involvement is critical at all stages of the project, including planning deployment locations, design of user interfaces for data access, development of educational programs, and long-term planning.

The following components of the community engagement process have been identified as crucial:

- Identification of community stakeholders and interested parties.
- Gathering community input through face-to-face meetings, workshops and personal communications about local environmental concerns, important/sensitive locations, other related research

projects and instrument deployments, educational opportunities and needs, and potential partners.
- Installation of monitoring equipment including site surveys, permitting and permissions, shore infrastructure development, above-water and underwater sensor deployment.
- Development of educational resources through collaborative process with community educators to adapt educational materials to suit local needs and to integrate appropriate traditional and local knowledge.
- Joint development of data products and services according to community needs.
- Ongoing engagement through sharing of data and research results and connection to the broader scientific community involved in environmental monitoring.

Indigenous communities

Key community stakeholders for Smart Oceans™ are First Nations on BC's North and Central coast and Inuit community members in Arctic locations. The project received funding for two positions to enhance ONC's capacity in this area: an Indigenous Community Liaison and an Indigenous Community Learning Coordinator.

Key targets and activities

Key targets and activities include:

- Development of a long-term engagement plan for ONC with Indigenous communities.
- Design and implementation if training and educational opportunities related to ONC data and technology in Indigenous communities.
- Incorporation Indigenous place-based knowledge with the guidance of each Nation into ONC educational and online materials.
- Direct engagement in communities to develop ONC's relationships for the mutual benefit of ONC and the communities.

Global research community

Scientific research with ONC is fundamentally community-driven, in the sense that as a research facility, ONC maintains infrastructure and web-based tools for the global scientific community (principal researchers in universities and other scientific facilities) to access data and conduct research projects. For the NEPTUNE and VENUS observatories, the selection of instrumentation and sites, the definition of maintenance priorities and online portal development are all conducted with extensive consultation of the scientific community. This geographically-distributed scientific community is also of fundamental importance for Smart Oceans™ as they will access and use data from community installations as well. ONC's goals include growing the global scientific user base and providing opportunities for local experts to connect with other researchers. These opportunities can be built through community workshops, personal introductions and collaboration on funding applications for further research projects.

Formal educational initiatives

Ocean Sense High School program

Kiilinik High School in Cambridge Bay, Nunavut and Brentwood College School in Mill Bay, British Columbia are the flagship schools participating in the pilot year of a novel educational program, "Ocean Sense," based on analyzing, understanding and sharing ocean data collected by cabled observatories. The core of the program is "local observations, global connections." First, students develop an understanding of ocean conditions at their doorstep through the analysis of community-based observatory data. Then, they connect that knowledge with the health of the global ocean by engaging with students at other schools participating in the educational program.

Schools in communities hosting an observatory are invited to participate in the program, alongside schools located in other coastal and inland communities. Students and teachers access educational material and data through a web portal, and use video conferencing and social media tools to communicate their findings. The pilot program is targeted to students in Grades 8–10. A series of lesson plans introduces the teachers and students to cabled observatory technology and instrumentation, including technical aspects and their value in monitoring changing ocean conditions. The program is designed to engage a diverse range of communities (i.e. Coastal BC to Arctic) and even regional communities (i.e. Northern BC) on a common subject of importance to all: the ocean. The program will provide a forum for students to share their ideas, interests and concerns with their peers, nearby and distant. Science teachers at the pilot schools

will be providing feedback and direction to ONC in developing and refining the program.

Community colleges

Figure 2: Talking about whales with an elementary school class in Cambridge Bay, NU

ONC is working to build partnerships with Northwest Community College (Prince Rupert campus) and Nunavut Arctic College (Cambridge Bay campus) to incorporate course content related to scientific instrument technology and data analysis into existing programs. This is being done in order to build local capacity for participation in the deployment and maintenance of observatory technology and data use and interpretation.

Project timeline and progress to date

Early 2012: In early 2012, the first prototype community observatory was installed at the dock at Brentwood College School in Mill Bay, BC. The Mill Bay location was chosen due to the school's interest in hosting the observatory, the availability of power and communication at the site, and the school's proximity to the ONC's VENUS observatory site in Saanich Inlet. Real-time data can be viewed at: CU summit participants-case studies-Oct 24.docx..docx
http://www.oceannetworks.ca/learning/community-observatories/mill-bay

September 2012: In September 2012, a proof of concept version was developed for colder northern environments and installed in the Arctic Ocean at Cambridge Bay, Nunavut. Today this community observatory offers year-round, continuous monitoring and science-based support for greater understanding and protection of fragile Arctic marine ecosystems. Real-time data can be viewed at:
http://www.oceannetworks.ca/learning/community-observatories/cambridge-bay

April 2014: Western Economic Diversification announced a federal investment of $9,127,000 to support the development of ONC's Smart Oceans™ BC program. IBM is contributing $12 million to this program.

June 2014: ONC's team visited Prince Rupert, Hartley Bay, Kitamaat Village and Terrace to begin the community consultation process. Meetings occurred with representatives of the Haisla Nation, the Gitga'at Nation, the Kitsumkalum Nation, the Metlakatla Nation, members of the North Coast Skeena First Nations Stewardship Society and the Port of Prince Rupert. Educational opportunities were discussed in each community and at Northwest Community College (Prince Rupert campus).

September 2014: ONC expedition team completed the third annual visit to Cambridge Bay to maintain and upgrade the observatory. Presentations were made at Kiilinik High School, Nunavut Arctic College, Kullik Ilihakvik elementary school and the community hall. Potential collaborations with the Canadian High Arctic Research Station and the Kitikmeot Inuit Association were initiated.

October 2014: An event was held at Brentwood College School to reinstall the Mill Bay Observatory and officially launch the Ocean Sense education program pilot year with Brentwood College School (Mill Bay, BC) and Kiilinik High School (Cambridge Bay, NU) as the flagship schools.

October 2014: ONC returns to northern BC to continue community consultation and planning.

Spring/Summer 2015: Planned beginning of installation of northern BC observatory locations.

March 31, 2016: First phase project end.

Figure 3: Existing and planned community observatory locations.

Domains of research excellence

Of the four domains of excellence, this initiative exemplifies two particularly well: community relevance and equitable participation.

Community relevance

The principal aim behind the Smart Oceans™ initiative is to use the ONC's observatories in an operational way. In order to do this, ONC is designing and creating products from observatory data which are useful and relevant to members of coastal communities, such as notifications of seismic events and information for safe vessel navigation such as marine mammal alerts. This greatly expands the primary user base of observatory data beyond the traditional scientific user. Publication of scientific results in peer-reviewed journals resulting from observatory data remains an important aim, but community relevance, ease of use and adoption are also priorities. The users and stakeholders of ONC data range from university and government researchers (e.g., at the University of British Columbia or Pacific Geological Survey), to large public organizations (e.g., BC Ferries), to local and international industry partners (e.g., IBM Canada and Ocean Sonics), to individuals in their communities. Particularly in the case of community observatory deployment, the priorities and needs identified in coastal communities are of primary importance, but as with all ONC data, the global community has access to the data. In this way, as in the Ocean Sense program's tagline, we promote, "local observations, global connections."

Equitable participation

By offering free and open access to data, we can foster an inclusive approach to scientific discovery. No longer is data only accessible to an elite group of scientists, but rather anyone can participate, from citizen scientists to international teams of researchers across diverse fields. Through the collaborative development of educational resources and programs, we are attempting to enable local community members to participate actively in the stewardship and understanding of their own ocean environment. This trust has been developed over an extended period of time through various formal and informal interactions, and contributed significantly to all aspects of the research.