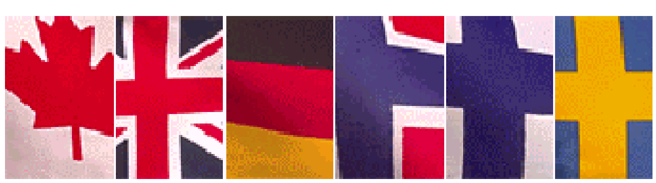
The
Northern View
Earth Observation for Northern Monitoring

An Invitation to the Arctic Council

A Project under the
Global Monitoring of Environment and Security (GMES)
initiative of the
European Space Agency (ESA)
and the
European Commission



The Northern View

Introduction

Organizations from Canada, Finland, Norway, Sweden, the United Kingdom and Germany have come together as the 'Northern View' team, and have been awarded a contract by the European Space Agency with the title of **The Northern View: Earth Observation for Northern Monitoring**. The intention of the Northern View is to create a service centre for earth observation data and analysis that meets the needs of those concerned with northern policy issues. The Northern View is interested in working with the Arctic Council and its member organizations in defining and providing these services.

Background

Global Monitoring of Environment and Security (GMES) is a joint initiative of the European Space Agency (ESA) and the European Commission. In November 2001, the ESA Ministerial Council approved a new 5-year, 80 million Euro, ESA programme dedicated to GMES, called the Earthwatch GMES Service Element (GSE for short), of which the first stage is the 15 million Euro "**Service Consolidation Actions of the Earthwatch GMES Services Element**".

The Northern View is one of ten projects under this first stage and has €1.5 million in funding for operations from February 2003 to November 2004. If, within that time, the benefits of earth observation in the context of northern policy can be successfully demonstrated to ESA, another €10 million may be made available over the subsequent five years to continue to support monitoring and analysis of northern issues.

Earth Observation in the North

Earth Observation (EO) is a powerful tool in the northern context. Because of the extent, remoteness, and isolation of northern regions, remote sensing is often the only cost effective and technically feasible means of obtaining information. Also, modern sensors can provide types of information that are not available from any other source. This information can support monitoring and analysis of issues relating to the environment (e.g. climate change, pollution, biodiversity), security (e.g. human activity monitoring, disaster management, search and rescue), and sustainable development (e.g. resource exploration, site remediation, bio-productivity monitoring).

The Northern View Services

The Northern View will deliver services to end-users, primarily (but not exclusively) from EO sources (example applications are discussed in the attached Appendix). End users will include policy makers, public bodies, and non-governmental organizations who formulate, implement and evaluate public policies relating to the environment and security in the north at local, national, regional, international and global levels. The project will enable end-users to become key players in the move from present generation EO satellites to future systems that will deliver vital information on global environmental and security issues.

The Northern View will have both short-term and long-term planning horizons. It is the long-term vision of the Northern View to establish a service centre that will be effectively a "one-stop shop" for key areas of interest to northern stakeholders. This long-term vision, however, will be built on the foundation of existing organizations and services that can provide benefits in the short-term. The objective for the next 20 months is to demonstrate to key organizations the utility and effectiveness of using EO data for northern monitoring, particularly in support of policy development, and to establish links with other northern stakeholders that might benefit from EO-based information.

The Northern View has begun offering services in the areas of oil spills and discharge monitoring, glacier and snow cover monitoring, and sea ice and iceberg monitoring. We expect to begin providing land cover mapping and water quality monitoring in the near future. These services are useful in diverse applications such as monitoring global climate change, studying marine and land animals and their habitats, assessing biodiversity and the impact of northern activities, enforcing environmental regulations, determining northern resource levels for sustainable development, and planning northern infrastructure.

The Northern View is very interested in learning more about the needs of potential users, and providing new services to meet those needs.

Involvement of the Arctic Council

The Northern View sees the Arctic Council and its Working Groups as exemplifying the type of organizations that could be end-users of the Northern View Service Centre. The long-term benefits to the Arctic Council of working with the Northern View will be considerable. Through this and subsequent projects under GMES, the needs of northern policy makers for EO derived information will be identified; the technology and systems to fulfill those needs, both space and terrestrial, will be created and implemented; and organizations will be formed to deliver the information on an operational basis. Northern policy makers will thus have much better information available upon which to base their decisions.

In the short and medium term, the Northern View can provide the Arctic Council with access to EO data interpretation services at significantly reduced costs. Also, the Northern View can provide training and promotional material and services.

In the long term, it is hoped that the Arctic Council will help to promote the use of earth observation in addressing northern policy issues where, and to the extent that, earth observation proves useful and cost effective.

The Arctic Council is not being asked to make any monetary investment at this time, and will be under no long-term obligation. Over the next few months, the Northern View would like to invite the Arctic Council and its Working Groups to work with us in defining their needs for northern information and determining the role that EO data sources could play in fulfilling those needs. There may also be opportunities for the Working Groups to participate in Northern View trials and demonstrations.

In summary, the Northern View welcomes the opportunity to work with the Arctic Council:

1. To raise awareness among the members of the Arctic Council of the benefits of earth observation within the northern context and the opportunity that the Northern View can provide for members of the arctic community to access information based on earth observation information.

2. To identify the needs for northern information of the Arctic Council, its working groups, and its members, and to estimate the benefits that earth observation can provide in meeting those needs.

3. To begin providing services to the Arctic Council working groups and others interested in northern policy issues.

4. To work towards a declaration at the next Ministerial Meeting concerning the value of earth observation in the northern context and the importance of ESA efforts to provide the necessary earth observation resources to support northern policy making.

Appendix: Earth Observation Services

An Introduction to Earth Observation

Satellite-borne Earth Observation (EO) systems have been providing imagery for more than two decades, and recent years have seen a dramatic increase in data availability, quality and access by end-users. EO is particularly useful for the monitoring of extensive, remote and isolated geographic regions that do not lend themselves easily to conventional, field-based data collection.

The discipline of remote sensing is concerned with the gathering of information about targets of interest from a distance. This is achieved by measuring the amount of electromagnetic energy emanating from those targets. EO systems are broadly classified into passive and active sensors. Passive sensors register the amount of solar radiation reflected or thermal radiation emitted by the earth's surface and therefore rely on an external source of illumination. Conversely, active sensors provide their own illumination by generating and emitting electromagnetic energy and measuring the proportion of that energy reflected by the targets of interest.

Passive sensors include panchromatic (PAN) and multispectral (MS) systems. Similar to aerial photography, PAN sensors are sensitive to the part of the electromagnetic spectrum that corresponds to visible light. MS systems, on the other hand, operate much like a spectrometer and register radiation in several distinct spectral bands. This makes it possible to identfy the specific reflection and absorption characteristics of any target features (e.g. vegetation, minerals) and increase the amount of information obtained for these types of targets.

The principal active remote sensing systems employ synthetic aperture radar (SAR) sensors. SAR systems do not rely on the sun to provide illumination and can therefore acquire imagery day or night. Moreover, the radiation used in SAR sensing can penetrate haze or cloud cover. This quality is particularly desirable in areas that are characterized by significant levels of cloud cover throughout the year.

The utility of remote sensing systems for a particular application is determined by their respective spatial resolution, revisit frequency and spectral configuration. Spatial resolution determines the amount of detail that can be captured by the sensor. It is expressed as the size of a picture element (pixel) in ground distance units (e.g. meters). Today's operational EO systems deliver data at resolutions ranging from <1 m to 1 km. The revisit frequency of the sensor is defined as the time interval between the successive imaging of the same geographic area. Revisit rates of current systems typically range from less than 1 day to 30 days. The spectral configuration of a sensor includes the number of spectral bands as well as their positioning in the electromagnetic spectrum and their respective sensitivity. Another important consideration is the swath coverage, indicating the area on the ground covered by a single image.

Current Northern View Services

The following section briefly outlines the services currently being offered by the Northern View. The next section describes other services that are expected to be offered in the near future. The Northern View is very interested in working with potential users to develop new service offerings that will meet their needs.

Oil Discharge Monitoring

The Northern View oil discharge monitoring service uses satellite imagery to monitor illegal discharge from ships and offshore structures. The service is provided to end-users concerned with enforcement, environmental monitoring, and surveillance of offshore areas.

The service provides reliable, weather independent coverage of northern oceans at high revisit frequencies. The large areal extent covered makes the service more cost-effective than conventional aerial surveillance, especially in offshore areas. The products delivered by the service can be readily integrated with other relevant data in existing information systems and monitoring frameworks.

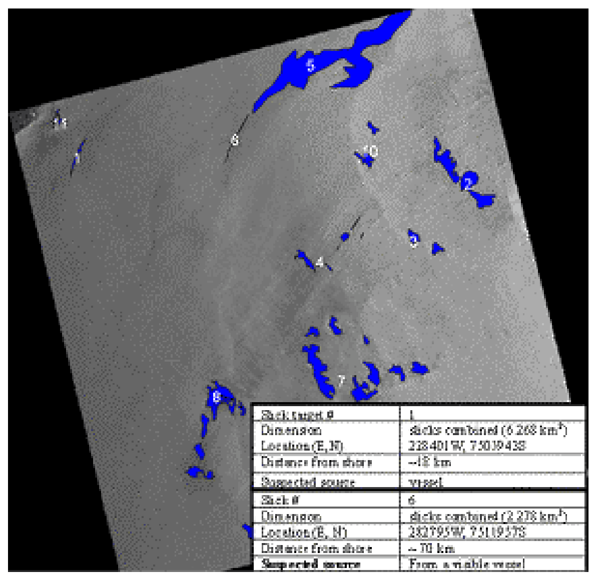


Figure 1: SAR image, delineated slick polygons and report

The service's principal data source is synthetic aperture radar (SAR) imagery collected by ENVISAT and RADARSAT-1. Potential oil slick locations are extracted from the satellite imagery in near real-time, i.e. in less than four hours from image downlink. The derived information can be integrated into existing monitoring, control and surveillance infrastructures, merged within a geographic information system (GIS), and disseminated using internet protocols. An oil slick report is generated identifying individual oil slick polygons, including geographic coordinates, size, distance from shore and likely source (Figure 1).

Ice-Edge Monitoring

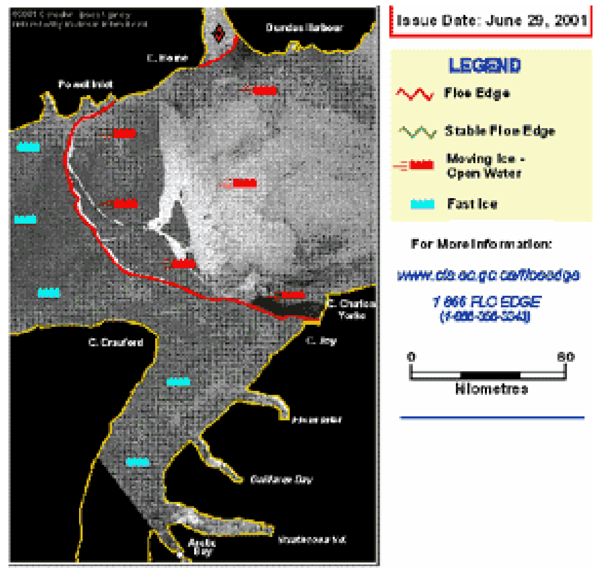


Figure 2: Floe Edge Information Product

Northern communities depend on the ice-edge for hunting and fishing, and it is a location of particular interest to the developing tourism industry. Traditional knowledge is becoming less effective in predicting ice conditions, possibly because of the effects of climate change. As a result, significant numbers of people need additional information to navigate safely in the ice-edge area. The Northern View provides ice information products to northern communities consisting of daily images showing the location of the ice-edge, where the ice is mobile, and where it is immobile or 'fast'. The product integrates satellite SAR imagery with an analyst's interpretation of the location of the ice floe edge, and the location of historical ice edges for the same time-period. The ice-edge products are stored inn an online system and delivered electronically over the Internet. Users can download and print the products for their use (Figure 2).

Glacier and Snow Monitoring

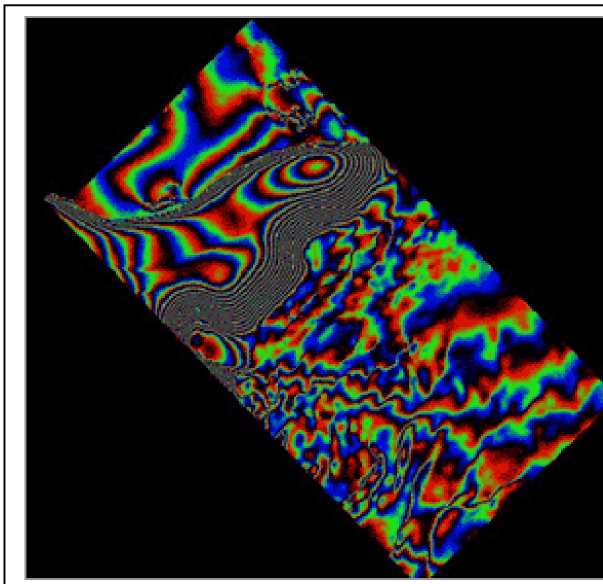


Figure 3: Interferogram showing glacier velocity variations

The glacier and snow monitoring service provides decision support tools for end-users using earth observation and numerical modelling solutions. End-users are typically water resource regulators with links to the hydropower industry, environmental managers and related policy administrators. To this end, the service provides integrated glaciological analyses focusing on the impact of climate change on glacial discharge, current mass balance distribution and glacier dynamics and stability. Depending on the specific needs of each end-user, a variety of information products can be provided, such as glacier topography, glacier velocity fields (Figure 3), glacier facies distribution, snow retreat and glacier surface energy balance.

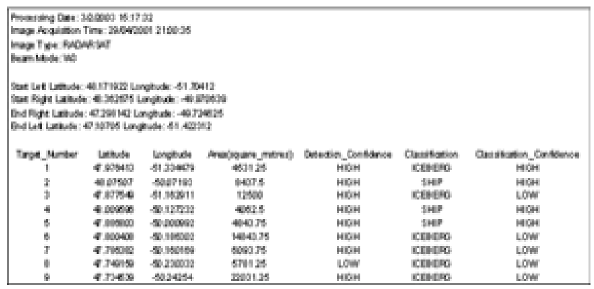
Sample products and services include glacier hazard evaluation, hydropower potential of a glacier system, seasonal runoff forecasting, and environmental impact assessments.

Iceberg Monitoring

The Northern View iceberg monitoring service supports safe shipping and offshore operations by providing near real-time detection of icebergs based on satellite synthetic aperture radar (SAR) imagery. The service is geared towards end-users concerned with transportation and offshore operations safety and compliance with regulations.

Satellite surveillance can be an effective alternative to aerial patrol. Satellite iceberg detection is cost effective for near shore surveillance and can be conducted more cheaply than aerial patrol for mid and far offshore regions. This is especially relevant as additional oil fields come into production and exploration activities move further offshore into deeper waters where the iceberg frequency is much higher.

Icebergs and other targets, such as ships and offshore structures, are extracted from the SAR imagery. A tabular detection report comprising target identification, location and detection confidence, is generated (Figure 6). The minimum size of detectable icebergs depends on image spatial resolution, shape of the iceberg look angle, and sea state. Under optimal conditions, icebergs as small as the sensor resolution can be detected, with a probability of detection exceeding 90% (Figure 7).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Beam Mode: W2

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Start Right Latitude: 48.362675 Longitude: -49.870639
End Right Latitude: 47.298142 Longitude: -49.734825
End Left Latitude: 47.10795 Longitude: -51.422312

Target_Number	Latitude	Longitude	Area(square_metres)	Detection_Confidence	Classification	Classification_Confidence
1	47.978410	-51.334479	4631.25	HIGH	ICEBERG	HIGH
2	48.07507	-50.87193	8407.5	HIGH	SHIP	HIGH
3	47.877549	-51.163911	12500	HIGH	ICEBERG	LOW
4	48.009598	-50.127232	4062.5	HIGH	SHIP	HIGH
5	47.895800	-50.200992	4040.75	HIGH	SHIP	HIGH
6	47.800408	-50.195002	14843.75	HIGH	ICEBERG	LOW
7	47.795082	-50.150169	6093.75	HIGH	ICEBERG	LOW
8	47.749159	-50.230032	5781.25	LOW	ICEBERG	LOW
9	47.734639	-50.24254	22031.25	HIGH	ICEBERG	LOW

Figure 6: Iceberg detection report

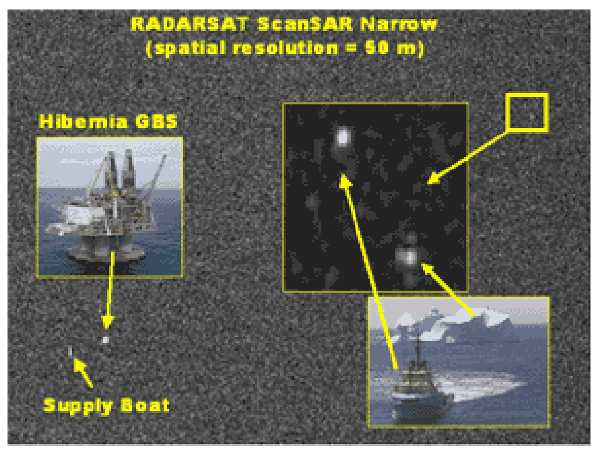

Figure 7: Iceberg and ship detection using RADARSAT imagery

In addition to the near-real-time service, historical iceberg information from archived data can yield quantification of length and geographic extent of icebergs seasons (and trends), and overall iceberg risk. This information is useful to legislators and regulators for defining ice management principles that must be employed for development in particular areas. These management principles include towing, burying of production facilities, the provision of platform disconnect capabilities. Improved historical information provided by the satellite SAR archive, dating back to 1992, will help regulators determine iceberg impact risk in deeper waters, such as the Flemish Pass, a region that is believed to have a much higher iceberg frequency than in the currently developed continental shelf regions. This historical archive can also be used in other iceberg-frequented regions to determine statistical iceberg concentrations, such as in Greenland and the Northern Coast of Russia, to enable safe operations for natural resource development.

Future Northern View Services

Land Use/Land Cover

One of the principal applications of EO data has been the monitoring of land use/land cover, as well as the tracking of land use/land cover changes over time. This can be achieved using a variety of different sensor at different spatial resolutions. Regular monitoring of land cover can also provide an indication of the health of the environment and could be achieved by creating repeated maps of the North (weekly, monthly, yearly, etc.). An example of an EO derived land cover map is presented in Figure 8.

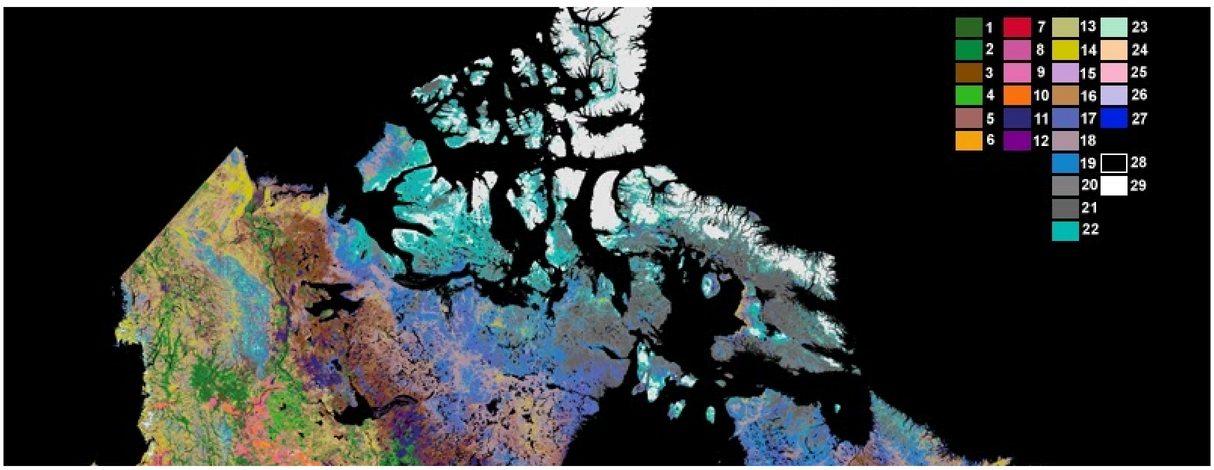

Figure 8: Land Cover Map Derived from EO Data

Surveillance of Marine Mammals

The routine surveillance of marine mammals over large areas is difficult to achieve using conventional field-based methods. However, airborne and satellite-borne high-resolution sensors offer considerable prospects for the cost-effective monitoring of northern mammal populations. An example is provided in Figure 9 showing the results of recent work with the goal of automatically detecting Beluga whales from aerial photography.

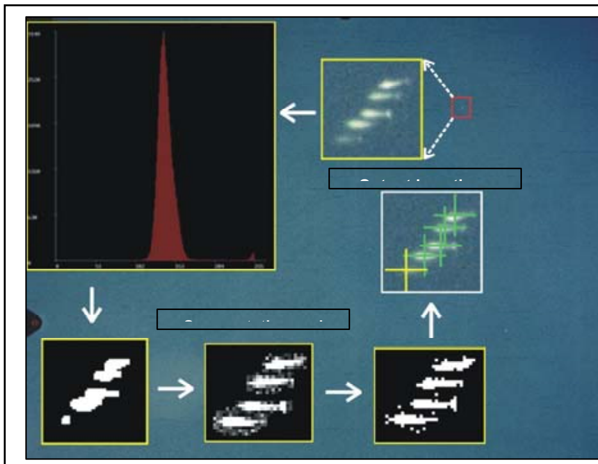

Figure 9: Automated Detection of Beluga Whales

Water Quality Monitoring

The quality of oceanic waters has long been monitored routinely using satellite imagery (see Figure 10). Water quality parameters extracted from such imagery include concentrations of phytoplankton, suspended sediment and dissolved organic matter. Similar techniques can be applied to large inland water bodies using the new MERIS sensor, which has been specifically designed to account for the inherent heterogeneity of inland and coastal waters.

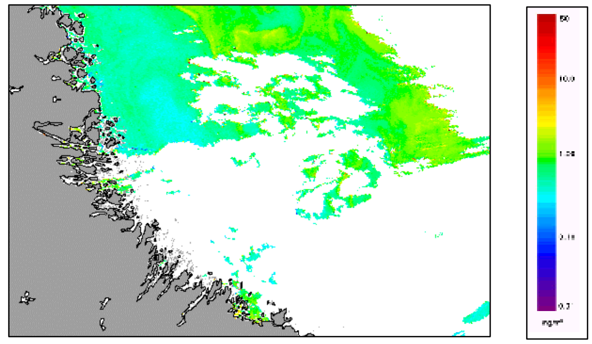

Figure 10: EO Derived Chlorophyll Concentration

Critical Infrastructure Mapping

Recently, a number of high-resolution satellite sensors have become available that are capable of collecting and delivering imagery at a quality and resolution comparable to aerial photographs (Figure 11). Comparative studies have proven the utility of such data for topographic and infrastructure mapping at spatial scales requiring a high level of spatial detail.

Figure 11: EO Infrastructure Identification