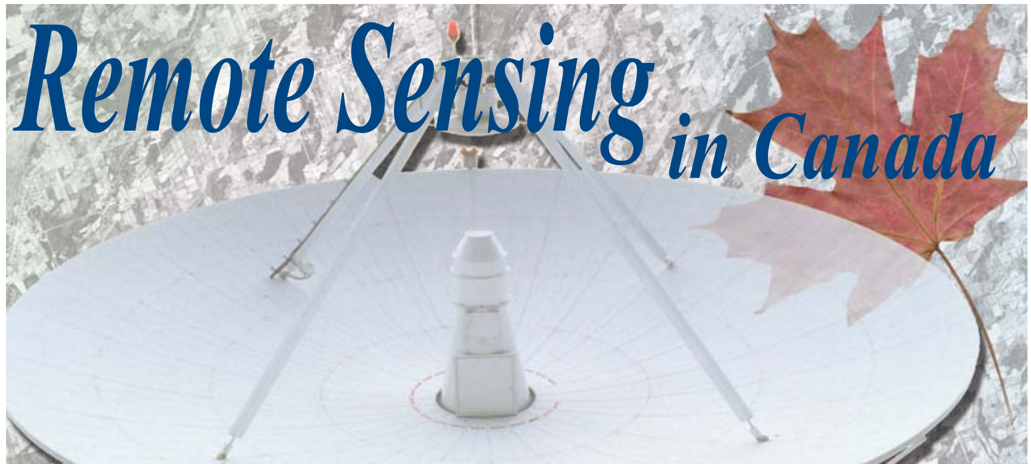
Natural Resources Canada   Ressources naturelles Canada

ISSN 0226-479X
Volume 30, Number 1
Spring 2002



Newsletter of the Canada Centre for Remote Sensing

Mapping and Monitoring Cordilleran Landslides

According to the Geological Survey of Canada, landslides cause more fatalities than any other natural hazard in Canada. Abrupt, shortlived geomorphic events, landslides are the result of the rapid downward motion of soil and rock materials in sloping terrains. Movement occurs when the shear stress of the slope material exceeds its shear strength. For this reason, the analysis of an increase in shear stress and/or a decrease in shear strength helps provide an understanding of landslides. Triggering mechanisms may include excessive precipitation, earthquakes, or deforestation; all of which upset the natural stability of the slope and result in the falling, sliding or flowing of the landmass due to gravity.

Historical records indicate that since 1850, landslides and snow avalanches have resulted in over 600 deaths in Canada and have caused billions of dollars of direct and indirect damage to our economic infrastructure. For instance, on March 26, 1997, a landslide caused the derailment of a Canadian National rail train near Conrad, British Columbia. The Trans-Canada Highway was threatened by a mudslide, cracks appeared in the pavement, and traffic was reduced to one lane. The two train crew members died and $20 million in infrasture damages resulted. While drainage and monitoring of the track has been improved by physical inspections and the installation of sensory equipment, developing new remote sensing techniques to identify and characterize

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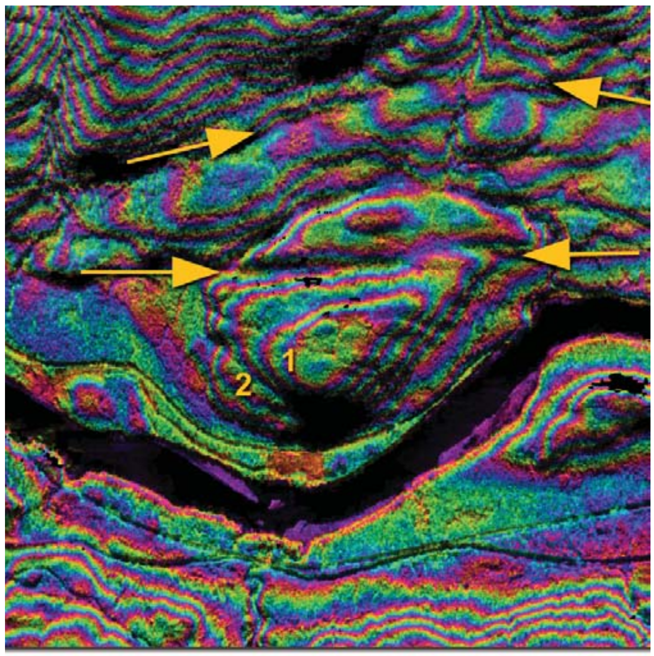

Figure 1a: Interferogram overlaid with RADARSAT-1 SAR image; Hope slide, British Columbia.

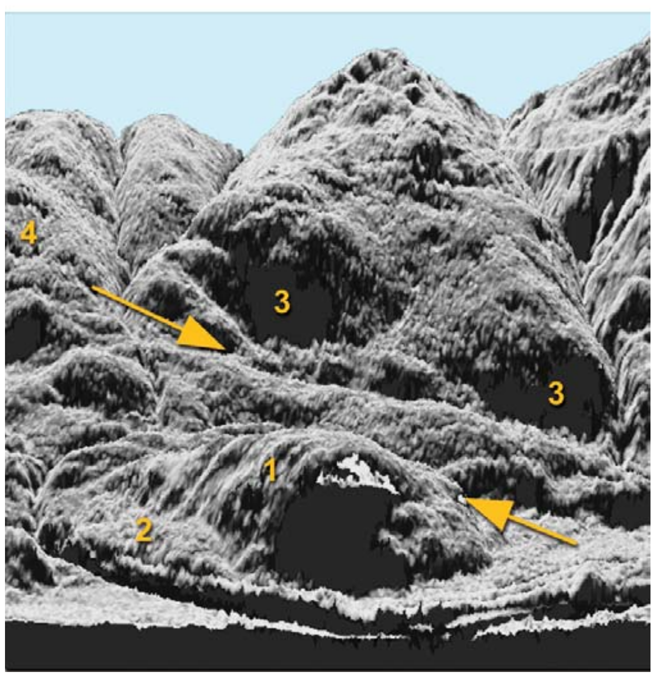

Figure 1b: Interferometric DEM; Hope slide, British Columbia.

1 Block Slide
2 Debris Slide
3 Slide Scarp
4 Transverse Ridge
→ Fault

"Remote Sensing in Canada"

RSIC is a bi-annual newsletter that provides a comprehensive view of remote sensing activities, programmes and products co-ordinated by the Canada Centre for Remote Sensing, Natural Resources Canada. CCRS works in co-operation with other Government of Canada agencies, provincial governments, Canadian industry, and Canadian universities. CCRS includes the National Atlas Information Network.

For more information about CCRS please consult our Web site at:
http://www.ccrs.nrcan.gc.ca/

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ON-LINE!

www.ccrs.nrcan.gc.ca

Information regarding over **200 Canadian remote sensing companies** active in the development of remote sensing products and services is available via the CCRS Canadian Remote Sensing Companies Database.

New Director General Takes Over the Helm

Dr. Bob Ryerson has been appointed as the fifth Director General of the Canada Centre for Remote Sensing (CCRS), Natural Resources Canada. Bob returns to CCRS after spending six successful years in the private sector where he was active in geomatics consulting to industry, governments, and international organizations as President of Kim Geomatics Corporation and a founding partner of Ryerson Batterham Associates Limited. In some respects, Bob considers himself to be "coming home" - having worked at CCRS from 1973 to 1984 as a scientist, then as Head of Marketing, and until 1996 as Chief of Industrial Co-operation.

Bob is looking forward to working with the excellent staff at CCRS, the Earth Sciences Sector team, as well as the many companies and agencies that rely on the expertise at the Centre. "***I have a mandate to help make our field grow - and with the people we have and the support we have from the Sector and the Department, the future is bright for us all.***"

Significant Listing for the Canadian Journal of Remote Sensing

The Canadian Journal of Remote Sensing (CJRS) (**http://www.casi.ca/canadian.htm/**), the official journal of the Canadian Remote Sensing Society (CRSS), is now in its 28th year of publication. Published bi-monthly, CJRS includes Research Articles, Research Notes, Review Papers, and Technical Notes that focus on remote sensing data acquisition, information processing methods, and applications. All published manuscripts require favourable peer review prior to acceptance for publication.

An application to include the CJRS in the Science Citation Index® (SCI) was submitted to the Institute for Scientific Information (**http://www.isinet.com/**) in November 2000. Almost one year later the CJRS was accepted for the Science Citation Index Expanded ™ (SCIE). Coverage began with the February 2001 issue. The SCI is a subset of the SCIE and is reserved for journals that generate consistently high citation activity as well as impact factors within their subject category and geographic origin. Most journals are not accepted for the SCI immediately. A full listing in the SCI will continue to be pursued for the CJRS over the next few years.

Starting with the February 2002 issue, the layout, printing, and distribution of CJRS has been transferred from the headquarters of the Canadian Aeronautics and Space Institute to the National Research Council Research Press (**http://www.nrc.ca/cisti/journals/rp2_home_e.html/**). The agreement also includes the production of an electronic version of the CJRS in which all articles will be available in Portable Document Format (pdf). Starting mid - 2002, the pdf files will be available free of charge for a limited time.

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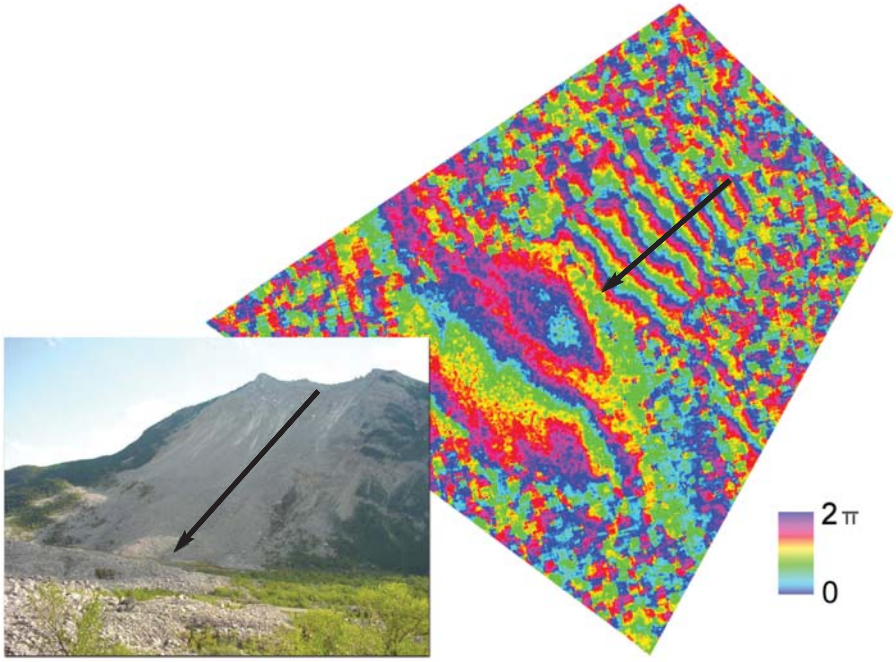

Figure 2: RADARSAT-1 Differential Interferogram with Topographic Phase; Frank slide, Alberta.

landslides will assist in the current national landslide inventory and hazard mapping initiative that is being developed by the federal government.

Scientists at the Canada Centre for Remote Sensing (CCRS), Natural Resources Canada, are using RADARSAT-1, airborne Synthetic Aperture Radar (SAR) interferometric, and stereo SAR data in conjunction with image fusion techniques to monitor landslide stability along Canada's two most strategically important transportation corridors - the Fraser Valley and the Crowsnest Pass. Almost all transportation lines that link the prairie provinces with metropolitan Vancouver use these two corridors, within which landslide processes such as debris flows, deep-seated landslides in fine grained glacial deposits, rapid flow slides, rock falls, and rock avalanches occur. The causes of landslides in this area include the weakening of failure planes in carbonate rocks, solution erosion, seismic shaking, the presence of clay infilling along discontinuities, steep slopes, excessive precipitation, and deforestation.

Thirty-five large landslides ranging in size from 1 million to more than 500 million cubic metres have been identified in the lower Fraser Valley. One such landslide occurred on Janurary 9, 1965 when a large rock avalanche, (forty-eight million cubic meters), 160 km east of Vancouver buried three vehicles, and caused four deaths. Considered to be the largest landslide in the history of British Columbia, the Hope slide was triggered by two small earthquakes measuring 3.2 and 3.1 on the Richter scale. Figure 1 shows an Interferometric Synthetic Aperature Radar (InSAR) visualization technique that can be used to indentify and interpret deep-seated landslides. InSAR operates on the principle that if two images of the same object taken at different times have different backscatter signals, then the object has either moved or changed. A combination of InSAR visualization products and stereo air photos can be used to identify steep slopes underlain by weak soils; slopes undercut by rivers; tension cracks; steep hummocky topography; failed surface scarps; anomalous bulges and lumps; terraced slopes; discontinuous bedding planes; drainage-vegetation patterns; as well as elongated ponds on hillslopes. Such mapping practices assist in producing an inventory of landslides in high risk mountainous terrains.

In the Crowsnest Pass, thirty million cubic meters of rock and rubble slid down from Turtle Mountain on April 29, 1903. Lasting not more than 100 seconds, this landslide buried the southern end of the town of Frank, Alberta and claimed 70 lives. Recently, movement has been detected on the slopes of Turtle Mountain; however, current monitoring systems are inadequate to detect precursor behaviour associated with the initiation of a major rockslide. At CCRS the SAR interferogram shown in Figure 2, is being evaluated as part of an integrated slope monitoring system. From a fine mode RADARSAT-1 image, a SAR textural map that coincides with the debris size distribution and ridge morphology of the Frank Slide, was generated. This product enables the post-failure mechanism and mobility of this landslide to be understood.

Information on slope morphology and gradual motion using permanent scatterers such as roads, changes in soil structure, and failures have been reported and are being evaluated on the Hope and the Frank sites. Such monitoring practices assist in developing mitigation strategies for landslides.

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AEROCAN Observations for 1994-2000 Available

A new CD-ROM containing AEROCAN observations for 1994-2000 is available from the Université de Sherbrooke. AEROCAN, (http://www.callisto.si.usherb.ca/~abokoye/aerocan_index.html), is Canada's ground-based aerosol monitoring network of automatic sun and sky radiometers, with a satellite data transmission system, and centralized data processing. It is a federated part of the National Aeronautic and Space Administration Goddard Space Flight Center's (NASA/GSFC) worldwide AErosol RObotic NETwork (AERONET) (http://aeronet.gsfc.nasa.gov/). AEROCAN's mission is to acquire sufficient spatio-temporal data to validate the development of a Canadian climatology for aerosol optical properties and derived particle size parameters. This climatology is targeted towards image atmospheric correction applications in remote sensing and the development of a validated Northern aerosol regional climate model.

Figure 1 on the right shows the current AEROCAN instrument sites across Canada in addition to those managed by AERONET in Alaska. The Canada Centre for Remote Sensing, Natural Resources Canada, and the Natural Sciences and Engineering Research Council fund AEROCAN equipment and research. The programme also benefits significantly from in-kind contributions from NASA/GSFC and the Meteorological Service of Canada.

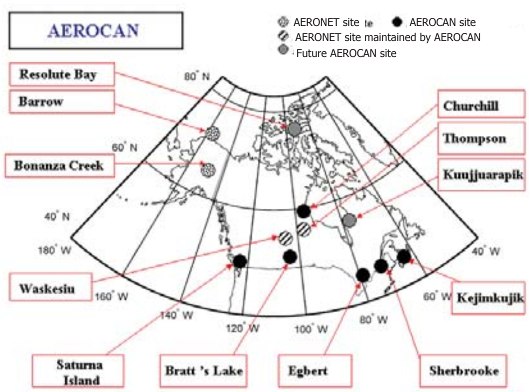

Figure 1. AEROCAN map provided by Dr. Amadou Bokoye, CARTEL

CIMEL Automatic Sun Tracking Photometer

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GlobeSAR-2 Educational Resources for Radar Remote Sensing CD-ROM

The eagerly anticipated GlobeSAR-2 Educational Resources for Radar Remote Sensing CD-ROM is now available! This package provides a comprehensive and unique set of radar remote sensing training materials.

The CD-ROM was produced to support the development of radar training capabilities in universities and agencies in South and Central America. It incorporates training slides developed by scientists at CCRS for the GlobeSAR and the ProRadar programmes as well as significant contributions from radar specialists and user agencies in many other countries. The CD-ROM is available in English/French and Spanish/Portuguese. A copy of this CD-ROM has been sent to all GlobeSAR-2 participants in Canada and Latin America. Additional copies may be ordered free of charge from:

GlobeSAR-2 Office
Canada Centre for Remote Sensing
588 Booth Street
Ottawa, Ontario
CANADA K1A 0Y7
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Fax: (613) 947-1385
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On the Move

The Honorable Herb Dhaliwal became Minister of Natural Resources Canada in January 2002. **Terry Fisher** is enjoyeing his retirement from CCRS. **Joanne Frappier** has left the GeoAccess division of CCRS to take up a new analyst position at the Geomatics Canada Office. **Shannon Kaya** has been newly appointed as GlobeSAR Project Coordinator. **Gunar Fedosejevs** has joined the *in situ* group of the Data Acquisition Division after four years with the Environmental Monitoring Section, Applications Division. **Ko Fung** has also left the Environmental Monitoring Section, Applications Division and joined the Data Acquisition Division where he will apply his system engineering interest in the development of the Canadian Disaster Management Information System. **Paul Deneumoustier** has returned to the Data Acquisition Division after working with the Innovation Acceleration Centre for fifteen months.

Maritime Boundary Mapping

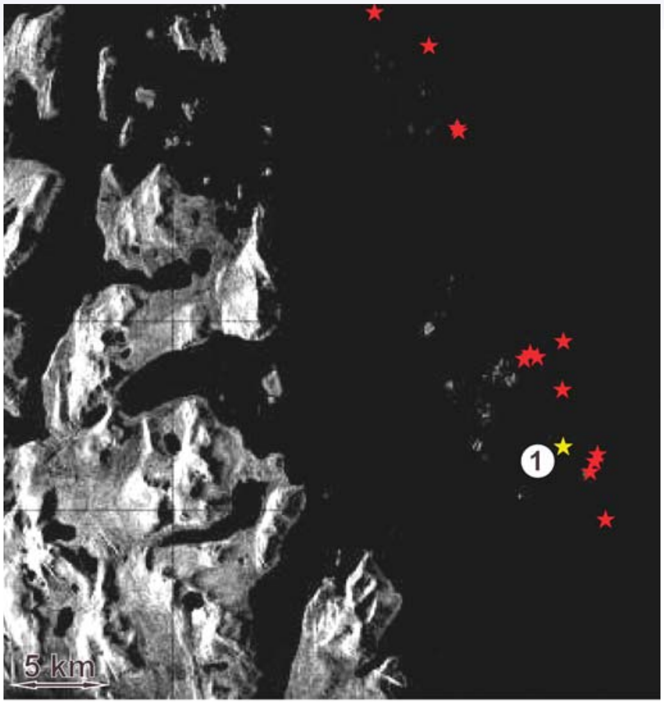

Figure 1: RADARSAT-1 Fine mode image subset showing a section of the North coast of Labrador on 2000-09-20 (© CSA 2000). The overlaid stars mark the GPS positions of rocks surveyed by the CHS in July and August of 1997.

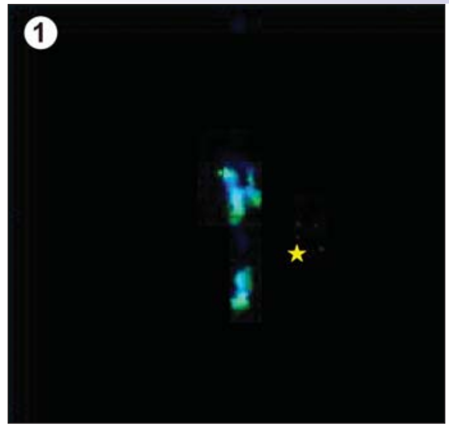

Figure 2: Two-date colour composite comprised of RADARSAT-1 fine mode images acquired on 2000-09-03 (in green) and 2000-09-20 (in blue). The feature is clearly imaged on both dates and represents the rock shown in the corresponding photograph.

No nation can fully exercise its sovereign rights to living and non-living resources in adjoining seas and oceans without accurate knowledge of its maritime boundaries. This query to sovereignty explains the significant interest countries attach to the mapping of their borders at sea.

The outer limits of maritime jurisdictions, such as the exclusive economic zone, are defined in terms of distances from the baselines of the territorial sea. In turn, these baselines are defined as straight lines joining headlands and islands or discrete points, such as drying rocks. Hence, reliable identification and positioning of the most seaward islands and rocks is a prerequisite for the establishment of precise maritime boundaries. Traditional methods for mapping these features typically include aerial surveys. However, the costs associated with such surveys can be prohibitive for complete mapping of extensive and isolated areas.

Scientists at the Canada Centre for Remote Sensing, Natural Resources Canada, on request of and in partnership with the Canadian Hydrographic Service (CHS), have applied RADARSAT-1 fine mode data to map the islets and rocks along the North coast of Labrador. In 1997, the CHS surveyed this particular area for the presence of such features by means of visual observation from a helicopter. Acquired during low tide conditions in August and September of 2000, the RADARSAT-1 data studied were processed to images with a pixel spacing of 3.125 m by 3.125 m. Joint analysis of images of two or more dates was implemented to minimize the chance of confusion between rocks and icebergs.

Through visual interpretation of the RADARSAT-1 data, 19 out of 22 surveyed rocks and islets could be confidently identified. The average offset between the recorded image positions and 1997 GPS positions (accuracy ± 100 m) was less than 150 m. Hence, it can be concluded that RADARSAT-1 images are a good source of information for supporting maritime boundaries definition. Moreover, mapping approaches that make use of RADARSAT-1 images are likely to be more cost-effective than those approaches that involve the deployment of airborne platforms. The potential for automated detection of rocks and islets in RADARSAT-1 images is currently being further investigated.

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Ground Station Operations and Satellite News

LANDSAT-7

LANDSAT-7 data distribution by the Canada Centre for Remote Sensing (CCRS), Natural Resources Canada, distributor network continues to perform well. The distributor network includes RADARSAT International Inc. (RSI) of Richmond, BC and most recently Resource GIS and Imaging Ltd. (RGI) of Vancouver, BC. RGI has achieved significant sales in its first full quarter of distribution, following its commencement of distribution in early October 2001.

EROS A1

EROS (Earth Remote Observation System) A1 data capture equipment provided by Core Software Technology was installed at the Gatineau Satellite Station on February 15, 2002. On February 26, 2002 a 90-day test/demo phase commenced. Continuation of reception services beyond the 90-day test period is subject to the results of ongoing discussions between Core and CCRS.

ENVISAT

ENVISAT (ENVIronment SATellite) was launched on March 1, 2002. The CCRS ENVISAT Ground Segment is on schedule and will support ASAR data reception test operations as soon as the European Space Agency (ESA) is able to make data available. ASAR data will only be available for testing and commissioning purposes until ESA commissions the space segment, expected by September 2002, by which time the CCRS ENVISAT Ground Segment will be fully operational. The CCRS ENVISAT Ground Segment will be the first outside of the ESA European Payload Data Segment network.

Client Survey

A Ground Systems Operations Client Survey was completed on March 22, 2002. A summary analysis was conducted by a consultant and delivered on March 28, 2002. The analysis indicates that clients are quite satisfied with the services and products of CCRS's Ground Systems Operations Section.

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CCRS Scientist's Contribution to Climate Change Research Acknowledged

Josef Cihlar, a scientist at the Canada Centre for Remote Sensing, Natural Resources Canada, has received a Certificate of Recognition from the Global Climate Observing System (GCOS). The certificate was awarded for "outstanding leadership and scientific contribution toward improved observations and monitoring of climate change". Over a 6-year period, Josef served as Chairman of the Terrestrial Observation Panel for Climate Change (TOPC), which reports to GCOS and the Global Terrestrial Observing System (GTOS). TOPC has earned recognition as an authoritative scientific group advising user communities on climate related data. The Plan for Climate-related Observations that was produced by TOPC is in great demand in the scientific and policy communities.

GTOS and GCOS are co-sponsored by five central United Nations organizations concerned with climate change. Josef Cihlar continues to lead international preparations for the Terrestrial Carbon Observation, a joint initiative of GTOS and the Food and Agriculture Organization of the United Nations.

Updated Canadian Land Use Databases

Land use and land use intensity datasets recently created by the Canada Centre for Remote Sensing (CCRS), Natural Resources Canada, are being included for national indicator status as part of the National Round Table on Environment and Economy (NRTEE) Environment and Sustainable Development Indicators (ESDI) Initiative. The NRTEE is an independent advisory body that identifies key issues with both environmental and economic implications, examines these implications, and suggests how to balance economic prosperity with environmental preservation. Both datasets are the first of their type for Canada, and were produced in co-operation with Statistics Canada. CCRS took a lead role throughout the methods development and applications stages.

The land use dataset was derived from 1998 SPOT4/Vegetation (VGT) imagery that was processed and classified using new techniques developed at CCRS. The 1996 Census of Agriculture was used to identify major crop classes and refine the final product. This dataset is at a 1km resolution and identifies land cover and major land uses in agricultural regions. The land use intensity dataset is polygon-based data that extends across Canadian agricultural regions. It represents a combination of chemical and fertilizer additions, livestock density, and manure production.

The process used to create these datasets has been dubbed LUCIA (Land Use and Cover with Intensity Assessment) to represent its integration of high quality land cover and land use intensity data with agricultural land use classifications. Since land cover and land use (agricultural and urban areas) information are strongly related, differentiation requires ancillary data. The LUCIA process creates a database that merges both of these types of information. The 1996 Census of Agriculture, conducted every five years to provide a profile of Canadian agricultural operations as well as comprehensive information on the industry, enabled a particular use to be based on spectral information derived from the classification procedure applied to the SPOT4/VGT imagery.

In addition to being used as indicators for environmental sustainability, both LUCIA products are being applied to the strategic issue of "species at risk" by linking spatial gradients of species endangerment to aspects of land use through advanced statistical procedures. The land use and land use intensity data sets are being made available for additional analysis of ecosystem function throughout Canada in partnership with the Department of Biology at the University of Ottawa.

These data sets represent recent advances in data availability and remote sensing technology by putting new emphasis on agricultural regions. They will be a key component in future monitoring activities that focus on biodiversity, water quality, as well as sustainability in areas where human influences are most apparent.

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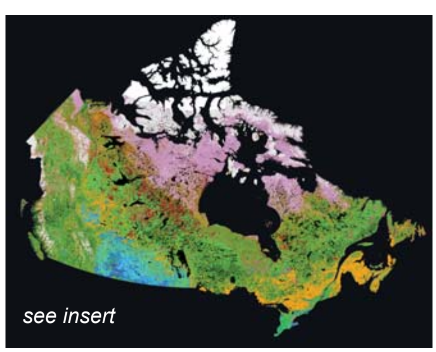

Gateway to Geographical Information on Climate Change

While considered a natural, forever changing process, it is thought that in the last 100 years climate change has been significantly influenced by human activities, in particular by the emission of greenhouse gases. Increased mean annual temperatures and thinner sea ice have been observed in many regions of the world, and according to global climate models continued increases in greenhouse gas emissions will cause further changes in temperature, precipitation, and other climate variables.

Based on extensive partnerships with many organizations and individuals of the climate change and geospatial information communities within the Canadian federal government, and relying on the technologies and services developed for the Canadian Geospatial Data Infrastructure, thousands of worldwide geospatial data collections relevant to climate change are searchable at the Geographical Portal for Climate Change (http://www.geoconnections.org/ccportal/). Users of this portal can also view a structured, series of climate change maps aimed to provide a synthesis of the best knowledge available on the issue of climate change.

To make your data searchable through the Geographical Portal for Climate Change, or to include your maps/data in the National Atlas Climate Change Map Series, please contact:

ceonet-info@ccrs.nrcan.gc.ca

For questions and comments on the content of this Portal, please contact:

info @atlas.gc.ca.

See RSIC On-line for more details.

RADARSAT-2 Ground Segment Infrastructure Upgrade Project

In preparation for the reception of RADARSAT-2 downlink data, the scheduling and reception facilities at the Canada Centre for Remote Sensing's (CCRS), Natural Resources Canada, ground stations are being extensively upgraded. The objectives of the upgrades are to support the RADARSAT-2 mission; to improve system performance; to increase automation; and to add a communication infrastructure between the Prince Albert Satellite Station (PASS), Booth Street, and the Gatineau Satellite Station (GSS).

Work packages being completed include:

- upgrading CEOSAM, which schedules multiple satellite missions reception activities for PASS and GSS, to include the RADARSAT-2 mission;
- replacing DAFControl, which automatically control and configure the equipment such as serial recorders and antennas for data reception at PASS and GSS, due to age;
- upgrading the Canadian Earth Observation Catalogue (CEOCat), which archives the meta-data and browse imagery files for data received at PASS and GSS, to accept RADARSAT-2 catalogue and browse entries from these two facilities, as well as from Network Stations. This catalogue will form the world-wide catalogue for the RADARSAT-2 Mission and will support both single and distributed directories for RADARSAT-2;
- replacing the current Anik link between PASS and GSS with a high bandwidth network connection;
- installing additional equipment at both stations to handle the 105 Mbps data rate of the second RADARSAT-2 channel. The older antenna at PASS will be upgraded and refurbished to provide dual channel capability;
- upgrading the Data Path Switch at PASS and GSS to increase the digital switching matrix, which is required to accommodate the additional equipment required for RADARSAT-2;
- replacing the existing HDDT serial data tape recorders at PASS and GSS with an automated, dual channel, serial data recording tape robot to provide redundancy against system failure. These robots and recorders will be controlled by the new DAFControl systems; and
- upgrading the SONY PetaSite®, which supports multiple missions for CCRS's archive. All RADARSAT-2 data will also be archived on this system.

Since the CCRS facilities support multiple missions, the upgrades must ensure support of the existing missions in addition to RADARSAT-2 requirements.

See RSIC On-line for more details. For more information, please contact:

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