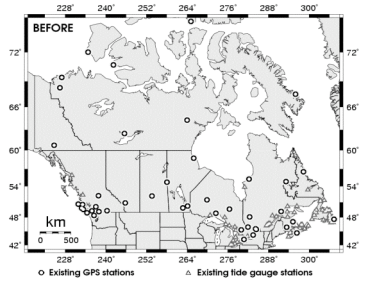
CAGENET: A Proposal for a Canadian Geodetic Network for Earth Systems Monitoring

M.G. Sideris and the CAGENET team

Department of Geomatics Engineering - University of Calgary

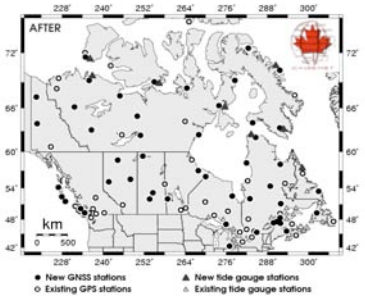
Introduction - Current Canadian Network

Currently, Canada has a very sparse, and thus highly insufficient, network of permanent GPS stations and GPS-collocated tide gauge stations – 49 and 12 (out of about 100 tide gauges), respectively, in total – for monitoring various Earth processes such as postglacial rebound, sea level and climate changes, surface water and arctic ice dynamics, storm surges and tsunamis, earthquake strain buildup, and regional and local tectonic stress fields and land deformations. This sparse coverage of monitoring sites severely compromises the ability (i) of Earth scientists and engineers to monitor, understand, model and predict complex Earth systems in Canada and world-wide, (ii) of government and industry to develop hazard mitigation, early warning and response strategies, and (iii) of Canada to play a key role in the

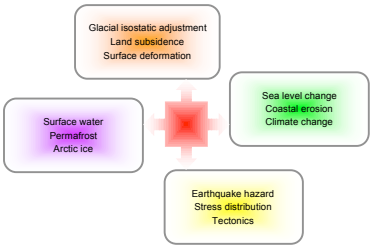


The Proposed Network Expansion

In order to improve this situation, a consortium of scientists from 11 universities and 5 governmental institutions across Canada have proposed the development and realization of a Canadian Geodetic Network for Earth Systems Monitoring. 50 new permanent Global Navigation Satellite System (GNSS) receiver stations are being proposed to be added nationwide, with upgrades to 10 existing permanent GPS receivers to GNSS receivers, and an addition of 8 new tide gauge stations co-located with GNSS stations. It is also proposed to increase dramatically the number of absolute gravity stations with the acquisition of an absolute gravimeter.



Research Objectives

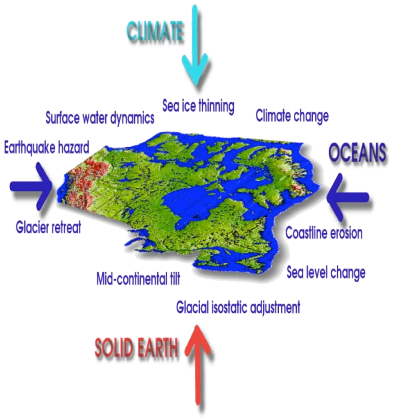


Glacial isostatic adjustment (GIA), land subsidence, surface deformation

- Strategically locate permanent GNSS stations to help with constraints for Earth parameters used in modelling GIA processes
- Absolute gravity changes will enable the separation of influence of changes of elevation from changes in the local mass distribution

Earthquake hazard, stress distribution, tectonics

- Earthquake prone areas: Western British Columbia and St. Lawrence river/Charlevoix region in Quebec
- Use monitoring stations to adequately characterize surface velocities from which patterns and rates of stress accumulation on faults can be estimated



Sea level change, coastal erosion, climate change

- Co-location of tide gauges and GNSS stations for absolute sea level change and vertical crustal motion separation
- Focus on Arctic and eastern coasts that are poorly covered with tide gauges

Surface water, permafrost and Arctic ice

- Monitor polar regions more closely
- Quantification of ice mass and its spatio-temporal change → in-situ elevation change for calibration and validation (by space geodetic and remote sensing techniques)

The Research Team

Principal Investigators

University of Calgary
Michael Sideris (Project leader), Alexander Braun
University of Toronto
Richard Peltier , Georgia Fotopoulos
York University
Spiros Pagiatakis
University of Western Ontario
Kristy Tiampo
University of Victoria
Herb Dragert
Laval University
Rock Santerre
Memorial University
Donald Forbes
University of New Brunswick
Richard Langley

CAGENET

Other partner institutions

18 other investigators from universities and government agencies, including:
University of British Columbia
University of Manitoba
University of Saskatchewan
Nunavut Research Institute
Canadian Hydrographic Service
Canadian Space Agency
Environment Canada
Geodetic Survey Division, Natural Resources Canada
Pacific Geoscience Centre, Geological Survey of Canada

Instrumentation

Innovation and Impact

Multi-sensors

- strategically situated and co-located set is the foundation for Earth systems monitoring by a combination of space and terrestrial-based technologies

Climate change

- quantify the status and assist in prediction of future scenarios
- impact of climate change on society involves food supply, health and diseases, environmental change, fresh water supply, etc.

Hazards

- Earthquakes, tectonics, coastal erosion and engineering, sea level rise, storm surges

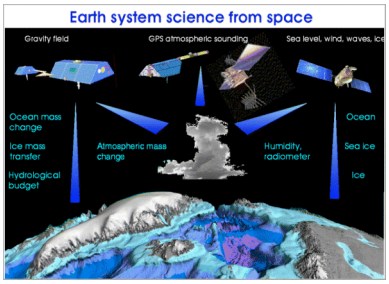
Advances in technology and engineering

- geomatics, geodesy, multi-sensor monitoring systems, etc.

Economical impact

- through increased and improved availability of geodetic reference data and their interpretation

Canada has already outlined its future goals in terms of **environmental and global change**. CAGENET will provide the infrastructure required for realizing these goals.



courtesy: Dr. A. Braun

Links to International Programs

Global Monitoring for Environment and Security – **GMES**

- bring data and information providers together with users

Global Geodetic Observing System – **GGOS**

- three fundamental pillars of geodesy (geodetic observables and their variations), i.e., Earth's shape, Earth's gravity field, Earth's rotational motion

US Earthscope - Plate boundary observatory

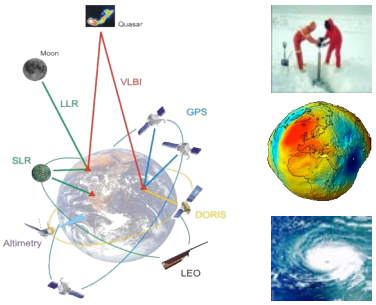
- geophysical and geodetic array

International GNSS Service - **IGS** – **TIGA**

- tide gauge monitoring by GPS

Group on Earth Observations - **GEO**

- global Earth observation system of systems



courtesy: GGOS

Benefits

- Monitoring of the state and temporal variations of the solid Earth, cryosphere, oceans, and surface water in Canada
- Monitoring, modelling and predicting flood, Earthquake and sea level rise induced hazards, and developing mitigation and emergency response strategies
- Contributing to the definition and realization of the new vertical datum of Canada and North America
- Becoming part of, and contributing to, the various international programs on global Earth observation
- Increasing the knowledge of our environment and its changes with time for the benefit of future generations

World Climate Research Program (WCRP) Workshop on Understanding Sea-level Rise and Variability, Paris, France, June 6-9, 2006