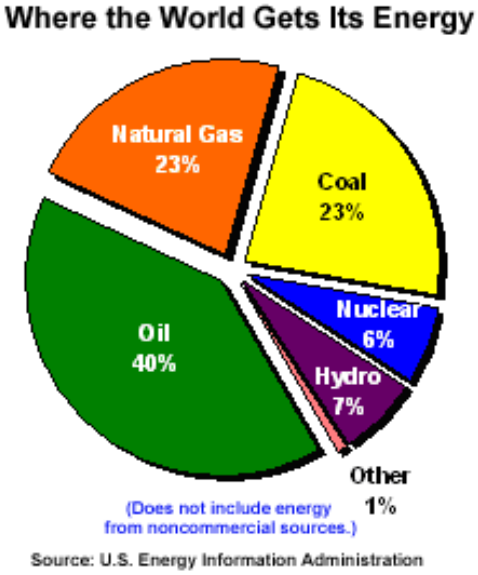
Energy and Mineral Development

The world population has reached over 6 billion people, up from 1.65 billion in 1900. The needs of modern, urban society have created unprecedented demands for energy and minerals, particularly for hydrocarbons, a non-renewable source of energy. In the case of minerals however, the demand can be in part be met through recycled products, and current mineral reserves are in plentiful supply, as demonstrated by low global commodity prices.

Recent innovations have led to significant development in renewable energy sources such as wind, solar or bio-energy. Hydrocarbons remain the dominant source of energy, despite demand outstripping new reserves for the past twenty years. It is currently forecast that global hydrocarbon reserves will be exhausted by 2050. Long before then, pricing will have a dramatic impact on global growth and consumption patterns.



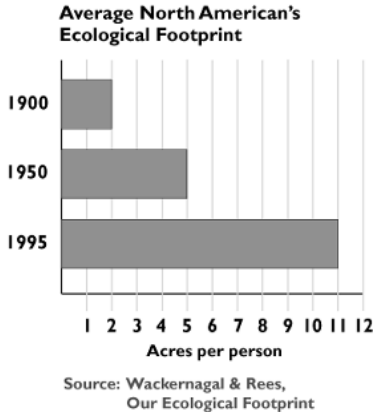
Global trends in energy and resource exploitation are driven by a number of factors or interrelated drivers of socioeconomic change and transformation, in particular:

- **Scientific and technological innovation.** Science and technology bring incremental efficiencies in energy use, stretching existing resources and prolonging expectations of energy reserve depletion;

- **Income growth.** The projected growth of global income of 3 percent a year over the next 50 years implies a fourfold increase in world gross domestic product (GDP), and an exponential growth in energy and resource use as the needs of developing countries match those of developed countries; as countries develop, their "ecological footprint" or resource consumption per capita also grows;

- **Demographic growth.** The global population will likely stabilize this century at 9 billion to 10 billion people, with 85 percent of this growth occurring by 2050. Larger populations mean greater demand for resources;

- **Urban transition.** By 2050, for the first time in history, the majority of people in developing countries will be living in towns and cities. The investments in infrastructure and other capital will affect land use, public space and energy, and the quality of life of both urban and rural residents and create stresses on freshwater and coastal ecosystems.[1]



[1] Adapted from http://www.dynamicsustainabledevelopment.org/showsection.php?file=overview.htm

Key Players

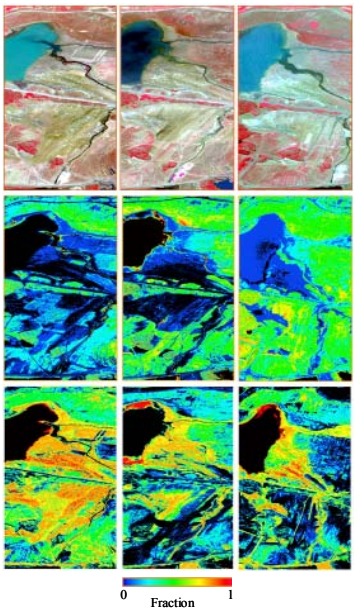
Natural Resources Canada (NRCan) specializing in the sustainable development and use of natural resources, energy, minerals and metals, forests and earth sciences; http://www.nrcan-rncan.gc.ca/inter/index.html

The **Canada Centre for Remote Sensing** (CCRS) is responsible for the reception, processing, archiving and dissemination of remotely sensed data for Canada; http://www.ccrs.nrcan.gc.ca

The **Minerals and Regional Geoscience Branch** of Natural Resources Canada is responsible for:

- mapping and interpreting the geology of the Canadian Shield and Cordilleran Mountain regions;
- documenting and interpreting the deep geology of Canada's continental crust;
- conducting geological and geophysical studies of the seafloor of Canada's Pacific coast;
- setting standards for and undertaking contracted aeromagnetic, regional geochemical and airborne radiometric surveys;
- conducting national mapping programs of the earth's gravitational and magnetic fields;
- providing expertise on the nature and origin of mineral deposits of Canada, including the development of innovative exploration guidelines, techniques and technologies;
- providing information relating to the natural distribution of environmentally significant elements;
- operating national observatories in seismology, geodynamics and geomagnetism;
- providing expert knowledge and information on natural hazards such as earthquakes, volcanoes and magnetic storms;
- providing essential geoscience information for land-use planning and policy formulation.

http://www.nrcan.gc.ca/gsc/mrgb_e.html



Hyperspectral images of mine tailings in Ontario

The **Canadian Association of Petroleum Producers** represents 150 member companies who explore for, develop and produce more than 98 % of Canada's natural gas, crude oil, oil sands and elemental sulphur. http://www.capp.ca

The **Mining Association of Canada** (MAC)'s mission is to promote, through the collective action of members, the growth and development of Canada's mining and mineral-processing industry, for the benefit of all Canadians. http://www.mining.ca/index.htm

"Hot" issues:

- Global hydrocarbon reserves;
- Northern resource development;
- Reconciling resource development and sustainable development.

Space and Energy and Mineral Development

For many years the exploration and mining community has been the largest single user group of EO data because of the new geological perspectives offered, the relative low cost of the data, the non-invasive nature of the data collection process, and the industry's willingness to evaluate new technologies.

Spatial resolution has increased from a resolution of 80m for 1972 Landsat images (4 spectral bands) to 10m for panchromatic imagery from the SPOT satellite or 30m for 7-band imagery from the Landsat TM instrument. A series of commercial satellites launched in the last three years to acquire imagery with spatial resolution between 1 and 3m (Ikonos, Quick Bird) offers "virtual aerial photography from space" and will revolutionise many aspects of mapping, map updating and spatial integration of many types of geoscientific data. For parts of the world, including some developing areas, that are habitually covered with cloud, the advent of spaceborne radar (eg. Radarsat-1, ERS-1, JERS-1) has also provided excellent new tools for base mapping, structural and tectonic analysis of many newly attractive exploration regions.

NASA's Hyperion sensor offers hyperspectral data, though the sensor is designed for scientific usage rather than operations. This detailed spectroscopic data allows determination of the mineralogical composition of exposed rocks and soils. Compositional mapping has long been the El Dorado of geologists since it focuses on fundamental geological attributes, not just "pictures" of the terrain. Data collected by airborne spectrometers have already demonstrated that it is possible to identify certain types of exposed mineralogy, to automatically label the minerals present, in some cases determine the chemistry of those minerals and to determine the fractions of the minerals occurring in small, sub-pixel units. Thus a new type of map, a "mineral map", can now be made to help explorationists home-in on zones of mineral alteration around mineral deposits, detect previously unrecognised mineral patterns across whole mineralised districts, document mineralogical components of the weathered regolith and to locate waste products, such as sulphate minerals, causing acid mine run-off from mine tailings.

Turning to future trends in spaceborne remote sensing for the mining industry, four new data types and their technologies are about to become commonplace. These are:

- Multi-attribute imaging radars having multiple frequencies and polarisations,
- Hyperspatial sensing providing 1 m resolution images of the earth from space,
- Global Digital Elevation Models (DEMs) providing detailed, world wide 2-3 m topographic models, and
- Imaging Spectrometry or Hyperspectral Sensing, using sensors with hundreds of spectral bands providing spectroscopy and compositional information about earth surface materials based on the principles of spectroscopy.

The reduction of in-house mining company experts, and the use of out-sourced specialists will mean that the uptake of these technologies will depend on the commercial satellite suppliers and service providers being extremely competitive and focusing on the provision of information services providing new knowledge about subtle geological processes in remote parts of the world where real competitive advantages can be gained.

In essence, sustainable development of energy and mineral resources requires attention on three fronts:

- Exploration: how do we find the best resources?
- Extraction: how do we monitor their extraction, ensuring it is not harmful to the environment?
- Remediation: how can we support the remediation of past pollution and accidents?

Issues for the CSA:

- How to engage the private sector;
- Private vs public data and information;
- Type and availability of national data products;
- Relative priorities of radar (most useful for hydrology and ocean exploration management) versus hyperspectral (most useful for mineral exploration) missions.

Related Themes
Cities & Urban Issues
Climate Change and Variability
International Development
North/Arctic
Sustainable Agriculture
Sustainable Water Resources

References:

Basic information
Energy: http://www2.nrcan.gc.ca/es/es/main_e.cfm

Minerals and Metals: http://www.nrcan.gc.ca/mms/hm_e.htm

Latest Update
Energy: http://www2.nrcan.gc.ca/es/es/main_e.cfm

Minerals and Metals: http://www.nrcan.gc.ca/mms/hm_e.htm

Closer Look
Try an ecological footprint quiz: http://www.earthday.net/footprint/index.asp#

Malthus and the global population (1798): http://www.msstate.edu/courses/ge14/ies/

For a non-malthusian view of global resources, see HORE-LACY, Ian, "The Sustainable Supply of Mineral Resources – a mineral industry perspective": http://www.uic.com.au/sustew.htm

Energy Technology Futures: http://www2.nrcan.gc.ca/es/etf/index_e.asp

Sustainable development paper 2003 – Excellent summary of requirements http://www.dynamicsustainabledevelopment.org/showsection.php?file=overview.htm

Draft list that compiles information submitted to the Office for Outer Space Affairs by the United Nations entities concerning their space-related initiatives and programmes that respond to specific recommendations contained in the Plan of Implementation of the World Summit on Sustainable Development ("Johannesburg Plan of Implementation").
http://www.uncosa.unvienna.org/iamos/2004/wssdlistcrpP5.doc

Sustainable energy glossary – many excellent links
http://www.planetecologie.org/JOBOURG/English/indexjoburg.html

Older but solid summary:http://www.atse.org.au/publications/symposia/proc-1998p6.htm

Mineral and Energy Resource Assessment of Proposed National Parks in Northern Canada, NRCan, http://www.nrcan.gc.ca/mms/poli/mera_e.htm

EarthSat, Image Processing for Mineral Exploration
http://www.earthsat.com/geo/mineral/ip_mineral.html