

Applications of Remote sensing

1. Agriculture



Agriculture plays a dominant role in economies of both developed and undeveloped countries. Whether agriculture represents a substantial trading industry for an economically strong country or simply sustenance for a hungry, overpopulated one, it plays a significant role in almost every nation. The production of food is important to everyone and producing food in a cost-effective manner is the goal of every farmer, large-scale farm manager and regional agricultural agency. A farmer needs to be informed to be efficient, and that includes having the knowledge and information products to forge a viable strategy for farming operations. These tools will help him understand the health of his crop, extent of infestation or stress damage, or potential yield and soil conditions. Commodity brokers are also very interested in how well farms are producing, as yield (both quantity and quality) estimates for all products control price and worldwide trading.



Satellite and airborne images are used as mapping tools to classify crops, examine their health and viability, and monitor farming practices. Agricultural applications of remote sensing include the following:

- crop type classification
- crop condition assessment
- crop yield estimation
- mapping of soil characteristics
- mapping of soil management practices
- compliance monitoring (farming practices)

2. Forestry



Forests are a valuable resource providing food, shelter, wildlife habitat, fuel, and daily supplies such as medicinal ingredients and paper. Forests play an important role in balancing the Earth's CO₂ supply and exchange, acting as a key link between the atmosphere, geosphere, and hydrosphere. Tropical rainforests, in particular, house an immense **diversity of species**, more capable of adapting to, and therefore surviving, changing environmental conditions than monoculture forests. This diversity also provides habitat for numerous animal species and is an important source of

medicinal ingredients. The main issues concerning forest management are depletion due to natural causes (fires and infestations) or human activity (clear-cutting, burning, land conversion), and monitoring of health and growth for effective commercial exploitation and conservation.

Humans generally consider the products of forests useful, rather than the forests themselves, and so extracting **wood** is a widespread and historical practice, virtually global in scale. Depletion of forest resources has long term effects on climate, soil conservation, biodiversity, and hydrological regimes, and thus is a vital concern of environmental monitoring activities. Commercial forestry is an important industry throughout the world. Forests are cropped and re-harvested, and the new areas continually sought for providing a new source of lumber. With increasing pressure to conserve native and virgin forest areas, and unsustainable forestry practices limiting the remaining areas of potential cutting, the companies involved in extracting wood supplies need to be more efficient, economical, and aware of sustainable forestry practices. Ensuring that there is a healthy regeneration of trees where forests are extracted will ensure a future for the commercial forestry firms, as well as adequate wood supplies to meet the demands of a growing population.



Non-commercial sources of forest depletion include removal for agriculture (pasture and crops), urban development, droughts, desert encroachment, loss of ground water, insect damage, fire and other natural phenomena (disease, typhoons). In some areas of the world, particularly in the tropics, (rain) forests, are covering what might be considered the most valuable commodity - viable agricultural land. Forests are burned or **clear-cut** to facilitate access to, and use of, the land. This practice often occurs when the perceived need for long term sustainability is overwhelmed by short-term

sustenance goals. Not only are the depletion of species-rich forests a problem, affecting the local and regional hydrological regime, the smoke caused by the burning trees pollutes the

atmosphere, adding more CO₂, and furthering the greenhouse effect.

Of course, monitoring the health of forests is crucial for sustainability and conservation issues. Depletion of key species such as mangrove in environmentally sensitive coastline areas, removal of key support or shade trees from a potential crop tree, or disappearance of a large biota acting as a CO₂ reservoir all affect humans and society in a negative way, and more effort is being made to monitor and enforce regulations and plans to protect these areas.

International and domestic forestry applications where remote sensing can be utilized include sustainable development, biodiversity, land title and tenure (cadastre), monitoring deforestation, reforestation monitoring and managing, commercial logging operations, shoreline and watershed protection, biophysical monitoring (wildlife habitat assessment), and other environmental concerns.

General forest cover information is valuable to developing countries with limited previous knowledge of their forestry resources. General cover type mapping, shoreline and watershed mapping and monitoring for protection, monitoring of cutting practices and regeneration, and forest fire/burn mapping are global needs which are currently being addressed by Canadian and foreign agencies and companies employing remote sensing technology as part of their information solutions in foreign markets.

Forestry applications of remote sensing include the following:

1) reconnaissance mapping:

Objectives to be met by national forest/environment agencies include forest cover updating, depletion monitoring, and measuring biophysical properties of forest stands.

- forest cover type discrimination
- agroforestry mapping

2) Commercial forestry:

Of importance to commercial forestry companies and to resource management agencies are inventory and mapping applications: collecting harvest information, updating of inventory information for timber supply, broad forest type, vegetation density, and biomass measurements.

- clear cut mapping / regeneration assessment
- burn delineation
- infrastructure mapping / operations support
- forest inventory
- biomass estimation
- species inventory

3) Environmental monitoring

Conservation authorities are concerned with monitoring the quantity, health, and diversity of the Earth's forests.

- deforestation (rainforest, mangrove colonies)
- species inventory
- watershed protection (riparian strips)
- coastal protection (mangrove forests)
- forest health and vigour

3. Geology



Geology involves the study of landforms, structures, and the subsurface, to understand physical processes creating and modifying the earth's crust. It is most commonly understood as the exploration and exploitation of mineral and hydrocarbon resources, generally to improve the conditions and standard of living in society. Petroleum provides gas and oil for vehicle transportation, aggregate and limestone quarrying (sand and gravel) provides ingredients for concrete for paving and construction, potash mines contribute to fertilizer, coal to energy production, precious metals and gems for jewelry, diamonds for drill bits, and copper, zinc and assorted minerals for a variety of uses. Geology also includes the study of potential hazards such as volcanoes, landslides, and earth quakes, and is thus a critical factor for geotechnical studies relating to construction and engineering. Geological studies are not limited to Earth - remote sensing has been used to examine the composition and structure of other planets and moons.

Remote sensing is used as a tool to extract information about the land surface structure, composition or subsurface, but is often combined with other data sources providing complementary measurements. Multispectral data can provide information on lithology or rock composition based on spectral reflectance. Radar provides an expression of surface topography and roughness, and thus is extremely valuable, especially when integrated with another data source to provide detailed relief.

Remote sensing is not limited to direct geology applications - it is also used to support logistics, such as route planning for access into a mining area, reclamation monitoring, and generating basemaps upon which geological data can be referenced or superimposed.

Geological applications of remote sensing include the following:

- surficial deposit / bedrock mapping
- lithological mapping
- structural mapping
- sand and gravel (aggregate) exploration/ exploitation
- mineral exploration
- hydrocarbon exploration
- environmental geology
- geobotany
- baseline infrastructure

- sedimentation mapping and monitoring
 - event mapping and monitoring
 - geo-hazard mapping
- planetary mapping.

3. Hydrology



Hydrology is the study of water on the Earth's surface, whether flowing above ground, frozen in ice or snow, or retained by soil. Hydrology is inherently related to many other applications of remote sensing, particularly forestry, agriculture and land cover, since water is a vital component in each of these disciplines. Most hydrological processes are dynamic, not only between years, but also within and between seasons, and therefore require frequent observations. Remote sensing offers a synoptic view of the spatial distribution and dynamics of hydrological phenomena, often unattainable by traditional ground surveys. Radar has brought a new dimension to hydrological studies with its active sensing capabilities, allowing the time window of image acquisition to include inclement weather conditions or seasonal or diurnal darkness.

Examples of hydrological applications include:

- wetlands mapping and monitoring,
- soil moisture estimation,
- snow pack monitoring / delineation of extent,
- measuring snow thickness,
- determining snow-water equivalent,
- river and lake ice monitoring,
- flood mapping and monitoring,
- glacier dynamics monitoring (surges, ablation)
- river /delta change detection
- drainage basin mapping and watershed modelling
- irrigation canal leakage detection
- irrigation scheduling

4.Sea Ice;-- sea ice information and applications include:

- ice concentration
- ice type / age /motion
- iceberg detection and tracking
- surface topography
- tactical identification of leads: navigation: safe shipping routes/rescue
- ice condition (state of decay)
- historical ice and iceberg conditions and dynamics for planning purposes
- wildlife habitat
- pollution monitoring

meteorological / global change research.

5.Land Cover & Land Use



Although the terms land cover and land use are often used interchangeably, their actual meanings are quite distinct. Land cover refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil or other. Identifying, delineating and mapping land cover is important for global monitoring studies, resource management, and planning activities. Identification of land cover establishes the baseline from which monitoring activities (change detection) can be performed, and provides the ground cover information for baseline thematic maps.

Land use refers to the purpose the land serves, for example, recreation, wildlife habitat, or agriculture. Land use applications involve both baseline mapping and subsequent monitoring, since timely information is required to know what current quantity of land is in what type of use and to identify the land use changes from year to year. This knowledge will help develop strategies to balance conservation, conflicting uses, and developmental pressures. Issues driving land use studies include the removal or disturbance of productive land, urban encroachment, and depletion of forests.

It is important to distinguish this difference between land cover and land use, and the information that can be ascertained from each. The properties measured with remote sensing techniques relate to land cover, from which land use can be inferred, particularly with ancillary data or a priori knowledge.

Land cover / use studies are multidisciplinary in nature, and thus the participants involved in such work are numerous and varied, ranging from international wildlife and conservation foundations, to government researchers, and forestry companies. Regional (in Canada, provincial) government agencies have an operational need for land cover inventory and land

use monitoring, as it is within their mandate to manage the natural resources of their respective regions. In addition to facilitating sustainable management of the land, land cover and use information may be used for planning, monitoring, and evaluation of development, industrial activity, or reclamation. Detection of long term changes in land cover may reveal a response to a shift in local or regional climatic conditions, the basis of terrestrial global monitoring.

Ongoing negotiations of aboriginal land claims have generated a need for more stringent

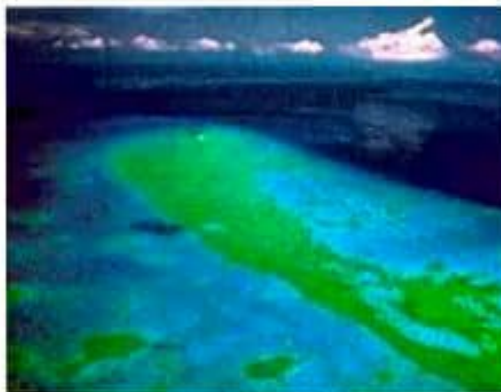
knowledge of land information in those areas, ranging from cartographic to thematic information.

Resource managers involved in parks, oil, timber, and mining companies, are concerned with both land use and land cover, as are local resource inventory or natural resource agencies. Changes in land cover will be examined by environmental monitoring researchers, conservation authorities, and departments of municipal affairs, with interests varying from tax assessment to reconnaissance vegetation mapping. Governments are also concerned with the general protection of national resources, and become involved in publicly sensitive activities involving land use conflicts.

Land use/ land cover applications of remote sensing include the following:

- natural resource management
- wildlife habitat protection
- baseline mapping for GIS input
- urban expansion / encroachment
- routing and logistics planning for seismic / exploration / resource extraction activities
- damage delineation (tornadoes, flooding, volcanic, seismic, fire)
- legal boundaries for tax and property evaluation
- target detection - identification of landing strips, roads, clearings, bridges, land/water

6.Oceans & Coastal Monitoring



Ocean applications of remote sensing include the following:

- Ocean pattern identification:
 - currents, regional circulation patterns, shears
 - frontal zones, internal waves, gravity waves, eddies, upwelling zones, shallow water bathymetry ,
- Storm forecasting
 - wind and wave retrieval
- Fish stock and marine mammal assessment
 - water temperature monitoring
 - water quality

- ocean productivity, phytoplankton concentration and drift.
- Oil spill
 - mapping and predicting oilspill extent and drift
 - strategic support for oil spill emergency response decisions
 - identification of natural oil seepage areas for exploration
- Shipping
 - navigation routing
 - traffic density studies
 - operational fisheries surveillance
 - near-shore bathymetry mapping
- Intertidal zone
 - tidal and storm effects
 - delineation of the land /water interface
 - mapping shoreline features / beach dynamics
 - coastal vegetation mapping