Websites: examples of remote sensing images in online mapping

University of Calgary fly-through: LiDAR DEM and draped orthophotography 'Geovisualisation'

http://www.youtube.com/watch?v=_myUhYPeAew

Prince George PGmap orthophotos 1993-2020

https://pgmap.princegeorge.ca/Html5Viewer/index.html?viewer=PGMap

BC iMap web mapping: <u>http://maps.gov.bc.ca/ess/hm/imap4m</u>

Remote sensing: review

The Electromagnetic Spectrum



Visible: **reflected** 'natural colour' – what we see

Near/SWIR: <u>reflected</u> from earth = vegetation; moisture

Thermal IR: <u>emitted</u> from earth = temperature

Microwave: unaffected by clouds – includes RADAR RADAR and LiDAR are ACTIVE systems; the rest are PASSIVE

Myth #1: Most satellite images are not photos; they are scanned except for...



ISS orbit: 400km, 51 degree angle

Satellites have two types of orbit

1. Geostationary: 36,000 km above equator, stay vertically above the same spot, rotate with earth - mostly weather images

e.g. GOES (Geostat. Operational Env. Satellite), some GPS



Earth from Space: Earth Observation (EO) satellites

Total number: ~15,000 satellites

2. Sun-synchronous satellites: Earth Observation

650-900 km altitude, orbit at ~ 81-82 degree angle to the equator (= near polar): captures imagery ~ same time each day (~ 10 - 11am)

These satellites map and monitor the world

Landsat: <u>http://earthnow.usgs.gov</u>

Earth from Space Satellite Images for mapping

from low resolution 10km (weather satellites) to very high

capable of detecting objects <1 metre

Hurricane Katrina (2005)

Geostationary satellite orbit

New Orleans, before and during Hurricane Katrina

January 1-20, 2020

February 10-25, 2020

Lanzhou

C

HINA

https://gisanddata.maps.arcgis.com/apps/opsdashboard/index.html#/bda7594740fd40299423467b48e9ecf

Airborne Nitrogen Dioxide Plummets Over China

NA

Wuhan

HI

Chongqing

Mean Tropospheric NO₂ Density (µmol/m²)

from industrial reduction Post-coronavirus

Shanghai

500 km

Beijing

Myth #2: "...its so big you can see it from space"

Russian tank convoy Ukraine invasion 'special military operation'

High resolution satellite imagery (Maxar), 15-30cm Feb 28, 2022

Spatial Resolution (pixel size) <1 metre to >10 kilometres

Low resolution (free)

Medium resolution (free)

High resolution (mostly free)

Very High resolution (costs \$\$)

Landsat – 30m pixels

1km - 10km (international) -small scale

100m - 500m (national) - < 1:250,000

10 -50 m (regional) - 1:50,000

25cm - 5m (Local) - > 1:20,000

McBride, BC Air photo: <1m pixels

Small scale satellite images (10km pixels) http://www.goes.noaa.gov/~70% cloudsGOES Alaska SECTOR IR Image

Low resolution imagery (~10km pixels)

Daily sea surface temperatures using Microwave wavelengths - cloud free

'Isarithmic thematic map'

Medium: Landsat 1-3 (NASA-1972)

Satellites 1,2,3 had a Multi-Spectral Sensor (MSS) with a pixel size 80 metres in resolution.

Bands (layers): Visible / Near-IR

First Landsat image: San Francisco 1972

Difference highlighted in brown

Reservoirs in Quebec 1975-2000

EOSD Image 15/22 (15 June 2001

After flooding of reservoir

Landsat 5 bands (1982-2011), followed by Landsat 7 (1999), 8 (2013), 9 (2021)

Band No.	Wavelength Interval (µm)	Spectral Response	Resolution (m)
1	0.45 - 0.52	Blue-Green	30
2	0.52 - 0.60	Green	30
3	0.63 - 0.69	Red	30
4	0.76 - 0.90	Near IR	30
5	1.55 - 1.75	Mid-IR	30
6	10.40 - 12.50	Thermal IR	120
7	2.08 - 2.35	Mid-IR	30

Think of these as different 'GIS / mapping' layers

High resolution: Landsat 4,5 Thematic Mapper (TM): 1982, 1984 Pixel size: 30 metres; mid-IR/Near-IR/Red (Moisture/dryness-Vegetation-Visible)

Bowron Lakes -Landsat natural colour composite RGB (e.g. Google maps / Earth)

Google Maps / Earth was based on Landsat 7 (1999-2003) with updates from later air photos/high-res imagery

PG: normal colour and 'red near-IR mid-IR'

Google Earth Time Lapse 1984-2022

39 years of Landsat images; 65,000 images - >1 petabytes of data https://earthengine.google.com/timelapse/

Note: mountain areas comparison are less effective due to seasonal snow

Ft. MacMurray: https://www.smithsonianmag.com/smart-news/google-earths-new-tools-shows-32-years-changing-planet-180961251/

Medium resolution: MODIS (since 2000)

500m - 1km

'national scale coverage'

Landsat 1984 – composite images Mid-IR/Near-IR/Red

Enhanced Thematic Mapper (ETM+) 1999 - [2003]

Landsat 7 (1999) is similar to the TM sensor; copyright removed in 1999, enabling websites where scenes can be downloaded. This is the basis of Google maps and Google Earth; data is free since 2008.

Landsat 8 was launched in 2013

Google maps

BC - imap

BC iMap: http://maps.gov.bc.ca/ess/hm/imap4m

European Space Agency (ESA)

Copernicus Program Sentinel 2A/B 2015 / 17

free download

10 / 20m pixels

RADAR ... As it is not affected by darkness or weather, it is especially useful in **arctic regions for mapping ice**; and tropical areas, which are often **cloud covered** and other areas

Ireland, 1991: Radar vs Landsat (Visible / Optical image)

RADARSAT 1-2 1995/2007

Radarsat 1 - 2 are the only <u>Canadian</u> satellite systems in space for mapping

Built by MacDonald-Dettwiler, Richmond, BC

John MacDonald, UNBC Chancellor 2010-15

RADARSAT-2 Data and Products @ MacDONALD, DETTWILER AND ASSOCIATES LTD, (2008) - All Rights Reserved - RADARSAT is an official mark of the Canadian Space Agenc

Canada produces the first complete image of Antarctica RADARSAT launched by NASA in exchange for complete map image

Radarsat was driven by the need to know and map sea ice extents in the Canadian Arctic

TOPOGRAPHIC DATA BASE PRODUCTION

Figure 12 illustrates the evolution of the Northern mapping project that began in 2004 up to 2010 (light green to dark green). Complete map coverage will be achieved with the 2011-2012 production plan utilizing SPOT5/HRS and Radarsat-2 data sources (Figure 13)

Figure 12 Northern Mapping project

GEOG 357 project - Remote Sensing

Use of satellite imagery for Digital mapping of Glaciers Purple), Water (green) and Vegetation (blue): Greenland

SRTM (Shuttle RADAR Topographic Mission)Feb 200030/90 metre pixels, 56°S - 60°N latitudee.g. Google Earth DEM

http://www.cgiar-csi.org/data/elevation/item/45-srtm-90m-digital-elevation-database-v41

Very high resolution satellites 2000->

First corporate satellites **2000** Ikonos: 1m resolution (2000) Quickbird: 60cm (2001)

Worldview3 (2014)

Rainbow Range Chilcotin, BC 31cm

Myth #2: "...its so big you can see it from space"

The giant dog you can see from space

Monday, June 9, 2008 BORIS the bull mastiff is so big that he can be seen lounging in his favourite position in the garden - from space. The 89kg dog has been captured on Google Earth's satellite images. 'He was in his favourite place,' said Fran Milner, from Bournemouth. We knew he was big but didn't think he was big enough to be seen from space.'

India successfully launches 104 satellites

Launch sets a record for most satellites launched at once

The Associated Press Posted: Feb 15, 2017 9:18 AM ET | Last Updated: Feb 15, 2017 11:54 AM ET

'doves'

This photograph released by Indian Space Research Organisation shows its polar satellite launch vehicle lifting off from a launch pad at the Satish Dhawan Space Centre in Sriharikota, India, Wednesday, Feb.15, 2017. (Indian Space Research Organization

Planet and Maxar (15-30cm pixels) – map the planet every day, apart from clouds

Planet and Maxar (15-30cm pixels) – map the planet every day, apart from clouds

The Smokehouse Creek Fire

Area burned in 2024 so far

Source: National Interagency Fire Centre, data to 29 Feb 2024

https://www.bbc.com/news/world-us-canada-68428496

Review: Remote sensing developments from wars

- **US Civil War: Photography** from pigeons, balloons, kites **1860s**
- **World War I:** Aerial photography photogrammetry 1910s
- World War II: RADAR- RAdio Detection And Ranging 1930s/40s
- Korean War: Infra-red photography 1950s
- **Cold War:** Satellite imagery originally for espionage 1960s
- **Gulf Wars: 3D imagery ->** Google Earth (2005)
- 'War on Terrorism': Unmanned Aerial Vehicles 2010s