## GEOG457/657 Advanced Remote Sensing

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Lectures: 5-154 Monday/Friday 12.30-13.20

Labs: Wednesdays 16.00-18.50 <u>Matt.McLean@unbc.ca</u>

- start next week in GIS Lab 8-125

Class of 2022:

9 (4+5) took GEOG357 in fall 2020 or 2021

1 Sir Sandford Fleming, 1 Graduate student (657)

Geography/Anthropology, Forest ecology+management, Computer Science

Course syllabus and notes: <u>http://gis.unbc.ca</u>

# Overall evaluation

- 40% Lab exercises / assignments
- 10% Class participation presentations
   High resolution (Jan 28) / MODIS (Feb 7)

- 30% Exams (Feb 18 and Mar 28)
- 20% Project (due Apr 8)

# Classes at UNBC: Winter 2022 (GEOG457) What's happening next week / after ?

Labs face to face in 8-125 (BYO mask)

Lectures: next week still virtual

rest of January: unsure, maybe hybrid ?

rest of semester: unsure, stay tuned

- It's a great time to study remote sensing
- -> Impact of humanity and warming
- -> size of Canada can only be seen with RS
- -> Growth in geospatial technologies (inc. GIS)
- -> Launch of many new satellites e.g. Landsats, Sentinels, DSCOVR, JEDI ......
- -> RS data mostly more current and 'border-free' ....
- -> Data processing -> -> information e.g. <u>http://sparkgeo.com</u> <u>https://earthnow.usgs.gov/observer/</u>



Geography, Earth & Environmental Sciences

#### Winter 2022

#### GEOG 457-3 / 657-3 Advanced Remote Sensing





Lectures: Monday / Friday 12:30 - 1:20 pm Lab: Tuesday 4:00 - 6:50 pm Instructor: Dr. Roger Wheate email: Roger.Wheate@unbc.ca



Remote sensing / télédétection ... "the science of gathering data of a planetary surface area from a distance (including the atmosphere), e.g. with aerial photography, radar or infrared imagery etc...

The term was first introduced in the 1960s (Evelyn Pruitt)





New millennium development examples: Rapideye (2008) and the Red Edge band (5 metre resolution)



Figure 1: Typical spectral reflectance curves of selected surfaces in relation to the RapidEye spectral bands

#### New millennium development examples: Unmanned aerial vehicles – UAVs (drones) Remotely Piloted Aircraft Systems (RPAS)



http://www.drmattnolan.org/photography/2014/uav/

### Milestones in the History of Remote Sensing

# 19<sup>th</sup> century

1839 Invention of photography

- use of balloons and kites
- pigeons
- oblique photos (mountain peaks)
- Stereo photography e.g. <u>http://www.londonstereo.com</u>

# 20<sup>th</sup> century

**1910s** First use of aerial photography from planes (World War I: photo interpretation)

- **1920s** Development of photogrammetry for mapping
- 1940 Military use of radar (World War II)
- 1945-> Main aerial photo programs in Canada
- 1950s Use of colour photography and infra-red
- 1960 First reconnaissance satellites: e.g. Corona
- 1961 First weather satellites: Tiros (1960); Nimbus (1964) (and first digital data transfer)

1960s Term 'remote sensing' first appeared (Evelyn Pruit)

Multispectral image processing: The Landsat Era This changed everything !

#### 1972 Launch of Landsat 1 satellite and the 80metre MultiSpectral Sensor (MSS)



Little known about image processing except contrast stretch / rectification

1975: Roger W. comes to Canada (Queen's U.)

Landsat print on the lab wall No commercial software available

Canada Centre for Remote Sensing (CCRS) was the first to acquire the Image100 system developed by General Electric - \$1million Display 512 x 512 pixels

# 1970s-early 80s

No commercial software, only in-house code

'Classification' without screen display

Dot matrix printer character display – colour pencil around similar areas



Facsimile image (me)



#### 1980s: Commercial Image processing software

#### 1. Earth Resources Data Analysis System (ERDAS)

The first version of ERDAS was launched in 1978 on <u>Cromemco</u> microcomputers running the <u>CDOS</u> - OS.

>Unix / Windows / Mac

Live link raster-vector 1988

➢Partnered with ESRI 2000



>Owned by Leica (2001) then Intergraph

>Current version: Imagine (filetype: .img)

## 2. PCI Geomatics, Canada 1982

... formed as Perceptron Computing Inc. (NOT MANY PEOPLE KNOW THIS)

>Windows and Linux

First versions (FORTRAN) were command line: EASI/PACE Engineering Analysis and Scientific Interface /PACE

Tutorials: <u>http://www.pcigeomatics.com/support/tutorials/</u>

Current version: Catalyst (2021)
Formerly know as Geomatica (2016)
File format: .pix

"PCI Geomatics, is the world leader in geo-imaging products and solutions. PCI Geomatics offers customized solutions to the geomatics community in over 135 countries."

Recognised as the most extensive RS software system

>Modules written by leading Canadian researchers

➢Best for orthorectification .. Orthoengine

➤Weakest link ? ... vector options and integration

#### Most support for new sensors

#### Toutin's Model

ASTER, AVNIR, CARTOSAT, CBERS, DEIMOS, DMC, DUBAISAT, EOC, EROS, FORMOSAT, GEOEYE, GF GOKTURK, GOSAT, HJ, IKONOS, IRS, KAZEOSAT, KOMPSAT, LANDSAT, MERIS, ORBVIEW, PLEIADES, PRISM QUICKBIRD, RAPIDEYE, RASAT, SJ9, SPOT, SSOT, TH, THAICHOTE, WORLDVIEW, YG, ZY 1980s Landsat 4/5 : Thematic Mapper (TM) 'next generation' 30m sensor': addition of mid-IR bands

1981: European Space Agency formed

1981: Alberta Government has image processing workstation

OVAAC 8 by Dick Economy (formerly GE), on VAX system, ... sold to PCI in 1985



University of Calgary (Survey Engineering) – in-house code TM data on 3 magnetic tapes, mounted, read, unmounted One image cost \$8000 and needed geo-rectification 1989: One Landsat scene fits on one CD

## 1990s software: ER Mapper, Perth, Australia 1990



"As a master's student, I interviewed with ER Mapper in 1991. I was very impressed with the software. I was somewhat concerned when they stated ER Mapper would be larger than ERDAS within 2-years. They hired Jill rather than me. I accepted a technical sales position at ERDAS.

In May 2007, ERDAS announced the purchase of ER Mapper Ltd

Main strength: data storage, compression and serving (.ecw format) web-serving

FREE download <a href="http://erdas-er-mapper.software.informer.com/7.2/">http://erdas-er-mapper.software.informer.com/7.2/</a>

#### ENVI: Boulder, CO 1991 "ENvironment for Visualizing Images"

http://www.exelisvis.com/ProductsServices/ENVIProducts.aspx





Extract specific objects with the ENVI Feature Extraction Module (ENVI FX), based on the object's spatial, spectral, and texture characteristics and identify them as objects like vehicles, buildings, roads, coastlines, rivers, lakes, and fields.

### IDRISI Raster GIS - Worcester (Boston) 1986



<u>http://www.clarklabs.org</u> Idrisi Canada: <u>http://www.idrisi.ca</u> Affordable GIS option for education, research and development

#### What's New

IDRISI Taiga Now Shipping! Includes Innovative Earth Trends Modeler Application Segment-based Classification! Learn More >

Focus Paper on Segmentation & Segment-Based Classification Now Available! Download >

See all Focus Papers >





### ArcGIS spatial analyst (GRID)

Spatial Analyst functional reference E Color Model (Spatial Analyst) E Conditional (Spatial Analyst) E Conversion (Spatial Analyst) Density (Spatial Analyst) Distance (Spatial Analyst) Extraction (Spatial Analyst) E Generalization (Spatial Analyst) E Groundwater (Spatial Analyst) Hydrology (Spatial Analyst) E Interpolation (Spatial Analyst) 🗄 🧼 Local (Spatial Analyst) 🗄 🧼 Map Algebra (Spatial Analyst) 🗉 🧼 Math General (Spatial Analyst) Math Bitwise (Spatial Analyst) Math Logical (Spatial Analyst) Math Trigonometric (Spatial Analyst) Multivariate (Spatial Analyst) E Seighborhood (Spatial Analyst) 🗄 🅪 Overlay (Spatial Analyst) E Raster Creation (Spatial Analyst) E Raster Management (Spatial Analyst) E Reclass (Spatial Analyst) E Solar Radiation (Spatial Analyst) 🗄 🅪 Surface (Spatial Analyst) 😪 Zonal (Spatial Analyst)

Multivariate (Spatial Analyst) U) An overview of the Multivariate tools Band Collection Statistics Class Probability ClassProb Create Signatures ClassSig Dendrogram Edit Signatures EditSig Iso Cluster Maximum Likelihood Classification MLClassify Principal Components PrinComp StackStats

### GRASS raster GIS (1982) - now in QGIS

Geographic Resources Analysis Support System <a href="https://grass.osgeo.org/">https://grass.osgeo.org/</a>

Started in 1982 by U.S. Army - Construction Engineering Research Laboratory (USA-CERL) in Champaign, Illinois. USA-CERL completed its last release of GRASS in 1992. GRASS development was assumed by academia in 1997, and became an OS project - an international team manages the source code. FREE



Dune Migration at Jockey's Ridge State Park, North Carolina Infrared photo draped on USGS LIDAR data



#### Raster GIS, Germany, 2004 - now in QGIS

Recently integrated into QGIS



http://www.saga-gis.org/en/index.html

## UNESCO- BILKO: (really!)



#### http://www.noc.soton.ac.uk/bilko/

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# 1990s

1990s Other countries' launch satellites / sensors: IRS: India (5 metre) JERS: Japan ERS: Europe RESURS: USSR

#### 1990 Canadian Space Agency

1995 Radarsat-1 Canada's first remote sensing satellite

2007 Radarsat-2 First complete mapping of Antarctica

MacDonald-Dettwiler, Richmond BC (1969->) manufactured Radarsat and previously built most of the world's satellite receiving stations **2013: Canada produces the first complete image of Antarctica –** we rock RADARSAT launched by NASA in exchange for complete map image



http://ice-glaces.ec.gc.ca/App/WsvPageDsp.cfm?ID=1&Lang=eng

#### Object-oriented classification eCognition, Germany, 2000 \$\$ Object-oriented classifier: Feature based not pixels [versus per pixel classifiers: Unsupervised/Supervised]

Spatial / earth sciences market applications sold to Trimble, 2010 Partnership with PCI Geomatics (who dropped their own Feature Object Extraction tool 'FOX')

Fully Automated Her2 Scoring - Cell-by-Cel Mighe and Data Analysis for Life Sciences http://www.pcigeomatics.com/ software/partner-

products/trimble-ecognition

eCognition: <u>htttp://www.definiens.com/</u>

#### More feature based / segmentation software

#### Feature Analyst plug-in for ESRI and ERDAS

http://www.textronsystems.com/products/geospatial/feature-analyst



#### SPRING, Brazil 1995 FREE

http://www.dpi.inpe.br/spring/english/

# New millennium events

Many new sensors including high resolution

Terra satellite: ASTER / MODIS

High resolution private sector satellites:

LIDAR, RADAR, RPAS,

Large datasets, DEMs

Free image data ....

Multi-year time series for environmental monitoring

Online image viewers- e.g. google earth

All topics for this course

**Google Earth Engine** is a cloud computing platform for processing satellite imagery and other Earth observation data. It provides access to a large warehouse of satellite imagery and the computational power to analyze those images.

https://earthenginepartners.appspot.com/science-2013-global-forest



Global Forest Change

Published by Hansen, Potapov, Moore, Hancher et al. Nas, or a non-norest to forest change entirely within the period 2000–2012. 'Forest Loss Year' is a disaggregation of total 'Forest Loss' to annual time scales.

Reference 2000 and 2014 imagery are median observations from a set of quality assessmentpassed growing season observations.

#### Download the data.

#### Reset to default view

#### Data Products

Forest Cover Loss 2000–2014 (Transparent)

Legend
 Loss

Other Data Layers

Tropical Hinterland Forests •

Background Imagery Year 2000 Bands 5/4/3 •

Example Locations

Forestry and Tornado in Alabama

Zoom to area

Global Forest cover loss 2000-2014