# **Feature Extraction**

"The identification of geographic features and their outlines in remote-sensing imagery through post-processing technology that enhances feature definition, often by increasing featureto-background contrast .... or using pattern recognition software."

Esri GIS

definitions

### Image interpretation

- > The **analogue** data unit is the photograph from a camera;
- >the digital unit is the scene, composed of pixels, created by using a scanner.
- >Analogue remote sensing involves interpretation and feature updating;
- >digital applications include classification & feature extraction based on DN's



Manual interpreting/digitization from photos | extraction of caribou habitats by Digital Numbers

### Manual 'feature extraction' by photo interpretation e.g. BC TRIM



### Digital 'feature extraction' e.g. by ratio enhancement or classification



### **Completion of the 1:50,000 National Topographic Database**

with satellite Imagery 2000-2012

But used as background, not classifiable image data Why not?

Figure 12 illustrates the evolution of the Northern mapping project that began in 2004 up (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

#### **Satellite Image interpretation** – manually uses the same factors as Air photos

#### -Colour

- -Tone
- -Texture
- -Pattern
- -Shape
- -Shadow
- -Size
- -Association

Digital also has: -Multispectral signature -e.g. water reflects no IR





### Reflectance of water based on dissolved solids



#### Some examples of interpretation of photos and satellite images

**Shape:** the form of an object on an air photo helps to identify the object. Regular uniform shapes often indicate a human involvement;





**Pattern:** similar to shape, the spatial arrangement of objects (e.g. row crops vs. pasture) is also useful to identify an object and its usage;





**Texture:** the physical characteristics of an object affects how they appear



**Shadow:** a shadow provides information about height, shape, and orientation



High-rise building (long shadow) Low-rise building

(short shadow)

e.g. calm water has a smooth texture; a forest canopy has a rough texture

PCI Catalyst: 'TEX'



427773-86 (July 1991) Notre Dame Ouest & Autoroute Bonaventure Montréal, Quebec

# Shadows: usually from the SE (~10am)



Northern hemisphere example – Mt. Robson

# Great Barrier Reef, Australia (20°S)



Sun in the NE (southern hemisphere)

#### Environmental change assignment, using Landsat geoTIF files Retreat of Evelyn Glacier, Hudson Bay Mountain near Smithers B.C.



30-Jul-1990



### 30-Jul-2010

**Size:** a measure of the object's surface area (e.g. single-lane vs. multi-lane highways);







**Time:** temporal characteristics of a series of photographs can be helpful in determining the historical change of an area (e.g. looking at a series of photos of a city taken in different years can help determine the growth of suburban neighbourhoods;

**Association/Site:** associating the presence of one object with another, or relating it to its environment, can help identify the object (e.g. industrial buildings often have access to railway sidings;







**Tone/Colour:** the colour characteristics of an object, relative to other objects in the photo (e.g. sand has a bright tone, while water usually has a dark tone; tree species can be determined by colour of leaves at certain times of the year);



A26999-20 (August 1986) Sandbanks Provincial Park Picton, Ontario



Feature extraction (digitising) from aerial photography is the most tedious part of mapping ..... why hasn't remote sensing been used more to update GIS data layers ?

- RS data are not well understood
- data are too expensive
- insufficient resolution
- classification accuracies
- complexities of reality

### – lack of homogeneity / contrast

Principles of GIS: Aronoff\* (1986) – the first GIS textbook

\* Stan Aronoff is a Canadian remote sensing author / expert

### Examples of resolution and complexity of reality



Higher resolution might help a. (left), but not b. (right)

### BC: updating of Vegetation Resource Inventory

where does it work?

-Feature simplicity Consistent shape, contiguity

- Feature homogeneity Consistency inside feature

- Feature certainty Contrast with other features Below is an example of the spatial change coverage from the Lillooet TSA. The delineated cutblocks are shown in white overlaid on the 15m panchromatic band.





- Feature simplicity
- Homogeneity
- Feature certainty
- e.g. cutblocks? alluvial fan deltas
- e.g. lakes, bare rock (sunlit)
- e.g. avalanche tracks, glaciers (?)

Process for creating feature vectors from image data: (one could also manually digitise from digital imagery... boring / subjective)

>1. Select bands / channels to maximise feature contrast

- 2. Classify (multispectral) or threshold (single channel) e.g. ratio, index or Tassel component
- >3. Create feature raster channel or bitmap
- >4. Clean results -> sieve or filter (generalise)

➤... we've done all these ...

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### We are doing these 5-7 below in the next lab

>5. RTV -> Raster /bitmap to Vector conversion ...

>6. Smooth lines / generalise -> (export to GIS)

>7. Massage attribute table / calculate areas etc.. (GIS)

Project example to automatically map a complex fire polygon



One approach: Normalised Difference Burn Ratio (NIR-SWIR)/(NIR+SWIR)



ISODATA classification showing 50 classes



EASI modeling ->feature extraction



Clusters 5, 7, 12, 15, 20, 25, 37 -> burn extent



Sieve

5,6,7: RTV: Raster to vector conversion, smoothing, and tabulation



# **6.** Generalise 'Smoothing the jaggies' ... e.g. algorithm: smmcmaster - Robert McMaster, derived from Douglas-Poiker (two Canadians) algorithm



Several different algorithms for line generalisation (from GIS history)

Smoothing – more faithful to geography, but is it as accurate ? - Compare with higher resolution PAN band if available or Google maps

### Extracting glaciers and cutblocks in Kakwa



Glaciers/snow TM 3/5 ratio -> 2.0



Cut blocks -Deciduous <-TM 4/3 ratio > 2.0





Extraction of Glaciers, Water, and Vegetation - the Southeast Coast of Greenland











Threshold images for ice, water and vegetation derived from ratios Mt. Edziza, BC

Land cover boundaries

Based on: Classification or Greenness a. 4/3 b. NDVI c. TCA 2

- Lava flows
- Bare ground
- Deciduous
- Coniferous
- (Glaciers)



#### Extraction of road networks – lines – not easy!



http://www.gis.unbc.ca/courses/geog432/projects/2006/jaminf/index.htm

#### Experiment to extract trees as points to avoid digitising Green / red ratio

#### **RGB** Colour photo





#### **Feature extraction – other applications**



# Solar Power plants, Mojave Desert Ivanpah, CA – Primm, NV



## 35° North, 115° West

# September 18, 1989 (LS 4-5 TM)



# September 23, 2014 (LS 8 OLI\_TIRS\_L1T)

