Remote Sensing and mapping

Computers have linked mapping technologies under the umbrella term:
Geomatics includes the following geospatial technologies:
… for data collection, analysis and output

a. Cartography
"The art, science and technology of making maps"

b. Geographic Information Systems (GIS)
"Automated systems for management, analysis, input and output of spatial data"

c. Global Positioning Systems (GPS)
"determination of ground locations using measurements from satellites"

d. Surveying
"science of determination of accurate coordinates of terrestrial locations"

e. Photogrammetry
"derivation of 2D or 3D locations from stereo pairs of aerial photography"

f. Remote Sensing
"Acquisition of information about a planetary surface from a distance"

Aerial photography / Remote Sensing

Early years 1850->
Birds, Kites, Balloons,
Planes with camera
(and now UAVs)

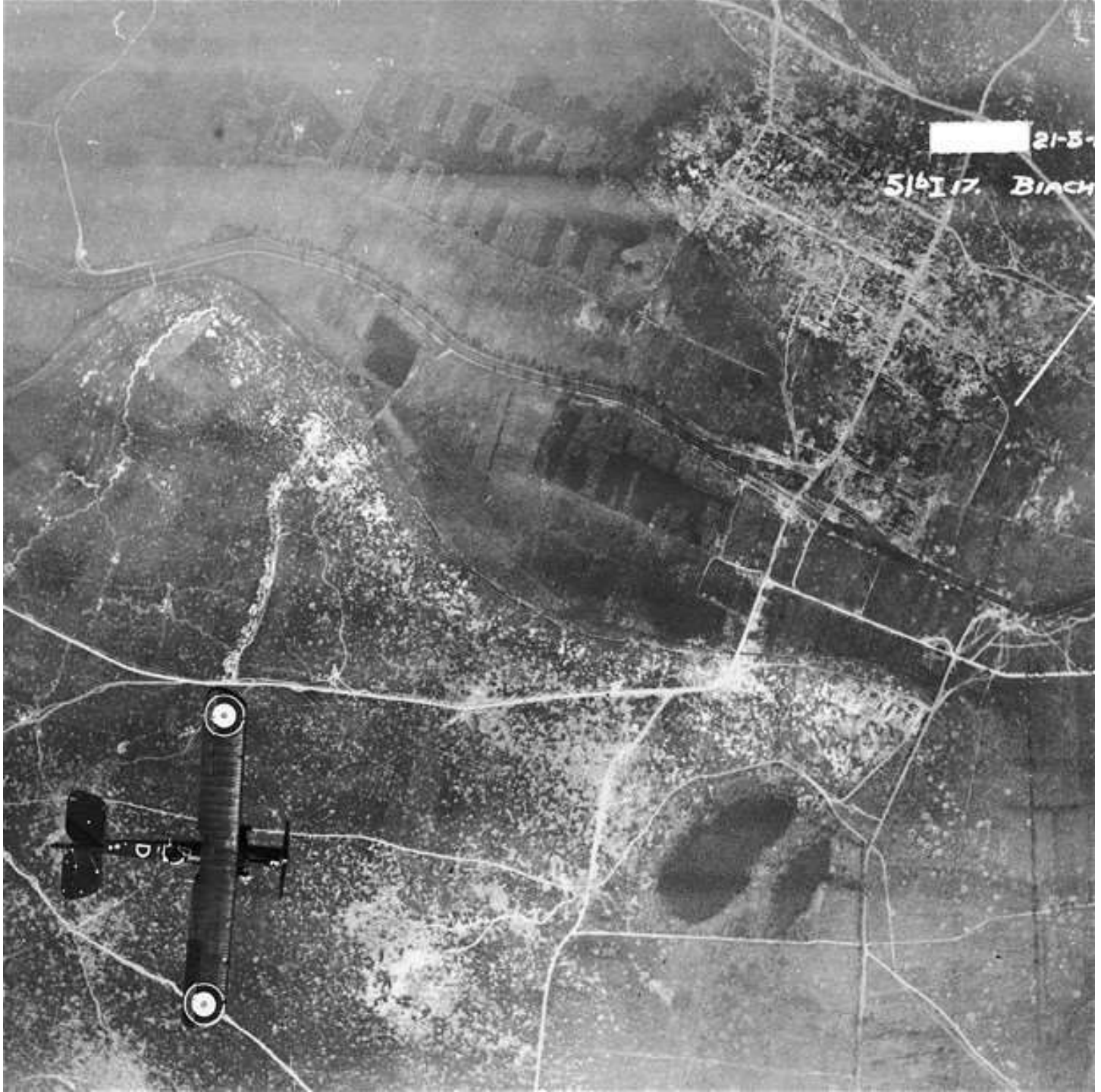
Air photos, World War 1

Reconnaissance and analysis

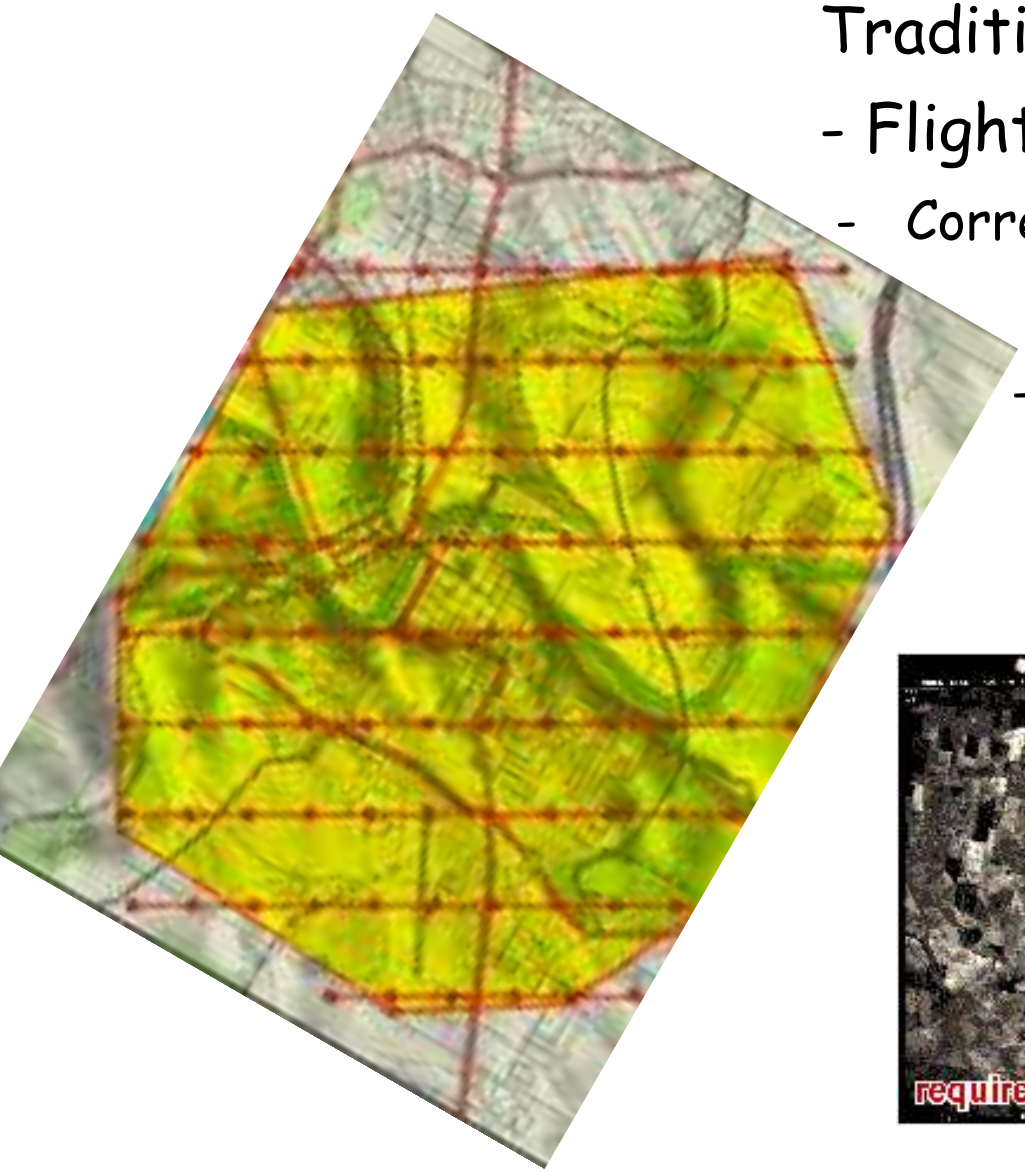
Postwar use: 1919-1938 limited by resources and the depression

World War 2: reconnaissance and mapping

Standard for mapping after World War 2 1946 ->



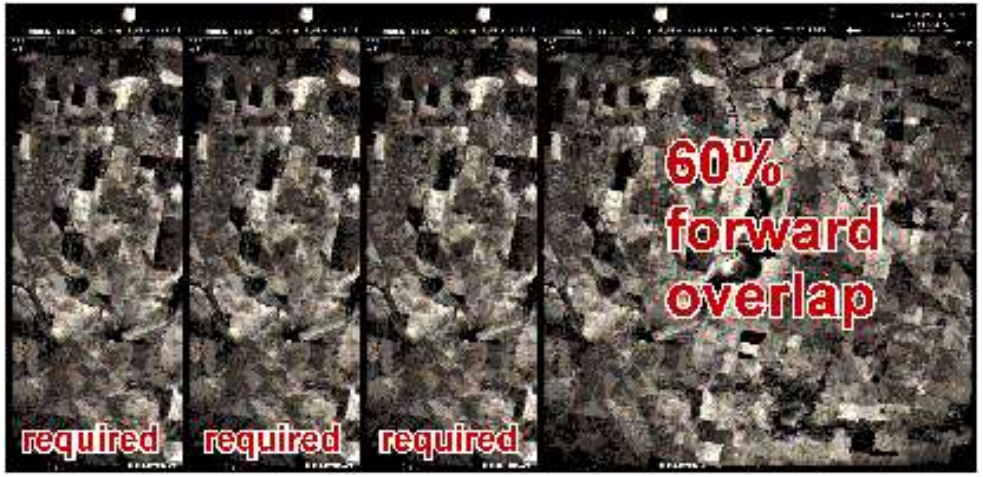
Aerial Photography

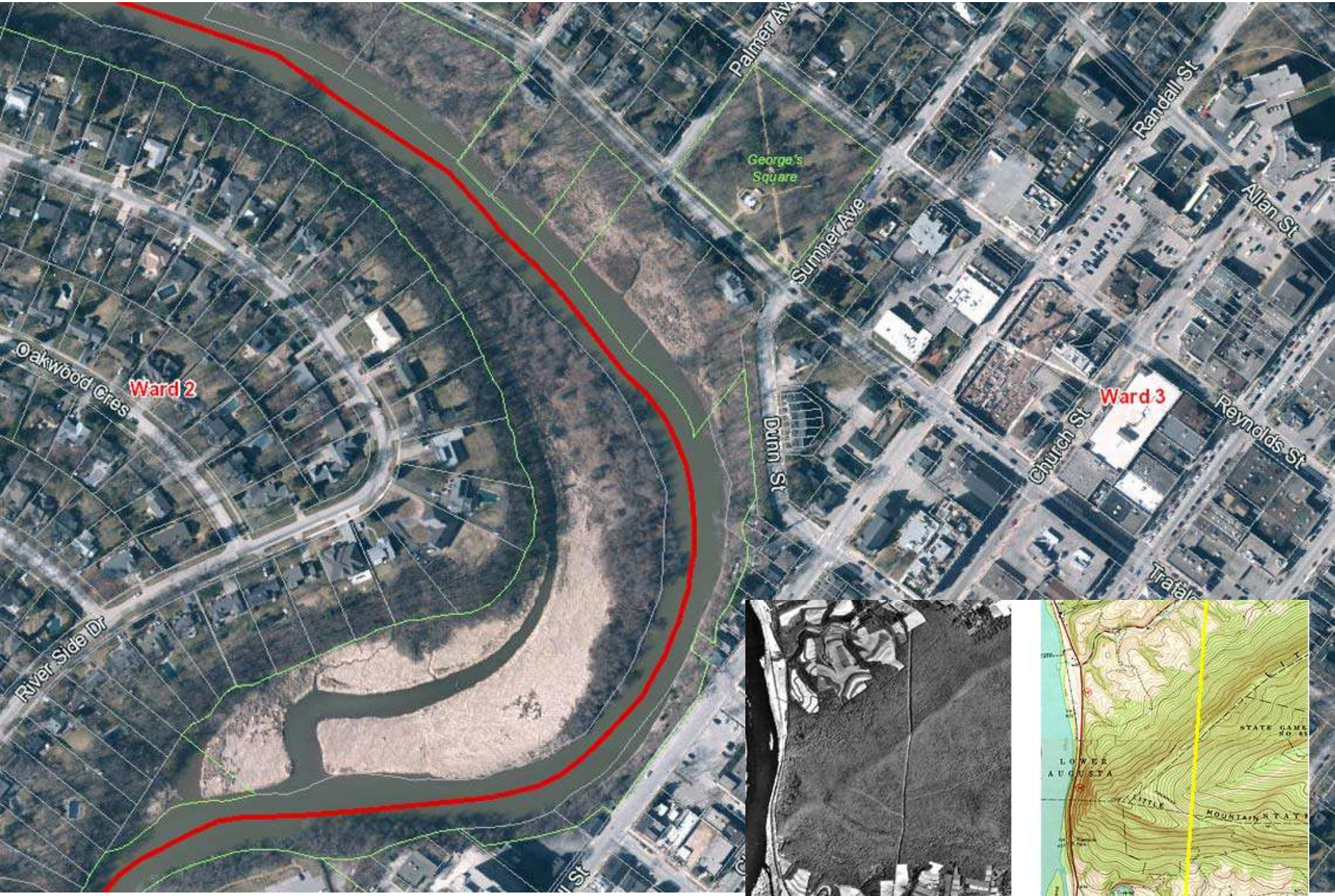


Traditional setup for film / photos

- Flightlines and overlap
  - Corrected, mosaicked -> orthophotos

- Panchromatic, Colour, Infra-red





Photomap example: Oakville, ON
No generalization of base layer

Most pre-digital aerial photography was panchromatic, not colour

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

Panchromatic air photo: 15th / University Way

Colour air photo: 15th / University Way; hardcopy cost = 2x

2000s Digital photogrammetry – no extra cost for colour

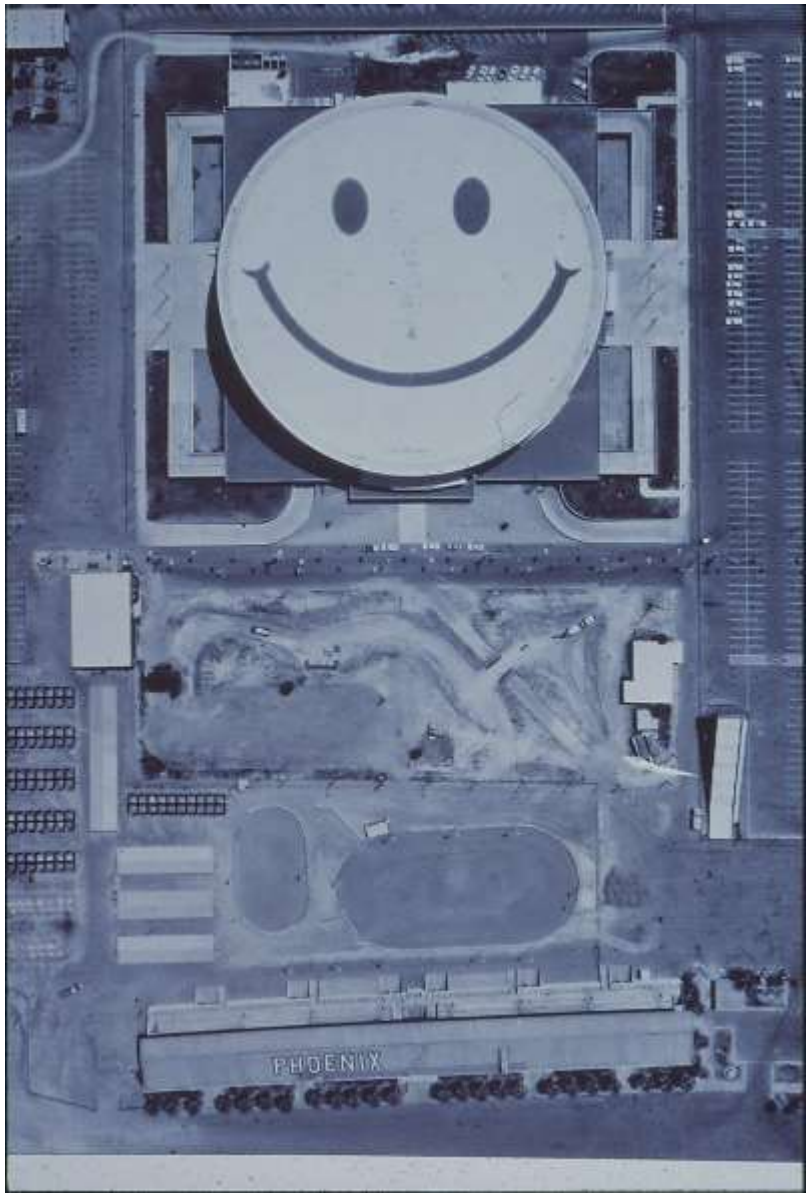
https://www.terrasaurus.ca/imagery-examples

What is Remote Sensing?

"Obtaining information about a planetary surface from a distance"

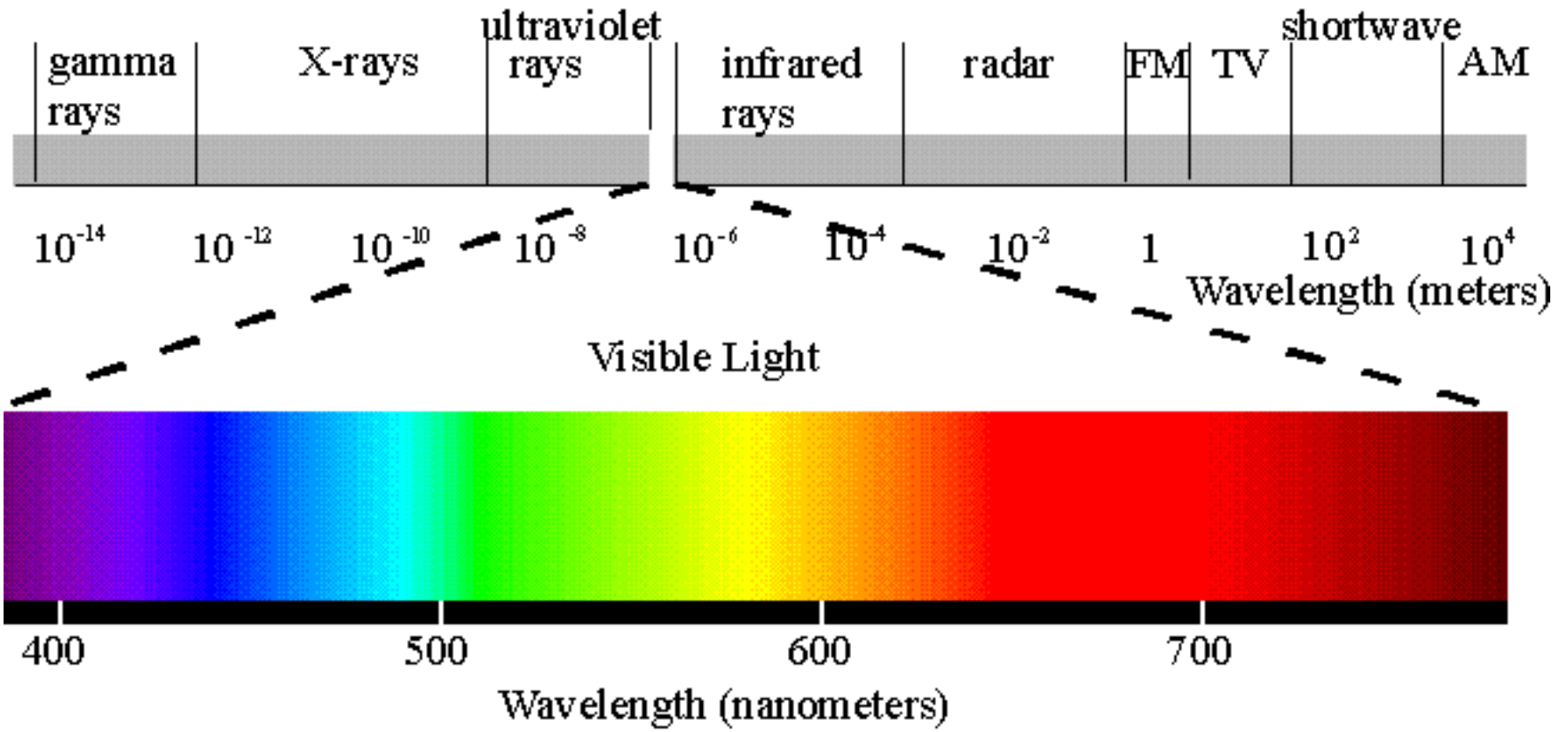
The term first appeared ~1965 with the first **satellite images** (previously there were only aerial photographs)

Also there was increasing use of non-visible parts of the **electro-magnetic spectrum**, such as the **Infrared**



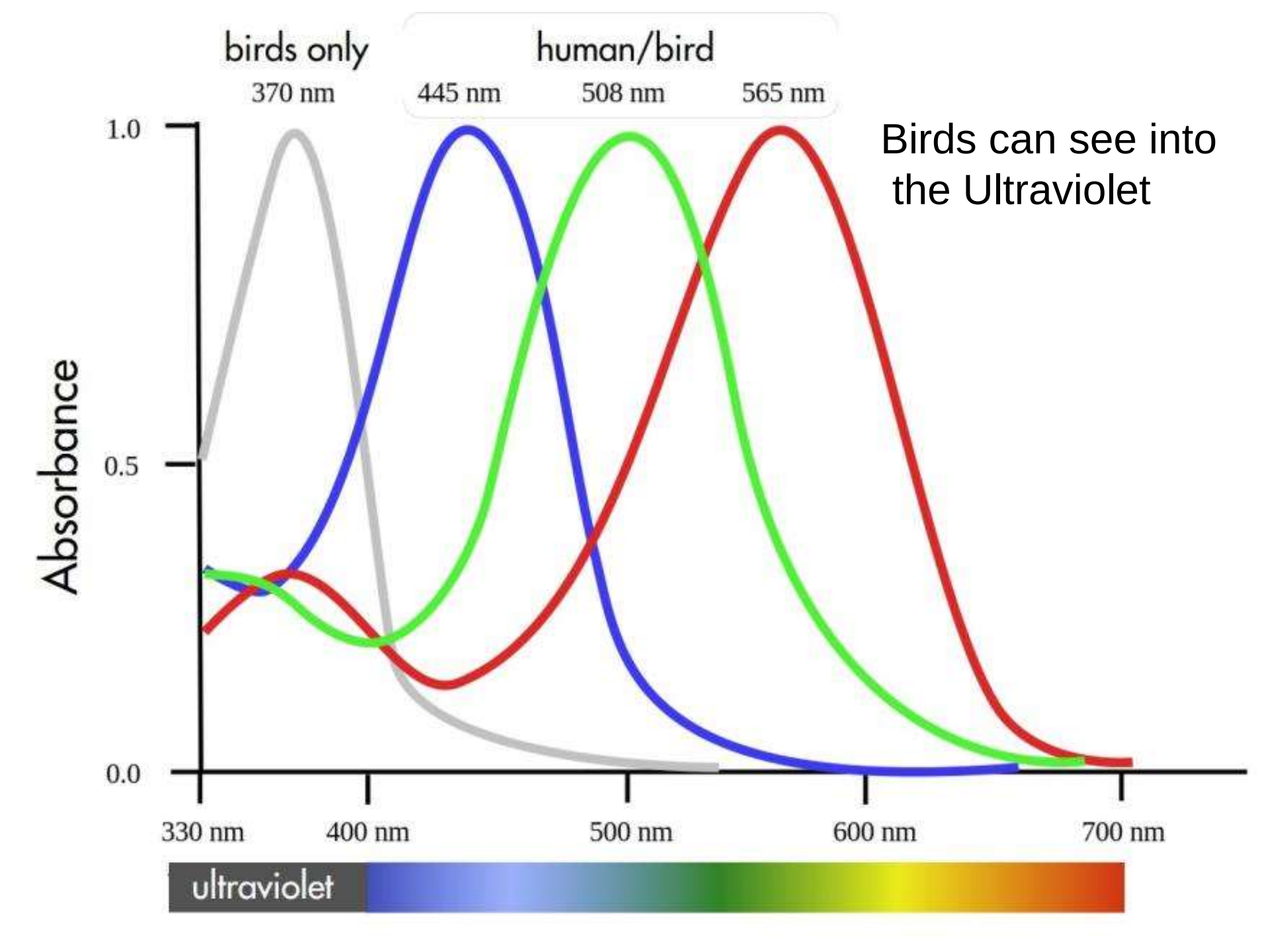
Shopping Center, Phoenix, AZ

Remote sensing and the electromagnetic spectrum



Blue	**0.4 - 0.5 µm**	**(microns)**	**= 400 to 500 nm nanometres**
Green	**0.5 - 0.6 µm**		**= 500 to 600 nm**
Red	**0.6 - 0.7 µm**		**= 600 to 700 nm**

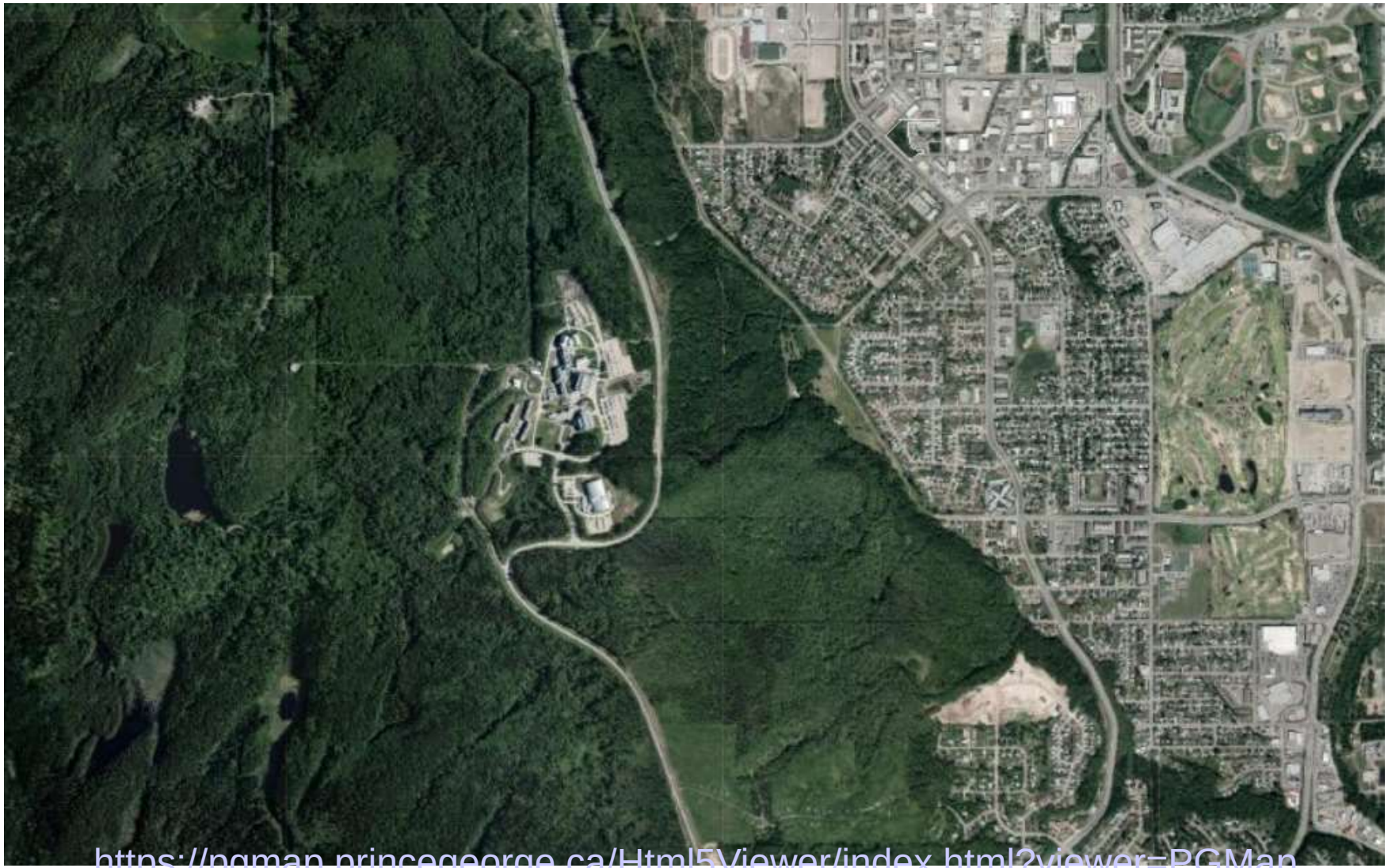
micrometres: 'microns' : millionths of a metre
nanometers: billionths of a metre



Birds can see into the Ultraviolet

Most birds have 2 - 8 times the visual acuity of humans

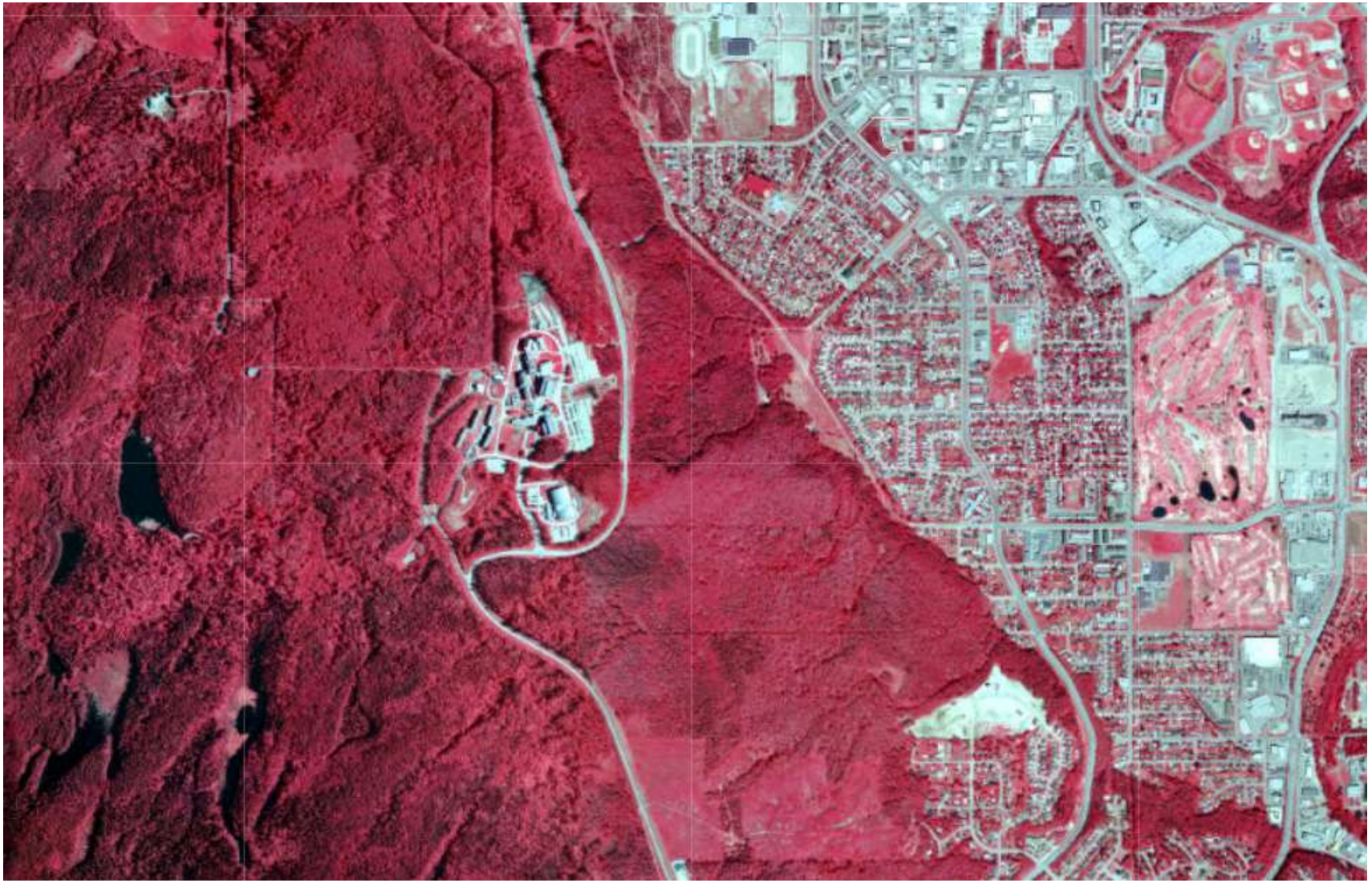
PGmap spring 2014 natural colour



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

We are used to seeing natural colour but there are Advantages of using Infra-Red wavelengths for mapping and GIS:

PGmap spring 2014 Infra-Red image:



- Land-water distinctions are enhanced (but not urban features)
- Vegetation differences are enhanced, coniferous v deciduous etc..

Table 2 : Characteristics of normal colour and false colour film

Normal colour film (Energy captured by film)	IR film (Energy captured by film)	Colour that results on film
B	G	Blue
G	R	Green
R	IR	Red

..the same with digital photos

Film has three layers (RGB), a yellow filter removes blue wavelengths, the film is sensitive to infra-red, reflected by healthy vegetation, in the red (film) layer.

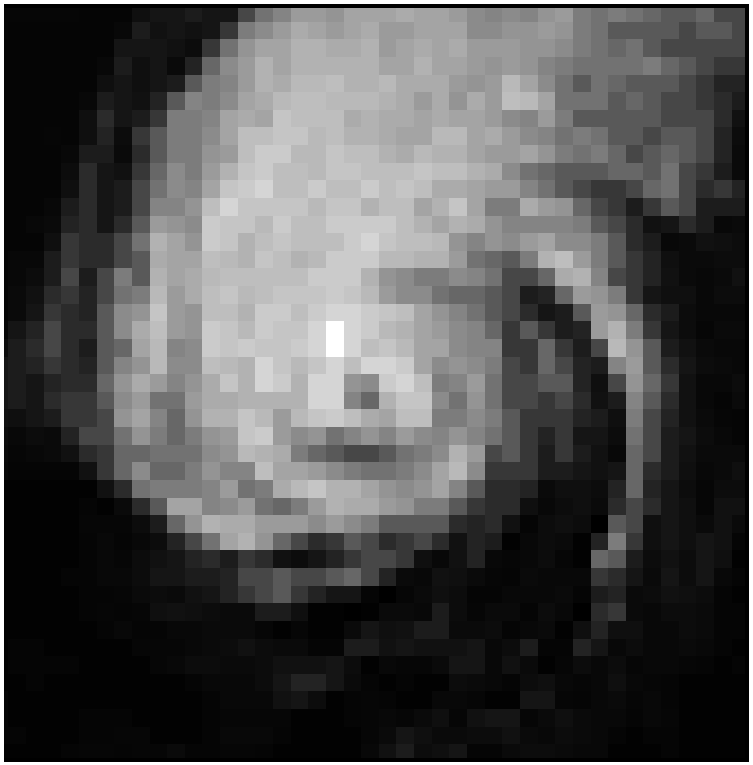
(Pan- IR) vegetation appears bright (almost as if snow-covered). There is less haze and higher land-water contrast.

Cameras: film or digital mostly record in the (UV), visible and near-IR

Digital Scanning: all wavelengths

A scanner creates digital images with pixels (picture elements) –

e.g. 8 bit = 256 values
(0=dark to 255=bright)



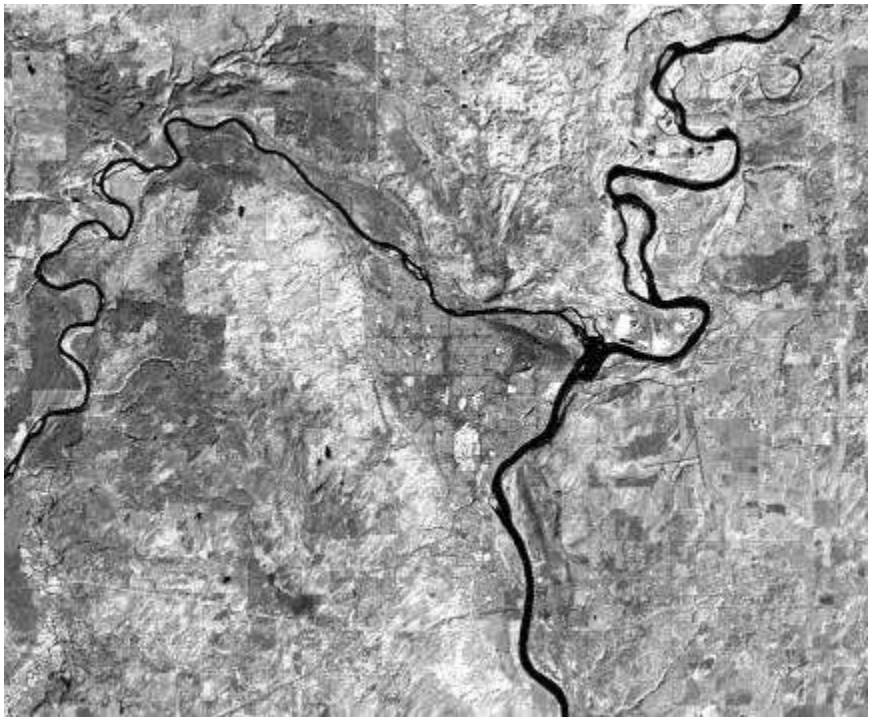
Close-up of pixels in a digital (scanned) image

<- Prince George – scanned IMAGE (not a photo)
Visible wavelengths .. Looks like a photo, but no camera

The **near IR** (0.7-1.3 microns) records energy related to **vegetation vigour** (health), while the **mid-IR** (1.3-3.0 microns) is dryness.

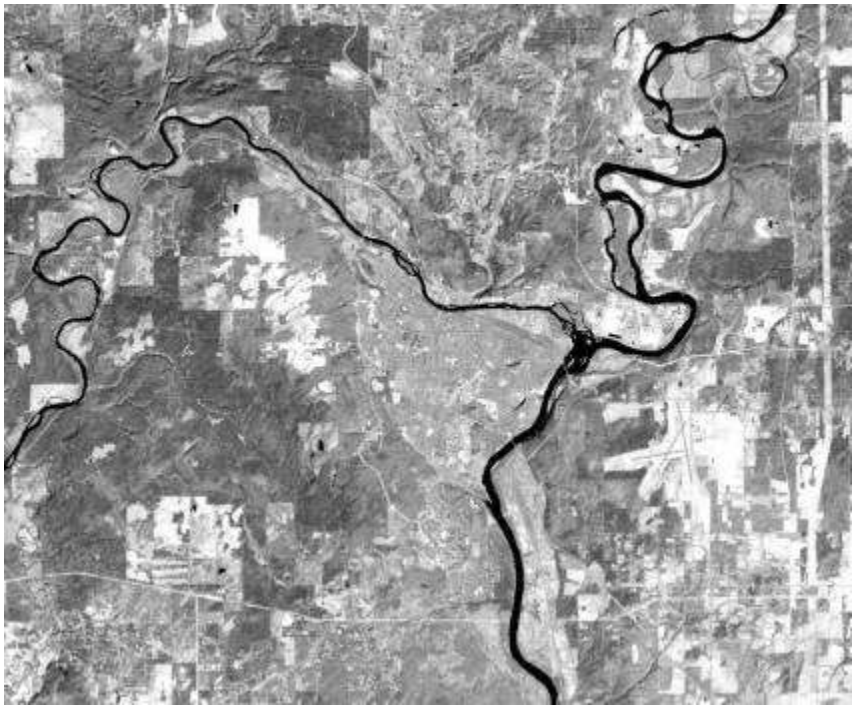
Neither have much to do with temperature

Near-IR



Vegetation health / vigour

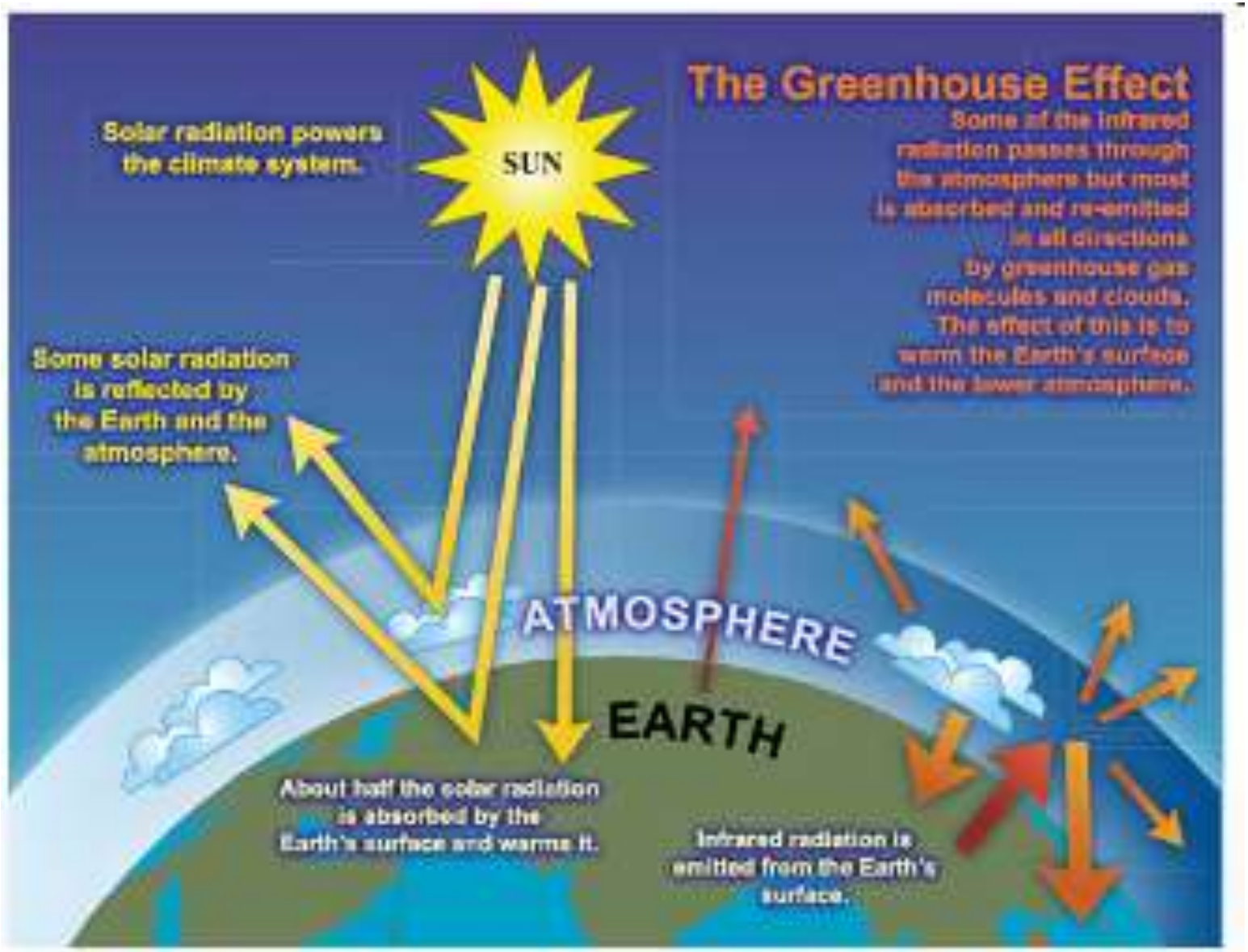
Mid-IR
(Shortwave)



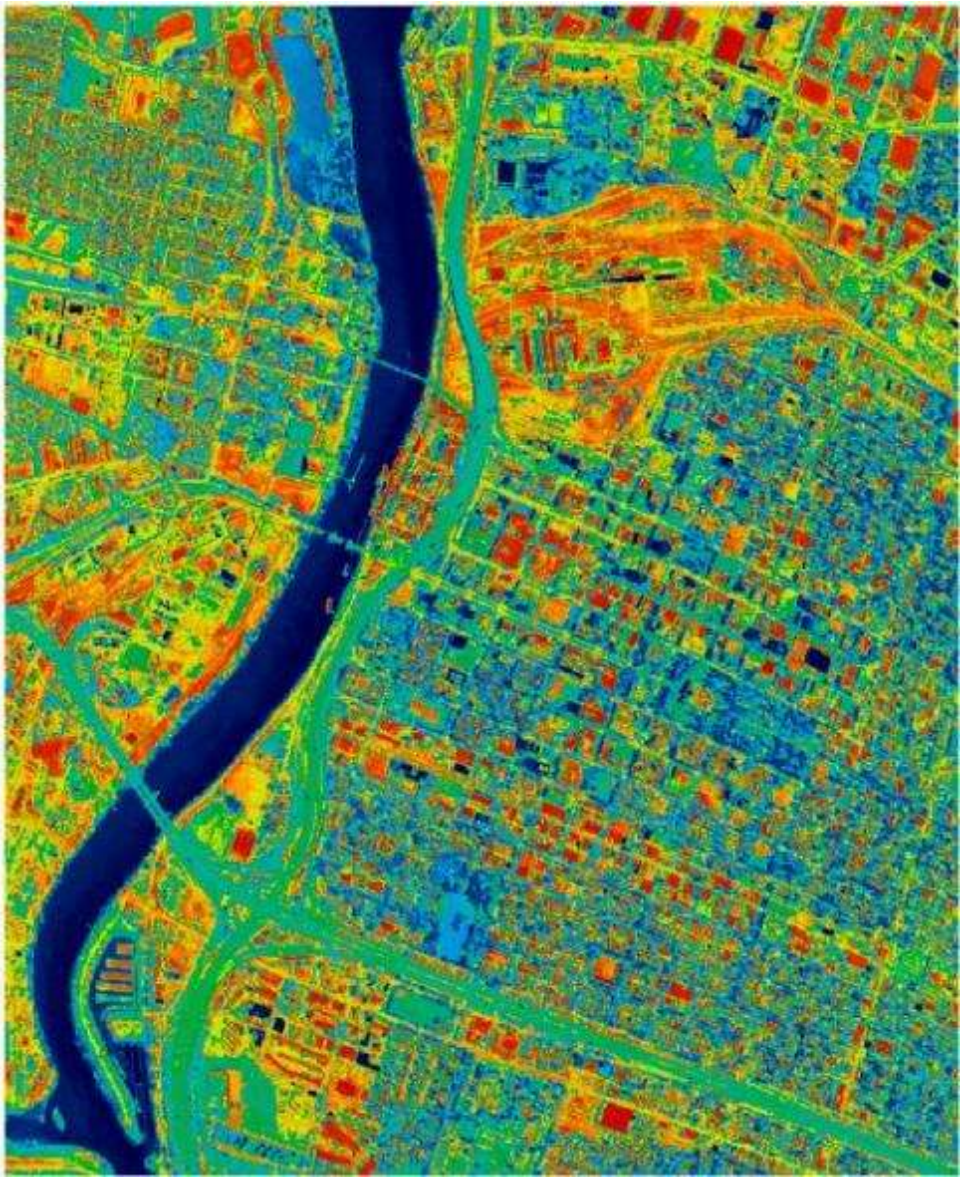
Moisture / dryness

Thermal Infrared (3-14 microns)

This records longer wavelengths and temperature as energy is **emitted** NOT reflected IR



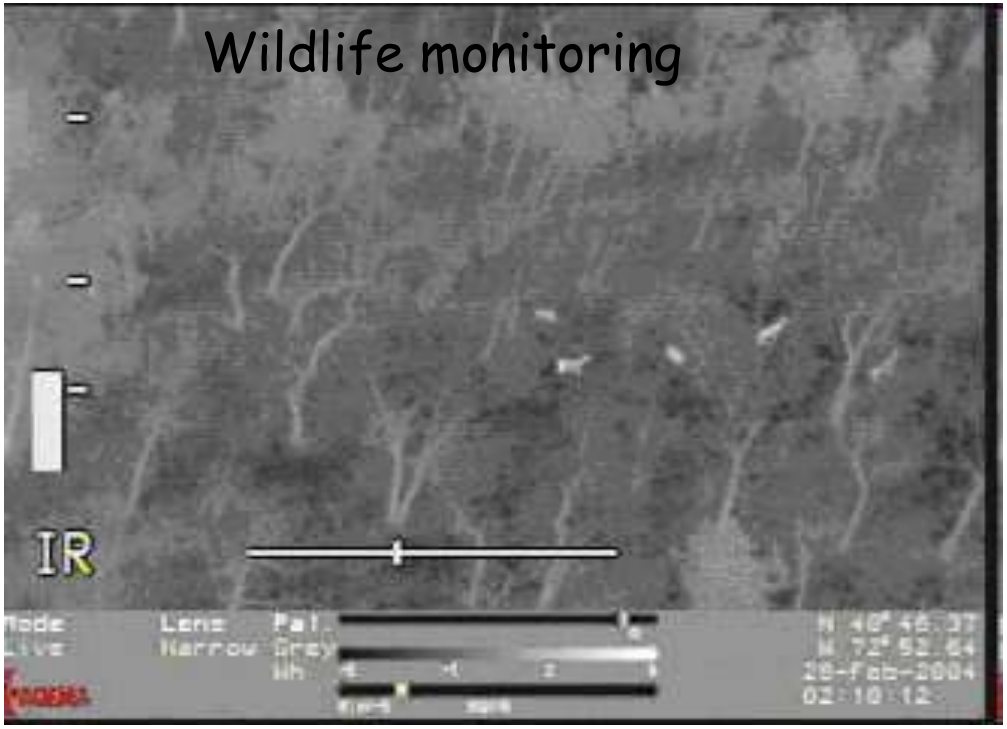
Daytime **Day and night**

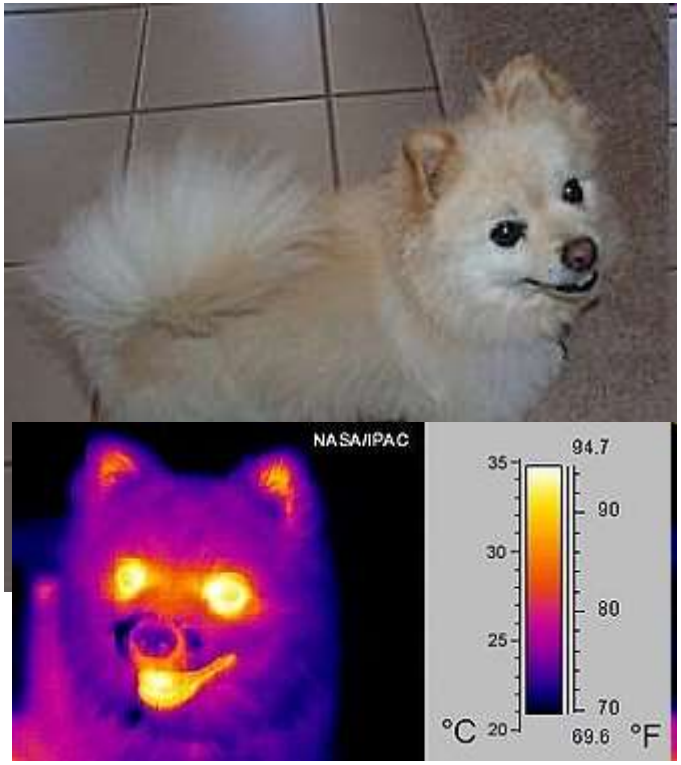


Normal colour and thermal images of Sacramento, CA

Drones with thermal cameras used to locate Koalas in Australian bush fires

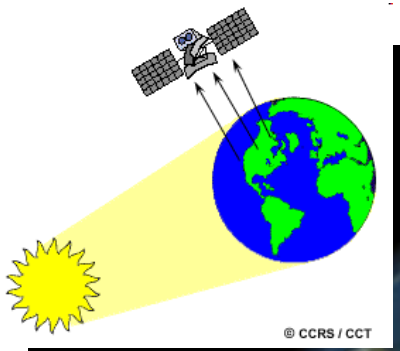
Night vision goggles (Russian military -> equipment) – sensing thermal IR





Microwave: (passive) 1mm – 1 metre

These wavelengths beyond the infra-red can 'see through' clouds, light rain, and snow, but there is a low amount of it; low resolution e.g. 10km pixels … this is why we use these wavelengths for communications.



Passive RS

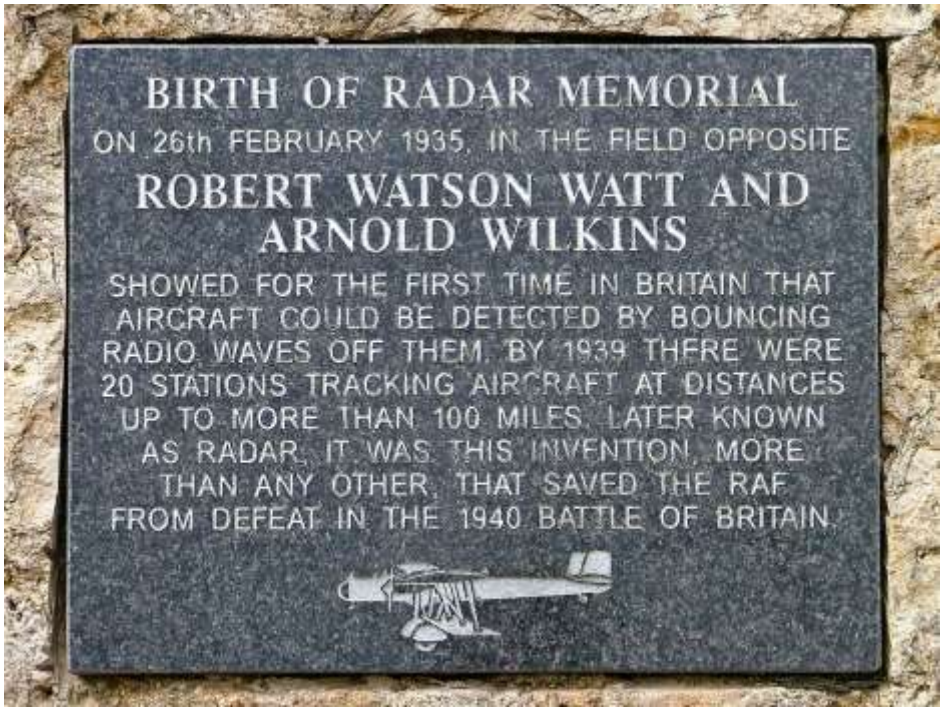
Active RS

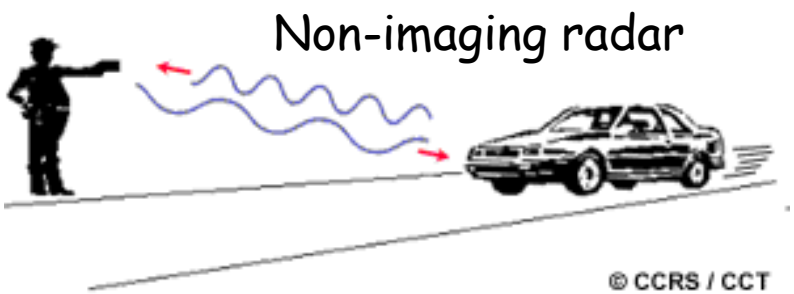
Microwave: - RAdio Detection And Ranging (RADAR)

'**active**' remote sensing at wavelengths of 1-30 cm

The original technology was developed in the 1930s

to detect enemy ships and planes during WWII





Imaging radar systems have been in use since the 1950s.

RADAR ..developed before/during World War II for aircraft detection
- early imaging RADAR for mapping was airborne.

Massachusetts-based Raytheon in 1947 named the original microwave the **“Radarange”** because it cooked food using the same radio-wave-producing magnetron tubes that the company manufactured for use in military radar.

Raytheon credits the discovery of microwave cooking to a radar engineer named Percy L. Spencer. One day in 1945, Spencer was walking through a radar test room with a chocolate bar in his pocket, and the candy began to melt.

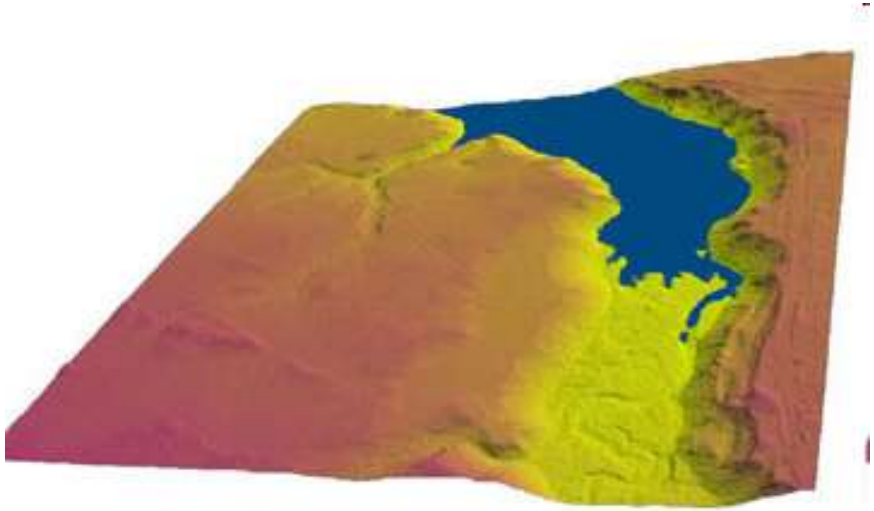
2000 -> LiDAR = Light Detection And Ranging

.. is the other common form of active remote sensing

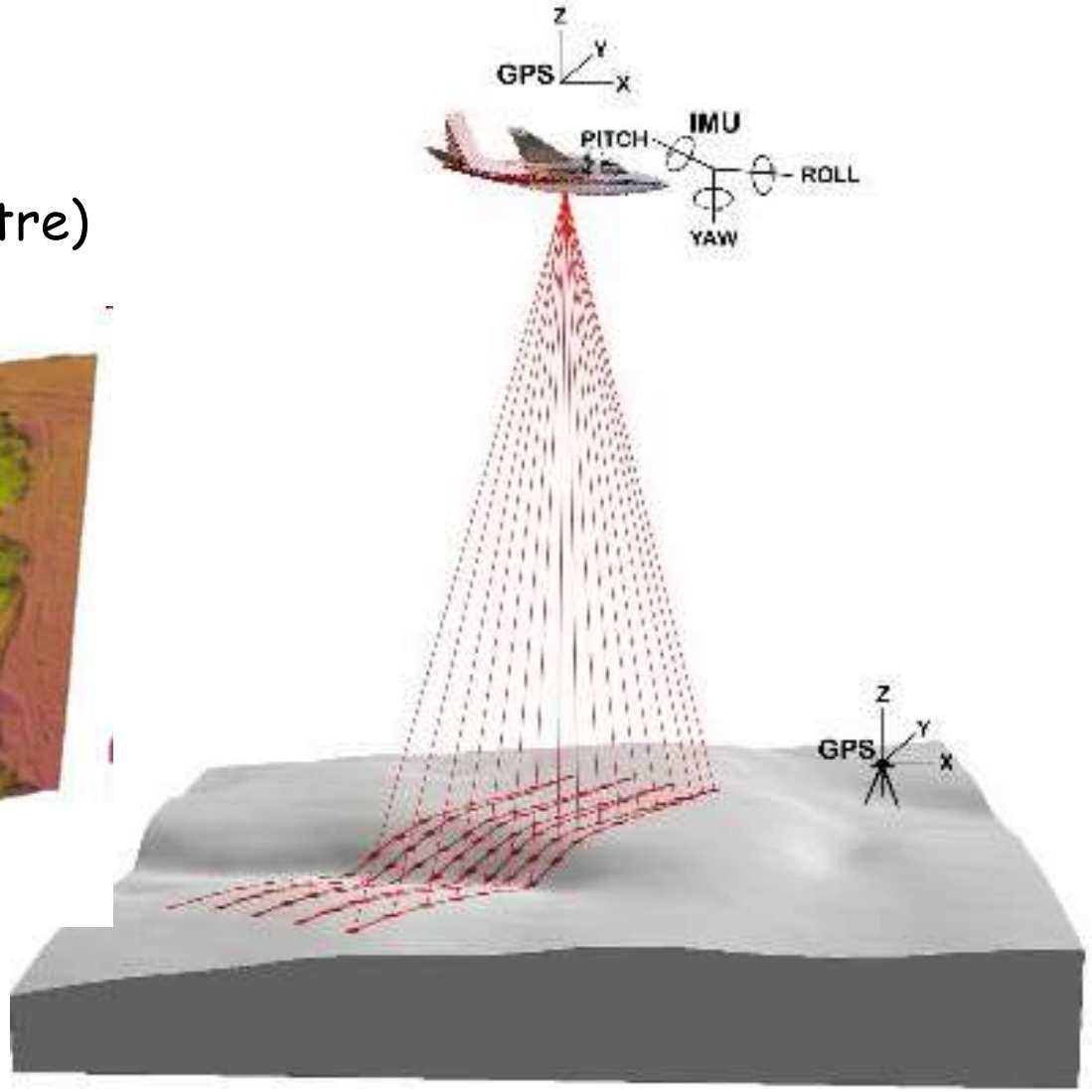
visible/NIR wavelengths

It is often used to create

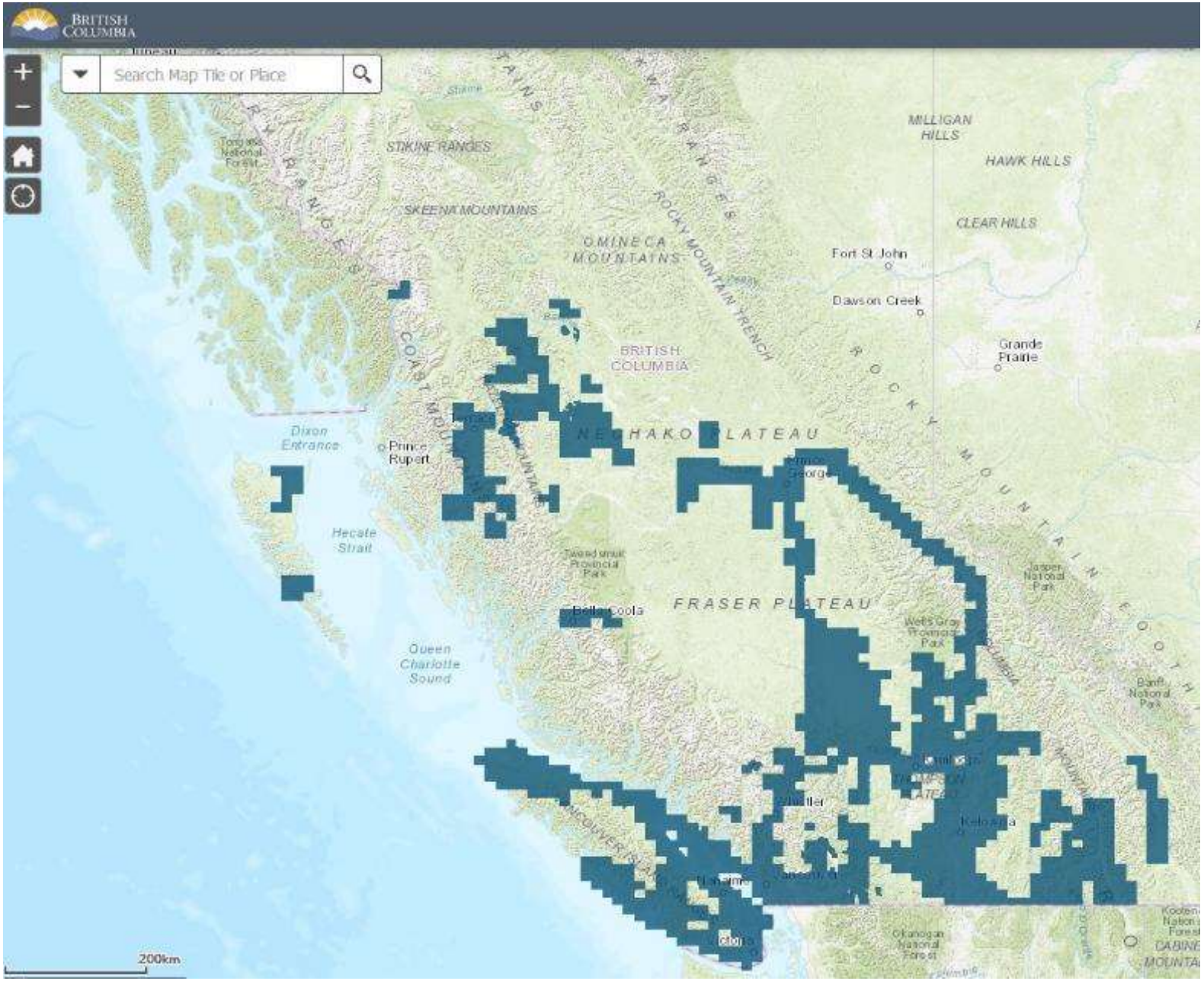
high resolution DEMs (< 1 metre)

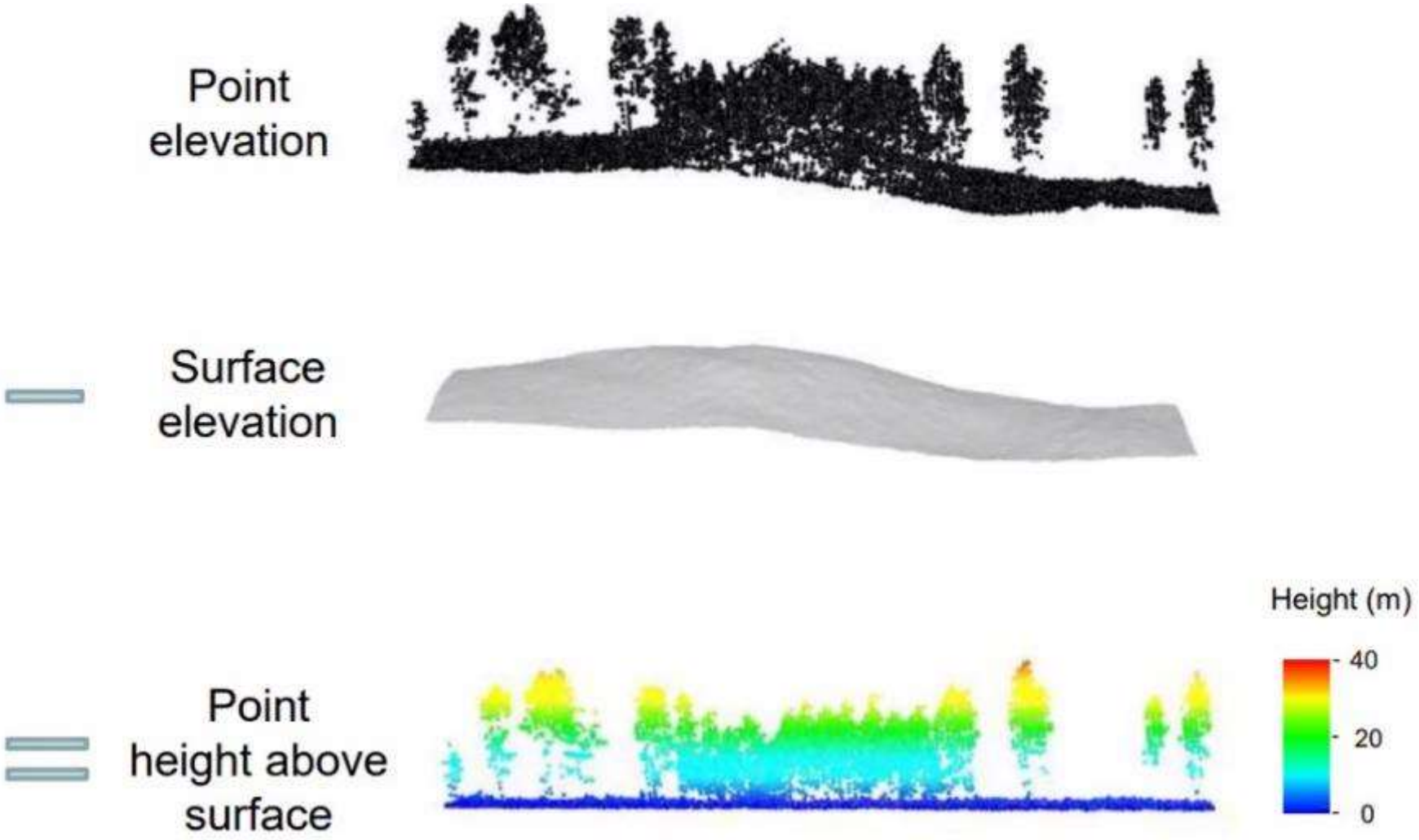


Major BC cities with rivers are mapped by LiDAR for flood levels



LidarBC - Open LiDAR Data Portal (2022)



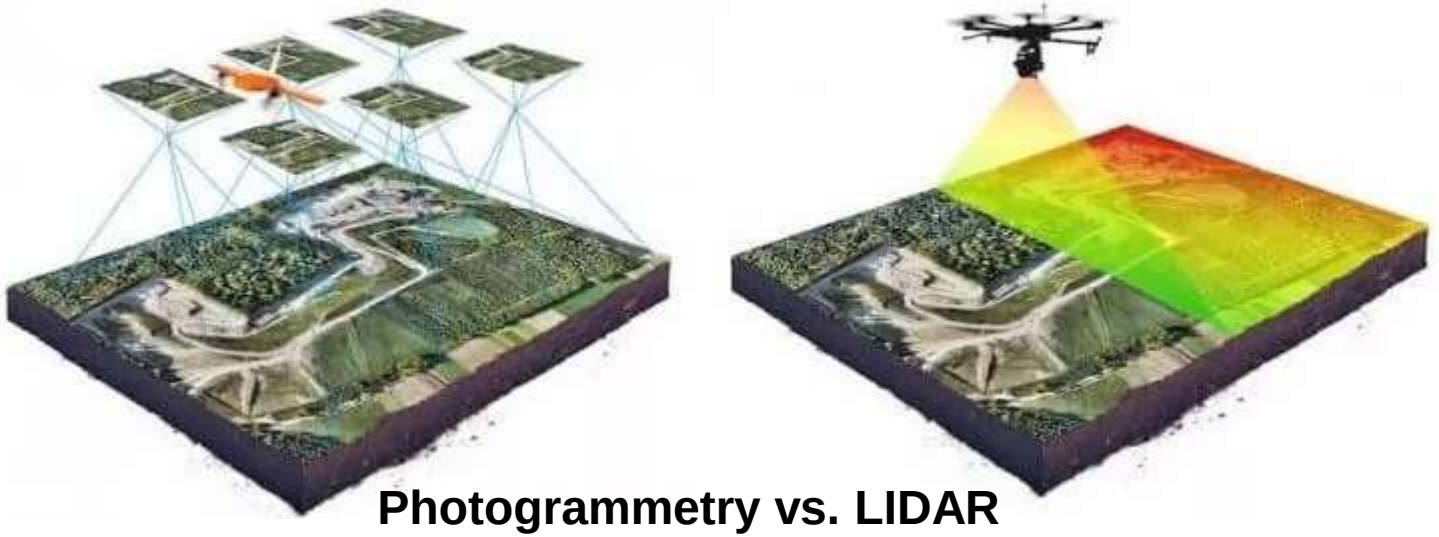


University of Calgary fly-through: LiDAR DEM and draped orthophotography

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

2000s -> Mapping from drones - UAVs

Unmanned Aerial Vehicles – easily and quickly launched



Photogrammetry vs. LIDAR

Matterhorn:
https://www.youtube.com/watch?v=Fs2C_wXQ_IM