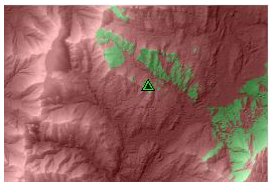
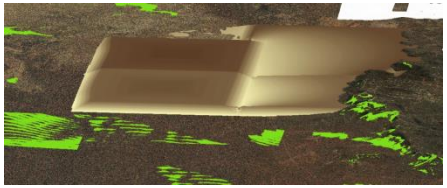
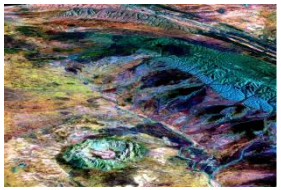
Remote Sensing on the Cheap

Solutions to help cash-strapped explorers

Author: Jason Beltran, Senior GIS Consultant, SRK Consulting



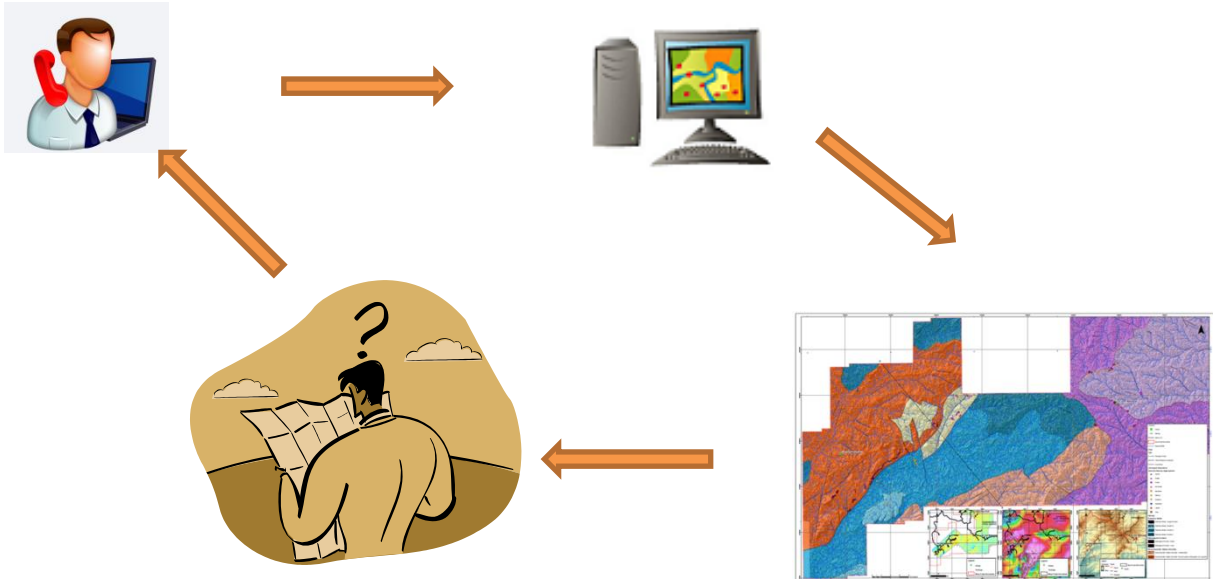




GPS “Bricks”: Late 1990

Background

- BSc (GIS) – Curtin University 2000
- Worked in GPS industry for over 10 years
- Developed maps for Magellan
- Seen many changes in GPS industry
- Last 3 years working with SRK GIS Coordinator



Free Data - Why

Abundance of free GIS data available.
Is free really free?

Things to consider

- What are you trying to achieve?
- Skills/tools required to use data?
- Consider the time required to find and use data?

It can be cheaper (time wise) to buy the processed data !

Outline

What “free” data is available?

- Remotely sensed data
- Vector data
- Is it useful - tips
- Some practical uses

Google Earth™

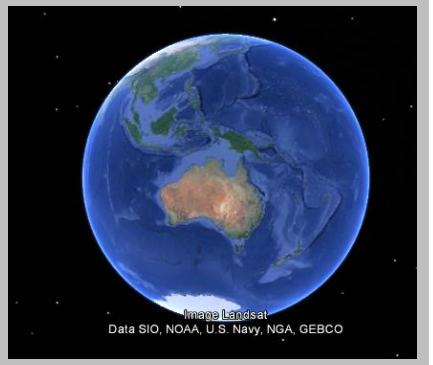
Google Earth has been the easiest way to get imagery for your project. Images tend to be cloud free.

Issues:

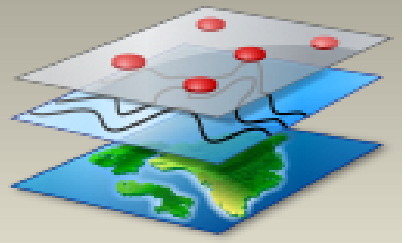
- Low Resolution
- Needs to be geo-referenced to be used in GIS software

Alternatives

- Purchase Pro Licence
- Use Basemaps in ArcMap or BING maps for Mapinfo



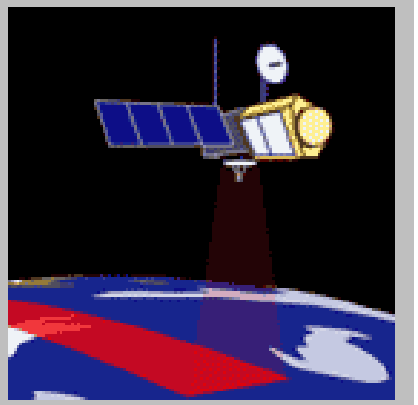
Vector Data

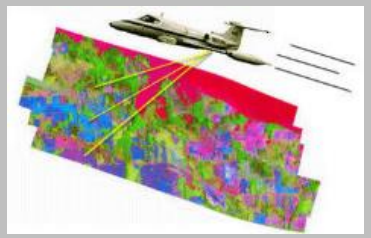


Anything that can be represented as a point, line or polygon:

- Geology
- Topographic
- Cultural - road, rivers, towns, ports etc.
- Mineral occurrences
- Mining projects

Image: Gravity Recovery and Climate Experiment (GRACE)





Ghcc.msfc.nasa.gov

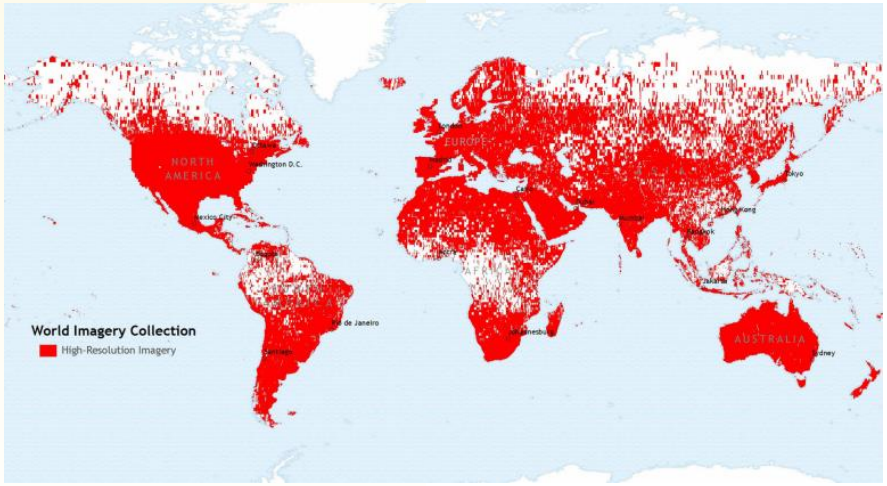
Remote Sensing

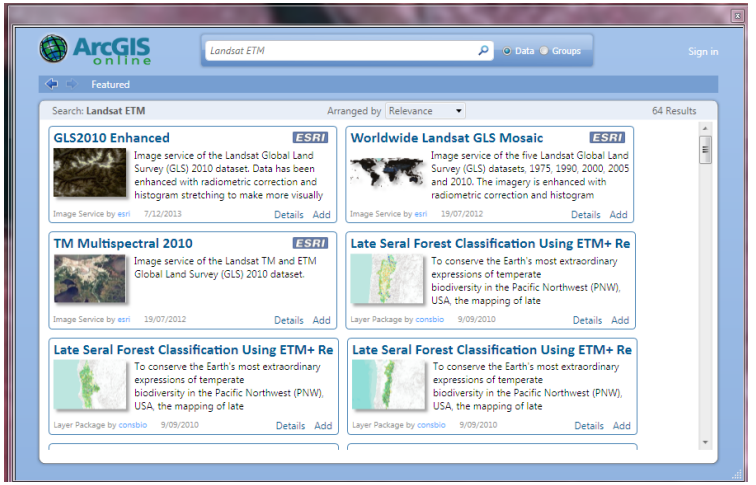
Remote Sensing: *acquisition of information about an object without physical contact. In this case, using sensors on board aerial vehicles (satellites/aircraft) to detect objects on earth.*

- Google Earth™, BING maps,
- DEM – SRTM and ASTER data,
- Government i.e. GSWA, DMP, Geoscience Australia, USGS (US Geological Survey),
- Streaming base maps - GIS Software ArcGIS and Mapinfo (BING)
- Geophysics - GADDS

Basemaps*

- DigiGlobe archived imagery available Depending on area 30-50cm resolution is available
- Also available, Landsat 7 Multispectral data using ArcGIS online tool

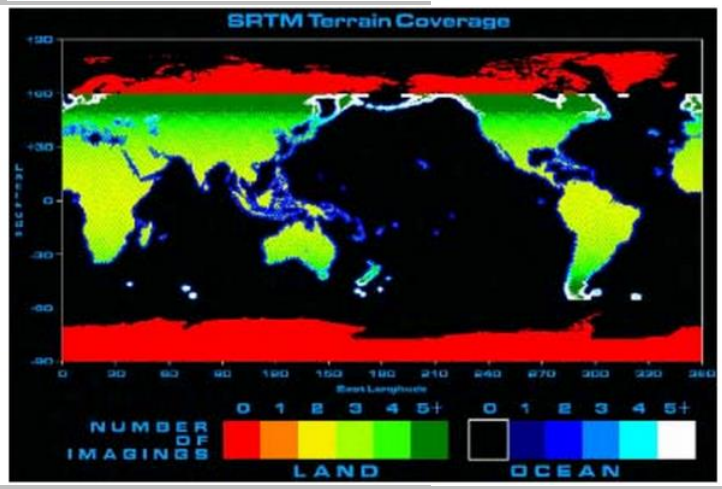




*ArcMap Licence needed

DEM: Shuttle Radar Topography Mission (SRTM)

The SRTM antenna mast being deployed from Endeavour. Photo: DSS



- Radar based system (cloud free),
- Coverage from 60°N to 54°S.

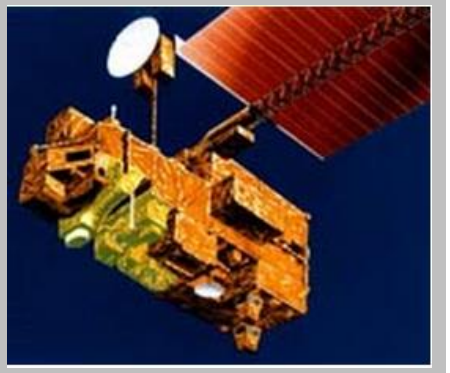
Resolution:

- 3 Arc Second (~ 90m) World
- 1 Arc Second (~ 30m) USA
- 1 Arc Second (~ 30m) Australia–NEDF
- <16m accuracy

Sources:

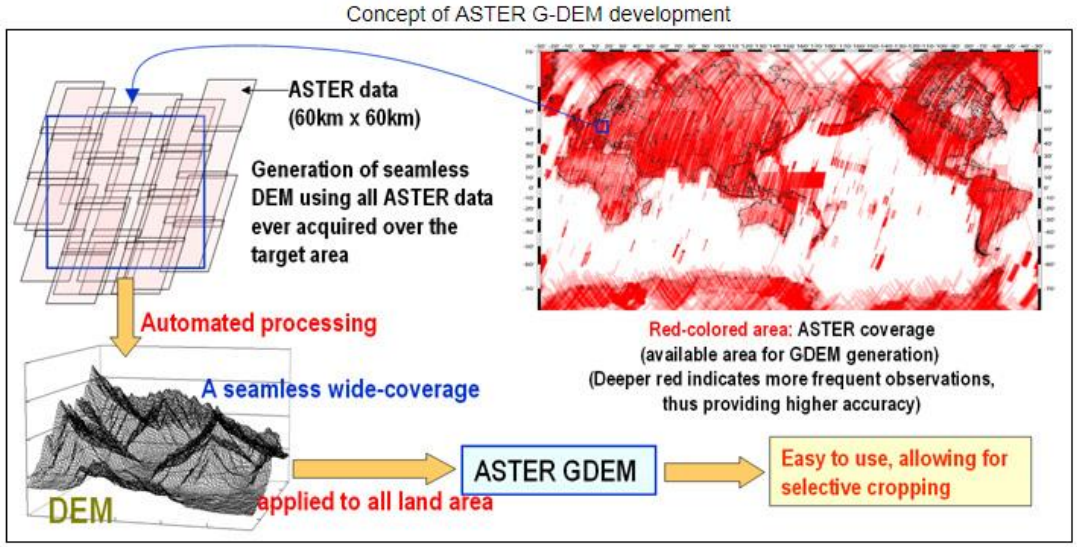
SRTM V2 (NASA):http://www2.jpl.nasa.gov/srtm/
CGIAR Version 4.1: http://srtm.csi.cgiar.org/
USGS earth Explorer: http://earthexplorer.usgs.gov/
NEDF (National Elevation Data Framework) – Australia:
http://nedf.ga.gov.au/geoportal/catalog/main/home.page

DEM ASTER GDEMv2



Advanced **S**paceborne **T**hermal **E**mission and **R**eflection **R**adiometer
Global **D**igital **E**levation **M**odel

- Released in 2009, result of collaboration between NASA and Japan Ministry of Econ. Trade and Industry (METI)
- Optical sensor, using stereo pair for elevation
- 1 second resolution (~30m)
- Coverage between 83° S and 83° S
- <17m accuracy



Sources
Japan Space Systems:
http://gdem.ersdac.jspacesystems.or.jp/
USGS earth Explorer:
http://earthexplorer.usgs.gov/

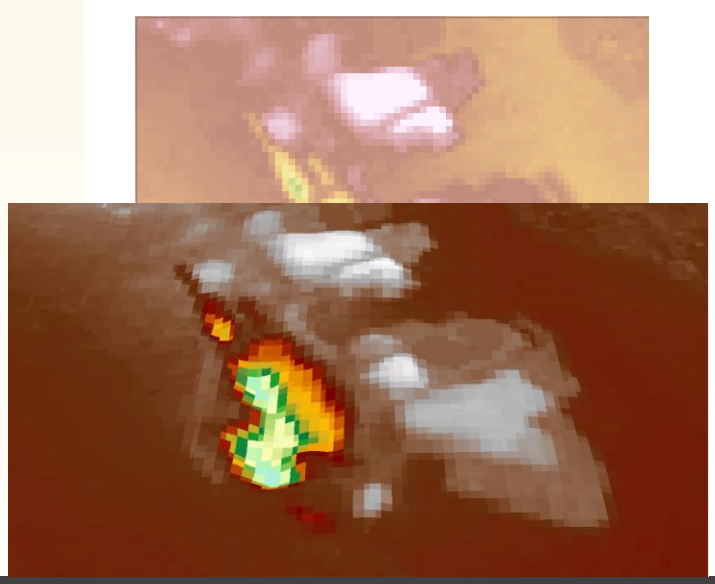
SRTM vs ASTER GDEM

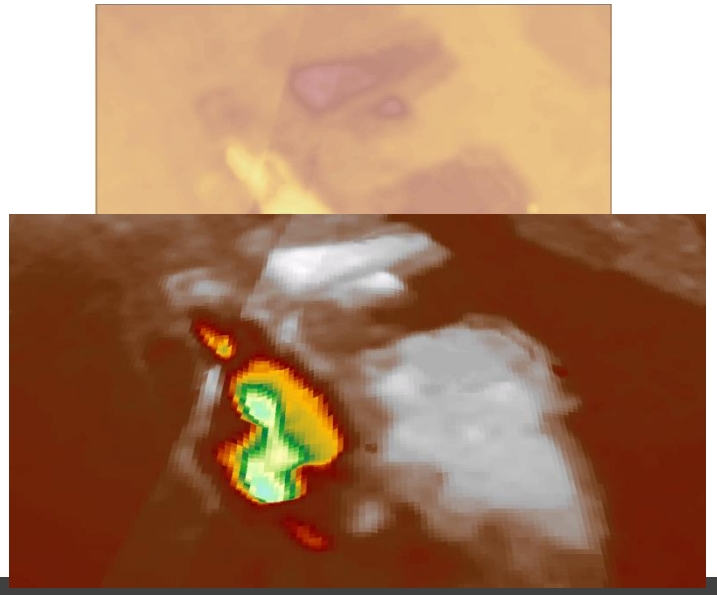
SRTM

- Maps all surfaces, including buildings and vegetation
- Snow, extremely smooth areas may create “void” values
- Very steep slopes can cause errors
- 80% of landmass covered

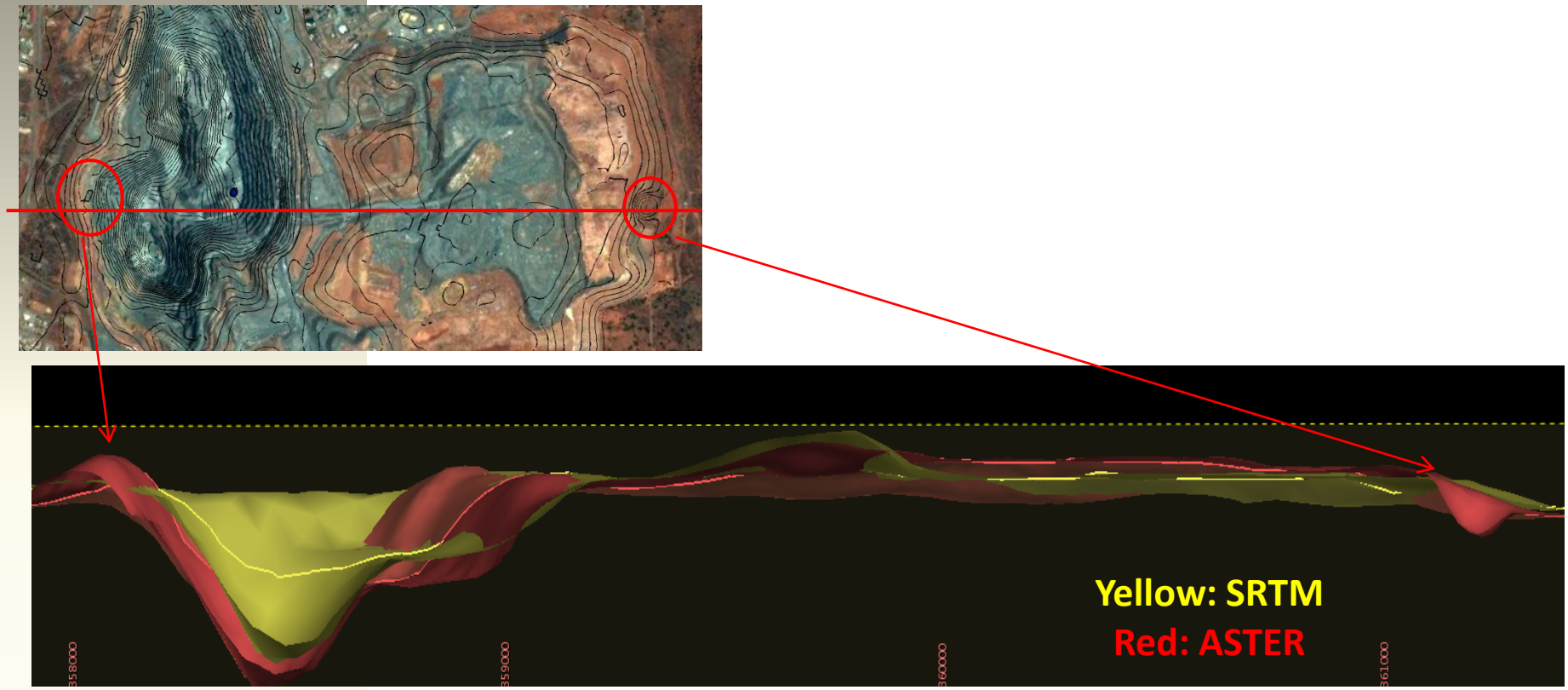
ASTER

- Cloud Cover over areas can cause data voids or artefacts
- ASTER Maps all surfaces including buildings and plant canopy
- Global coverage

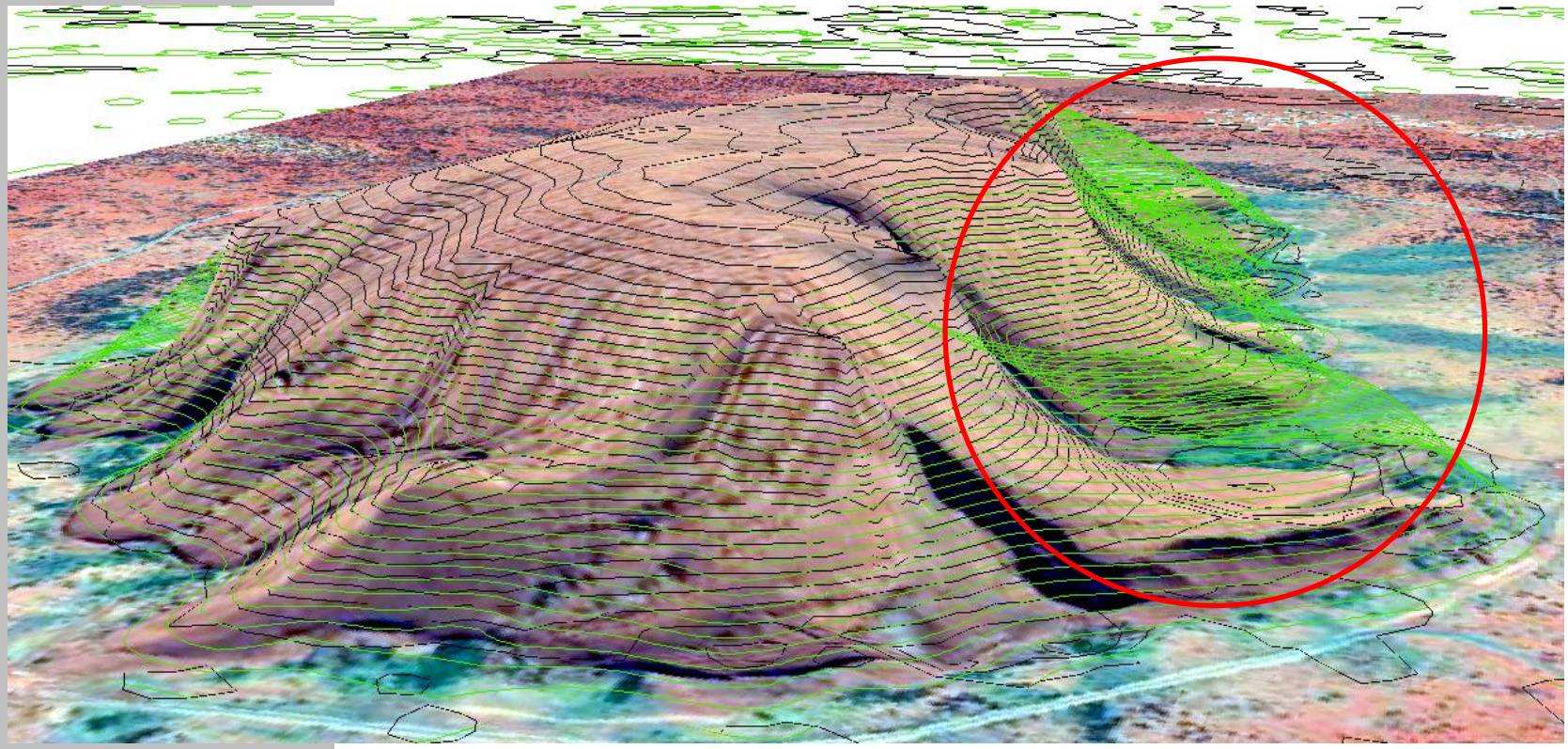




SRTM vs ASTER GDEM



Australia's Favourite Outcrop



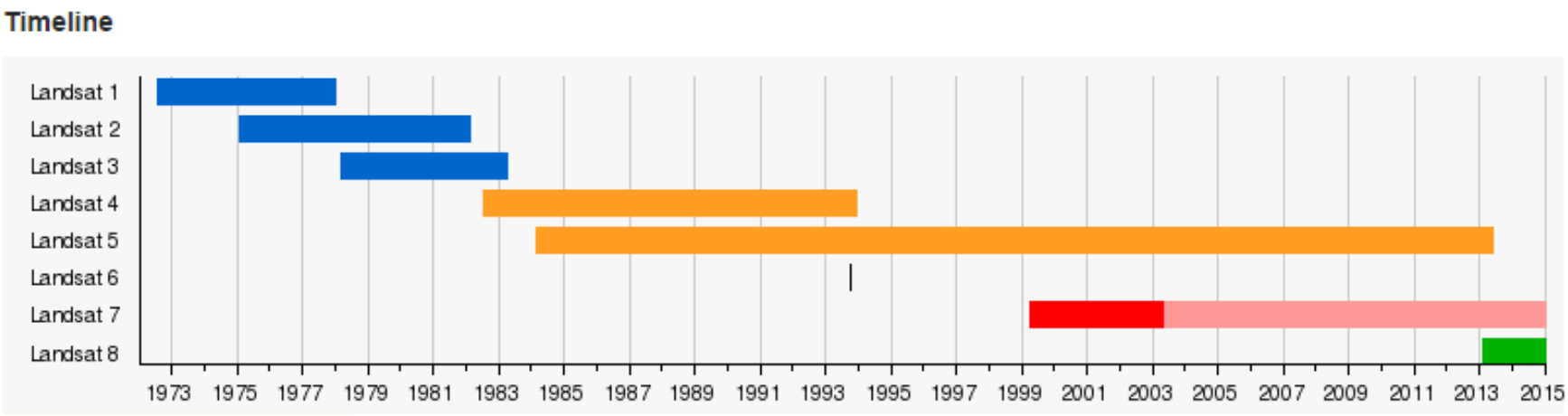
Green Contour : ASTER
Black Contour : SRTM

SRTM incorrectly represents the cliff faces. Possibly too steep for resolution.

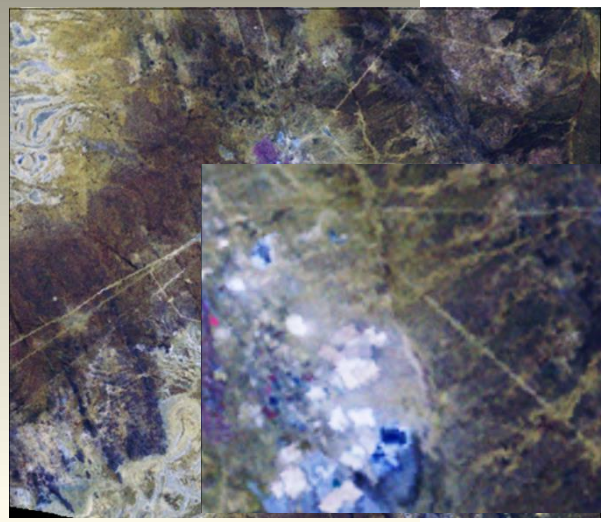
Landsat 1 - 8

Landsat Program is the longest running,
1972 to present day

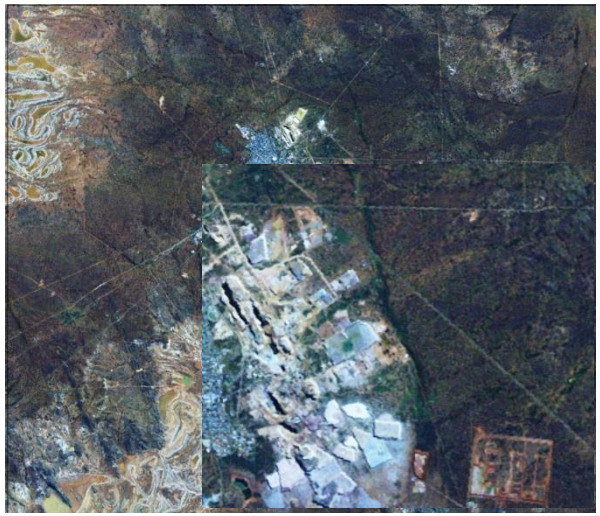
- Landsat 1 – 4 : Multispectral Scanner (MSS – 4 Bands) 80m
- Landsat 5 : Thematic Mapper Scanner (TM – 7 Bands) 30m and MSS 80m
- Landsat 7 : TM 30m, Panchromatic 15m (8 Bands)
- Landsat 8 : 15m Pan and 30m Multispectral **O**perational **L**and **I**mager OLI ~ TM (11 Bands)



Landsat 1 - 8

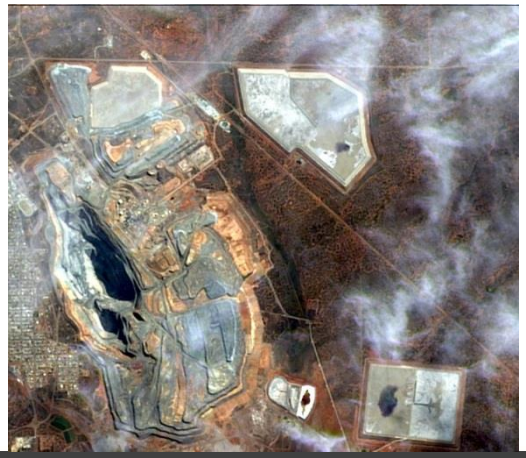


Landsat 1: Oct 1972



Landsat 5: July 1989

Landsat 7: May 2000

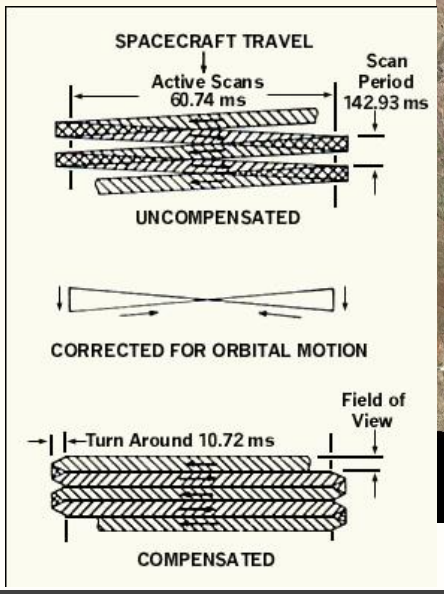


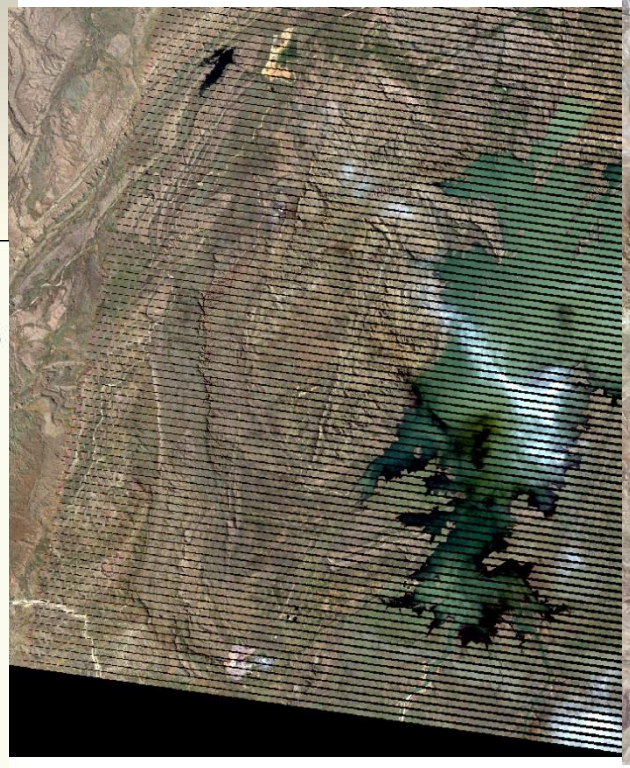
Landsat 8: August 2014

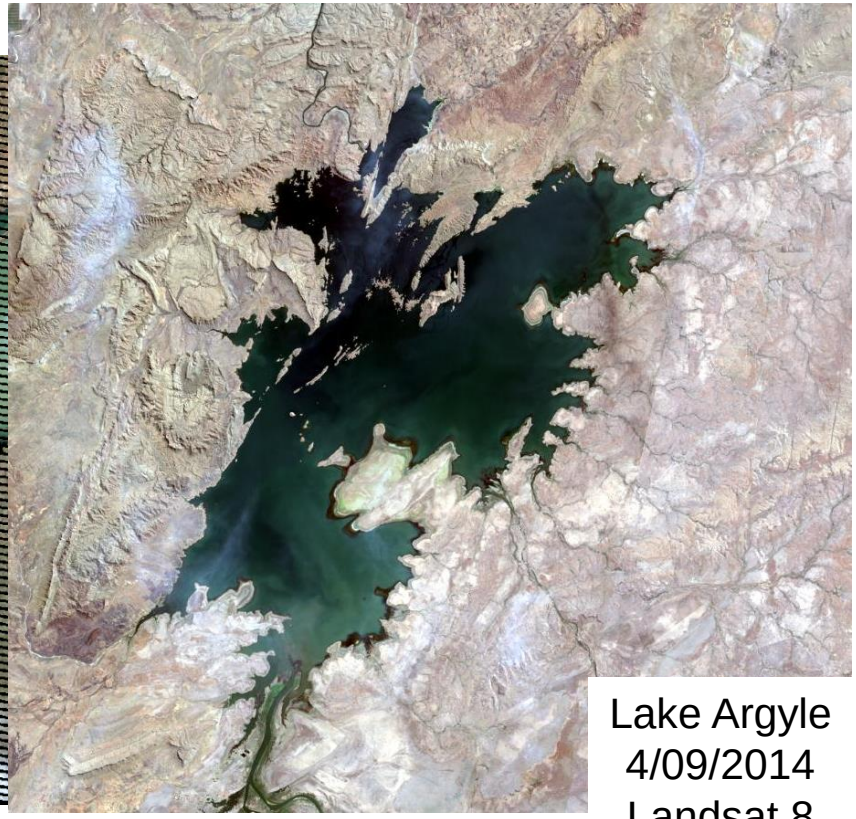
Used for Change Detection

Landsat 7 and 8 : Current

- May 2003 Landsat 7 developed problem with Scan Line Corrector, which now causes images to have a zig zag pattern. (~78% of pixels available for use)

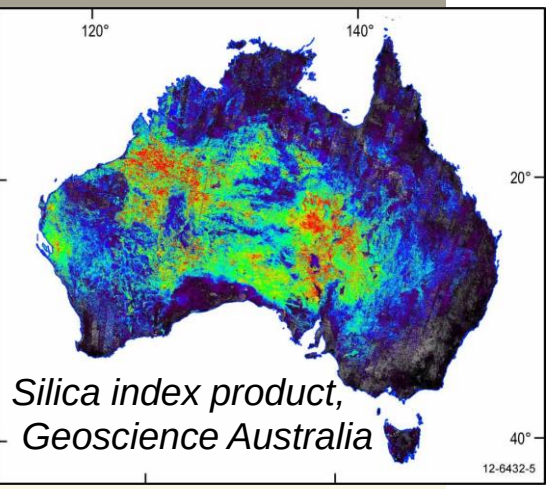




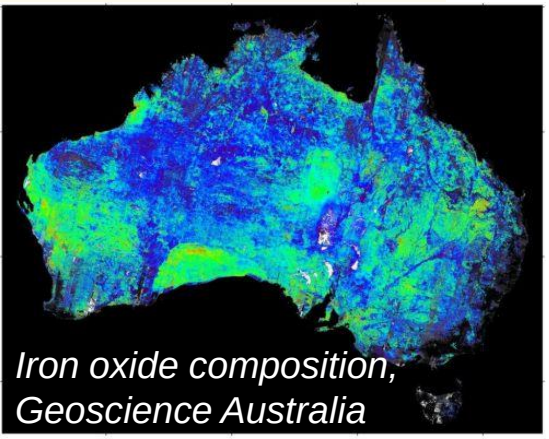


Lake Argyle
4/09/2014
Landsat 8

Multispectral ASTER.



Silica index product, Geoscience Australia


Iron oxide composition, Geoscience Australia

Mapping of groups of minerals and associated rocks. Already processed by CSIRO for Australia.
http://c3dmm.csiro.au/Australia_ASTER/index.html

14 ASTER products representing mineral groups such as:

- Ferric oxide content ⇒ $\frac{B_4}{B_3}$:
  - ✓ exposed iron ore or surface lag: hematite/goethite, mapping of jarosite (acid conditions)
- AlOH group content ⇒ $\frac{B_5+B_7}{B_6}$:
  - ✓ presence of phengite, muscovite, illite, kaolinite… in exposed saprolites, clay-rich horizons, phyllic hydrothermal alteration
- MgOH group content ⇒ $\frac{B_6+B_9}{B_7+B_8}$
  - ✓ presence of calcite, dolomite, chlorite, amphibolite, talc, serpentine… in hydrated Fe-Mg rocks, prophyllitic hydrothermal alteration, carbonate-rich rocks
- Ferrous iron content in MgOh/carbonate ⇒ $\frac{B_5}{B_4}$
  - ✓ Unoxidised parent rocks vs transported cover, talc/tremolite (Mg-rich, cool colours) vs actinolite (Fe-rich, warm colours)

High-resolution imagery

Lake Cowan – North of Norseman

No single best solution, depends on area and scale

High-resolution imagery uses

Useful for planning field work in remote areas to identify existing tracks or paths and villages, outcrops in exposed areas, identification of geological features (contacts, folds, lineaments…)

But:

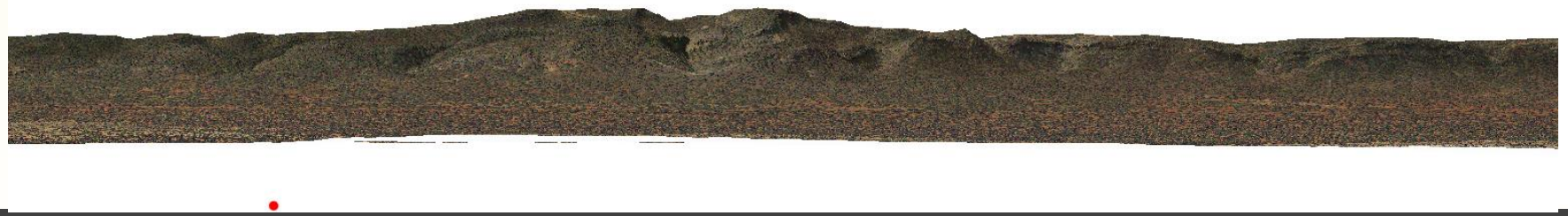
- Low resolution when exporting images, unless using Google Earth Pro™
- Manual geo-referencing of the images.

Case study – Viewshed Analysis

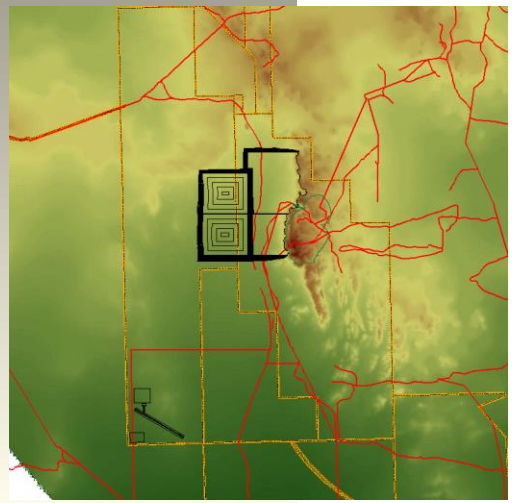
Design of TSF (Tailings Storage Facility) to make sure height does not restrict view from the major road.

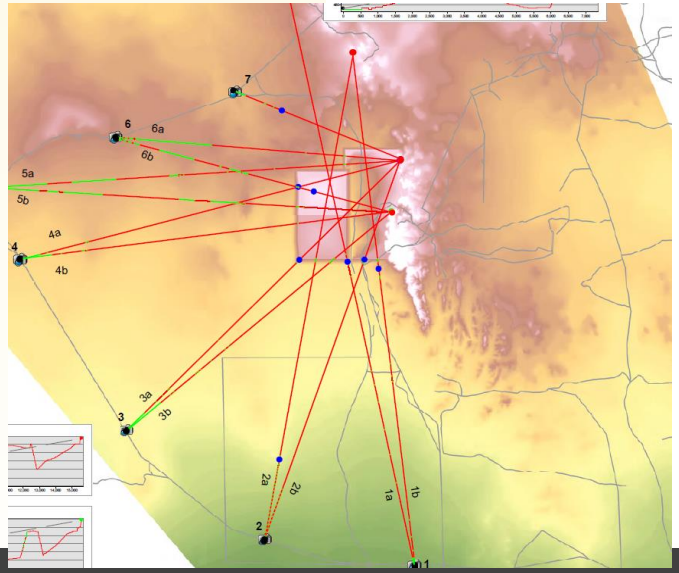
What was needed:

1. Cultural features – roads
2. Topography
3. TSF Design



Process

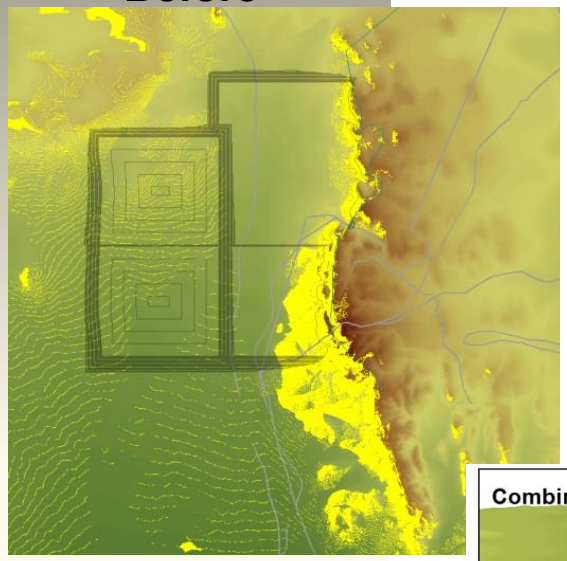




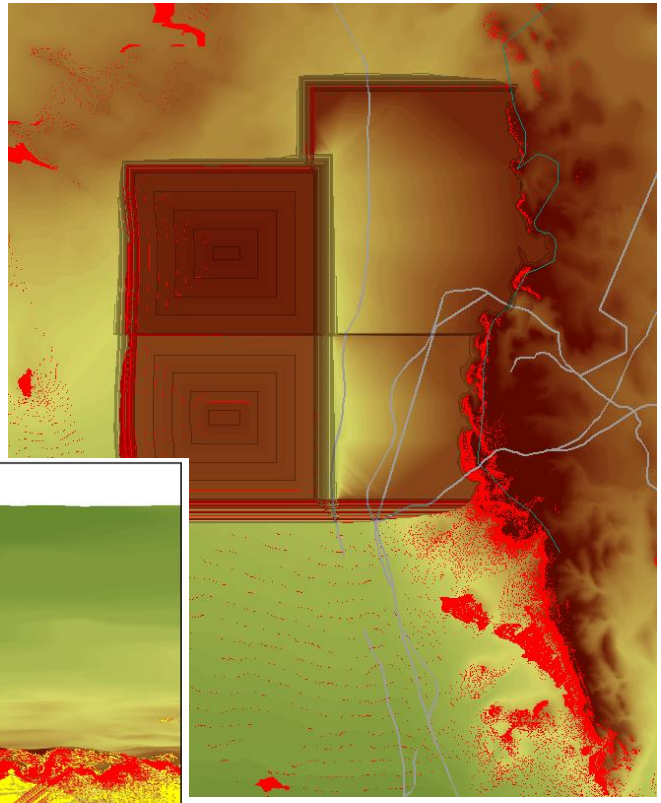
- SRTM obtained (NASA/CGIAR)
- Roads (Geoscience Australia)
- Sight lines and observation points identified

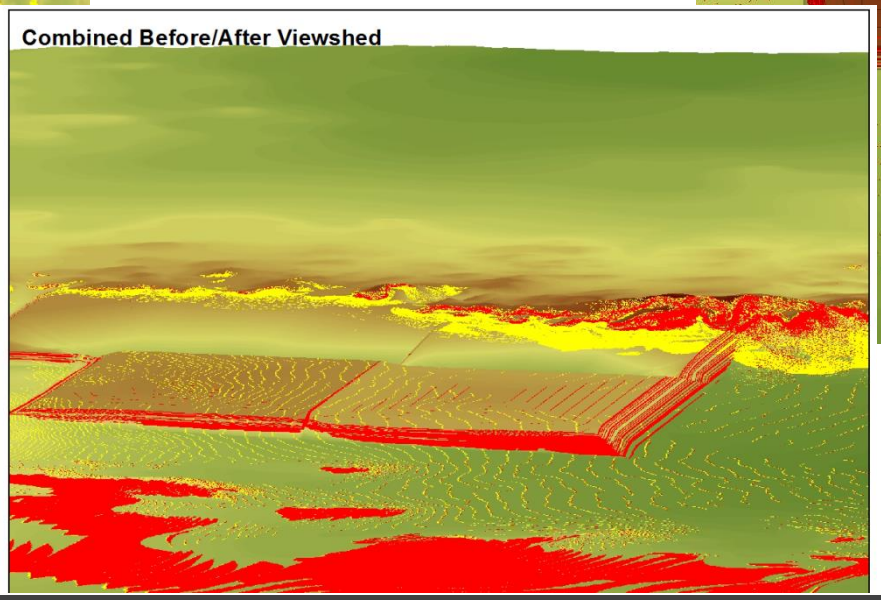
Viewshed Results

Before



After





Case study - Digital mapping for early stage gold exploration

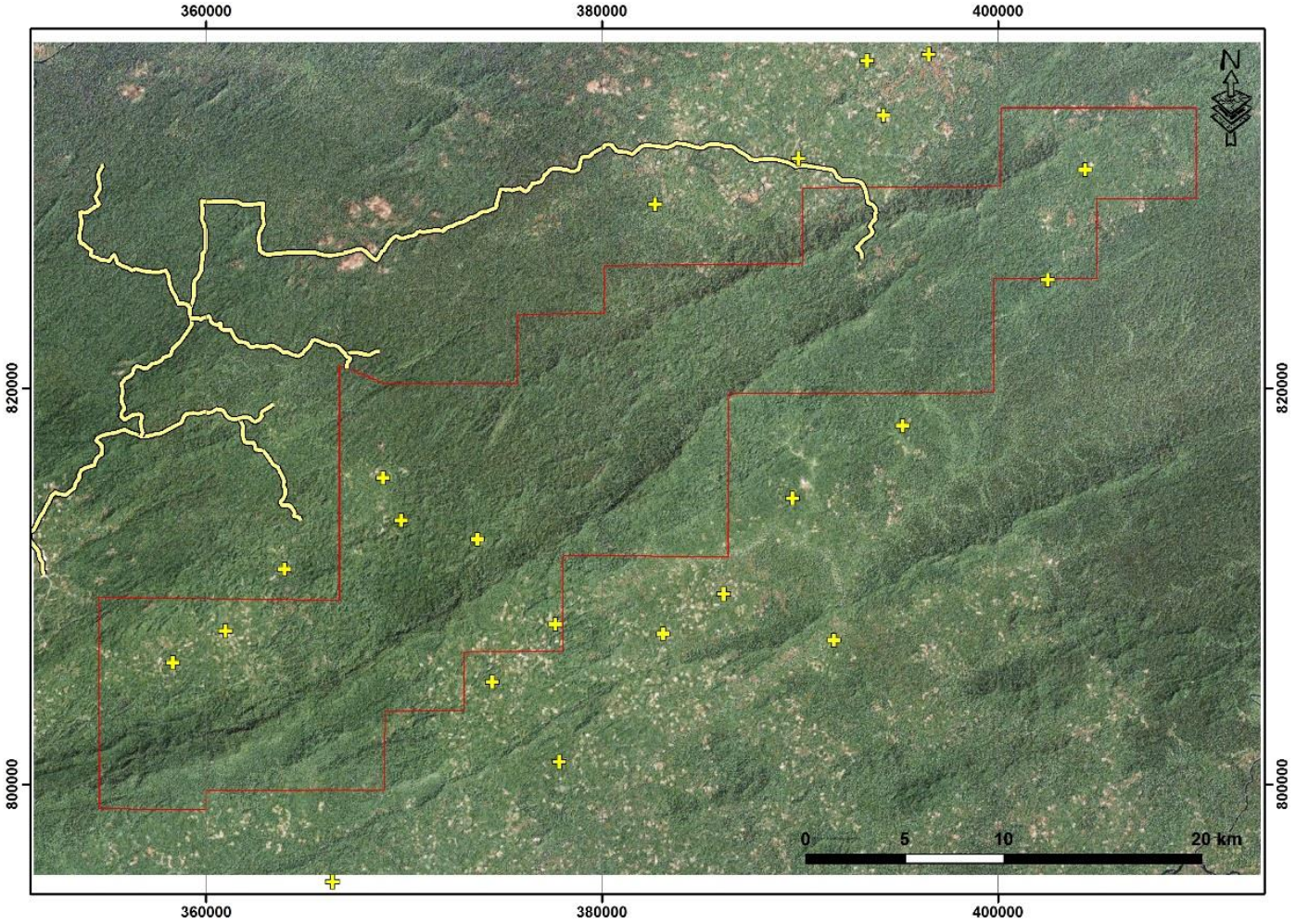
Design of sampling and geological mapping programs in West Africa from free data.

What was needed:

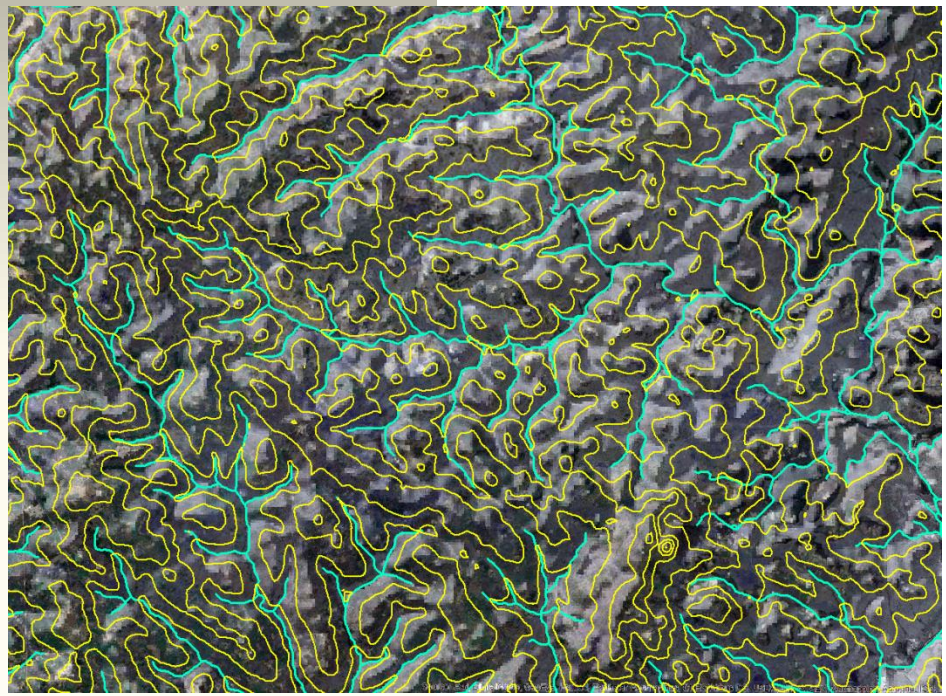
1. Cultural – access tracks and villages
2. Topography
3. Stream networks
4. Catchments

Case study – 1. Cultural mapping

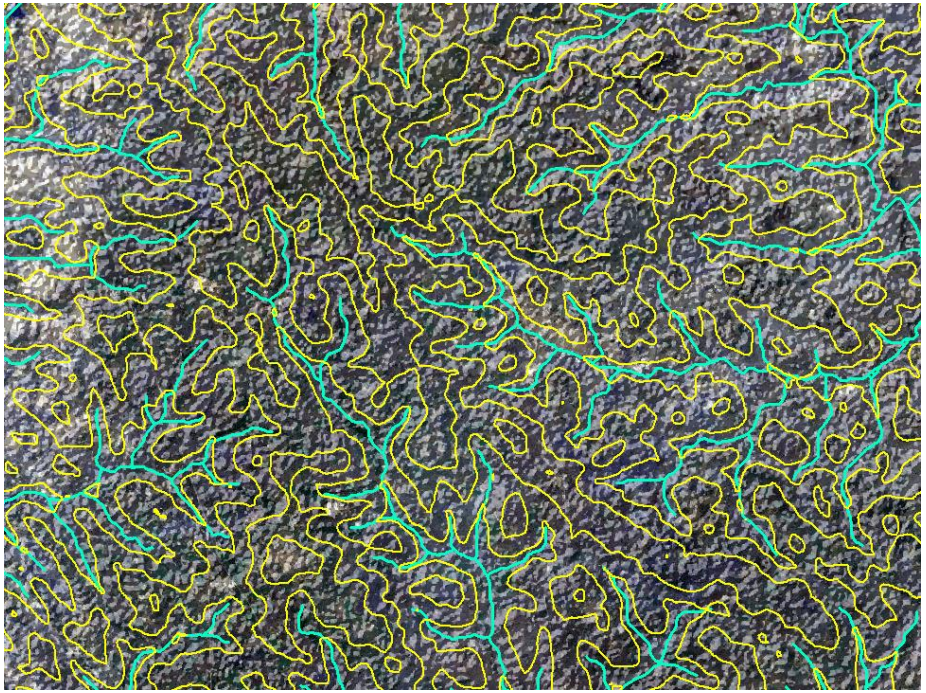
Access and villages identified from Bing Maps:



2. Topography



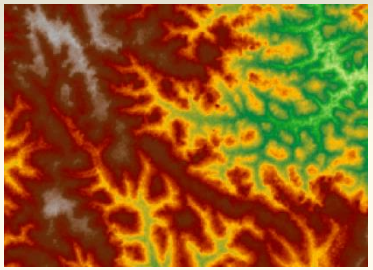
SRTM hillshade
with contours



ASTER hillshade
with contours

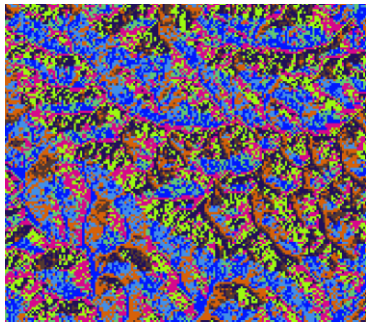
3. Stream and catchment mapping

- Areas of heavily canopied vegetation, hard to see streams/river courses from imagery,
- No river/stream vector data available for area.

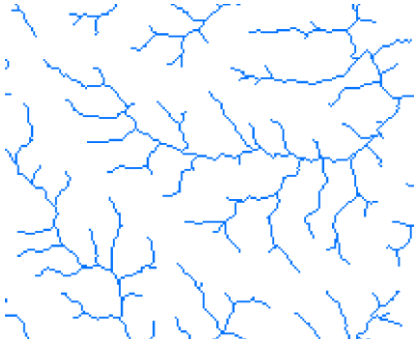


DEM

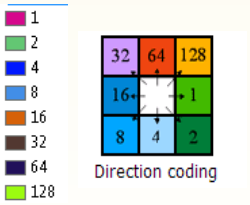
Solution:
Use SRTM DEM to generate streams and catchments for stream sediment mapping



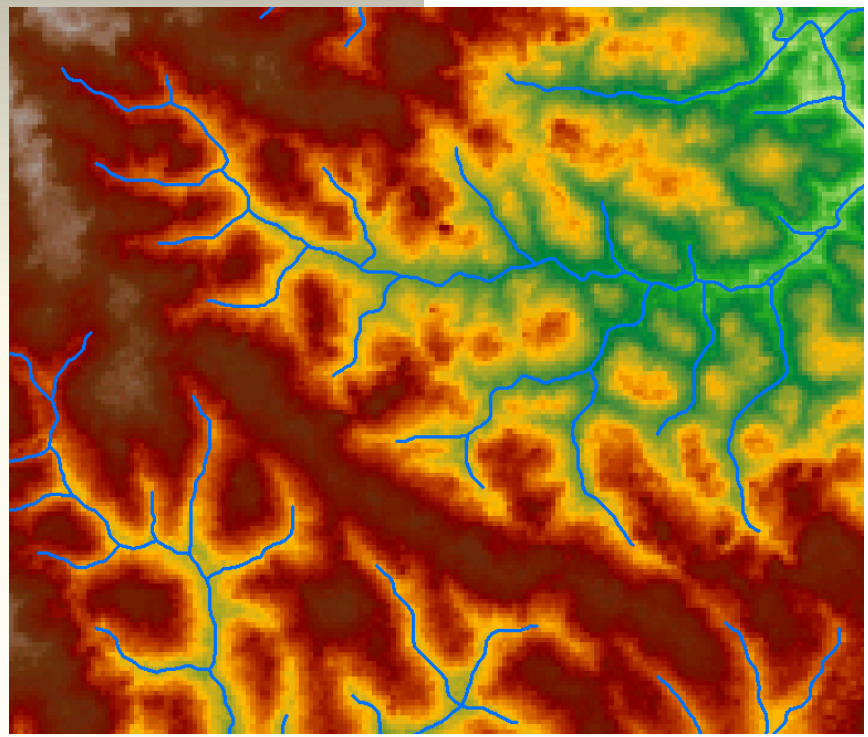
Flow Direction



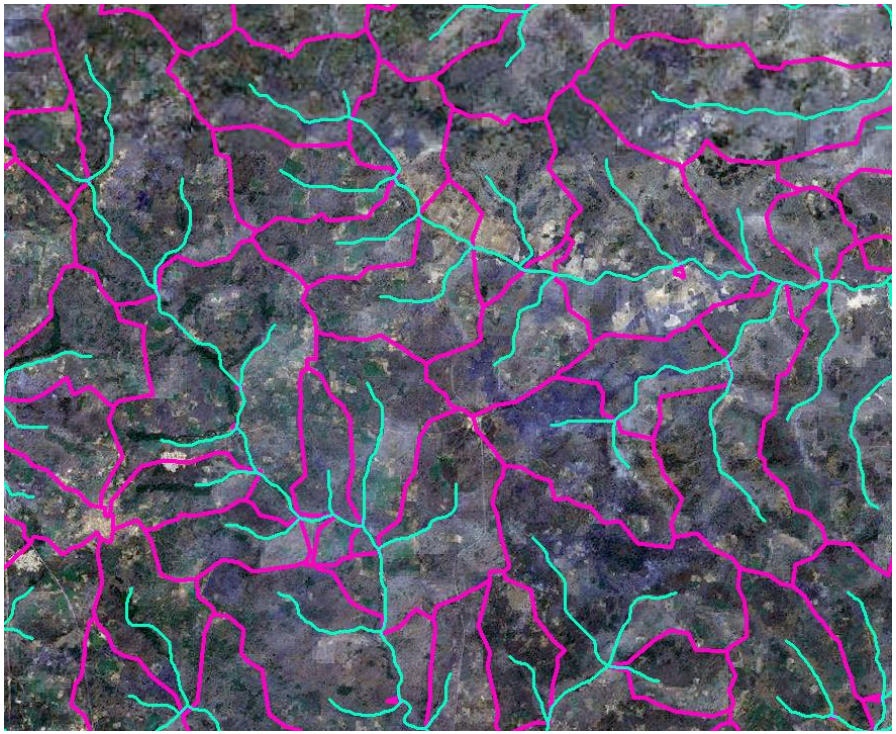
Flow Accumulation = Streams



Rivers/Watersheds and Catchments



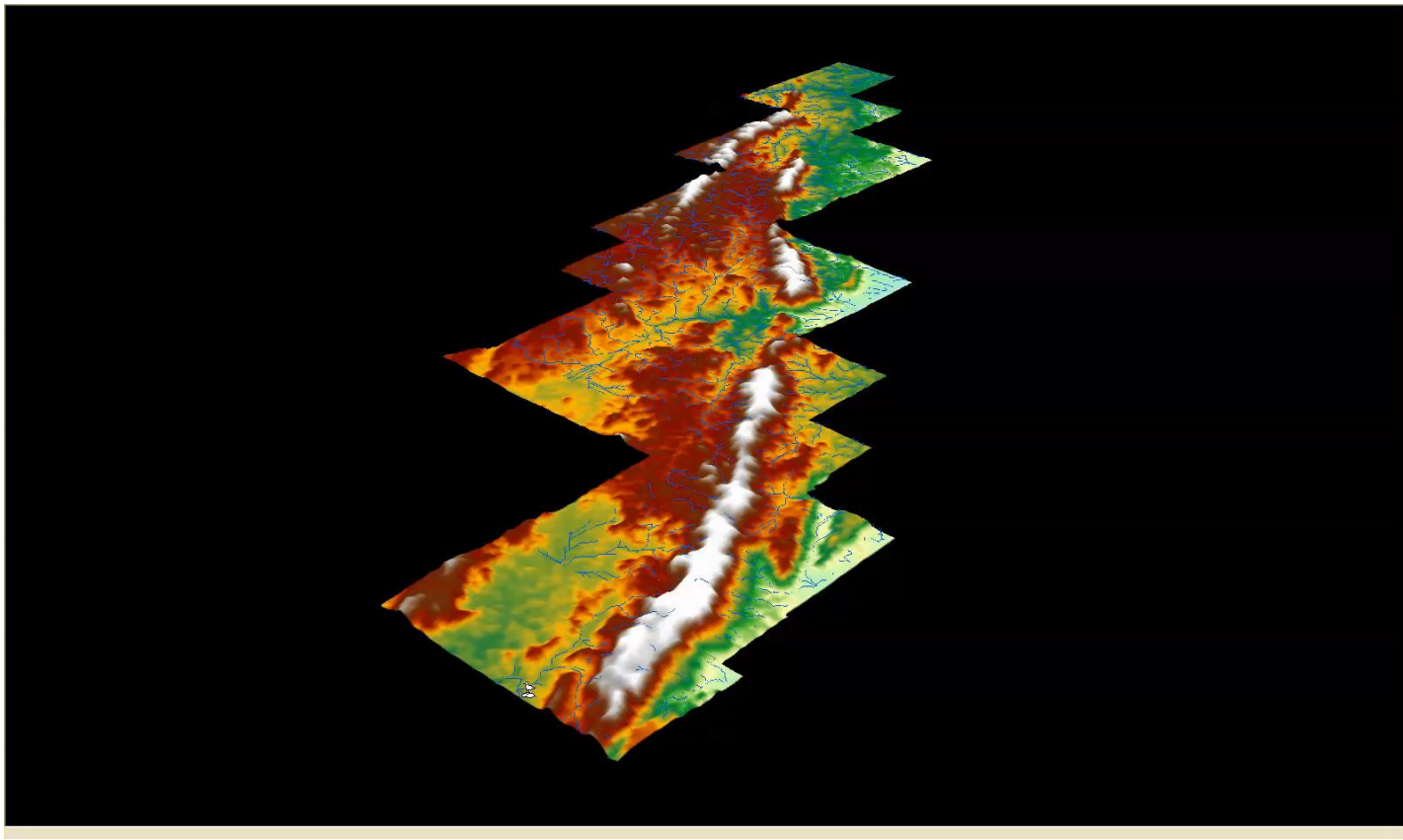
Flow accumulation – vectorised displayed over SRTM



Rivers and catchments with satellite image and hillshade from SRTM DEM

Sample Location Planning

Extracting the stream network and planning the sample location:



Digital mapping

Field work with mobile devices and GIS software (ArcPad):

Digital mapping: Field Based Solutions

Software:

- Open source mobile GIS applications e.g. Quantum GIS for Android. Android version still in development
- Discover Mobile (Mapinfo) or ArcPad (ArcGIS): more advanced GIS capabilities

Visualise your data and existing mapping in the field, collect lithological, structural, sampling data in customised databases with drop-down lists (ArcGIS).

Easy check-in into your existing GIS workspace in particular with ArcGIS.

Digital mapping Desktop Solutions

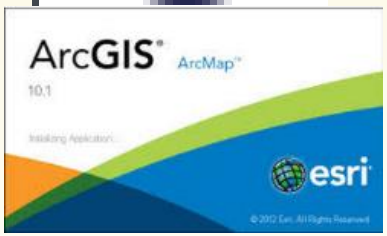
Free Open Source Solutions

- QGIS http://www.qgis.org/en/site/
- GRASS http://grass.osgeo.org/

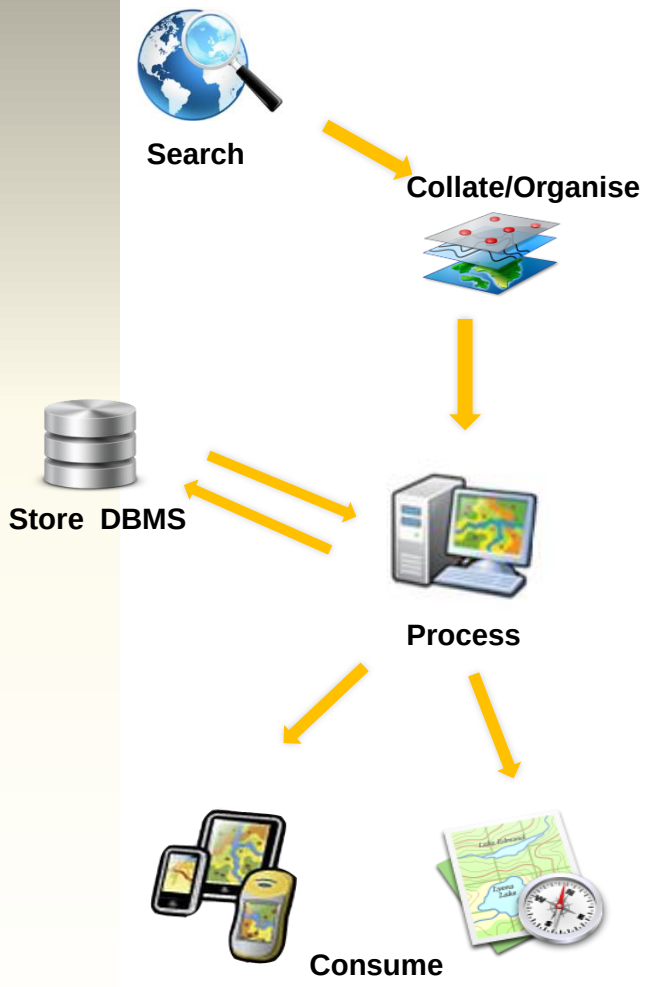
- PostgreSQL: Open source DBMS

Paid Solutions

- Global Mapper,
- OZIexplorer
- ArcGIS
- Mapinfo

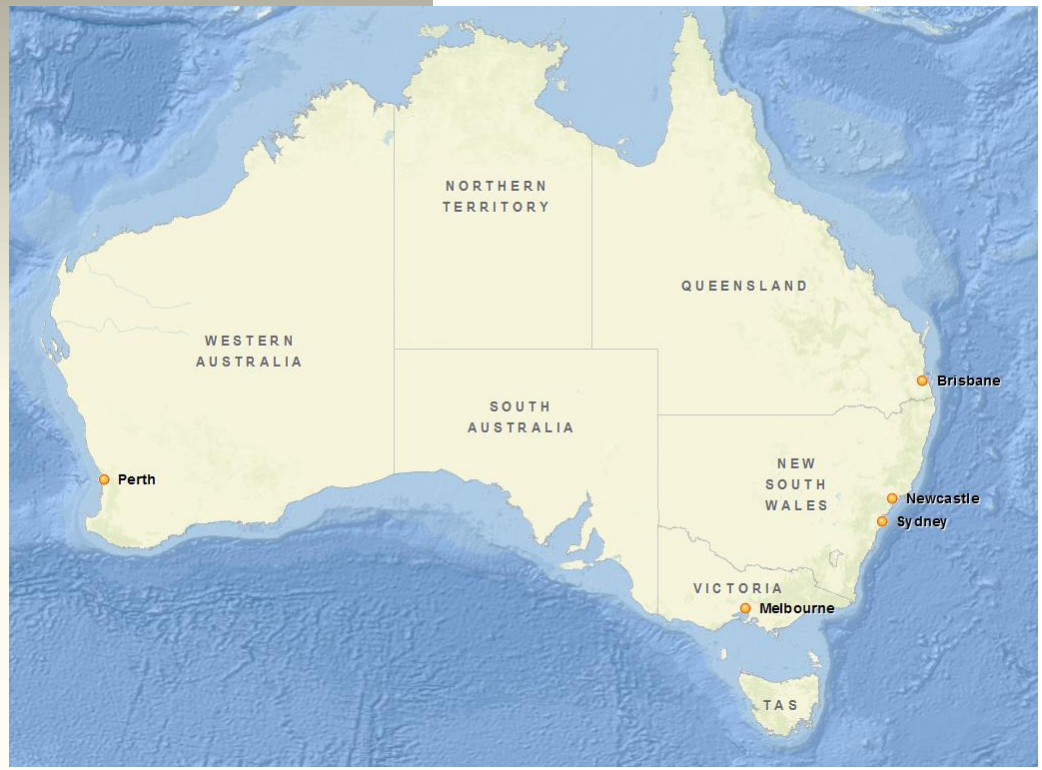


Things to Consider



- What data do you need?
- Check mines department first
- Is it suitable? ie ASTER Vs SRTM
- Scale / resolution appropriate?
- Imagery: Cloud cover and processing?

Questions?



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