



Australian Government  
Geoscience Australia

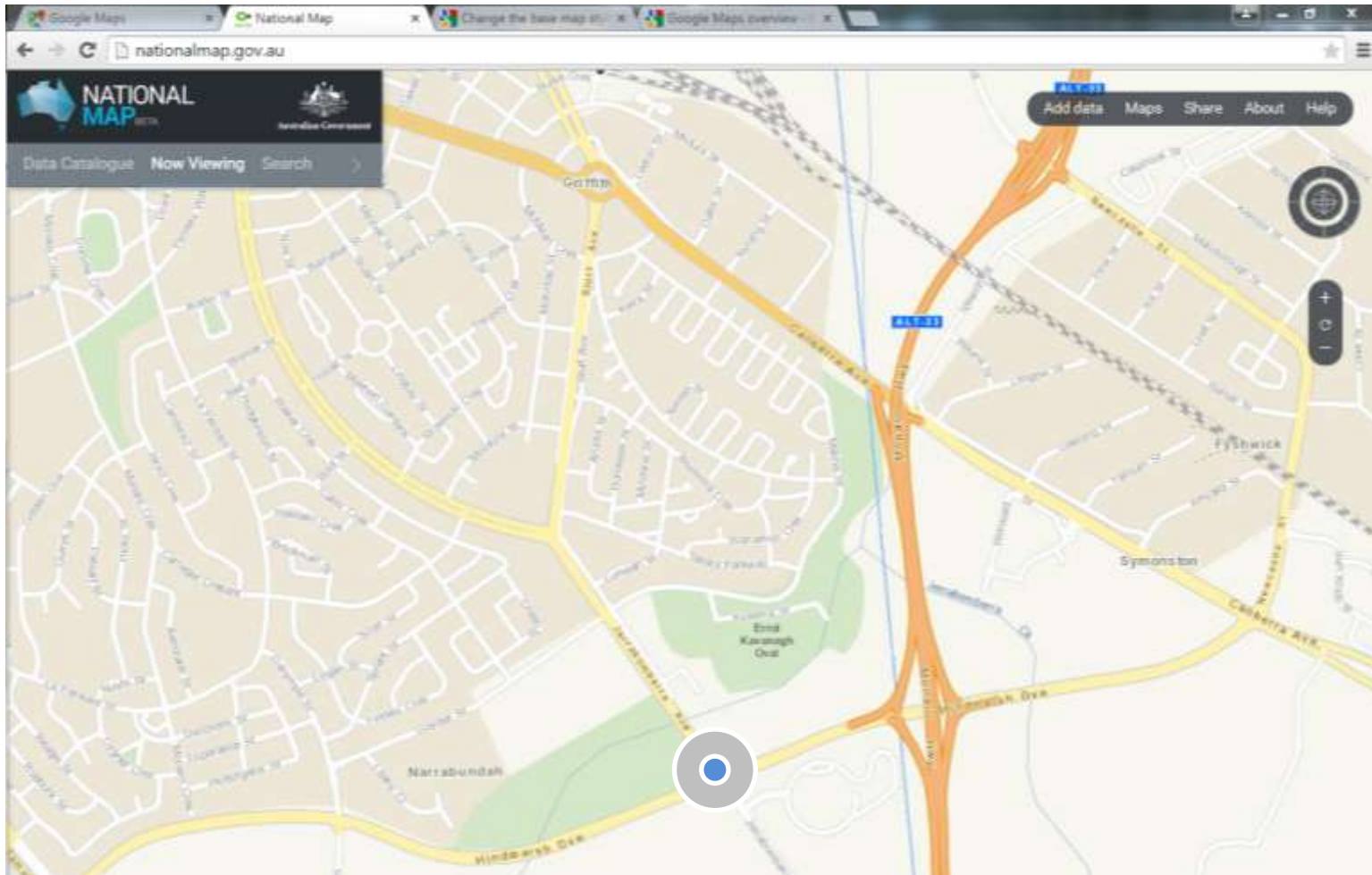


# The Foundation Spatial Data Framework and The Australian Geoscience Data Cube:

## Australia in space and time.

Dr Stuart Minchin

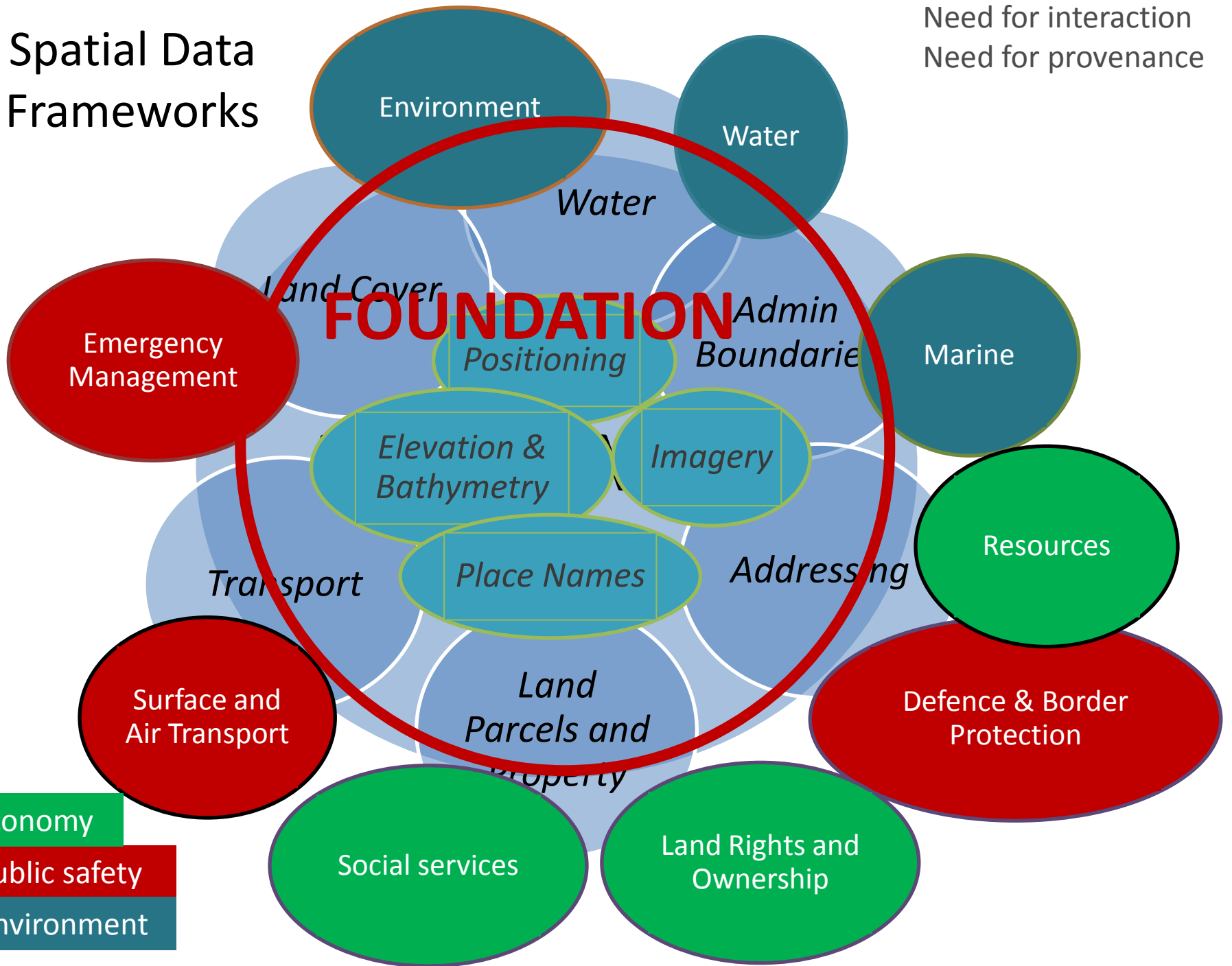
Geoscience Australia



- Positioning tells you where (and when) you are...
- An image might show what is around you...
- But the other spatial data gives you the context to make decisions...

# Spatial Data Frameworks

Need for interaction  
Need for provenance



# Foundation Spatial Data Framework: Herding the cats

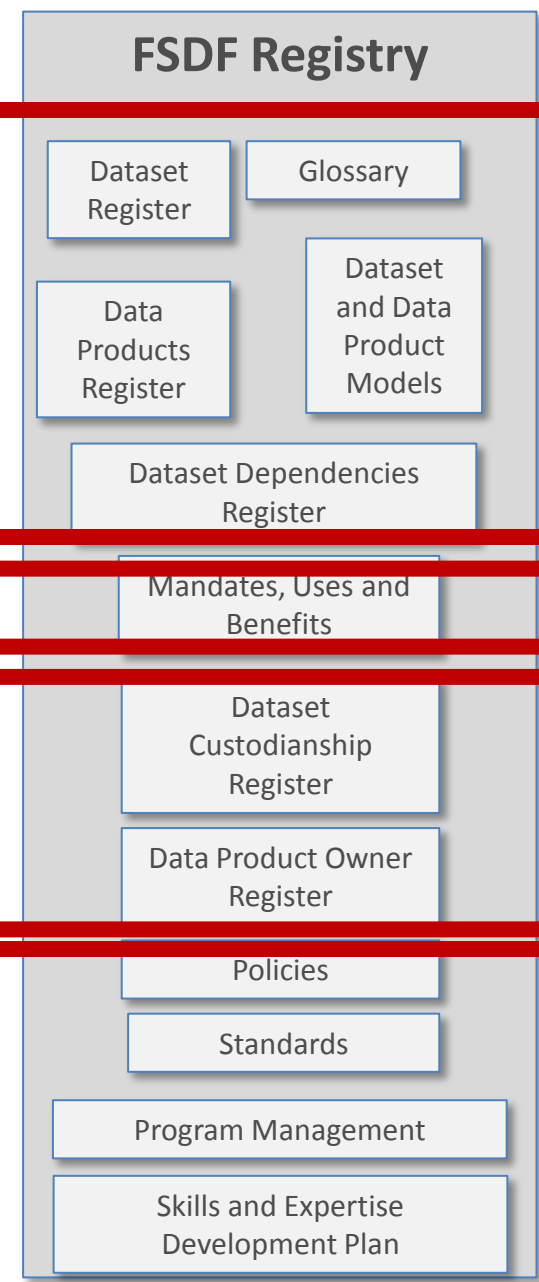


What Are We Looking After?

Why We Do It

Who Looks After Which Bits

How we are going to do it...





Australian Government  
Geoscience Australia



# A new paradigm for analysing Earth Observations in space and time:

## The Australian Geoscience Data Cube



# Traditional remote sensing product process

Petabyte  
heirarchical  
archive:



Millions of individual  
scenes. Tape store  
accessed by robot.

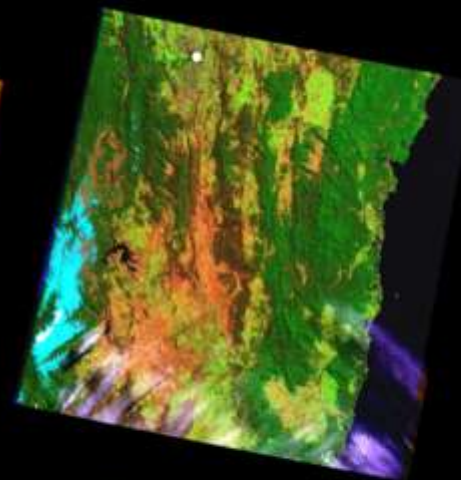


# The Data Cube Approach





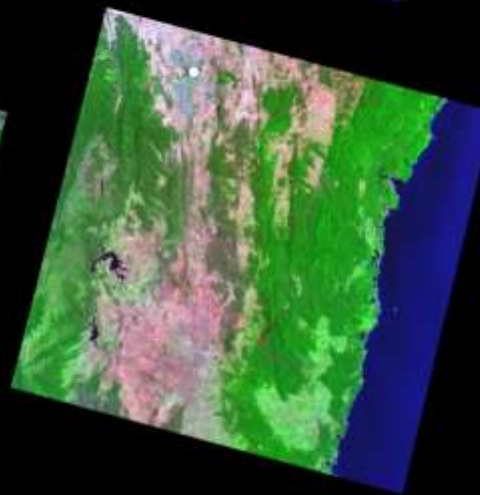
Canberra



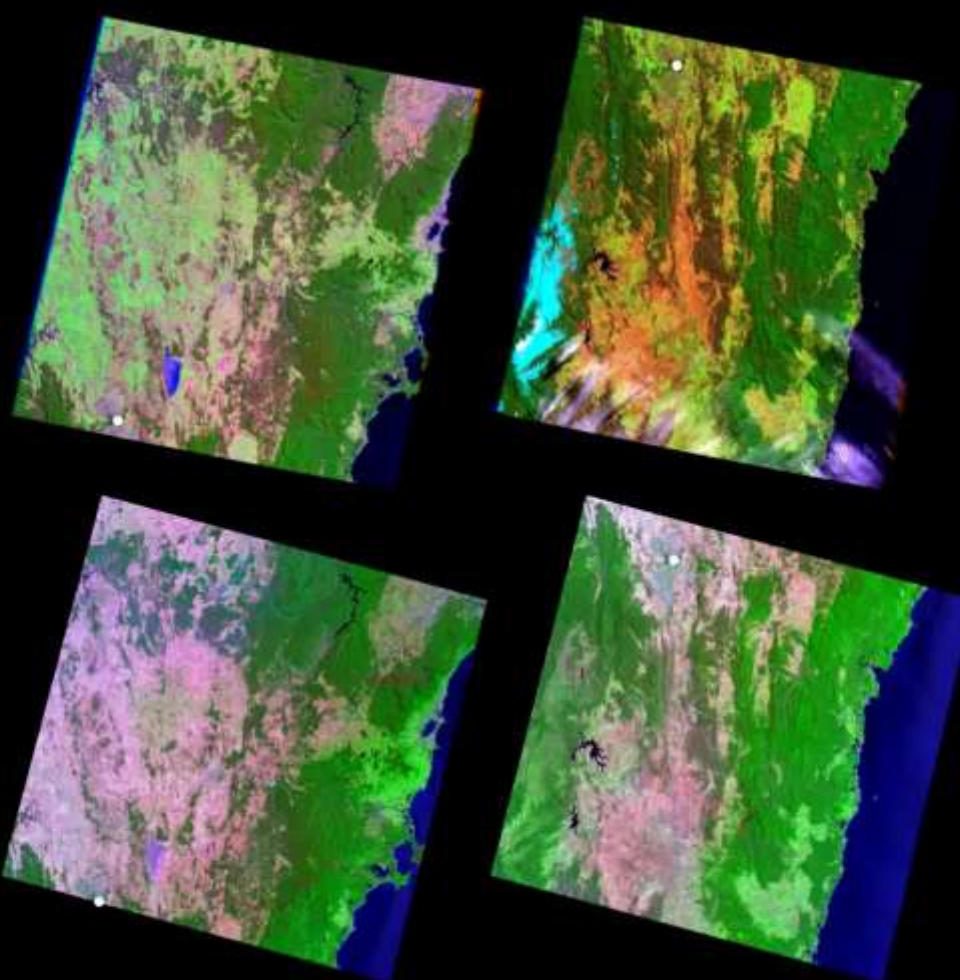
Canberra



Canberra



Canberra



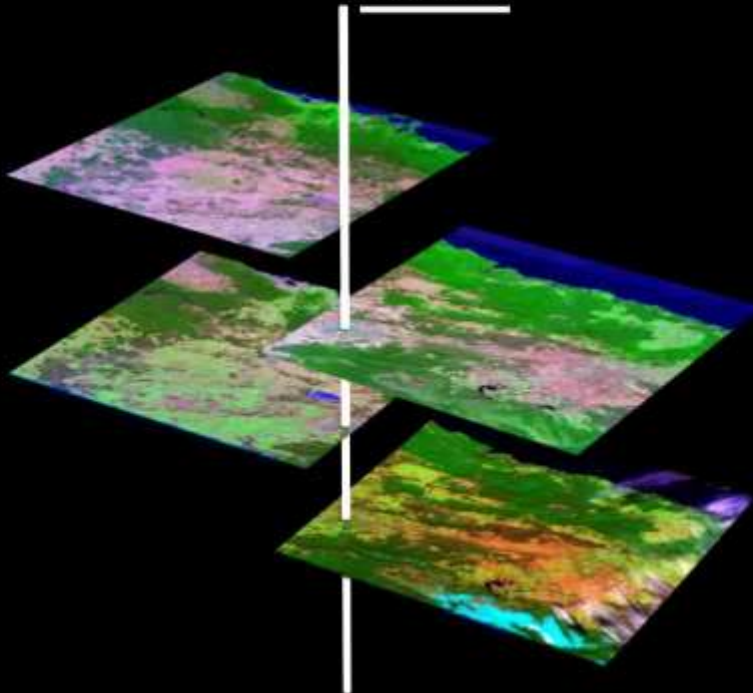
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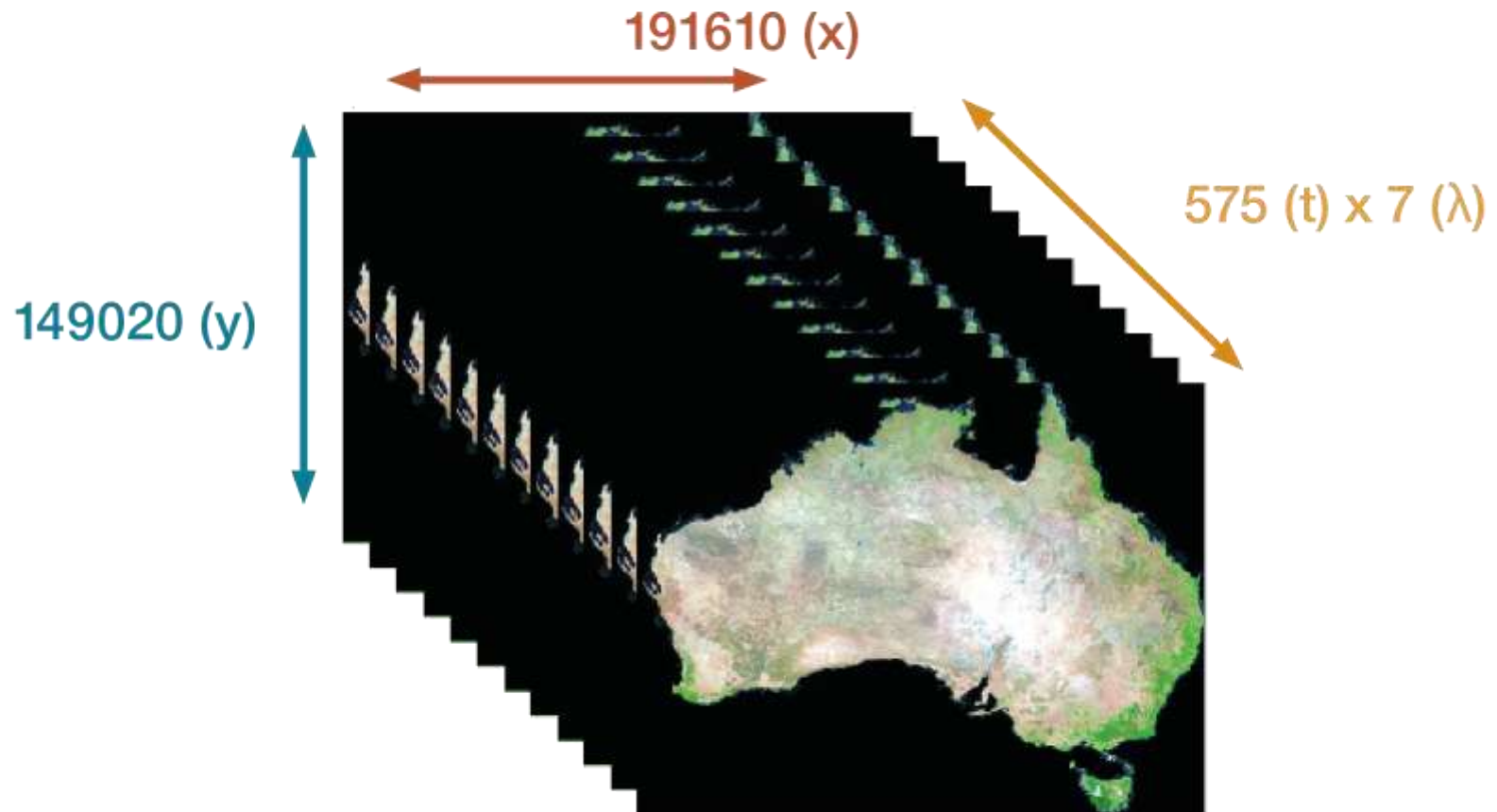
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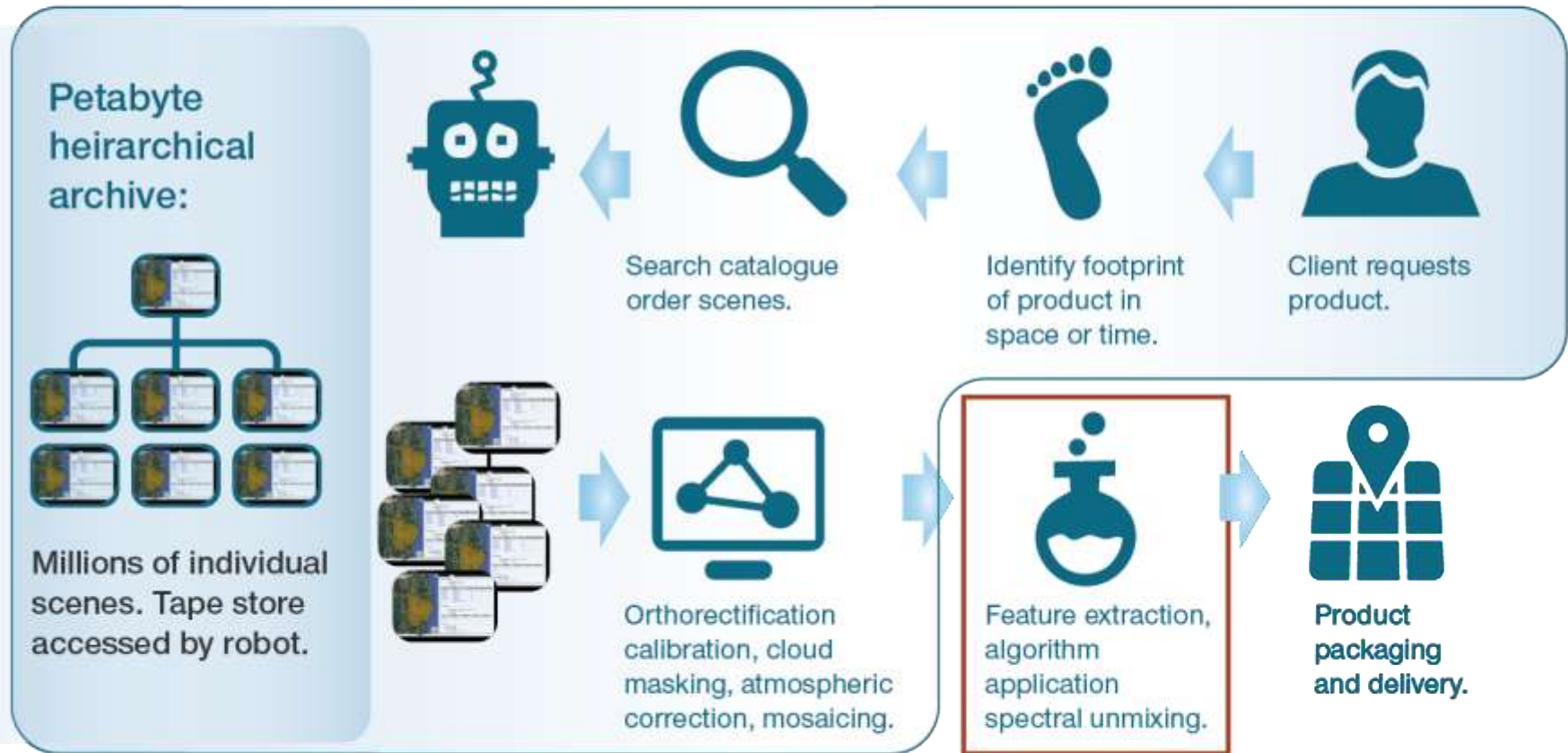
Canberra



# The Data Cube concept



# Traditional remote sensing product process



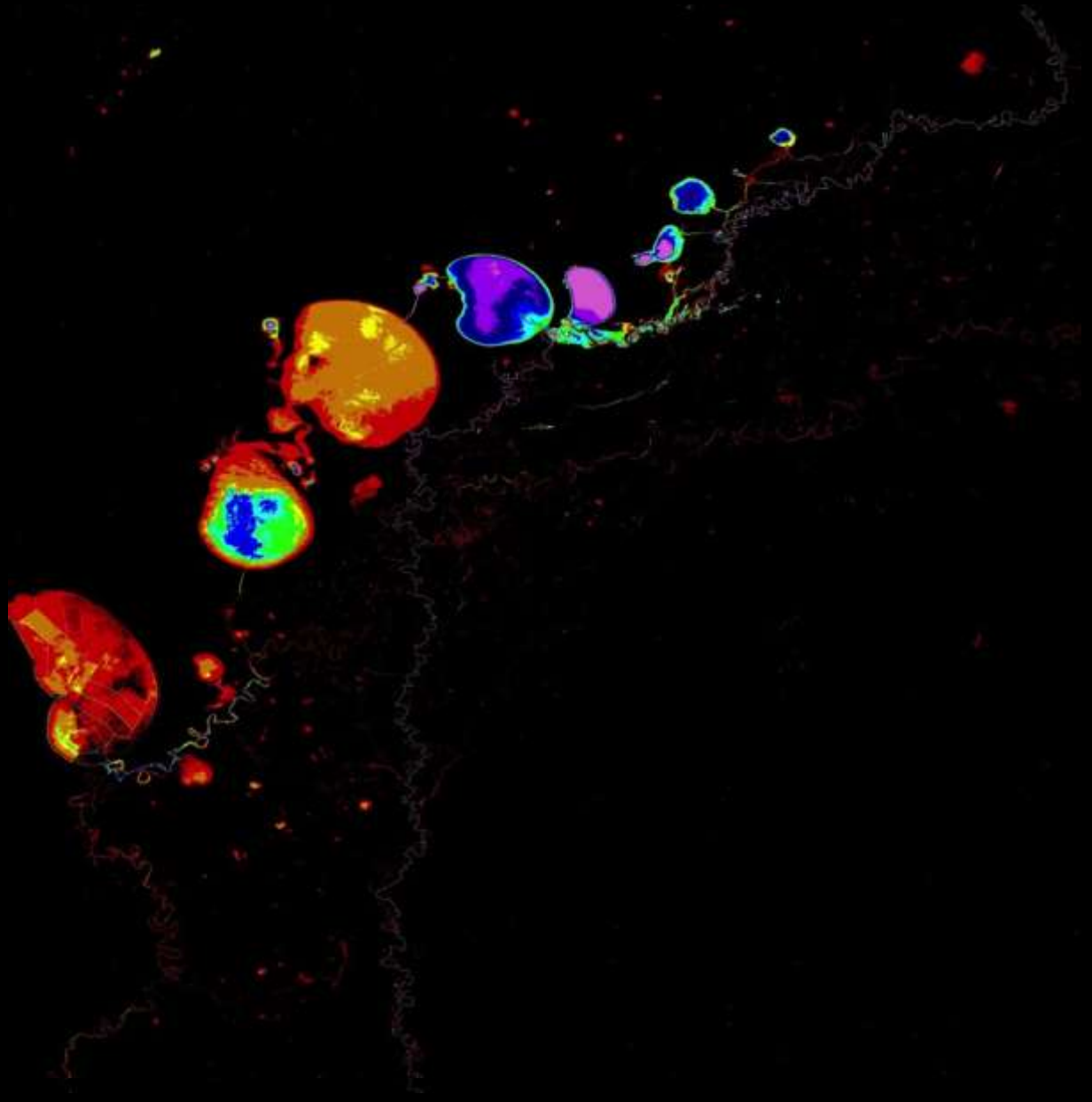
# Surface water

Menindee Lakes  
time series

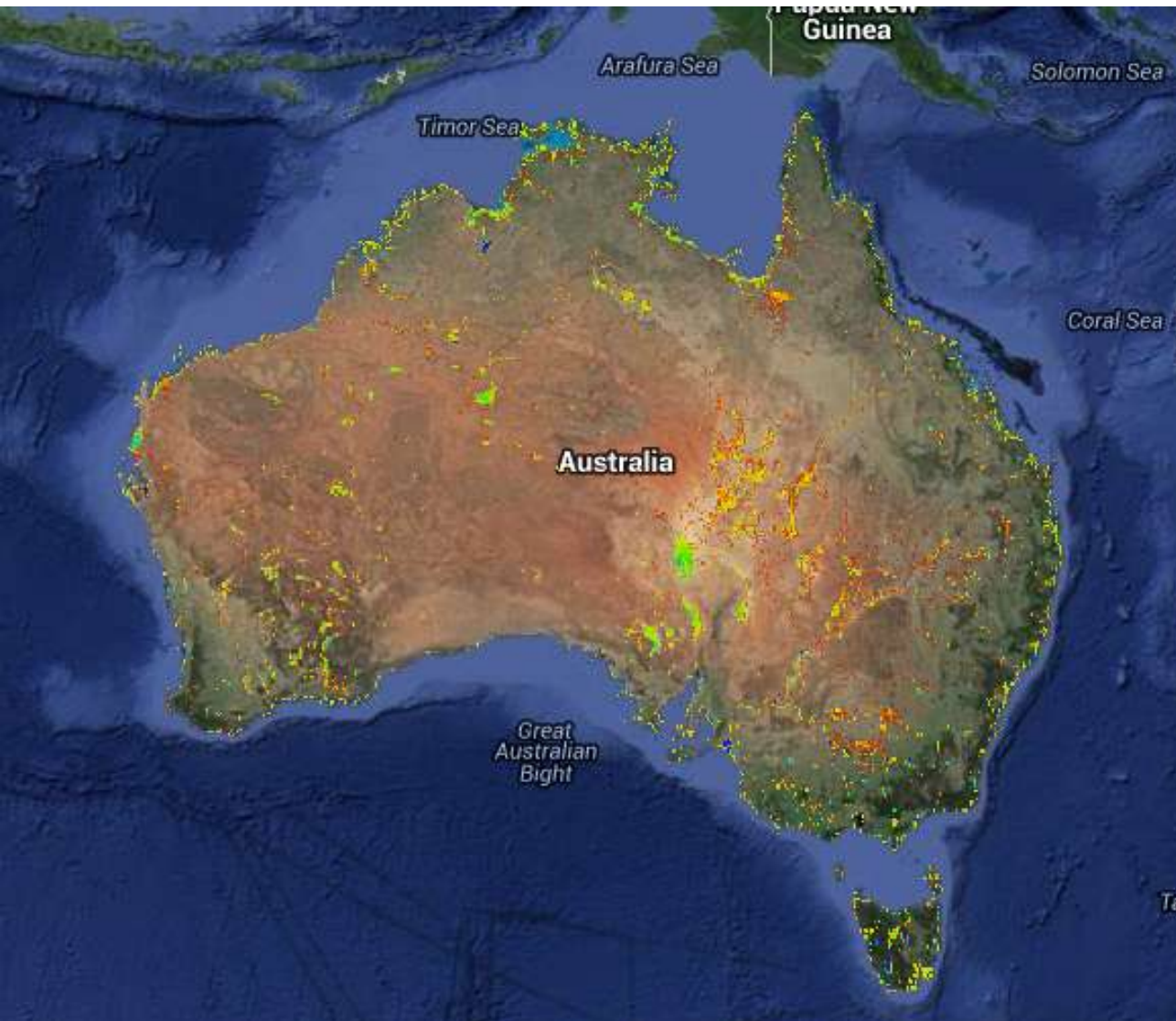
1998-2012

Total observations  
per grid cell  
~600-1200

4000\*4000 grid  
cells



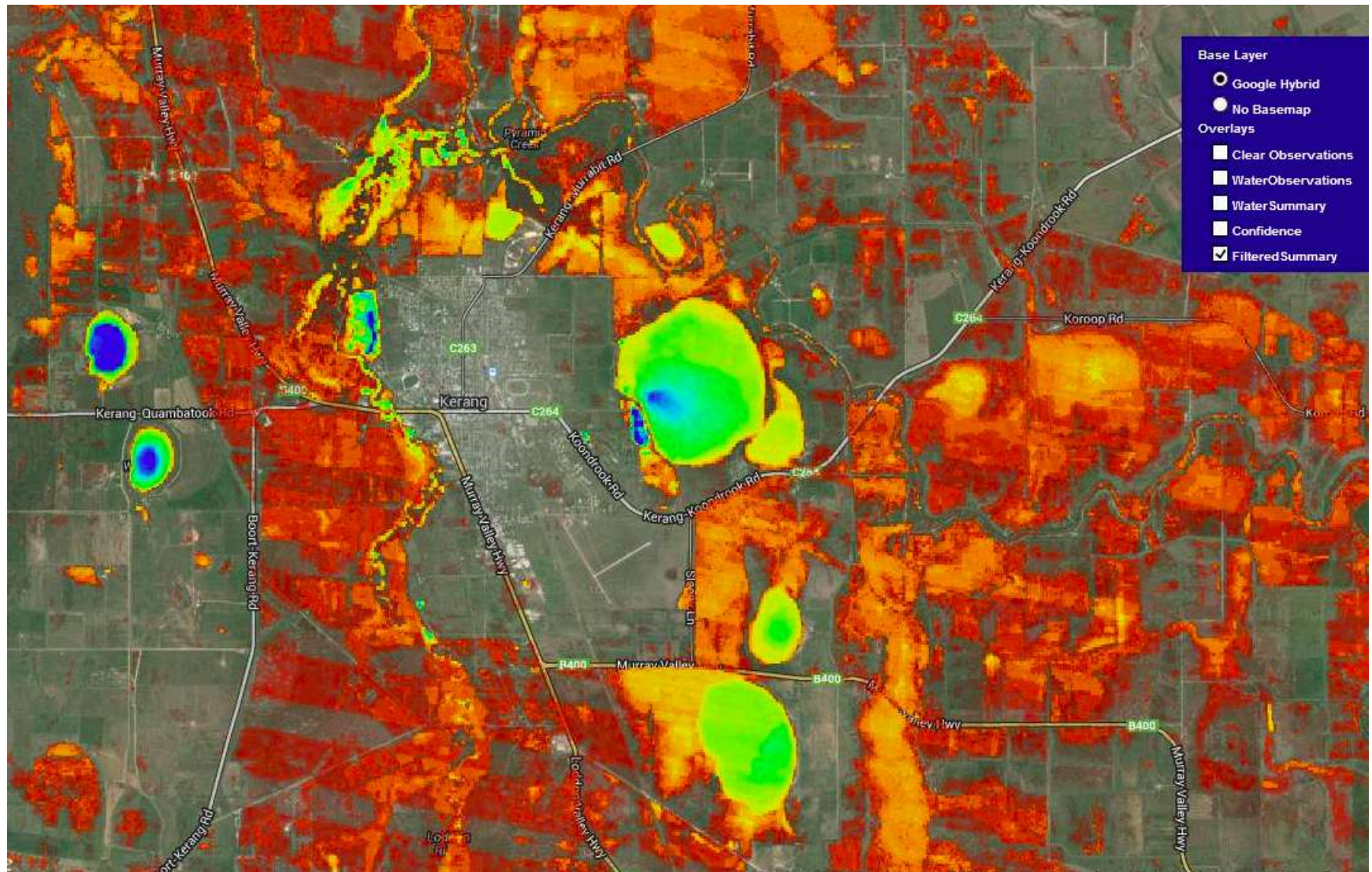
# Continental Scale Water Observations from Space



## WOFs water detection

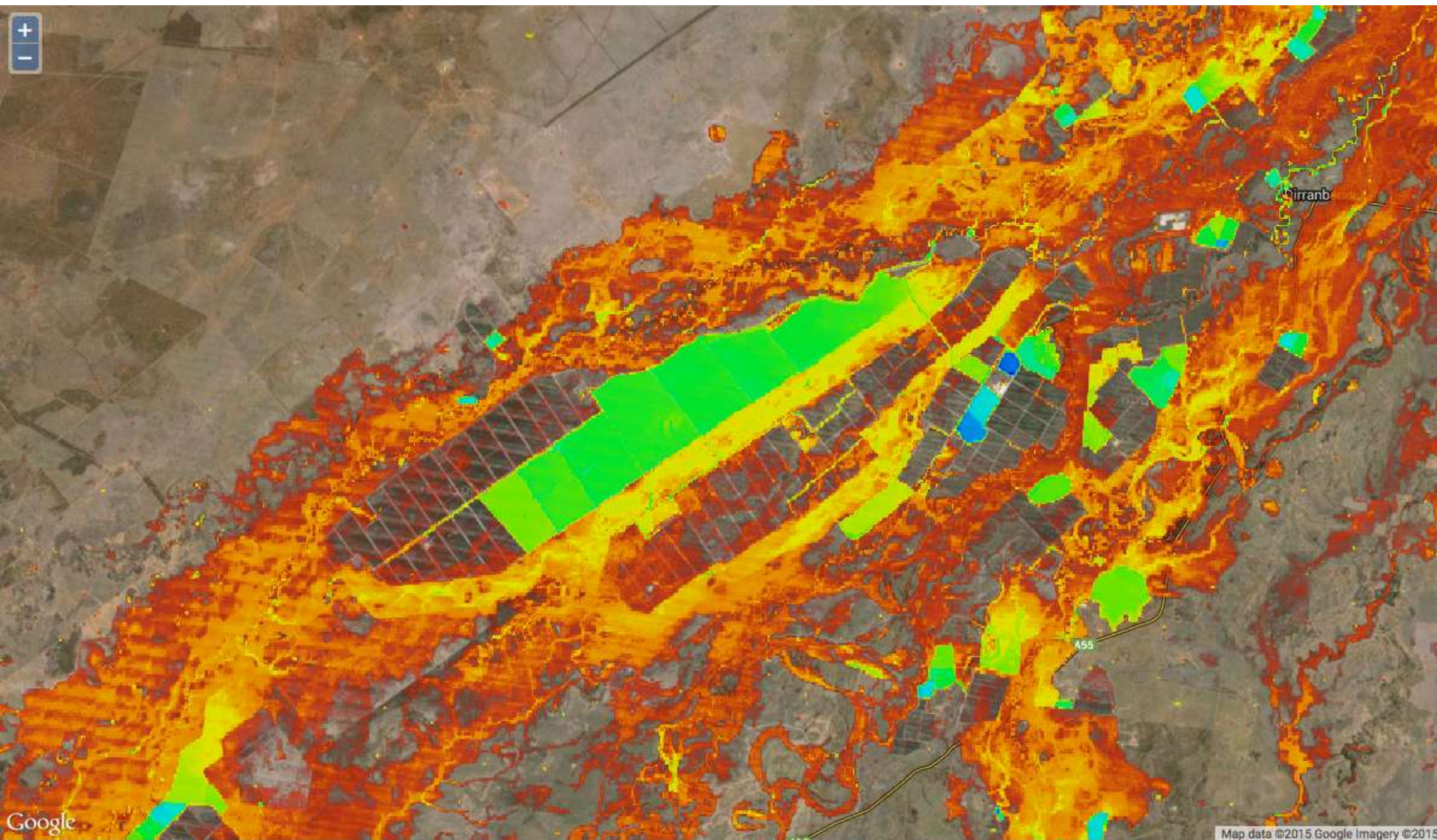
- **27 Years** of data from LS5 & LS7(1987-2014)
- **25m** Nominal Pixel Resolution
- Approx. 300,000 individual source ARG-25 scenes in approx. 20,000 passes
- Entire 27 years of 1,312,087 ARG25 tiles =>  **$93 \times 10^{12}$  pixels** visited
- **0.75 PB** of data
- **3 hrs** at NCI (elapsed time) to compute.

# Kerang: Impact of flood levee banks



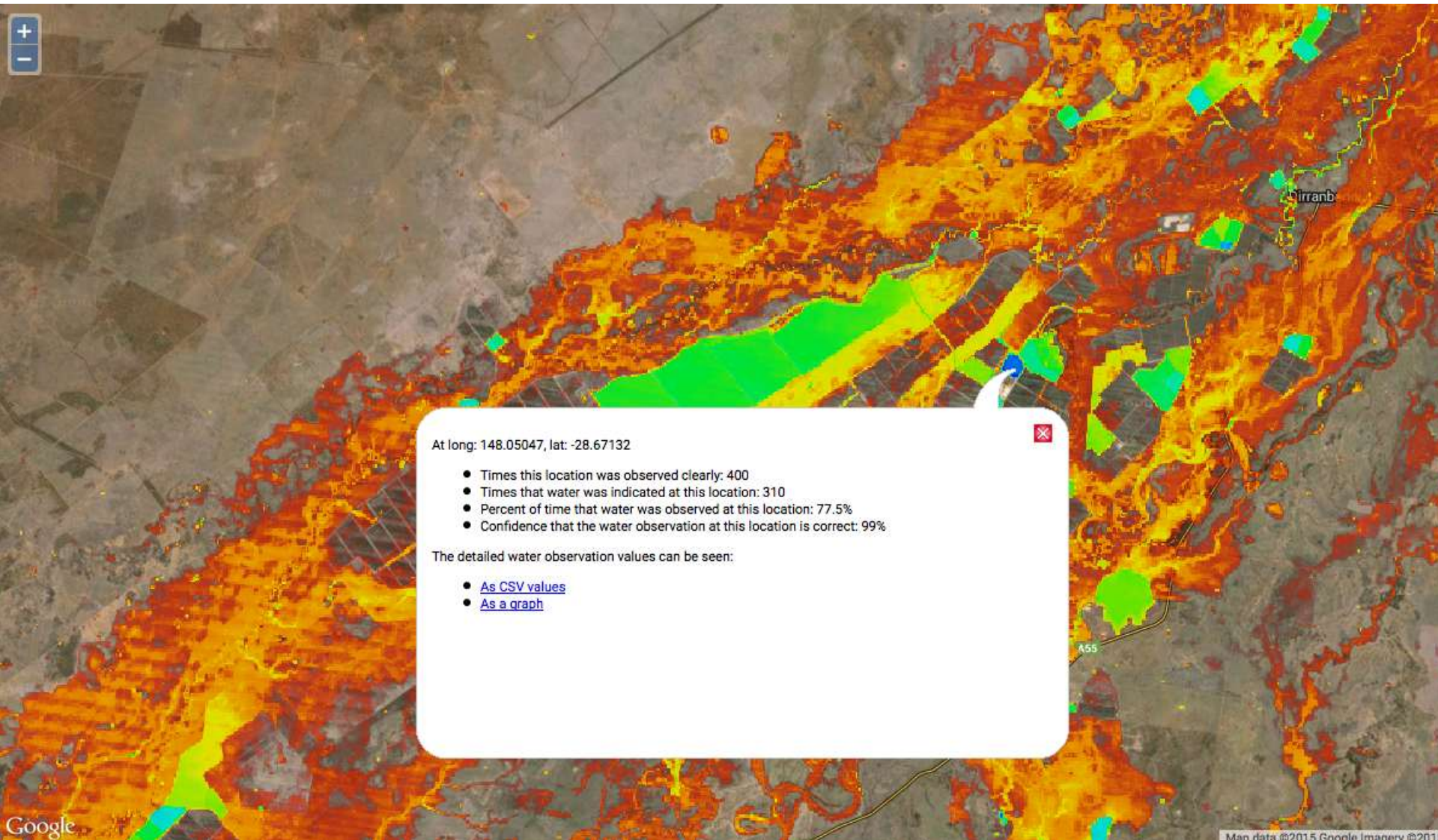


# Cubbie Station: floodplain water storages

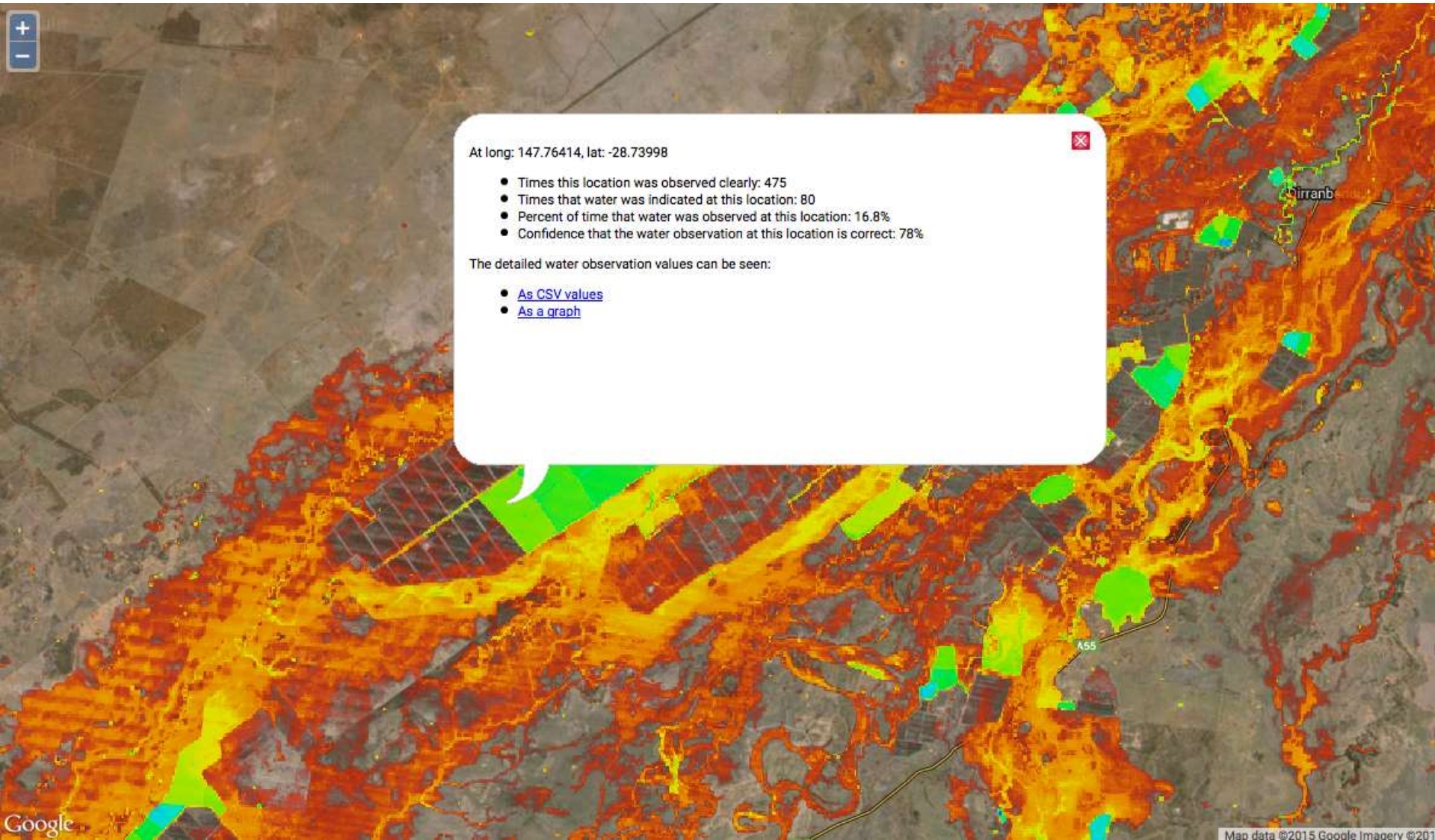


Map data ©2015 Google Imagery ©2015

# Cubbie Station: floodplain water storages



# Cubbie Station: floodplain water storages



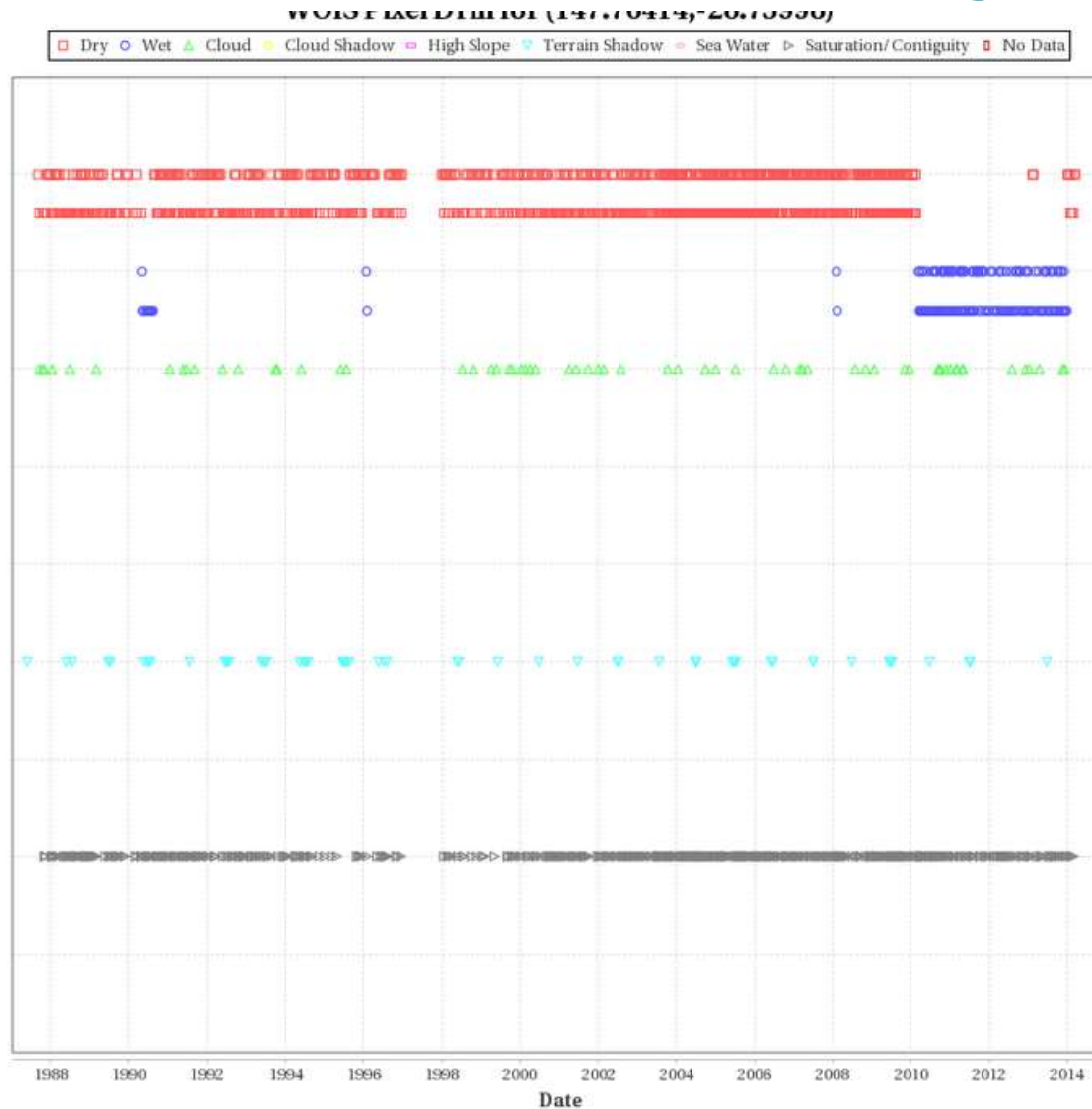
At long: 147.76414, lat: -28.73998

- Times this location was observed clearly: 475
- Times that water was indicated at this location: 80
- Percent of time that water was observed at this location: 16.8%
- Confidence that the water observation at this location is correct: 78%

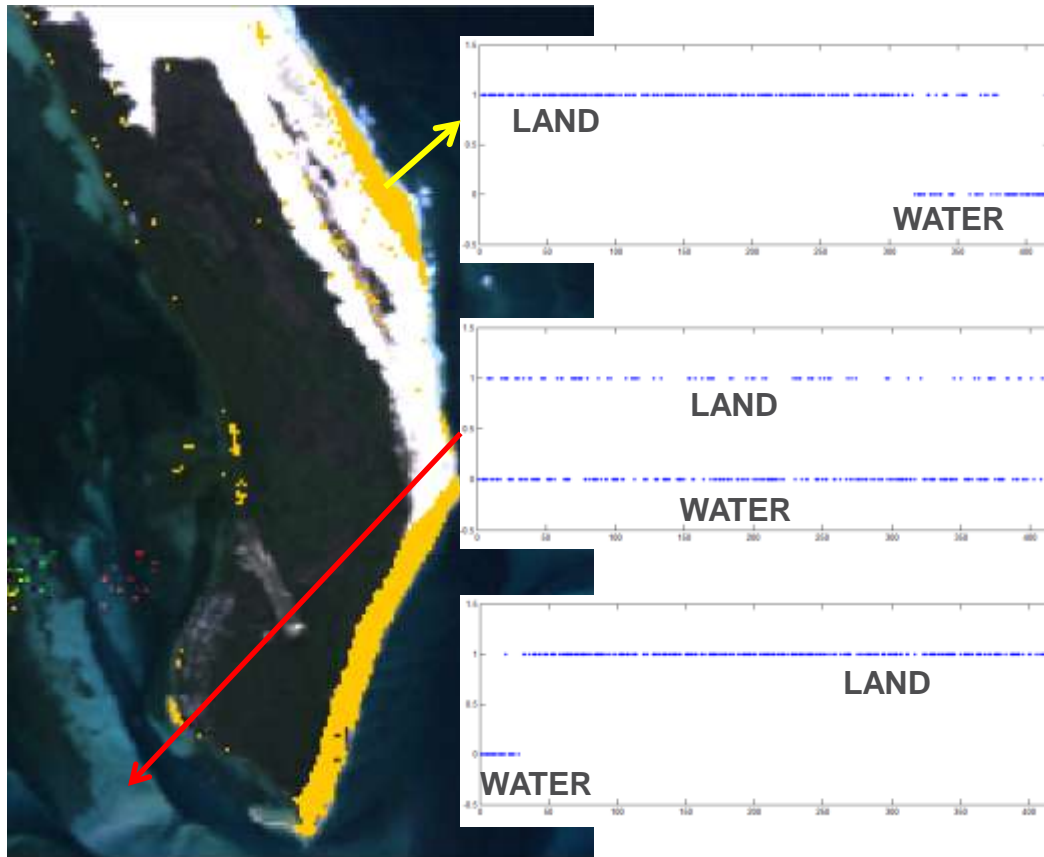
The detailed water observation values can be seen:

- [As CSV values](#)
- [As a graph](#)

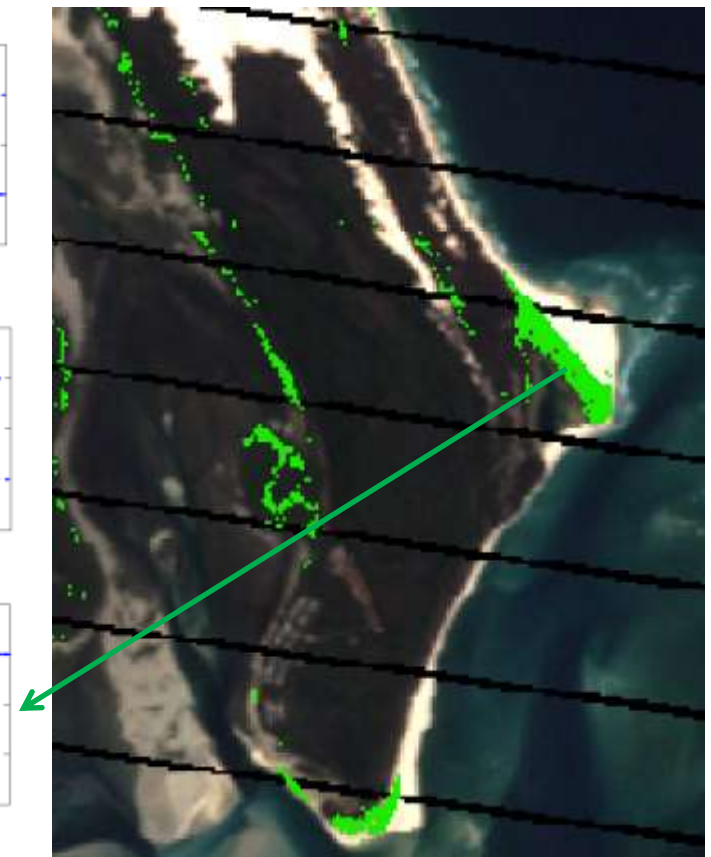
# Cubbie Station: floodplain water storages



# Coastal Change Detection



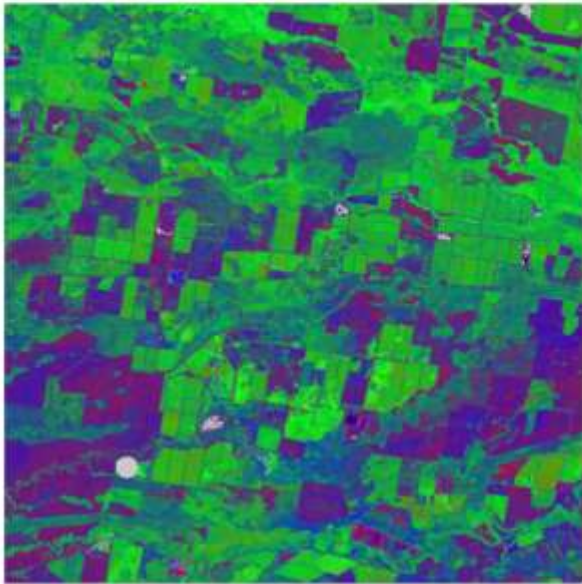
1988 Landsat 5  
First Water Observation Anomaly



2013 Landsat 7  
Last Water Observation Anomaly

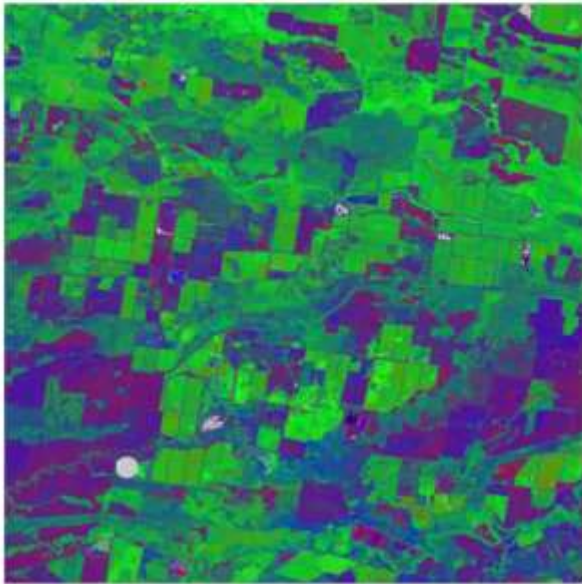
# Land use change: Cropping patterns

Land Management – Keytah Station. ‘Fractional cover’



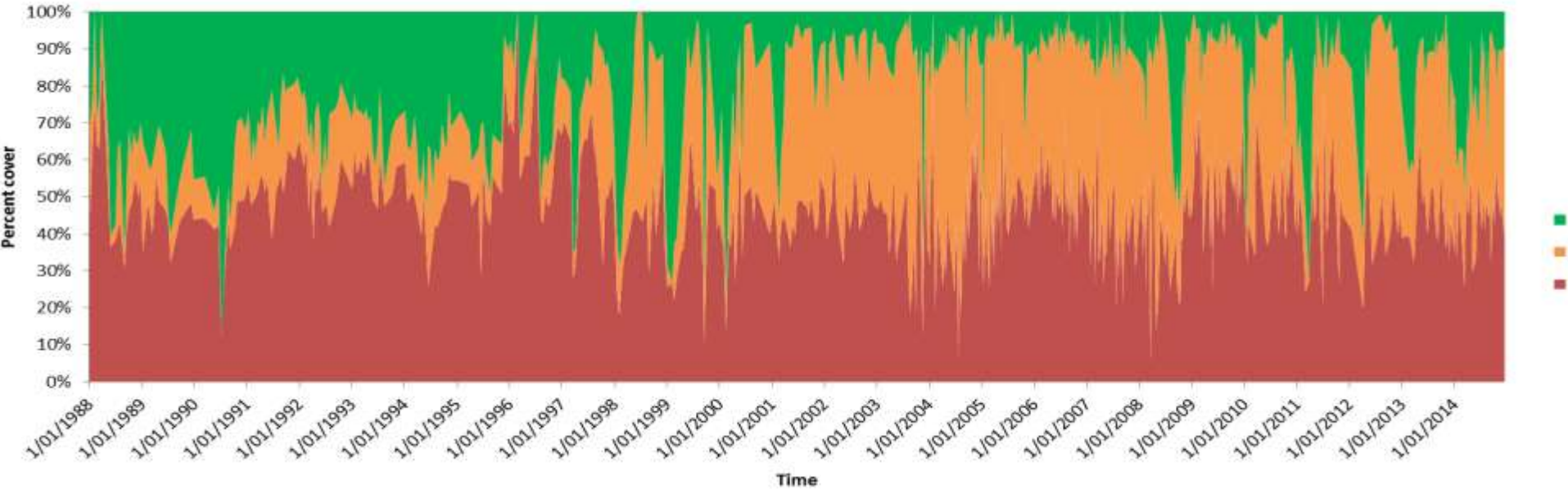
# Land use change: Cropping patterns

Land Management – Keytah Station. ‘Fractional cover’



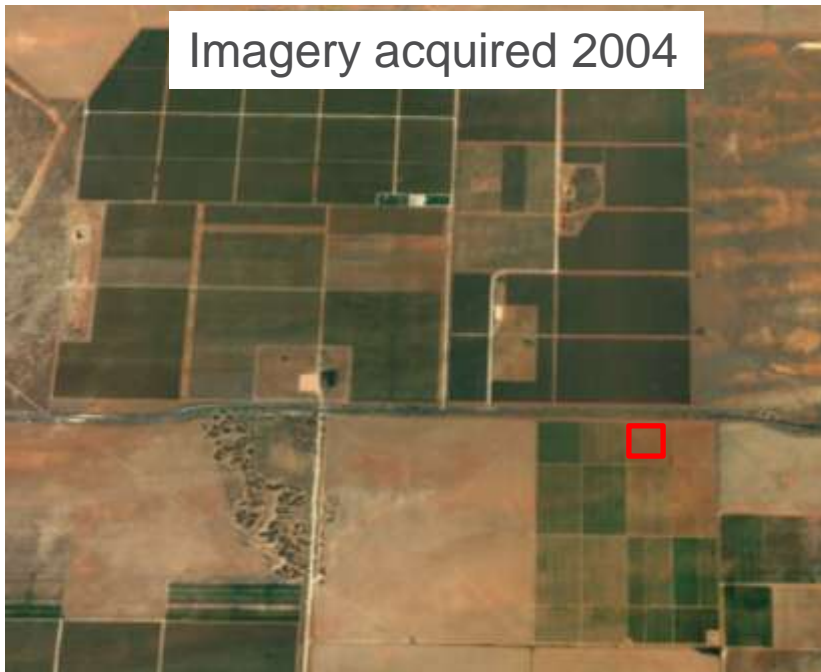
# Cubby station example

## Conversion from woodland to cropping

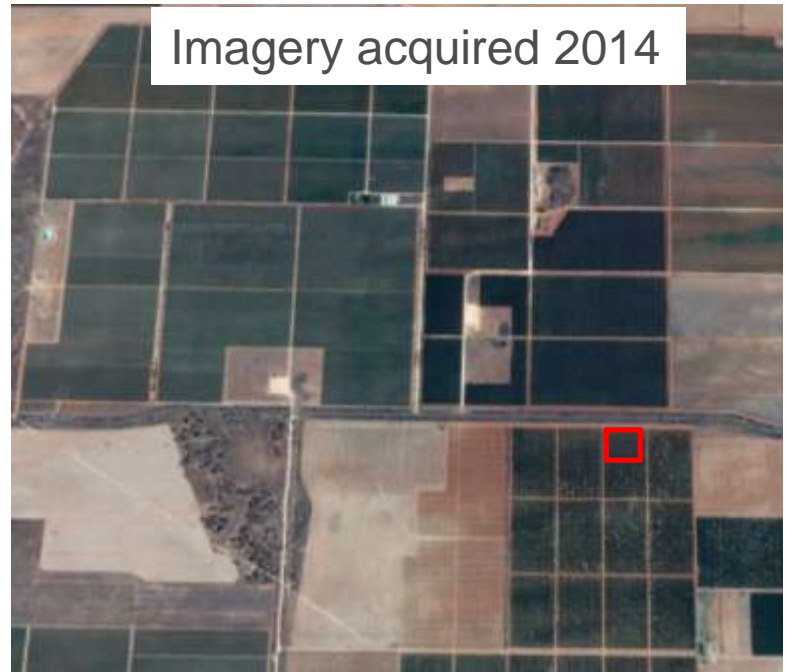




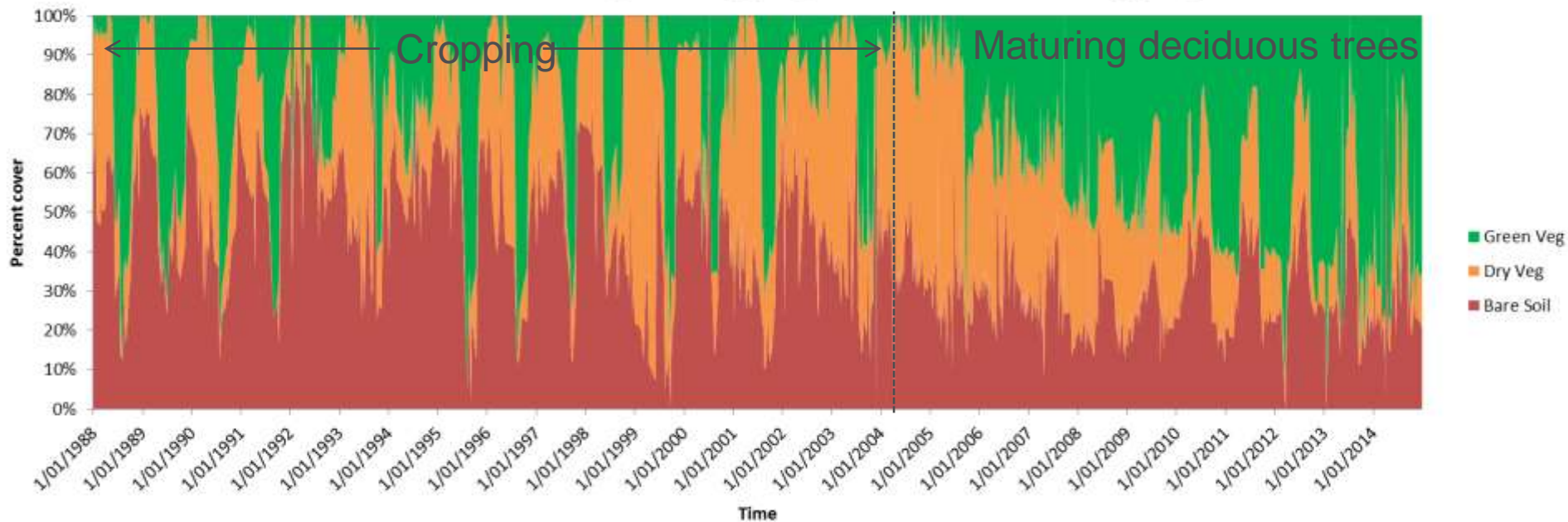
Imagery acquired 2004



Imagery acquired 2014

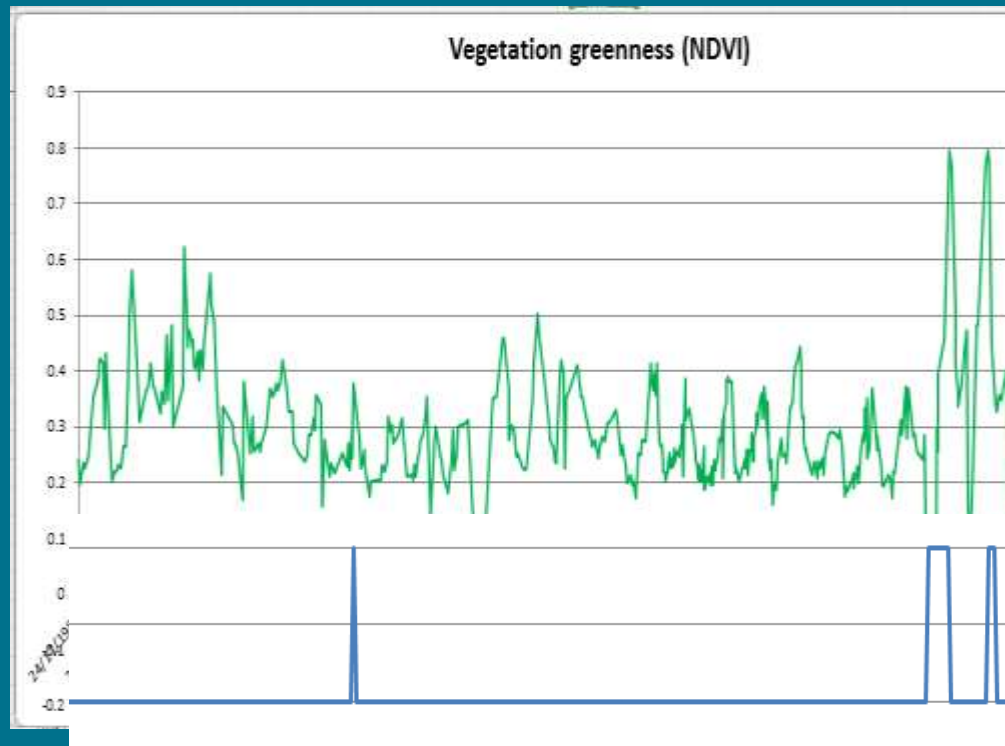
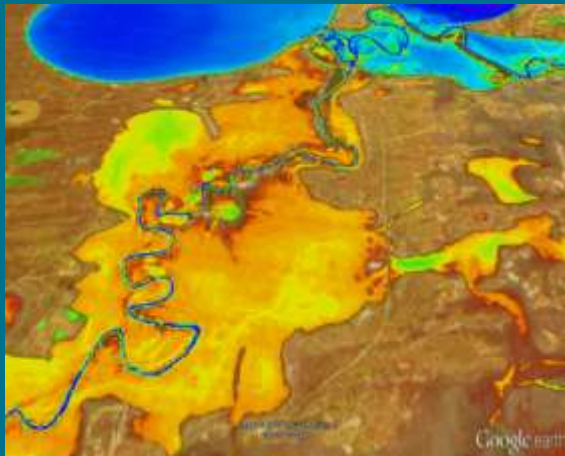


### Conversion from grain cropping to deciduous tree cropping



# Floodplain vegetation response near Broken Hill

Floodplain vegetation peaks in greenness are detected in association with observed floods



*Floods are not the only driver for vegetation greenness*

$N = 514$  observations:

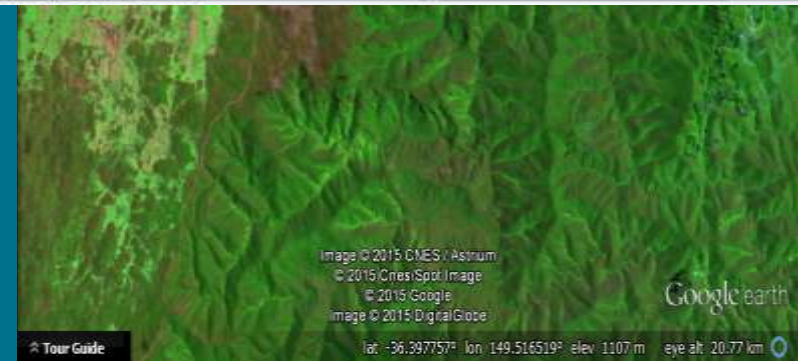
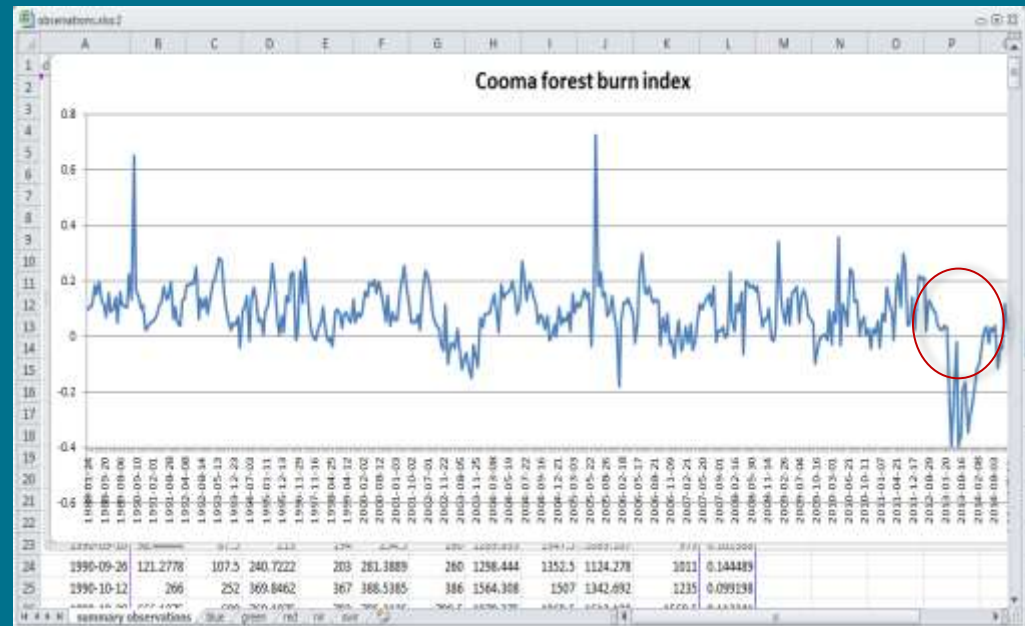
# Cooma forest fire

Google Earth imagery (no fire)

Data cube – Land surface  
December 2014 shows fire scars

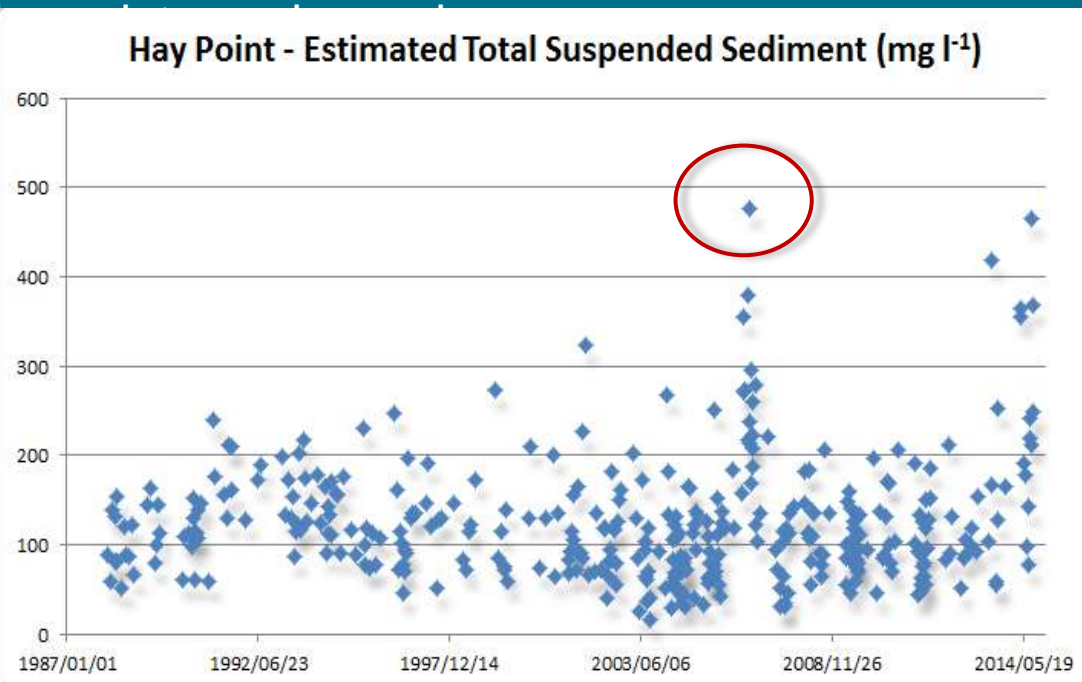
Data Cube detects changes due to the fire

(Other, smaller or less intense fires are indicated in 2002 & 2006)



# Great Barrier Reef Water quality - history

H  
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D  
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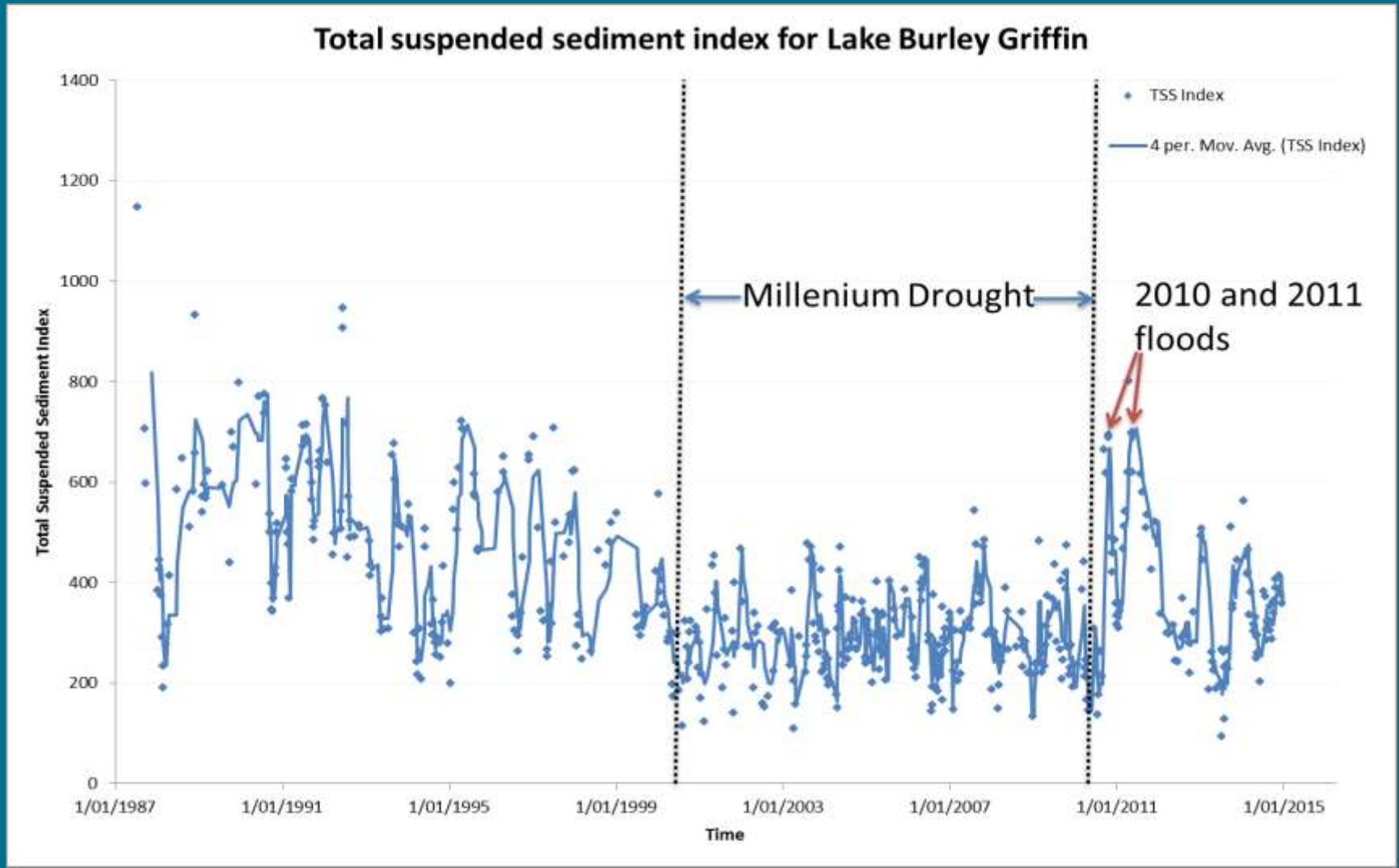


with timing of works



True colour image of the sediment plume produced by dredging. Image taken 27 August 2006 by Landsat Satellite.

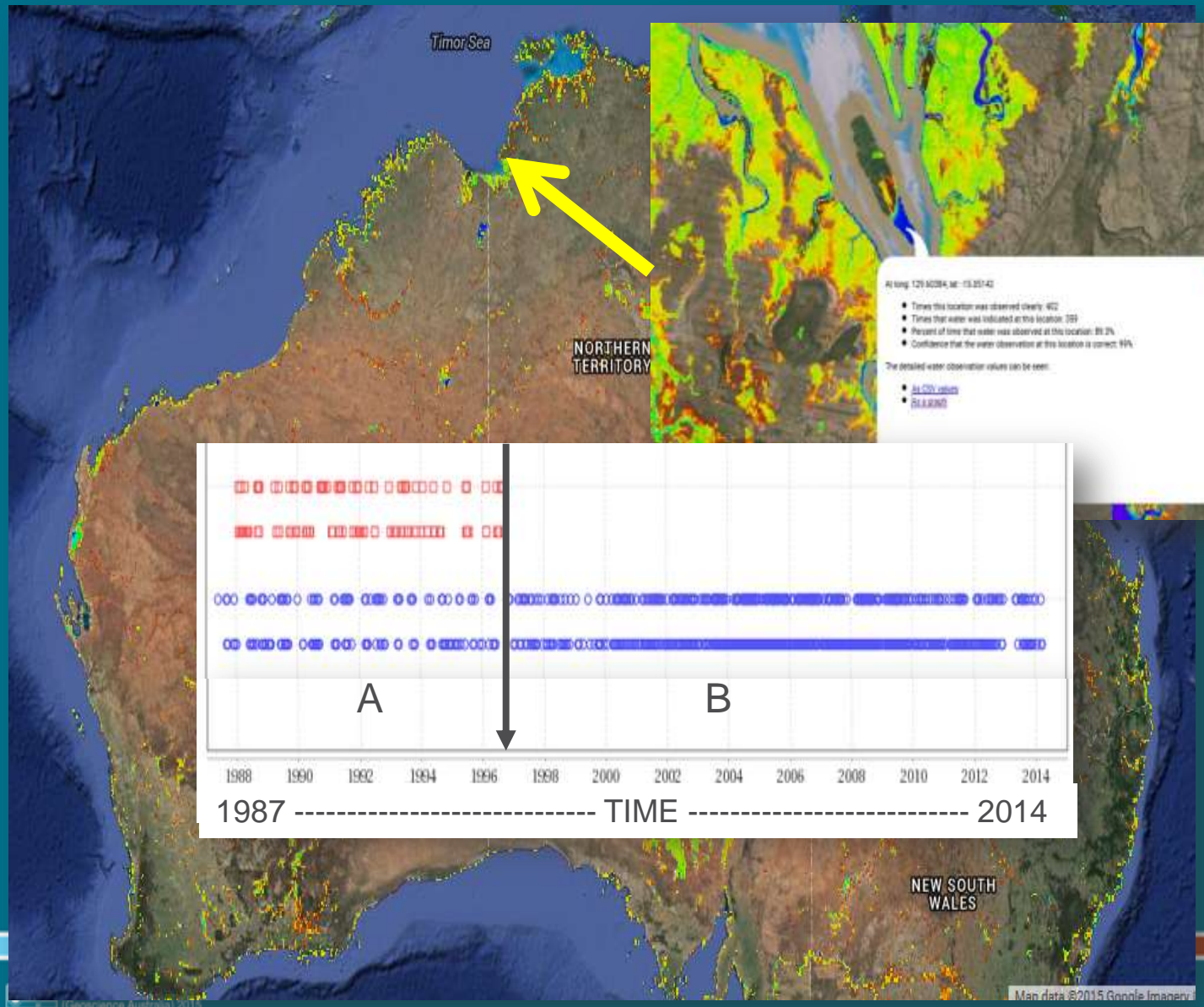
# Water quality monitoring – Lake Burley Griffin



# The potential for change detection: Mangroves

Timing and strength of change for any (data cube) variable

National & regional shoreline erosion studies, mangrove change mapping



# Some (already identified) applications for the data cube:

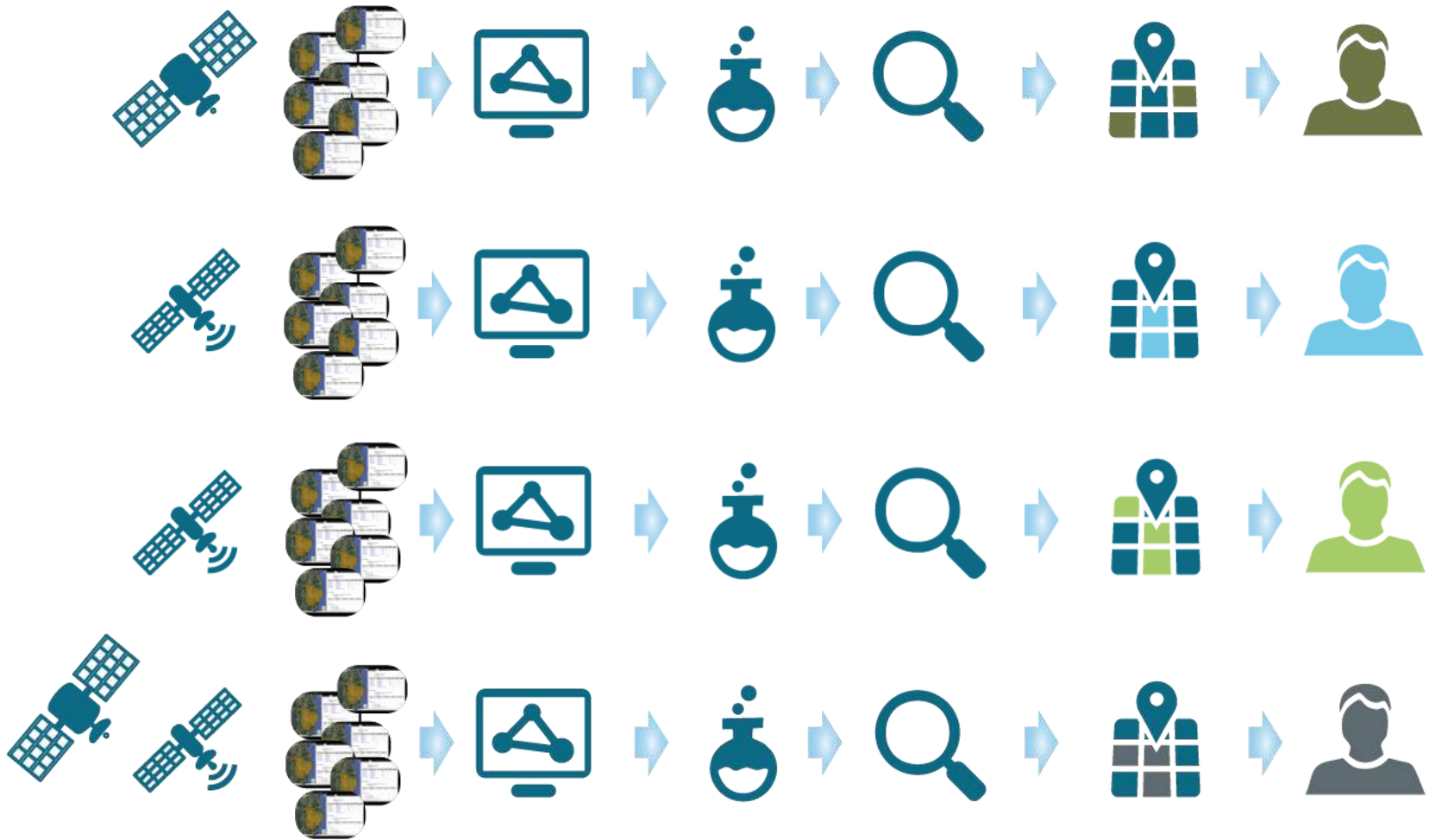
- Vegetation change, agricultural production
- Flood inundation mapping, farm dam development
- Wetland management and characterisation
- Carbon accounting
- Seagrass and substrate mapping
- Coastal change and water quality
- Shallow water bathymetry
- Mining footprint and urban development
- Bushfire scar mapping and forestry inventory
- Location-specific products for mobile platforms
  - “Map my paddock”

# Why the Data Cube?:

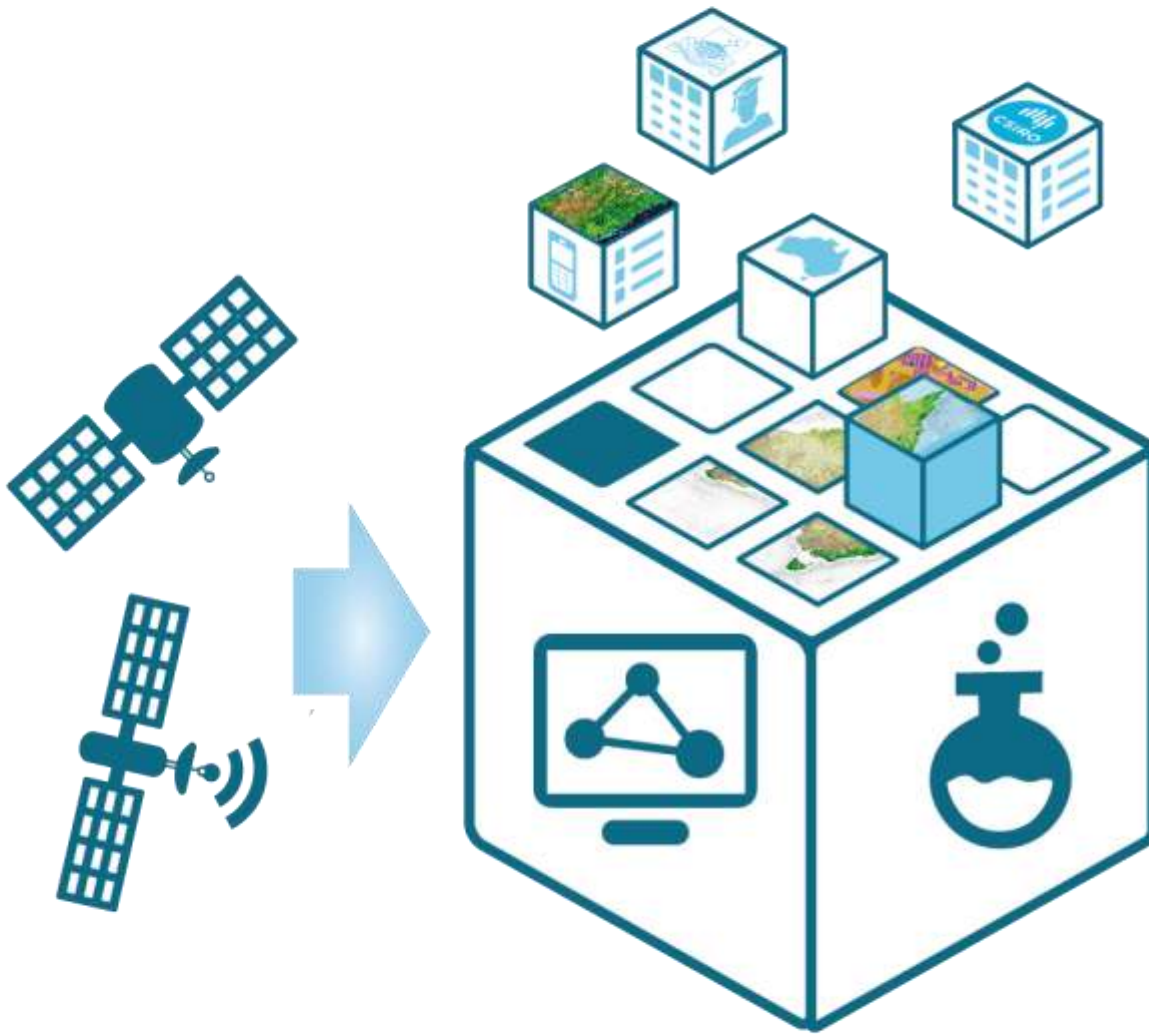
- Data is getting too big to move - computing and data all need to be together. But this creates opportunities:
- As more data is added to the infrastructure you improve all products (snowball effect).
- You can integrate remote sensing, in-situ and modelled data and services.
- A sustainable approach to dealing with the deluge of new satellite sensors ahead (Himawari 8 alone: 2 Tb/day)
- Efficiency (don't pay for reinventing the wheel)
- Common, comparable and transparent information base
- Requires us to cooperate in building this capability but we build once: use many times across government



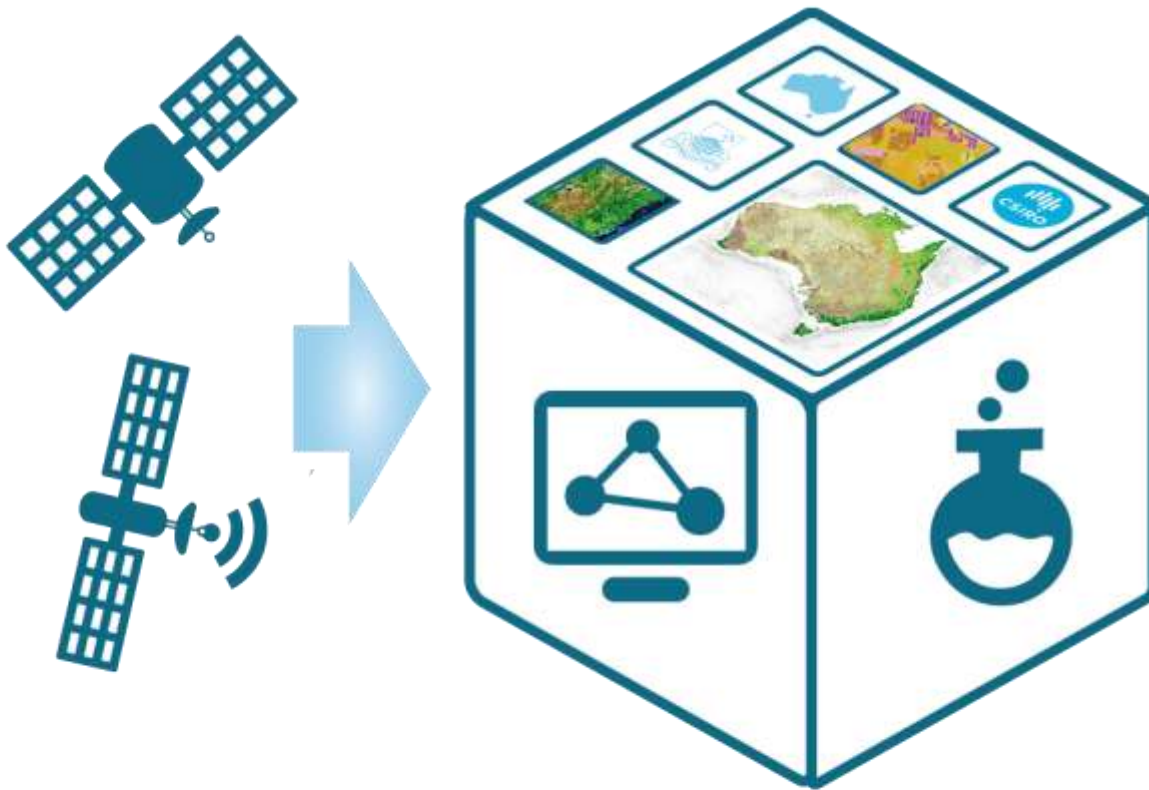
# Don't reinvent the wheel!



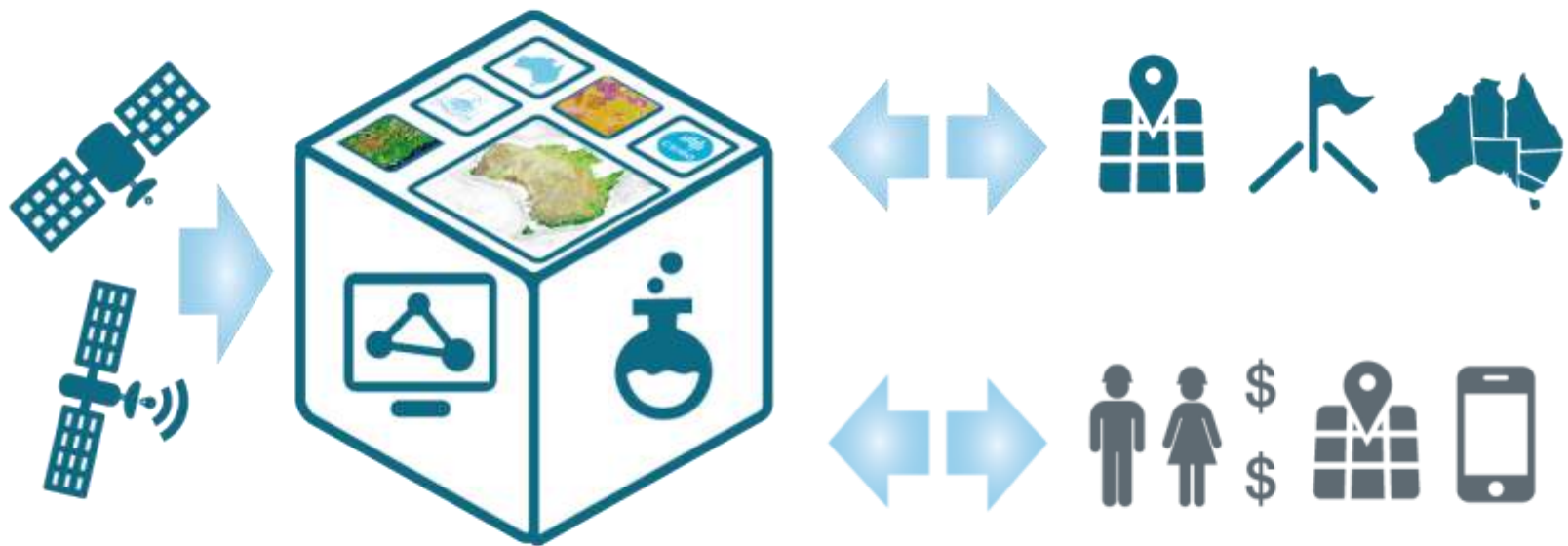
# Data Cube: National information infrastructure



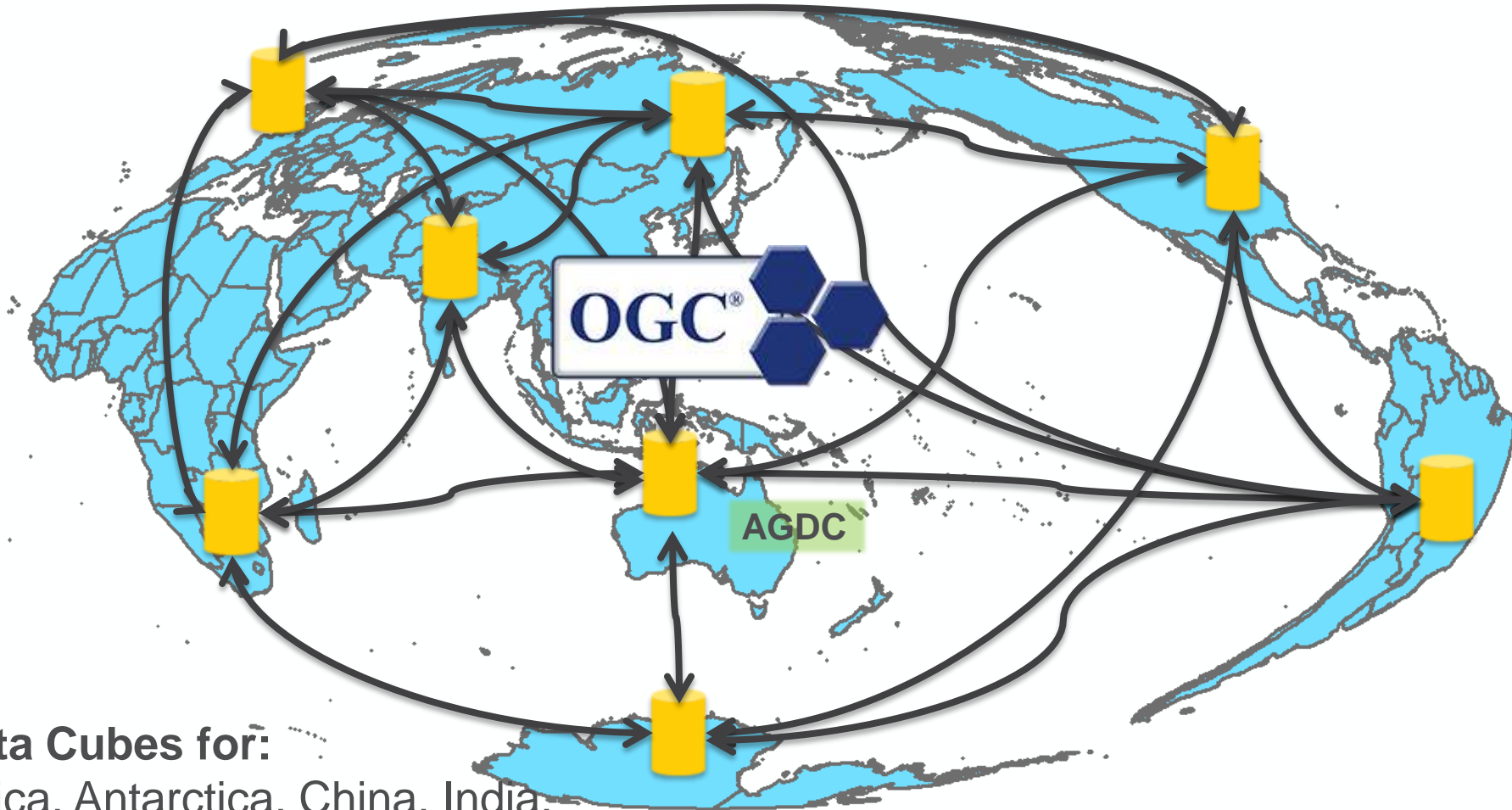
# Data Cube: National information infrastructure



# Data Cube: National information infrastructure



# GEOSS: a global network of regional data cubes?



**Data Cubes for:**  
Africa, Antarctica, China, India,  
Europe, North America, ...

**What questions do YOU have?.....😊**