



AquaWatch Australia

A 'weather service' for water
quality





I would like to begin by acknowledging the Traditional Owners of the land and waters that we're meeting on today, and pay my respect to their Elders past and present.



Sediments & Floods



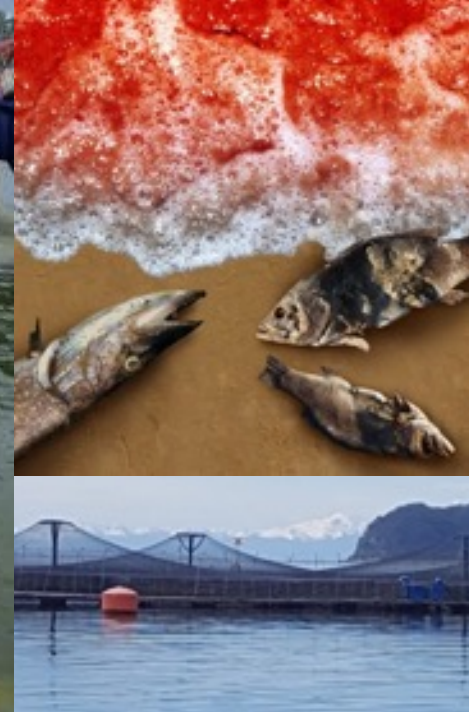
Fish-kill events



Sewage/Pollution



Harmful Algae Blooms



3 Billion people world-wide don't have access to clean water and sanitation



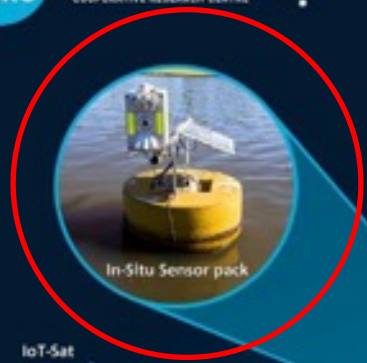


AUSTRALIA'S VOLUNTARY COMMITMENTS TO THE WATER ACTION AGENDA

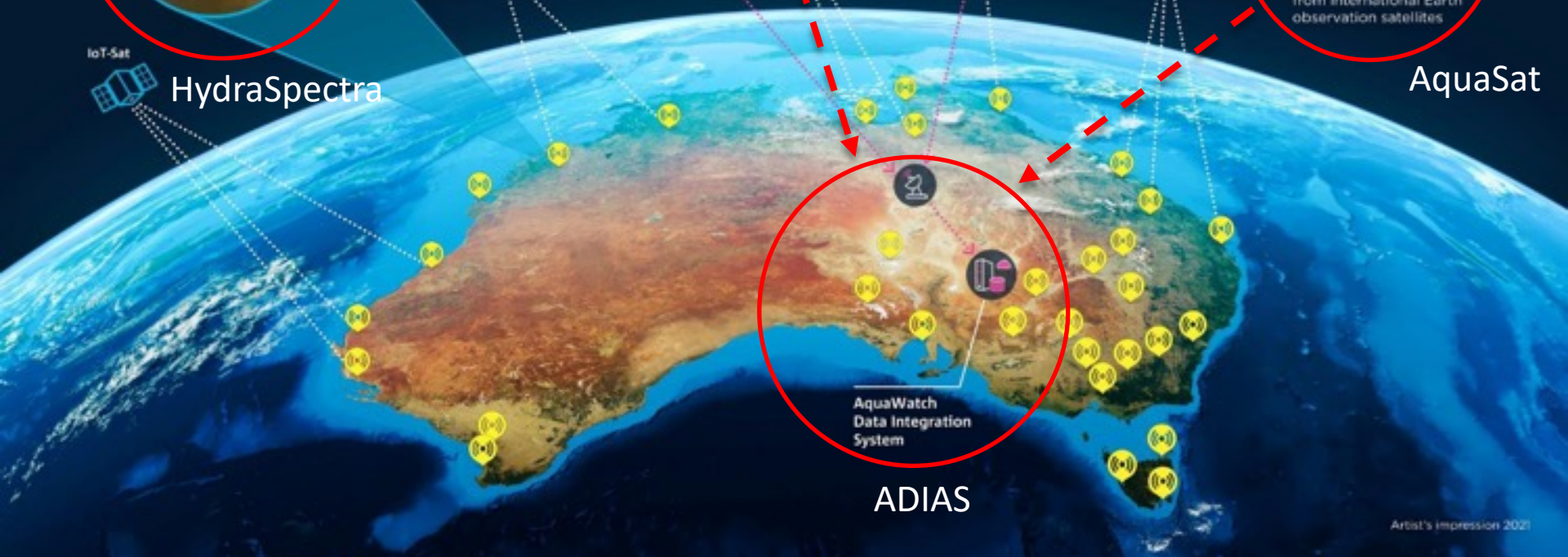
1. *Renewing the National Water Initiative (DCCEEW)*
2. *First Nations Water Entitlements (DCCEEW)*
3. *First Nations Water Infrastructure (DCCEEW – National Water Grid Authority)*
4. ***AquaWatch Australia (CSIRO)***

AquaWatch Australia Mission Concept

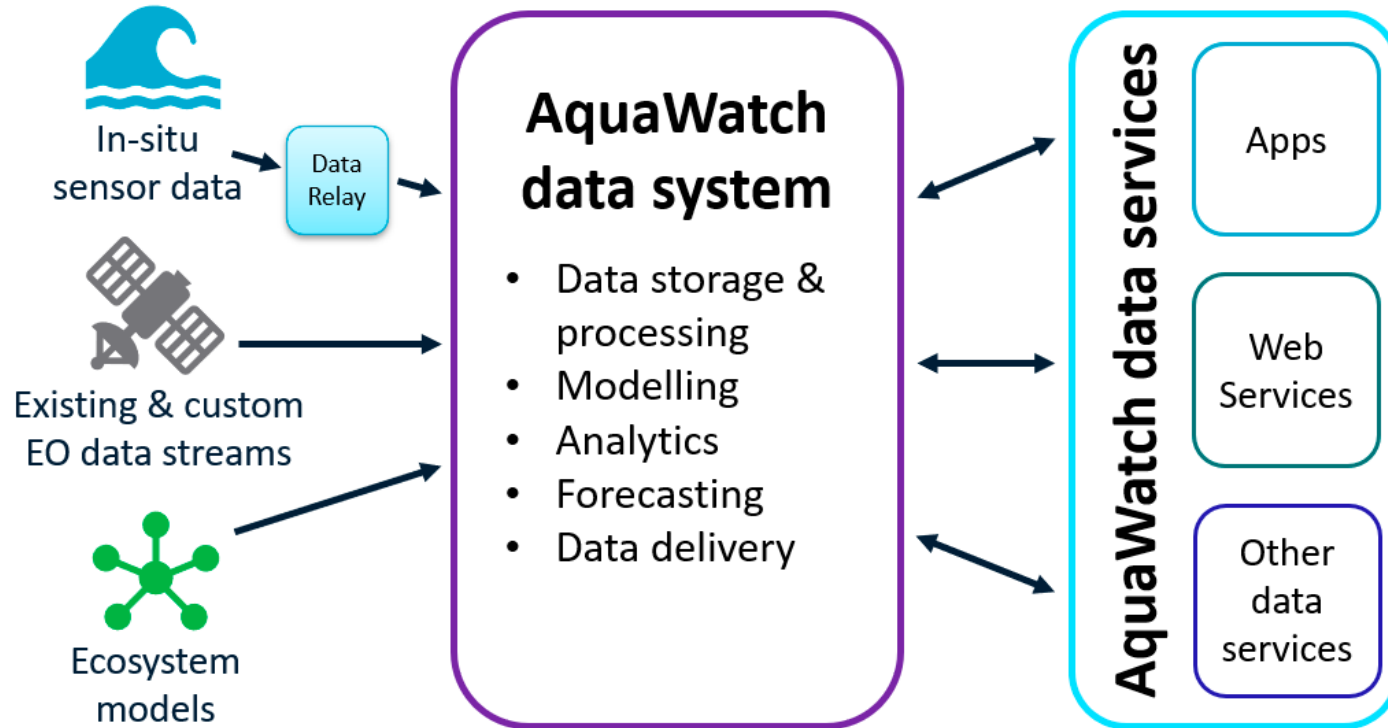
Virtual Satellite Constellation



AquaSat

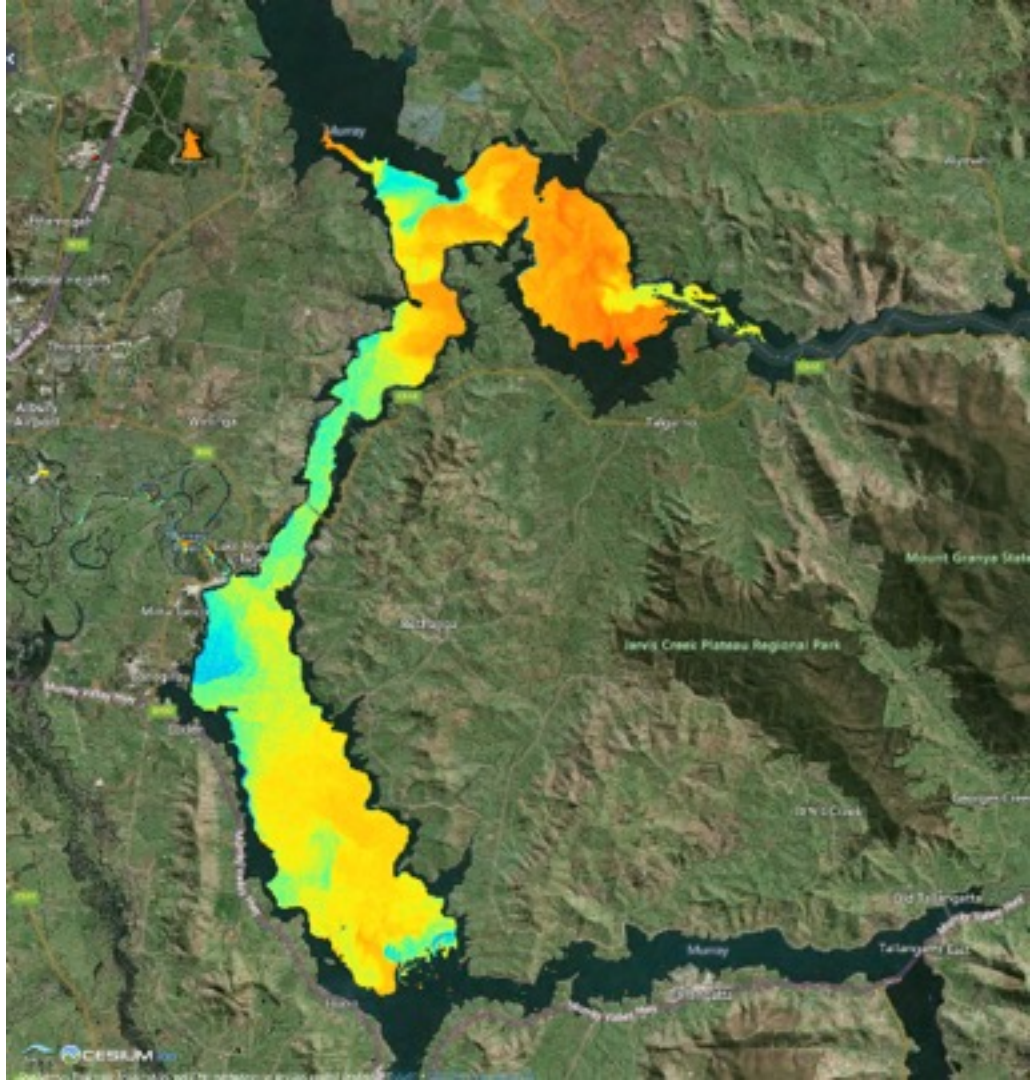


AquaWatch Technical Elements



CSIRO Scope of AquaWatch

- **Technology Element** for space-to-ground water quality monitoring and forecasting, with key milestones in 2026 and 2030.
- **Research program**, for continuous improvement, with aligned R&D and support for growth in the user base.



- Chlorophyll-a
- Phycocyanin, PC *
- Phycoerythrin, PE*
- Species / genus differentiation:
 - Blue-green algae (inland & species levels) *
 - Dinoflagellates (coastal waters) *
 - Phytoplankton Functional Types (PFT) *
- Peridinin (=dinoflagellates) *
- Total cell counts (phytoplankton abundance)
- Biovolume (may be used with species/types for a HAB index)
- Total Suspended Matter
- Secchi Disk Transparency
- Turbidity
- Coloured Dissolved Organic Matter (CDOM)
- Dissolved Organic Carbon
- Vertical attenuation, Kd*
- Forel Ule scale (water colour)
- Water Column Depth (Bathymetry)
- Floating and Submerged Aquatic Vegetation Types*
- Benthic & Coral Reef Habitat*
- Water-related ecosystems & land-use

*= Hyperspectral
Data Required

Extras (mostly COTS in-situ sensors)

- Temperature
- Dissolved Oxygen
- Water Surface Height
- Water surface velocity
- PH

Require more R&D on miniaturization & automation

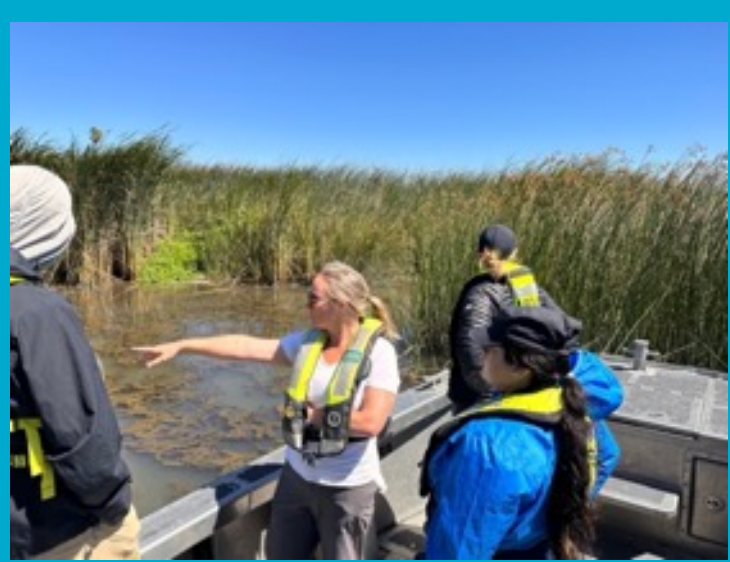
- Salinity/Conductivity
- Total phosphorous
- Total inorganic Nitrogen (Nitrate-N as surrogate)
- Methylisoborneol (MIB)
- Geosmin
- MicroPLastics
- Metals (heavy and other)
- Organic micro pollutants (Pharmaceutical, antibiotics, endocrine disruptors, insecticides, herbicides)
- Pathogens (e-COLI, cholera, water borne...etc)

DRAFT
for Discussion Only



Co-Design Pilots

Build new Partnerships
Testing and validating system



**Keppel Bay/Fitzroy River (QLD)**

Objective: Estimate sediment and carbon fluxes flowing from Fitzroy river into Keppel Bay region, and their impact on GBR region coastal water quality.

Moreton Bay (QLD)

Objective: To integrate and visualise multiple space and ground-based sensor data streams, combined with hydrodynamic model outputs to understand the link between water quality changes and white spot disease.

Lake Hume (NSW)

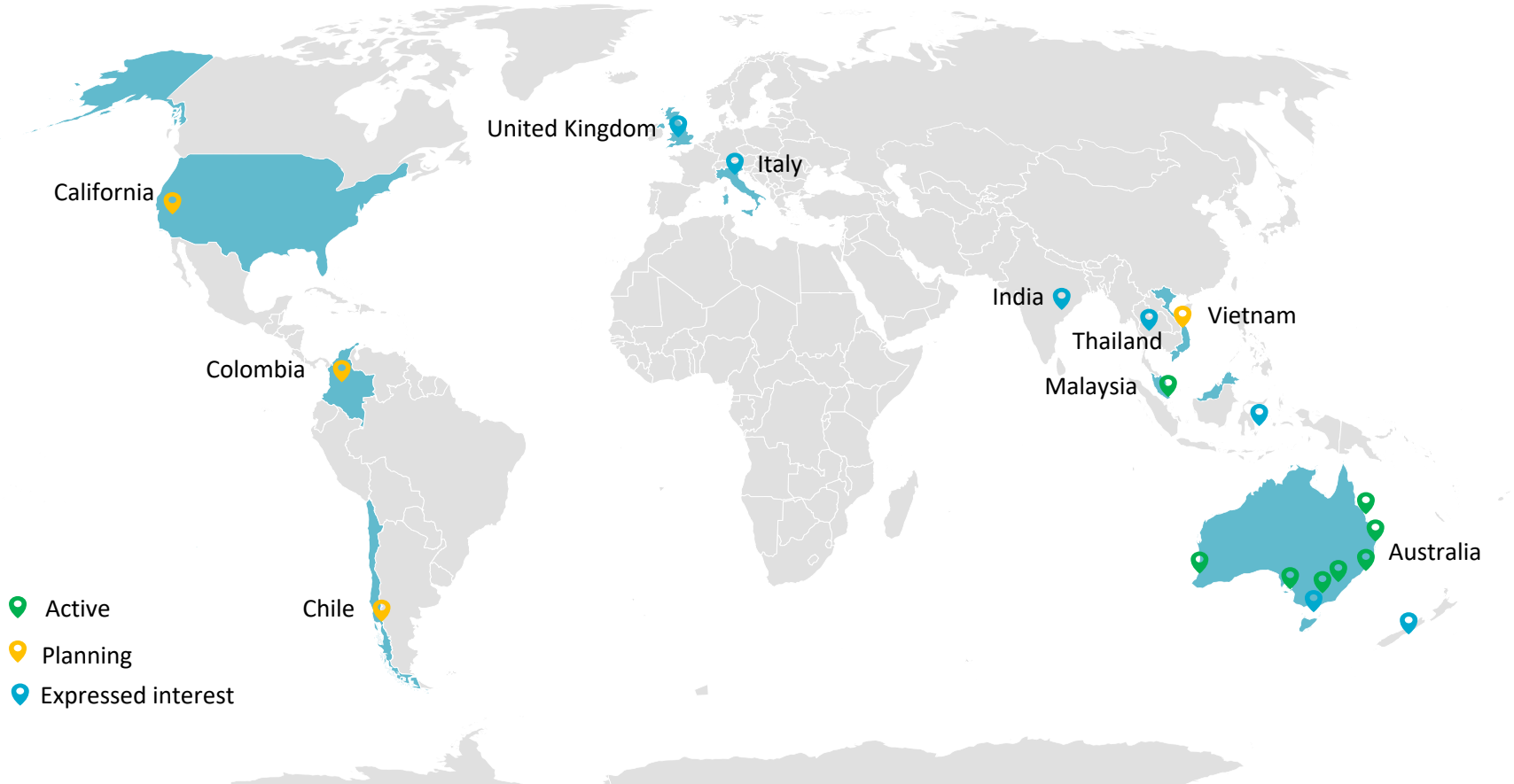
Objective: To demonstrate a 'ground-to-space water quality monitoring and forecasting tool' for toxic algal bloom detection and mapping.

Cockburn Sound (WA)

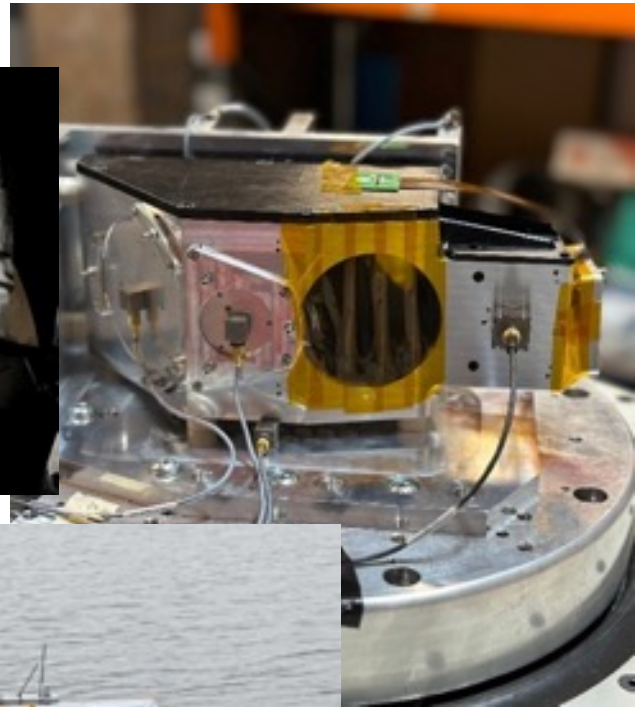
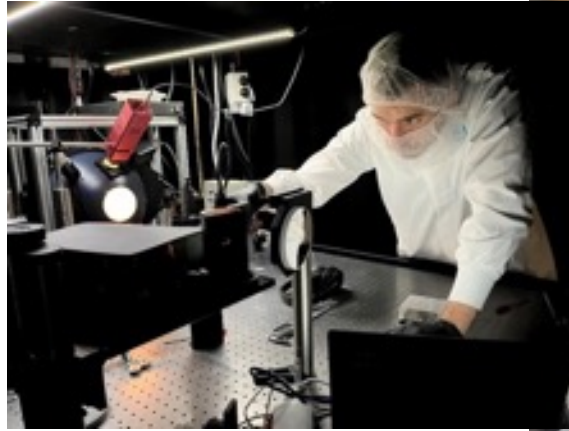
Objective: Integrated in situ and remote sensing approach to study water quality response to coastal infrastructure development.

Spencer Gulf (SA)

Objective: Demonstrate the integrated use of data derived from in-situ sensors and Earth Observation satellites to support environmental monitoring and sustainable growth of the aquaculture industry.



CSIRO



Technologies



Pilot Site Instrumentation Stations for In-situ Water Quality Measurement and Satellite Data Validation

Instruments include:

- CSIRO Hydraspectra
- TriOS Ramses E_d , L_{sky} and L_w
- Pan/tilt unit
- Weather station
- Cameras horizontal and forward-looking
- Water temperature (below surface & 2 depths (4/8m))



HydraSpectra Mk IV



Deployments @ national pilots



Great Barrier Reef



CSIRO Satellite Data from 'AquaWatch Virtual Constellation

- Operational
 - Copernicus: Sentinel-2, Sentinel-3
 - Landsat 8,9, -> Landsat Next
 - Himawari, GOES ?
- Science Missions:
 - Hyperspectral: EnMAP, Prisma, CHIME, SBG
 - SWOT, Trishna...
- Commercial (tbd)
- AquaWatch Pathfinder: Cyanosat, AquaSAT-1, ...



CSIRO Cyanosat-1

- Aquawatch Pathfinder
- CSIRO Satellite Optics Lab, Adelaide
- Launched – June 12th on Skykraft payload
- Communication with payload, under commissioning
- Cyanosat-2 in development

Sovereign Design

Linear Variable Filter

Customized Low Power Electronics

Sovereign Manufacturing

High Precision CNC machining

Novel Easily aligned telescope

Deployable Baffle

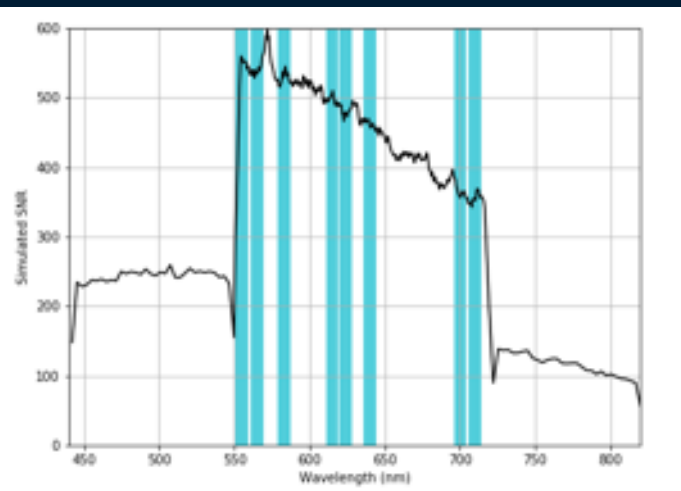
Qualification and... Launch!

Integration

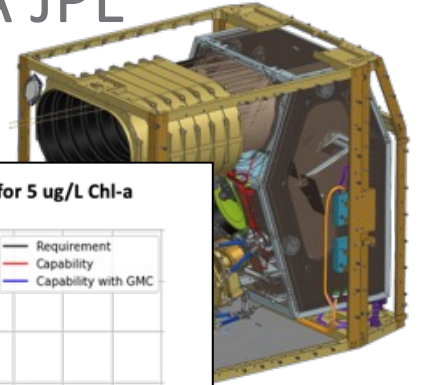
Optical Metrology

Vibration Testing and analysis

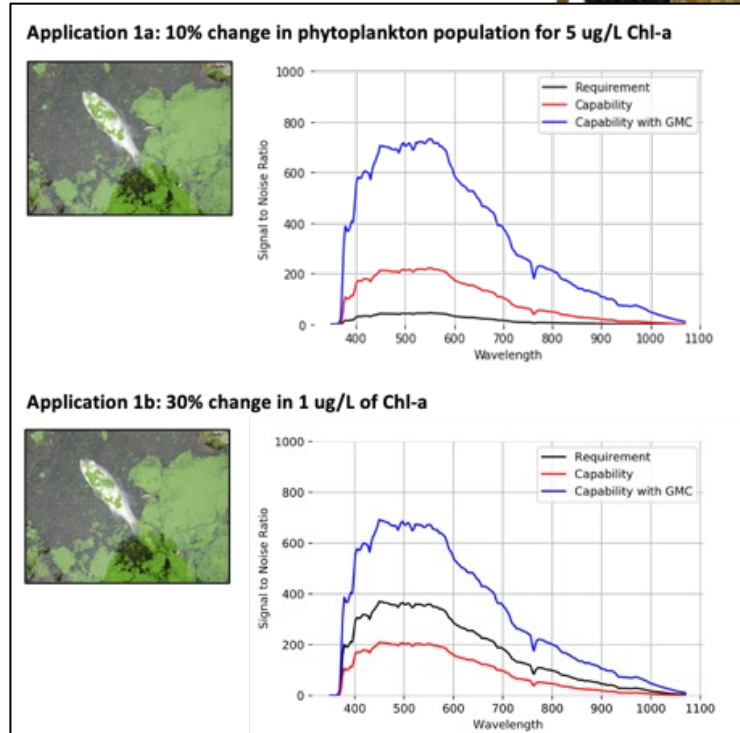
Thermal Vacuum Cycling



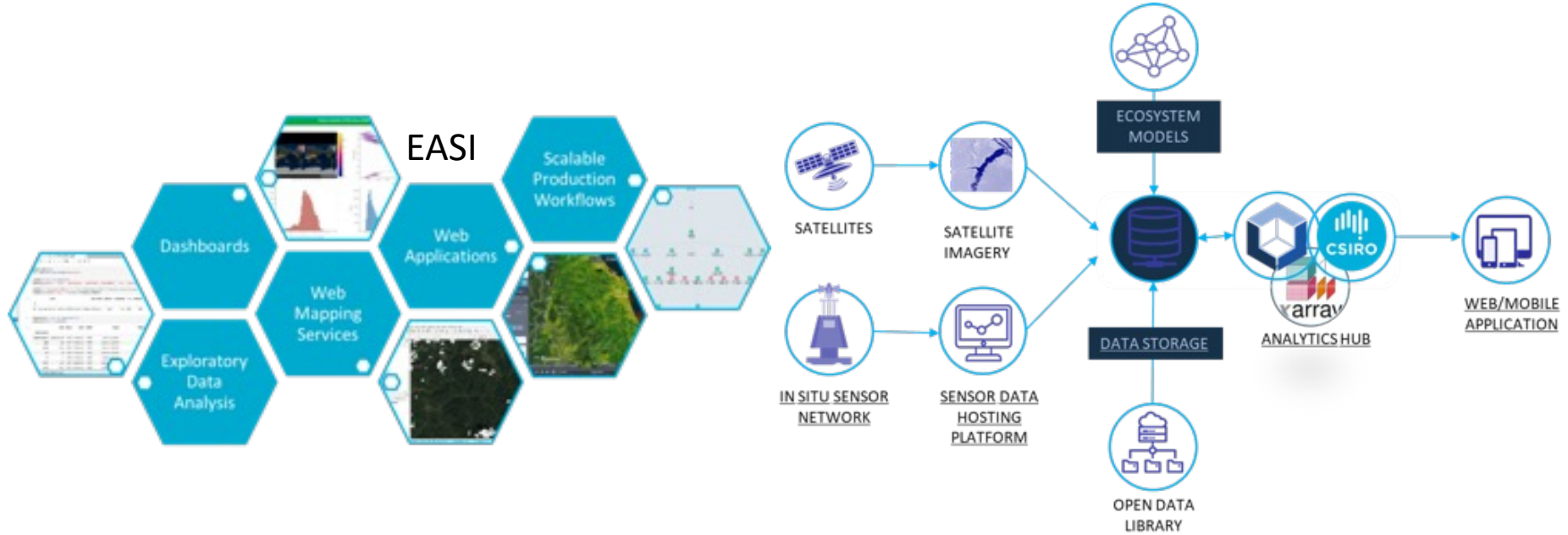
CSIRO AquaSAT-1 Feasibility study, with NASA JPL



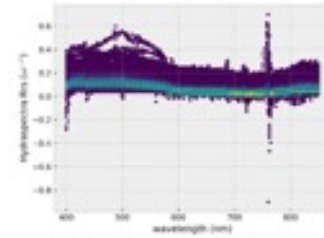
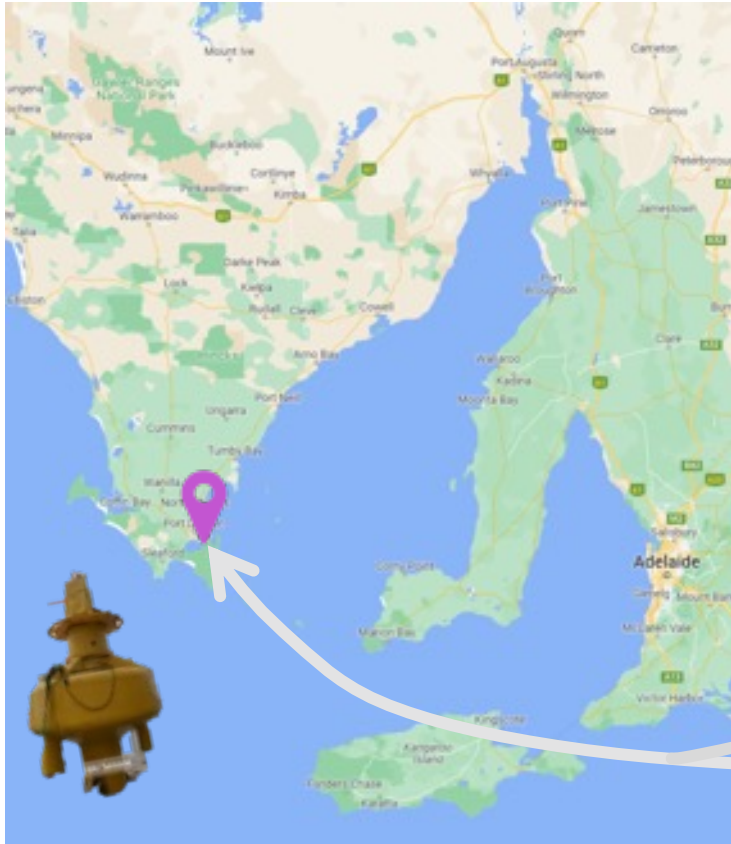
- **Orbit:** sun-synchronous, ~noon crossing time, ~400 km altitude (trade study: 600 km altitude)
- **GSD:** 18 m
- **Imaging coverage:** target sites (key lakes, rivers, estuaries, coral reefs in Australia and the US West)
- **Revisit:** 5 days with +/- 30 deg cross-track slew (not accounting for cloud cover, sunglint, target site conflicts, etc.)
- Dyson imaging spectrometer (350 to 1050 nm, 9.6 nm FWHM)



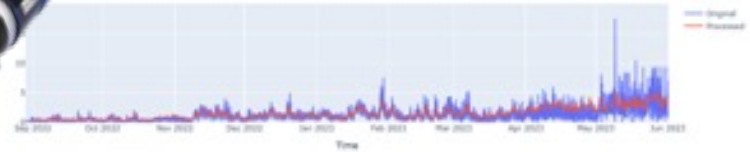
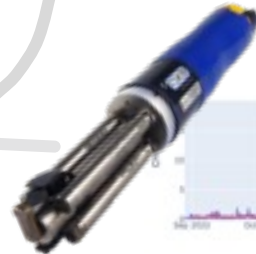
Multi-sensor Data integration and analytics

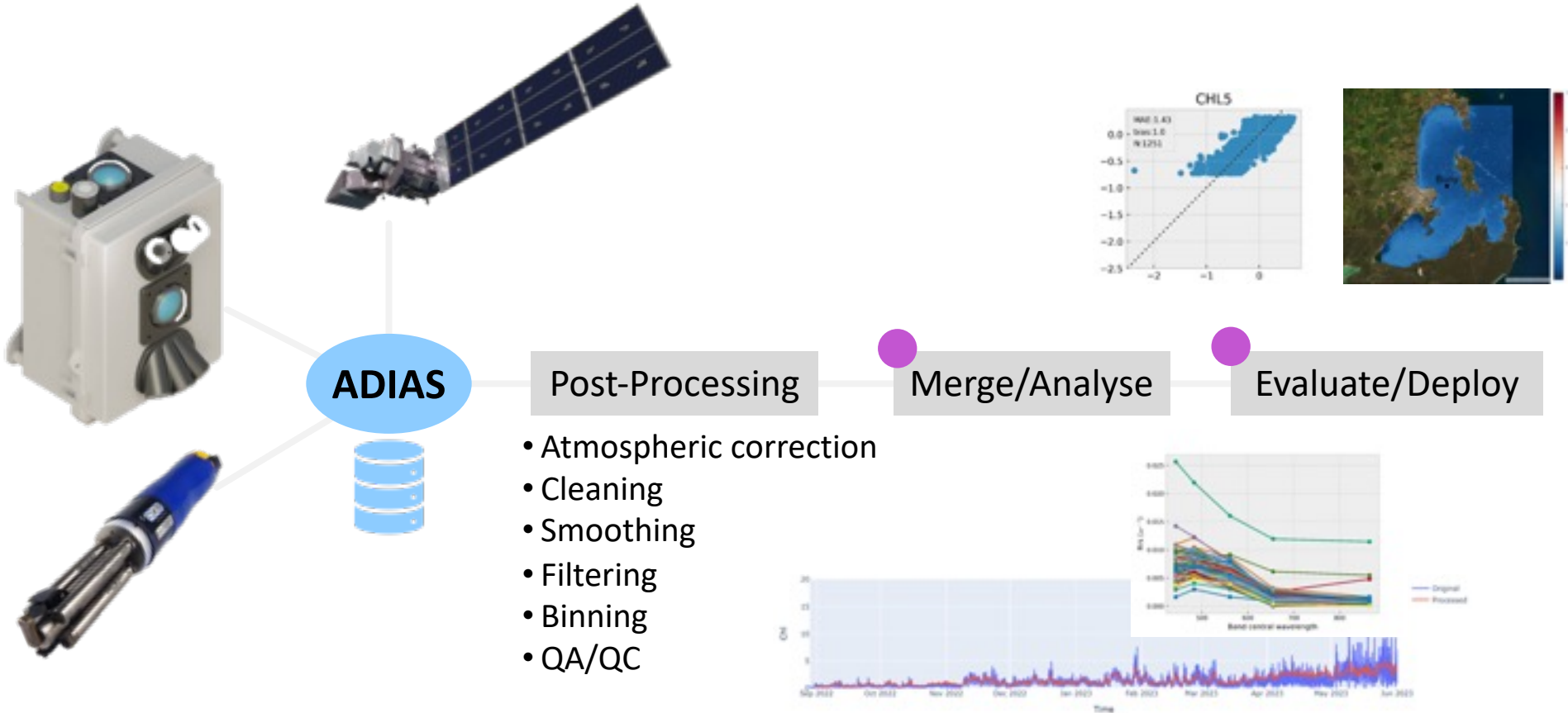


CSIRO Spencer Gulf pilot – Data Sources

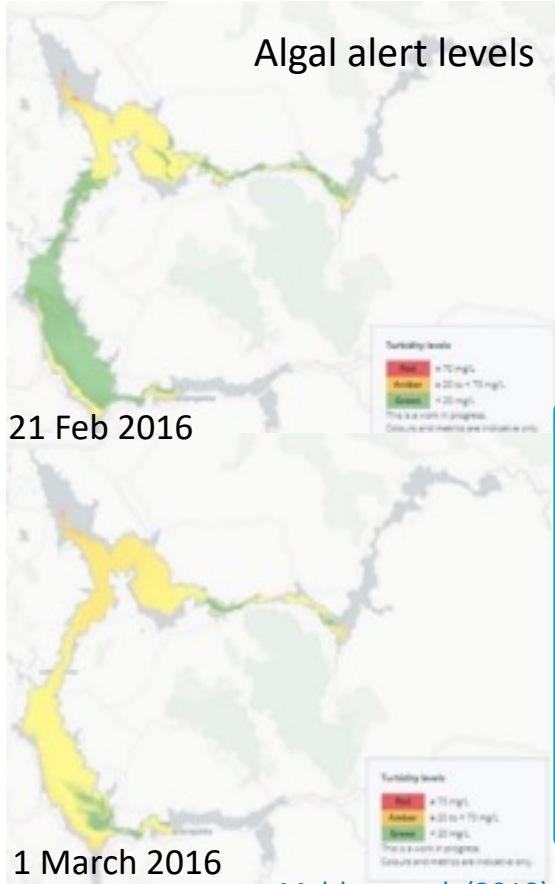


Bio-optical
Data

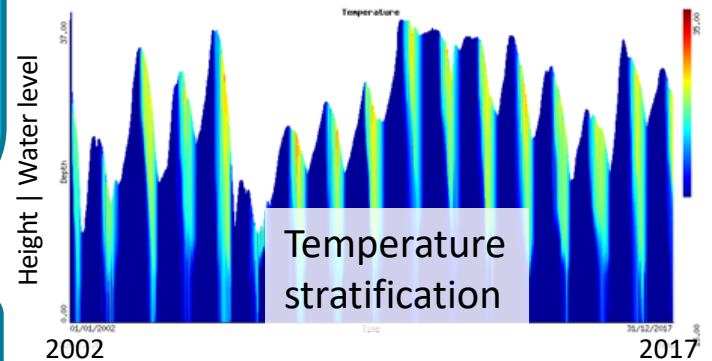
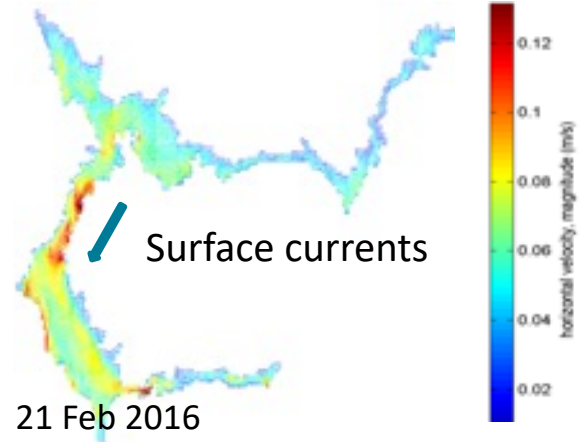
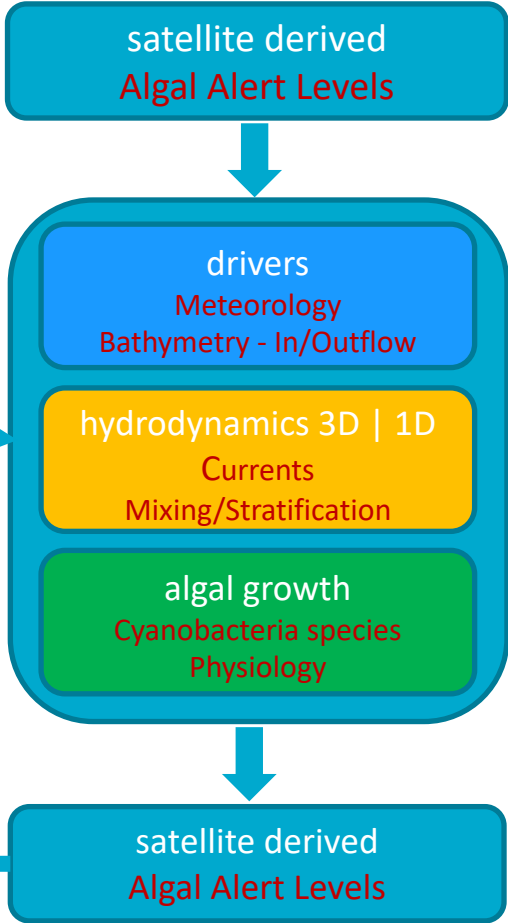




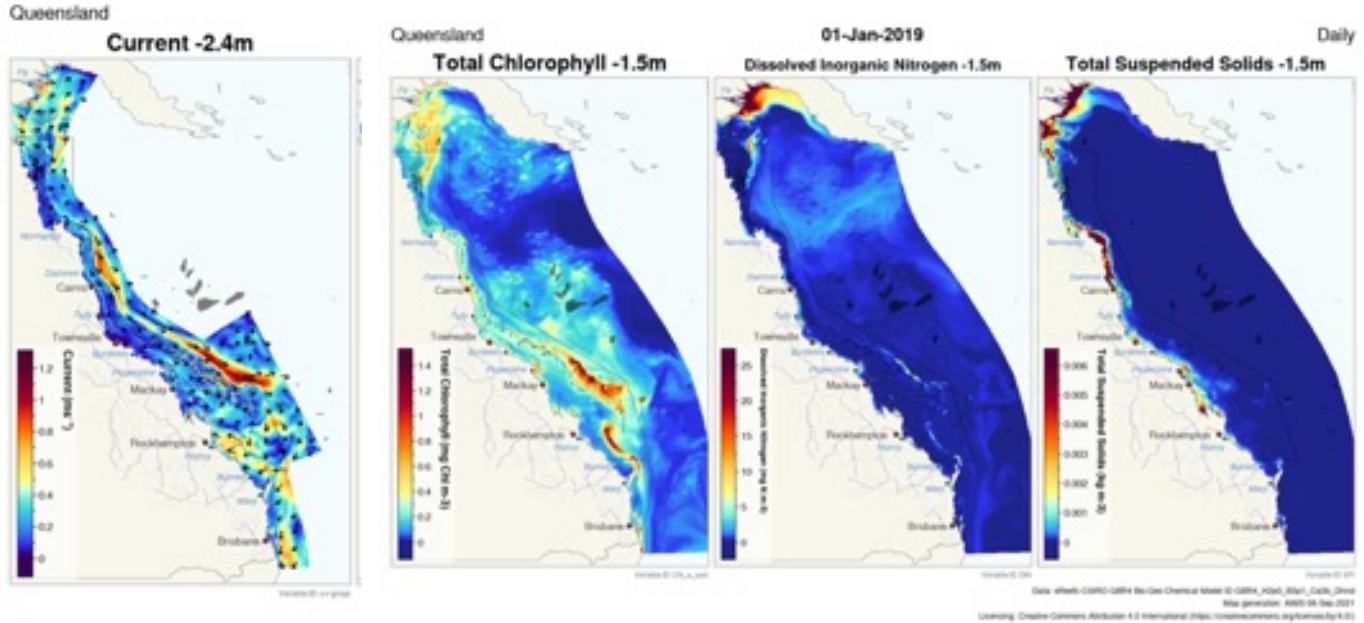
Algal alert levels

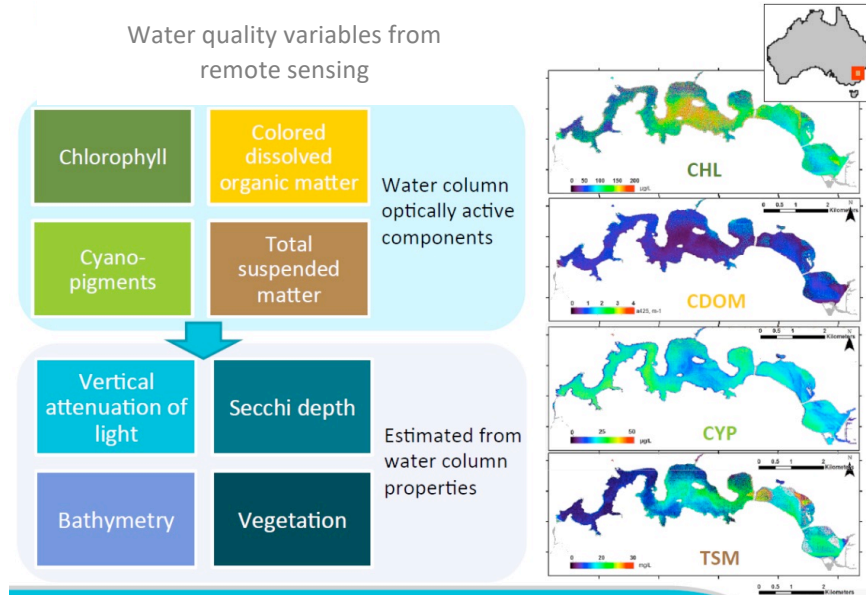


Malthus et al. (2018)



Joehnk et al. (2018a)





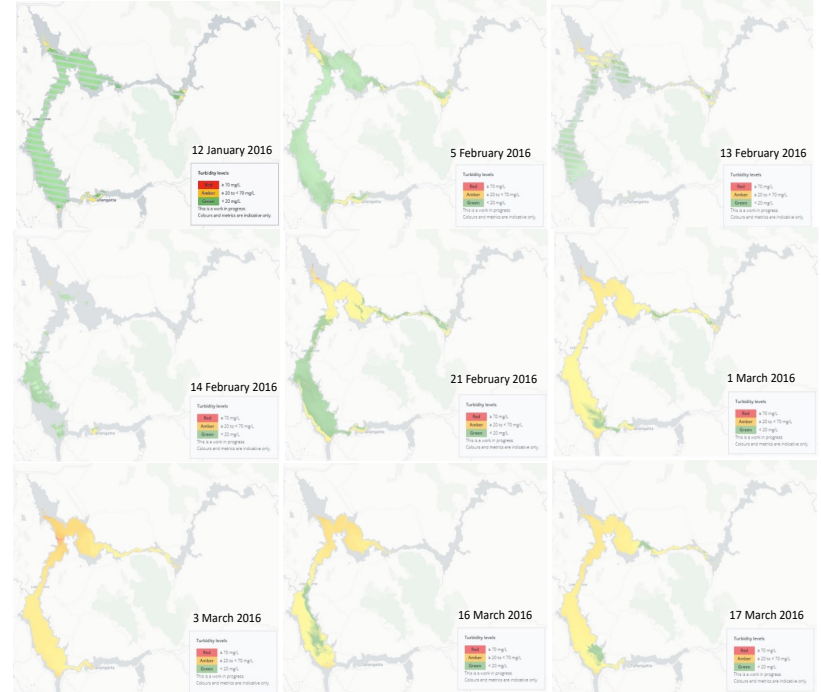
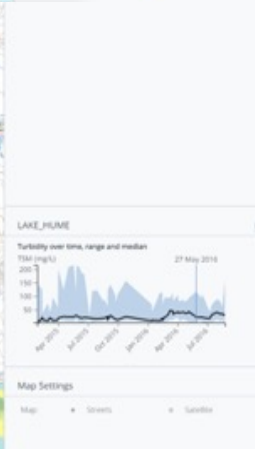
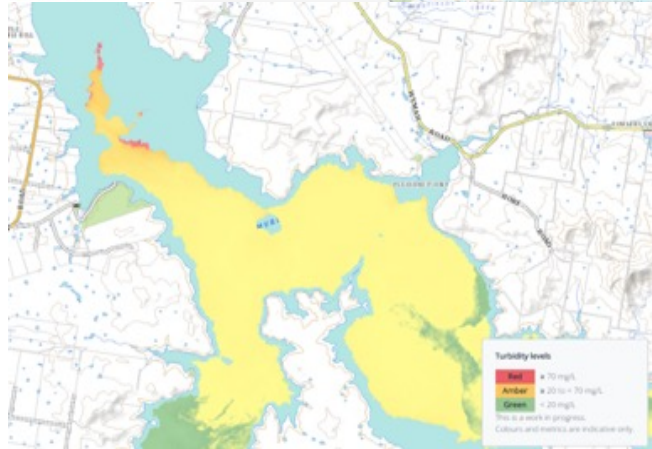
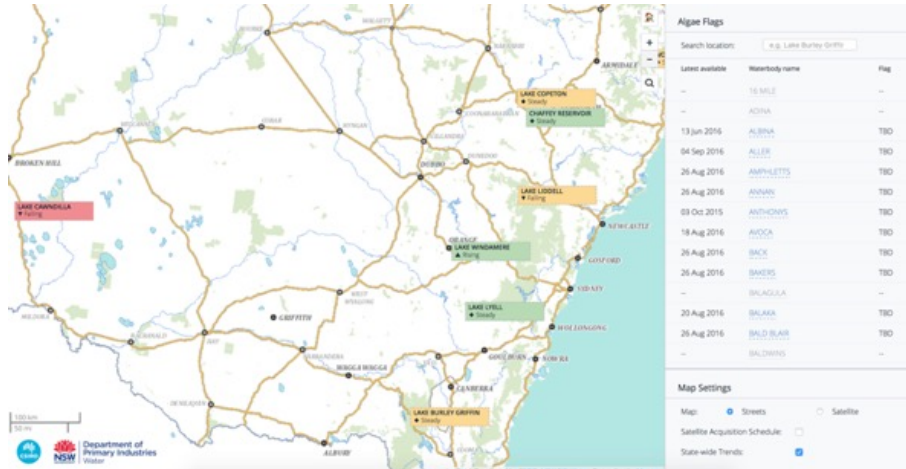
Canberra, ACT



Source: Imagery copyright 2019 Google.
Map data copyright 2019 Google

Dekker, Malthus and Hestir (2013)

CSIRO Visualization – Eg. Statewide and local overviews



Lake Hume, time series, January to March 2016



Thank you

CSIRO Space & Astronomy

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csiro.au/en/about/challenges-missions/AquaWatch