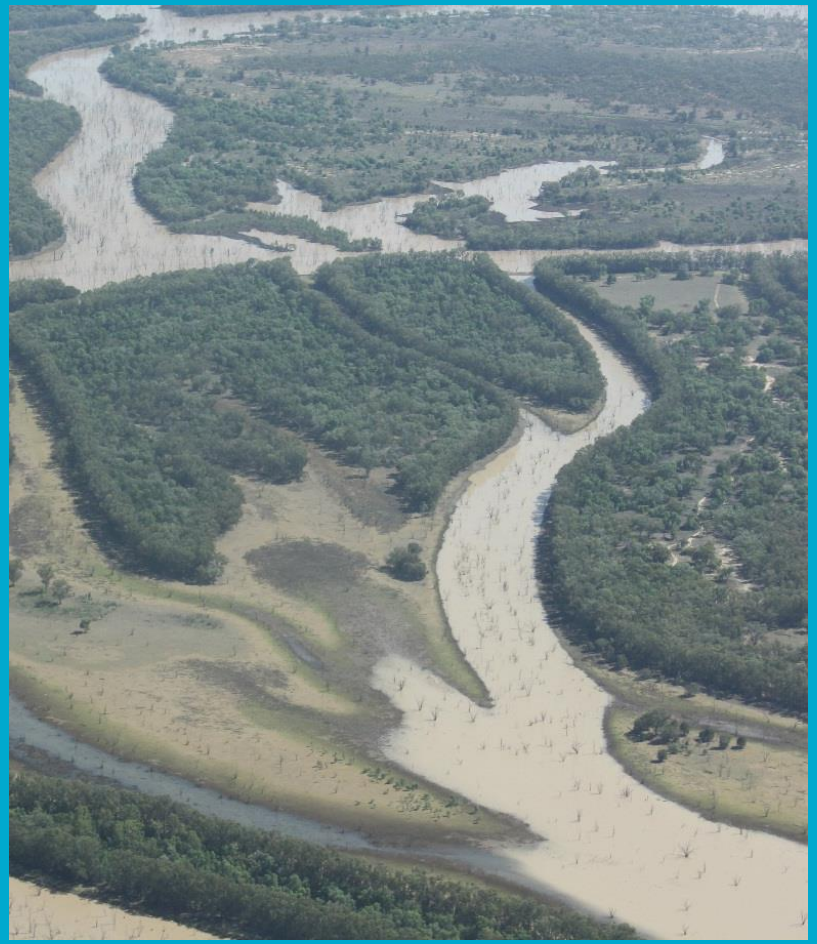
Mapping surface water extent with Landsat in the Murray Darling Basin

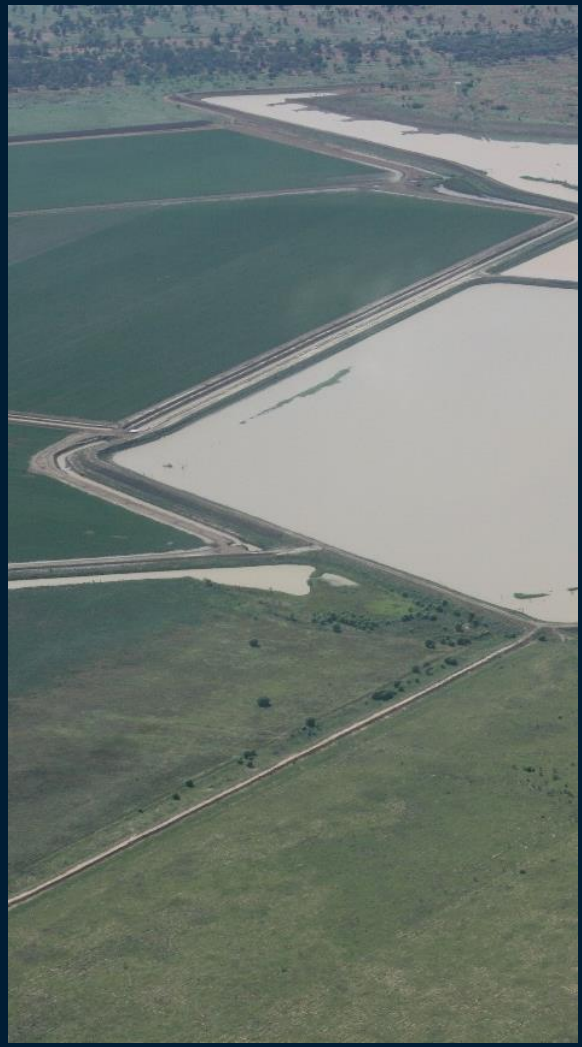
Combining water mapping indices into a new multi-index method

Cate Ticehurst, Jin Teng, Dave Penton, Ashmita Sengupta



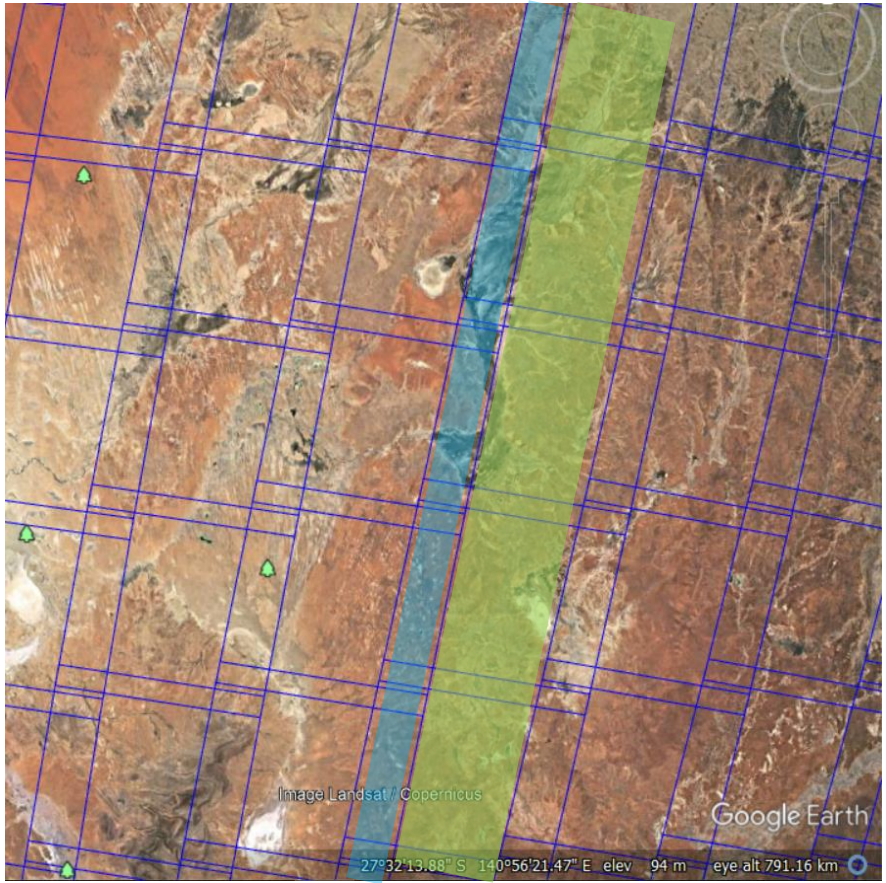
Background

- Connectivity between river channels and floodplains
- Remote sensing to characterise surface water dynamics
- Two-monthly maps of surface water extent using Landsat



Landsat sensors

- Data available since 1980s
  - Landsat 5 (TM) – 1984-2011
  - Landsat 7 (ETM) – 1999-
  - Landsat 8 (OLI) – 2013-
  - Landsat 9 (OLI-2) – 2021-
- 30m x 30m spatial resolution
- 185 km swath width
- Overpass every 16 days
- Cloud cover/ cloud shadow will limit useful data



Landsat data

- Landsat archive for Australia
  - Digital Earth Australia
  - Analysis-Ready Data
  - Available through:
    - National Computational Infrastructure (NCI)
    - CSIRO EASI platform
  - Accessed using JupyterLab (notebooks and python scripts)

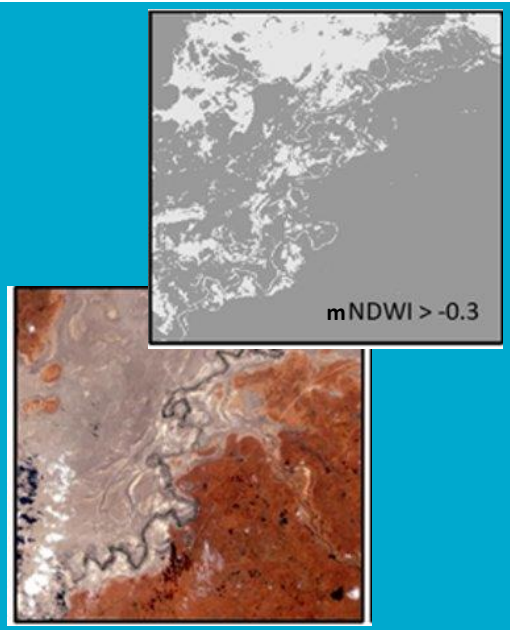
Mapping surface water with Landsat

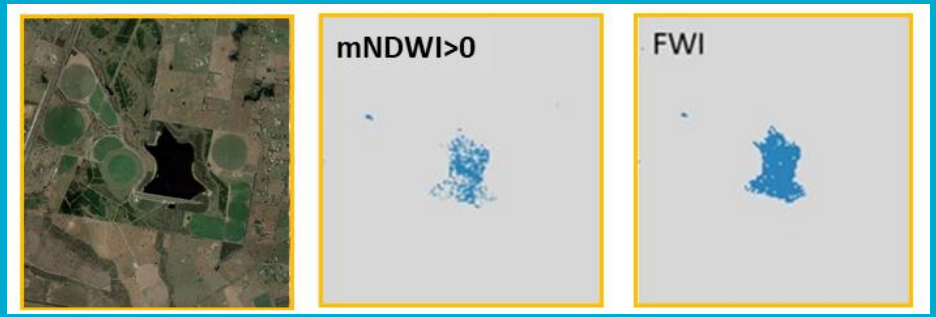
- Commonly used method for mapping surface water in Australia:
  - Modified Normalised Difference Water Index (mNDWI):
    ƒ (green, mid-infrared)
    - Thresholds of >0 and > –0.3 often used
  - Fisher's Water Index (FWI) * :
    ƒ (green, red, near-infrared, mid-infrared)
  - Water Observations (from Space) (WOFS)
  - Tasseled Cap Wetness Index (TCW):
    ƒ (blue, green, red, near-infrared, mid-infrared)
    - Thresholds of > –0.01 and > –0.035 often used

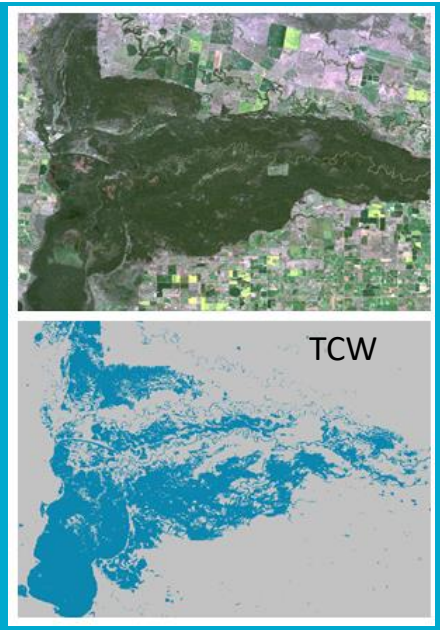
* A.Fisher, N.Flood, T.Danaher (2016) in Remote Sensing of Environment

Mapping surface water with Landsat

- Different methods (index and threshold) perform better depending on vegetation cover, soil colour, soil moisture, water colour
  - mNDWI> –0.3 detects river channel, but misclassifies dark soil as water
  - TCW> –0.035 to identify flooded in wetlands
  - FWI and mNDWI (threshold>0) can identify different water bodies



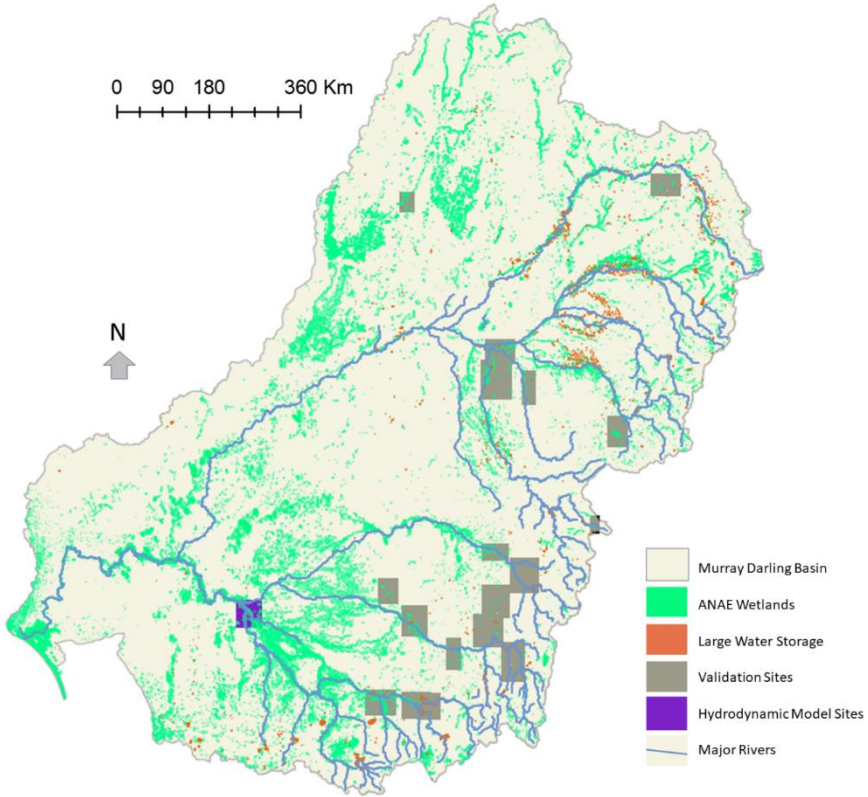




Comparison of water indices

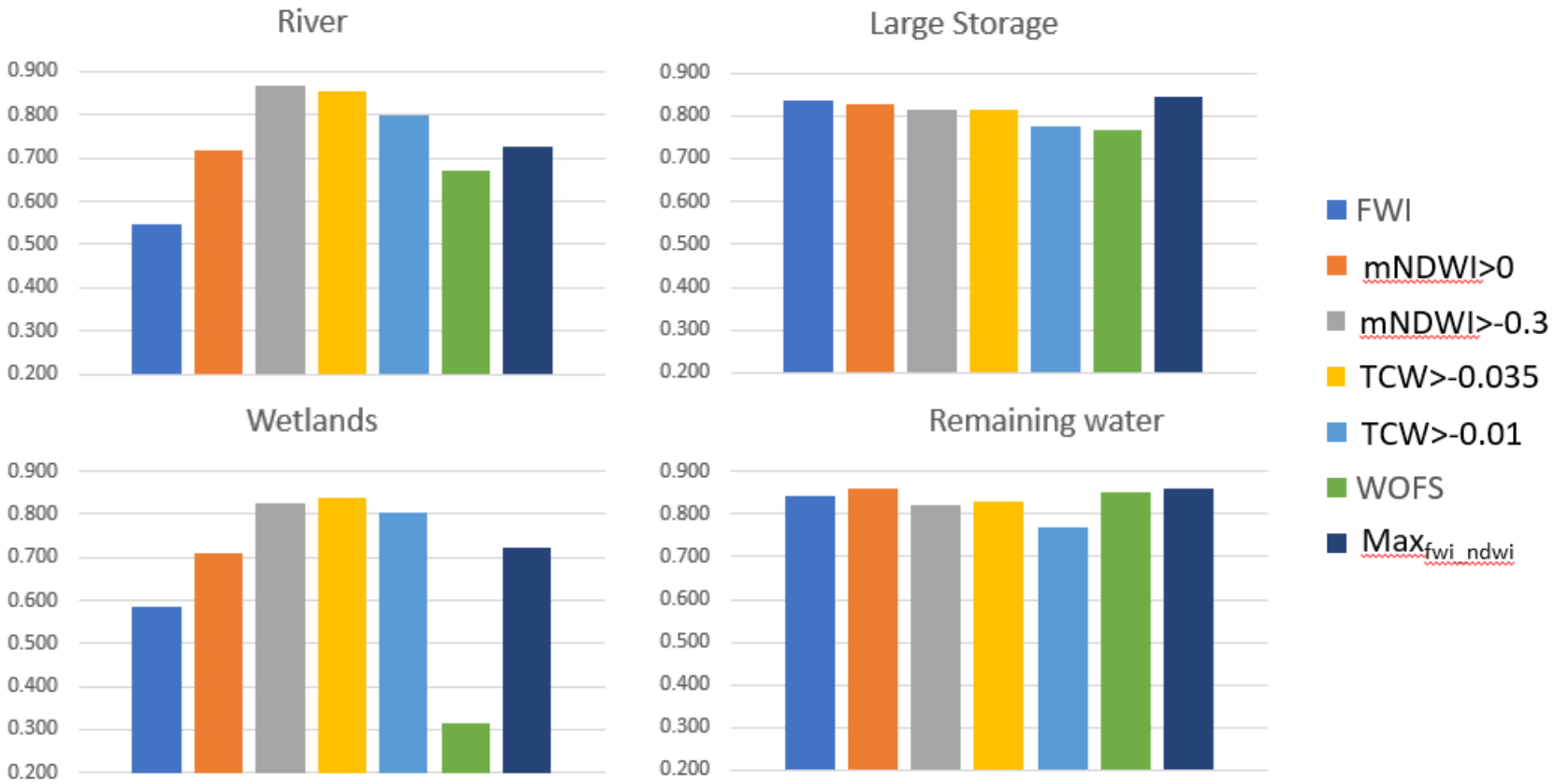
- We used >450 validation plots (mostly from Fisher et al. 2016*) to evaluate best index/threshold for different water environments (lakes, wetlands, major rivers, others)

Australian National Aquatic Ecosystem Wetlands
Geofabric Large Water Storage
Geofabric Major Perennial Rivers (with buffer)
Location of validation sites



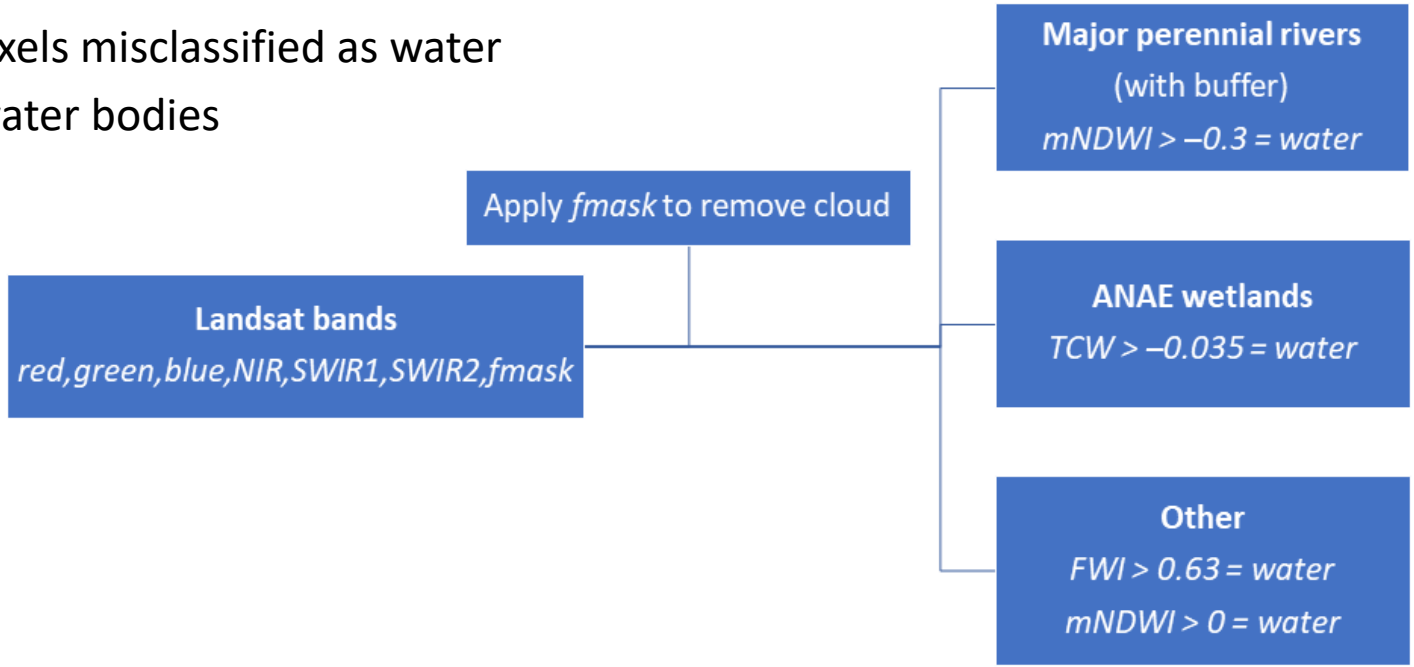
* A.Fisher, N.Flood, T.Danaher (2016) in Remote Sensing of Environment

Comparison of water indices



Using a multi-index method

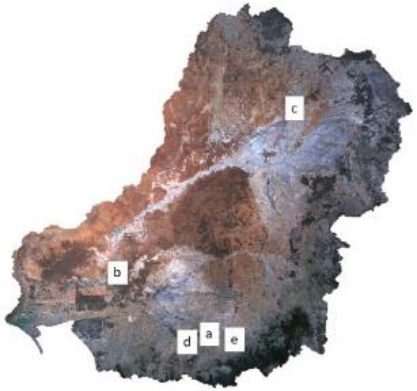
- We developed a multi-index method for mapping surface water in MDB
  - Simple and fast
  - Minimise dry pixels misclassified as water
  - Identify small water bodies

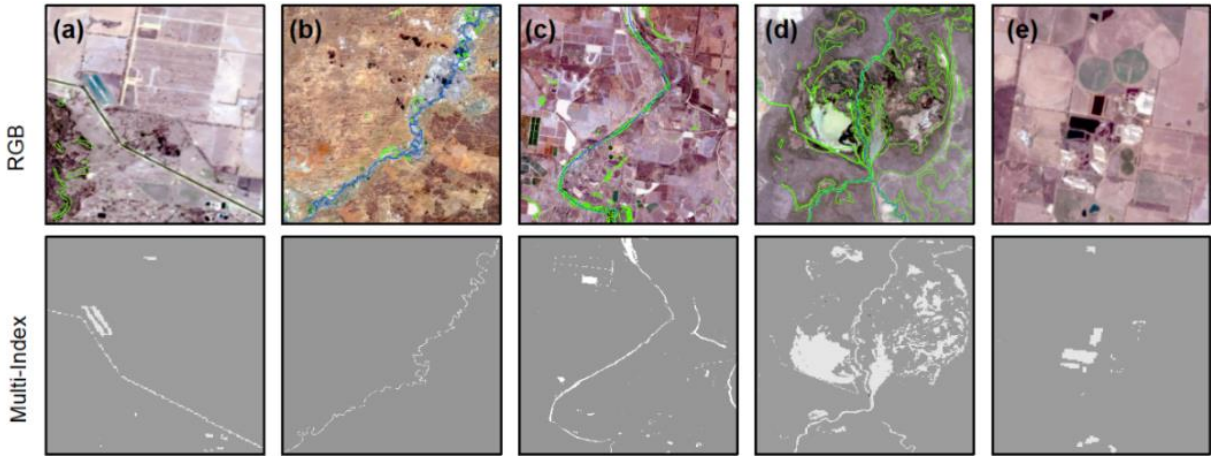


Using a multi-index method in MDB

- Slightly higher accuracy, but indices targeted to areas where they work best
- Identifies water in major rivers and wetlands while maintaining high accuracy for dry pixels

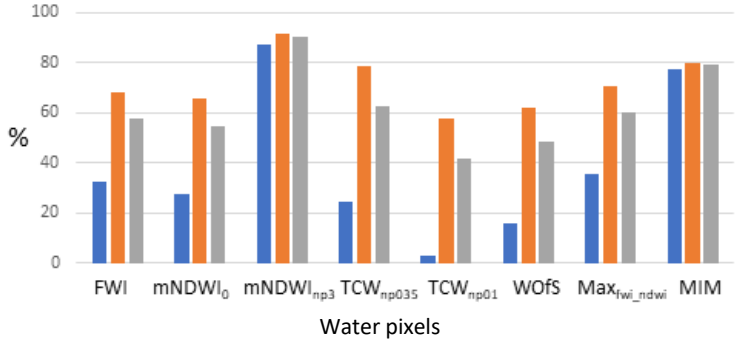
Water Index	Balanced accuracy
MIM	93%
Fisher WI	91%
mNDWI>0	91%
mNDWI>-0.3	90%
TCW >-0.035	92%
TCW >-0.01	90%
WOFS	86%



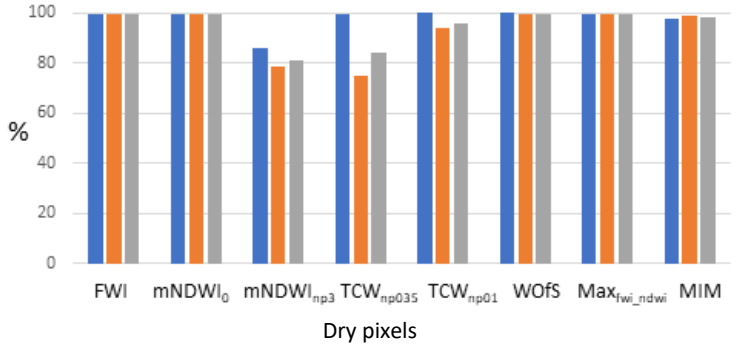


Using a multi-index method in MDB

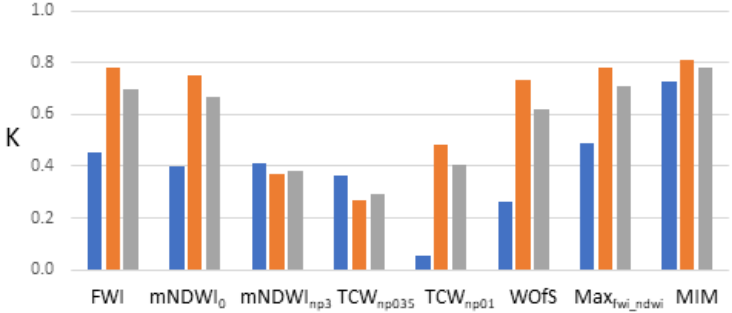
- Validation using independent sites



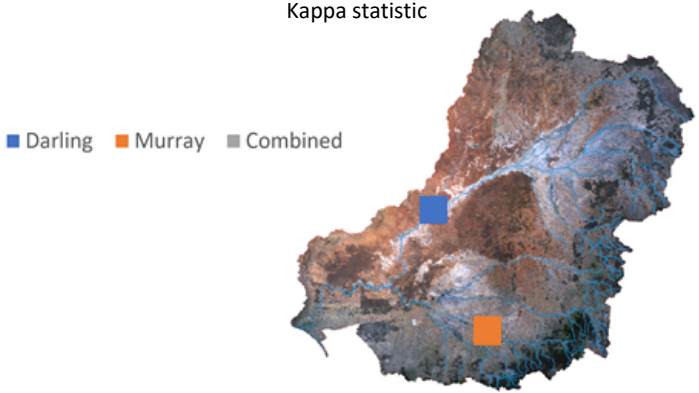
Water pixels



Dry pixels



Kappa statistic

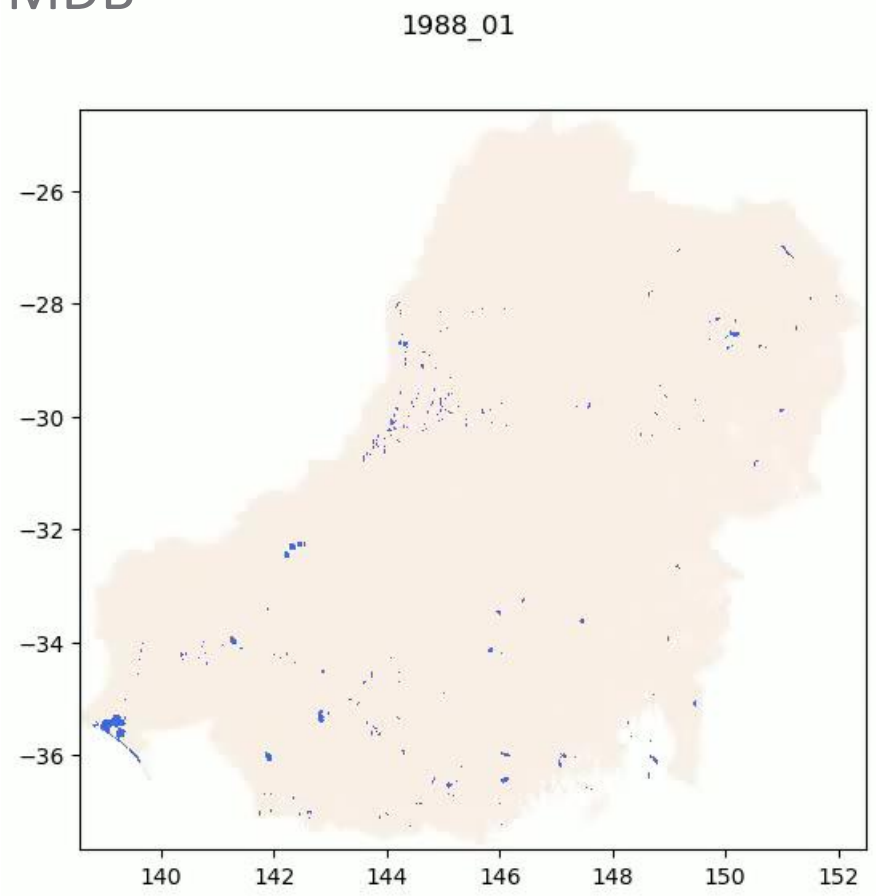


Mapping surface water using a multiple-index method

- Advantages
  - Can identify narrow river channels, different colour water bodies and flooded wetlands
- Disadvantages
  - Relies on information derived from GeoFabric and ANAE wetland layers
  - mNDWI> –0.3 and TCW> –0.035 can over-map water

Two-monthly water extent for MDB

- Maximum two-monthly extent of surface water
- 1988 to May 2022
- Method:
  - Read in all Landsat data within tiles with <20% cloud for two months
  - Calculate maximum water extent
  - Fill in gaps using WOFS two-monthly maximum water extent



Published material and products

- Development of a Multi-Index Method Based on Landsat Reflectance Data to Map Open Water in a Complex Environment. Remote Sens. 2022, 14, 1158. https://doi.org/10.3390/rs14051158
- Maximum two-monthly surface water extent for MDB from MIM and WOFS (version 1). https://doi.org/10.25919/wkg9-7t35
- Maximum two-monthly surface water extent for MDB from MIM and WOFS (version 2). Coming soon to CSIRO Data Access Portal
- Persistent water in the MDB from 1988 to 2020. Coming soon to CSIRO Data Access Portal
- Maximum number consecutive dry years (includes improvement to River Red Gum floodplains). Coming soon to CSIRO Data Access Portal

Thank you

Land and Water
Cate Ticehurst

+61 2 6246 5842

Catherine.ticehurst@csiro.au