Environment Institute Landscape Futures Program

THE UNIVERSITY OF ADELAIDE AUSTRALIA

New understanding of Great Artesian Basin wetlands through advanced remote sensing

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Great Artesian Basin Springs

Great Artesian Basin

- Jurassic-Cretaceous sandstone aquifer system
- Area ~ 20% Australia
- Total volume 64 900 000 GL
- Artesian discharge in spring groups near Basin margins

South Australia

- 23 major spring groups
- > 4,000 springs located so far…
- The most diverse, extensive & preserved springs

Great Artesian Basin Springs

Springs are highly important

- Geologically rare
- Endangered arid wetland ecosystems
- Ancient & endemic species
- Culturally significant
  - Indigenous Australians
  - European heritage
- Economically important
  - Mining & Petroleum
  - Pastoralism
  - Tourism
  - Towns & Domestic supplies

Great Artesian Basin Springs

Springs & wetlands are under threat

- Aquifer drawdown – reduced pressure
  - Artesian bores & wells
  - Dewatering for mining/petroleum operations
  - Mining expansion
- Excavation & modification
- Overgrazing
- Feral plants & animal invasion

Allocating Water & Maintaining Springs in the Great Artesian Basin

Major collaborative project

$14.6 million 2008-2011

Aims

- to better understand the hydrogeology and ecology of the springs and underlying aquifers
- develop new tools to assess and monitor surface water flows in response to groundwater extractions

Monitoring Mound Springs Wetlands with Advanced Remote Sensing

Aims

- Develop new tools to assess and monitor surface water flows in response to groundwater extractions
- Advanced remote sensing techniques for spring wetland survey
- Improved inventory, mapping of spring wetlands
- New tools for monitoring changes over time
  - Rapid & repeatable assessment

Government of South Australia

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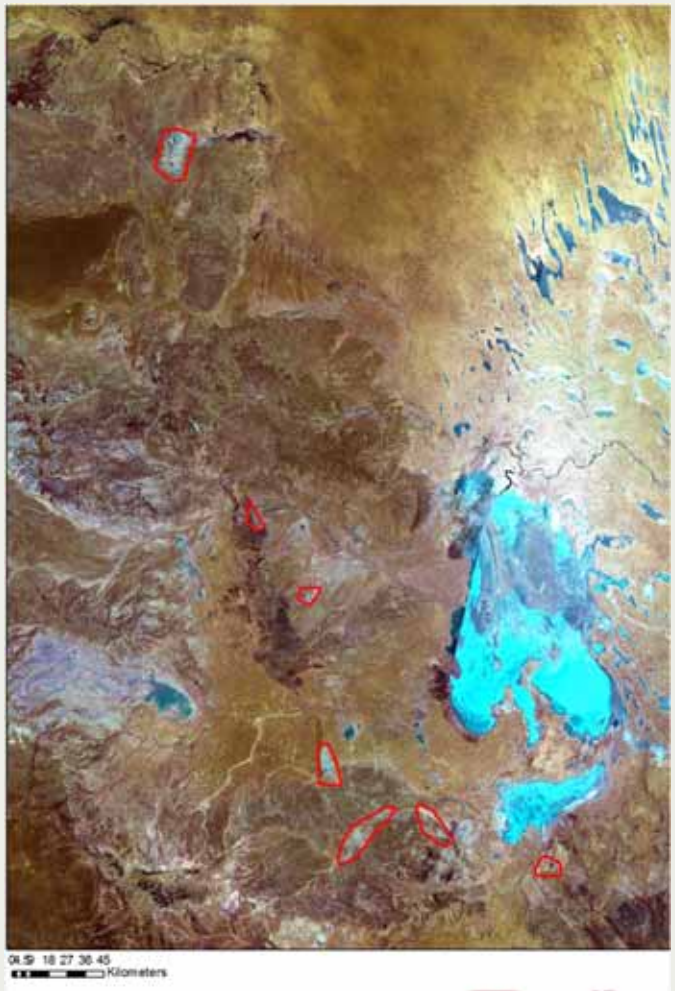
Imagery & Spatial Data

- HyMap airborne hyperspectral
- ARA Eagle airborne hyperspectral
- QuickBird very high resolution satellite
- WorldView very high resolution satellite
- UltraCam aerial photography
- ASTER VNIR, SWIR & Thermal
- MODIS 2002-10

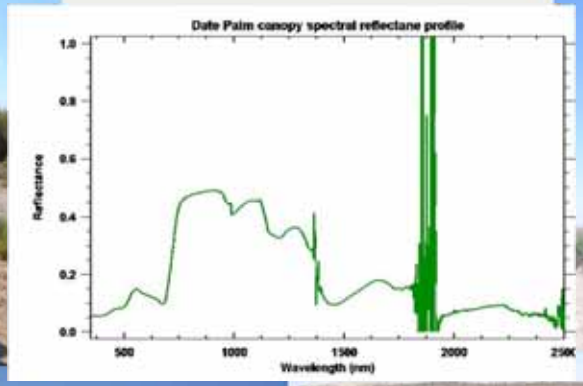
- 3 m DTM & DSM from 30cm orthophoto mosaic
- 30 m Australian SRTM DEM
- ARA Airborne LiDAR

- Trimble R8 GNSS RTK DGPS survey of spring vents



Vegetation & Soil Field Data

Spectral measurements



SA mound springs are highly diverse

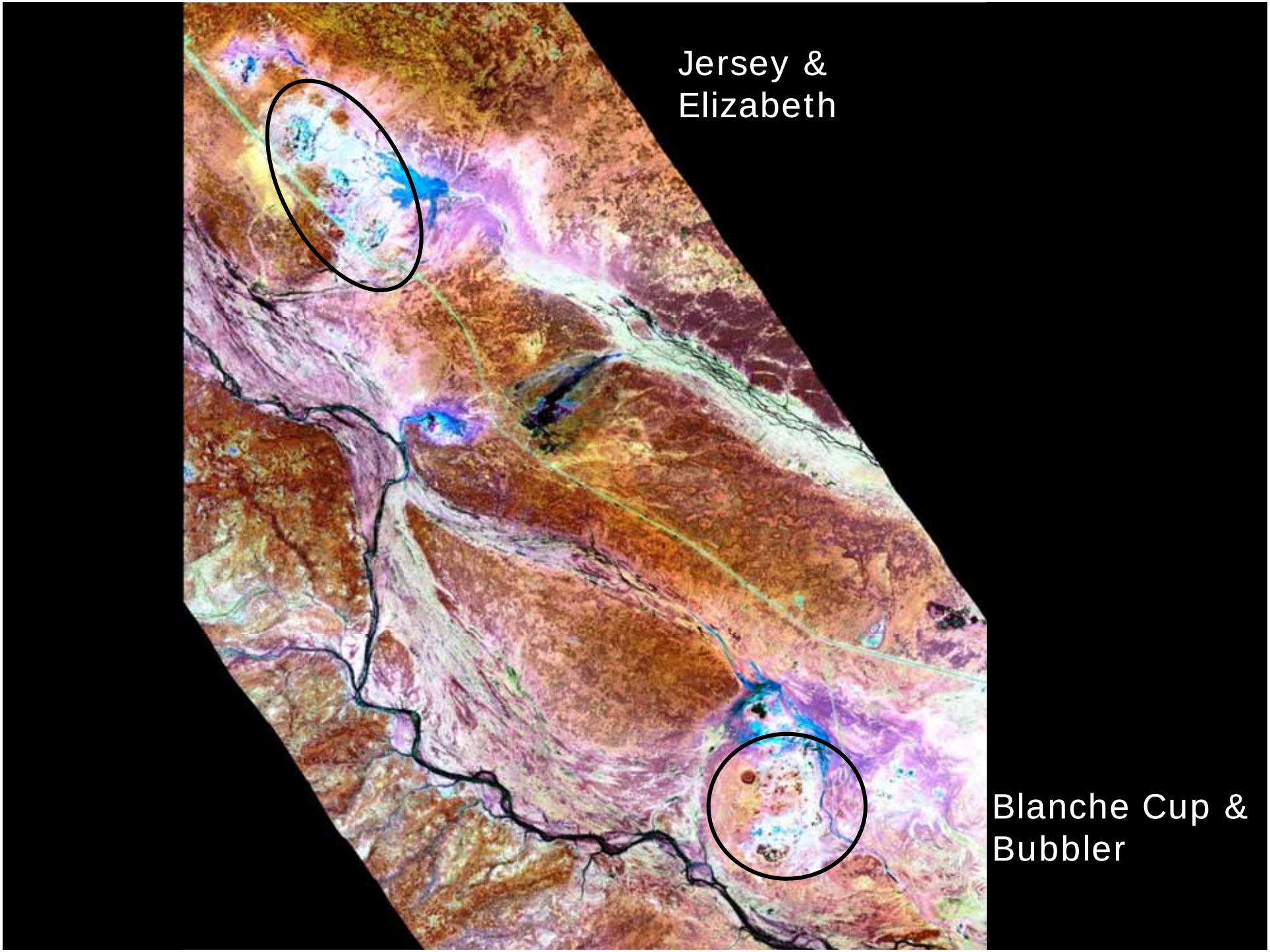
- Numerous
- Geomorphologic setting
- Vegetation & extent
- Diffuse discharge zone

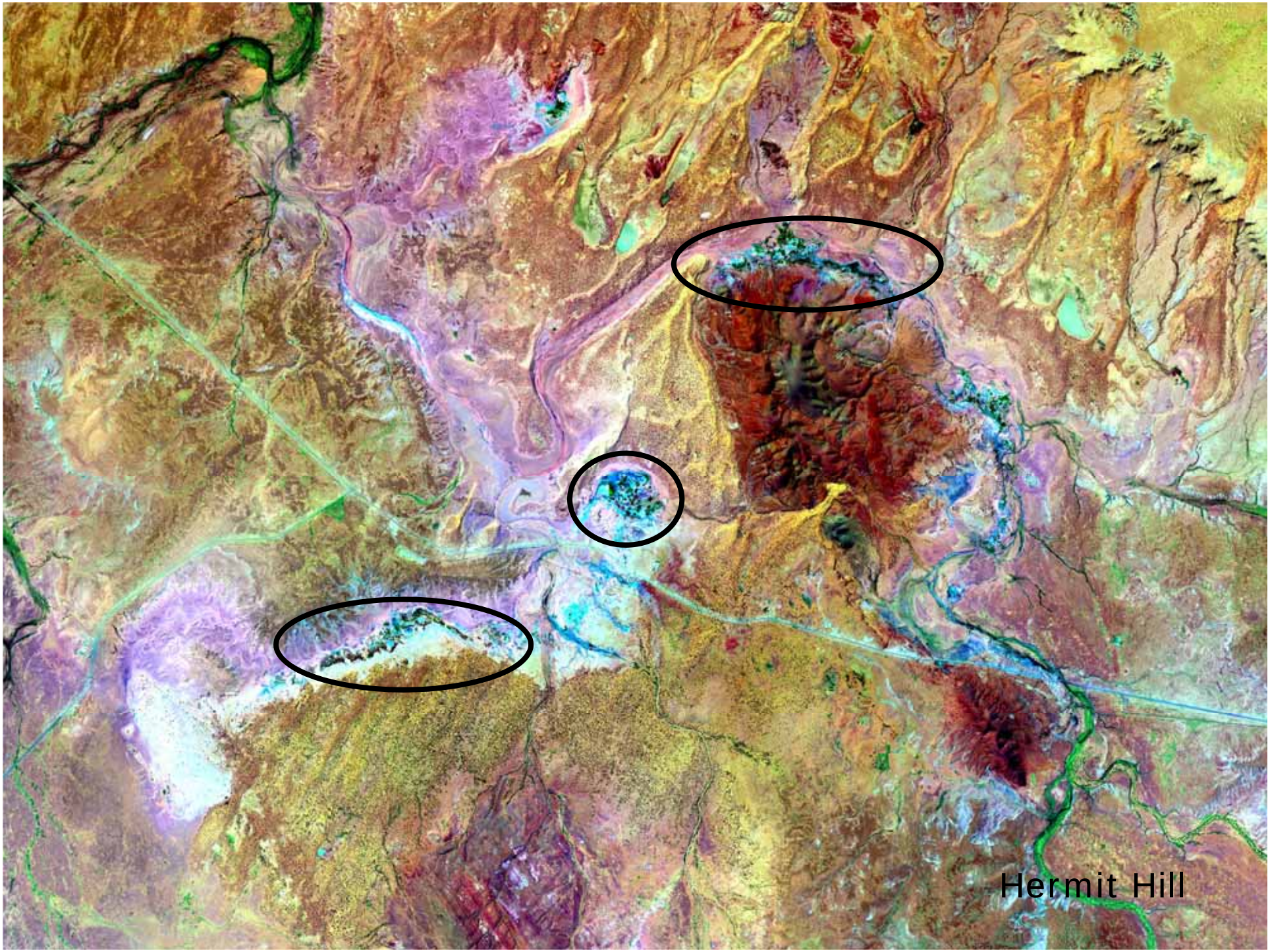
4000+ springs in numerous groups - geographically dispersed

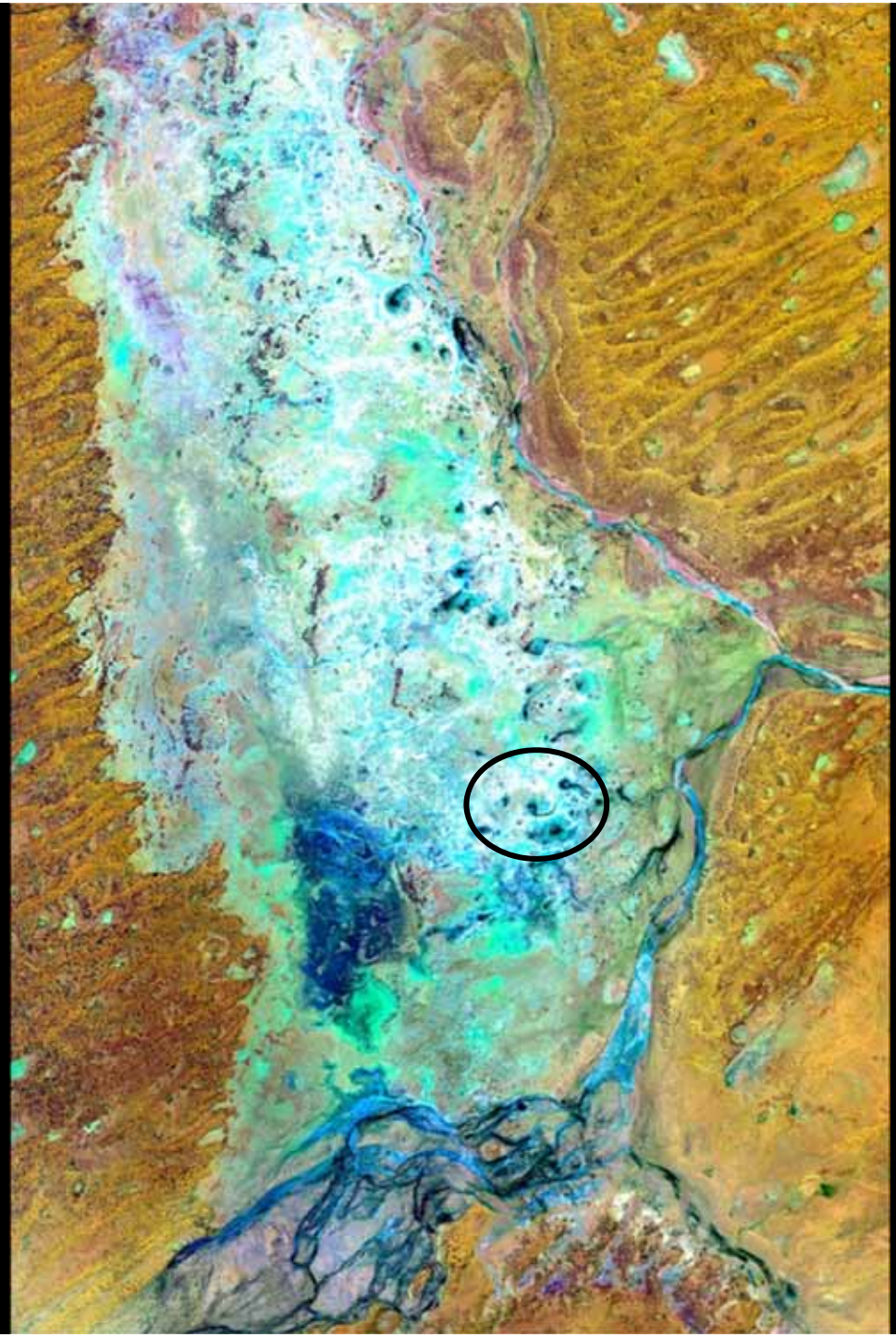
- First comprehensive precision survey of SA springs
- New springs discovered & surveyed

Trimble R8 GNSS RTK DGPS
GPS or Scaled from map
Omnistar DGPS
RTK DGPS

Dalhousie


Jersey &
Elizabeth
Blanche Cup &
Bubbler

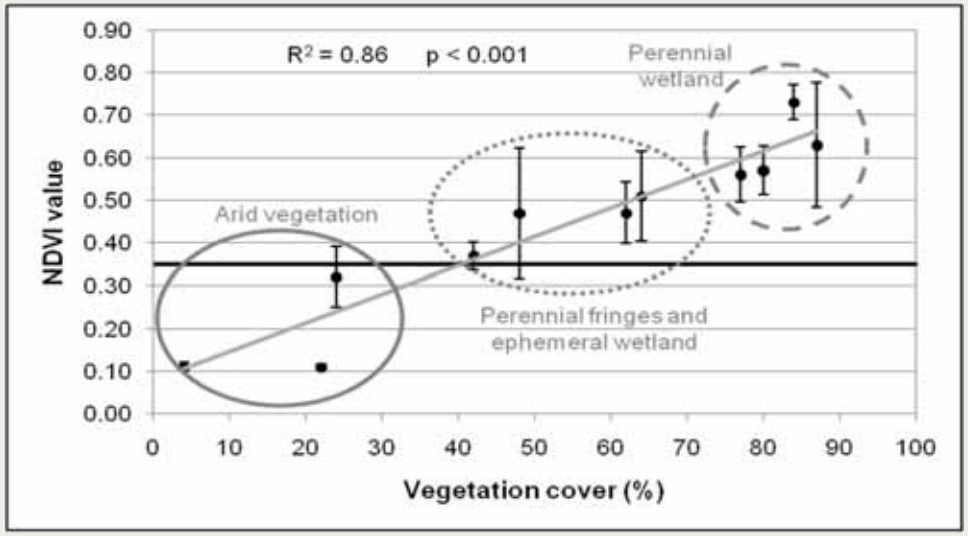

Hermit Hill

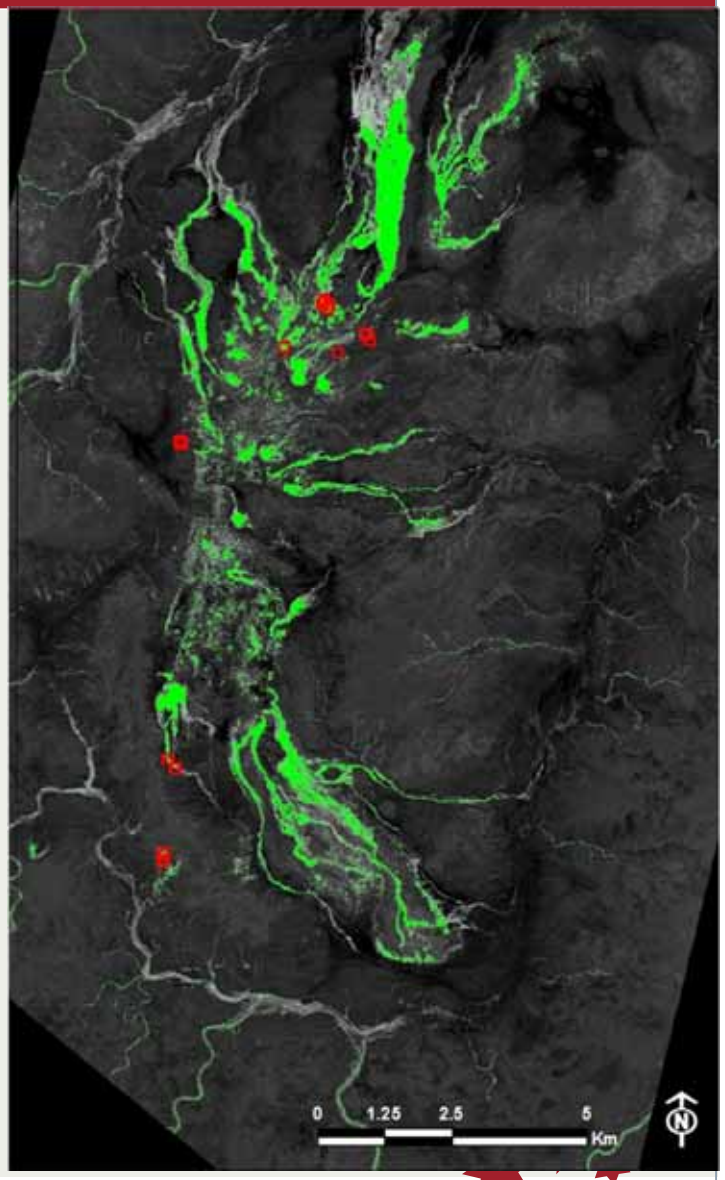


Francis Swamp

High resolution mapping of wetland extent

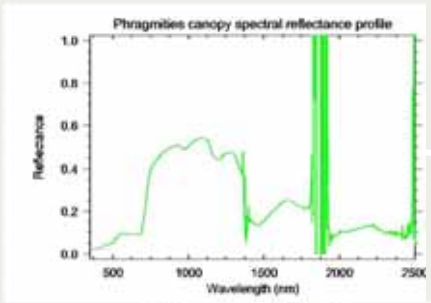
NDVI is related to % cover in field samples

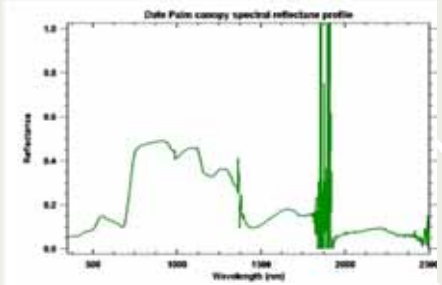


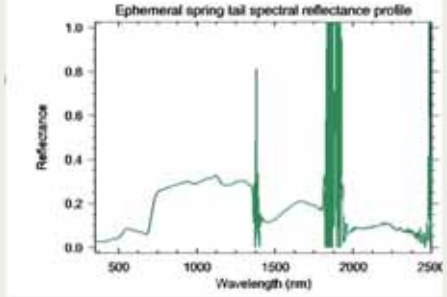


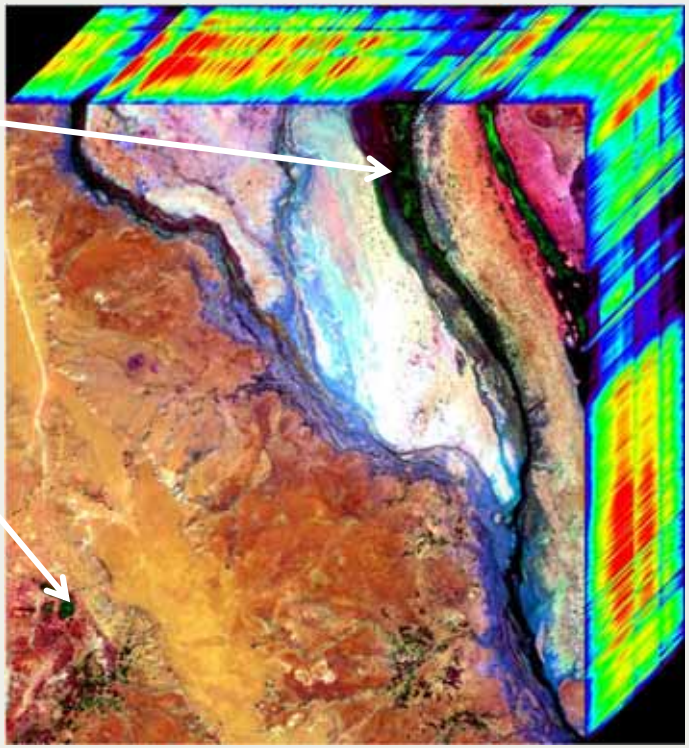
NDVI applied to HyMap, Dalhousie

Distinctive spectral features for different vegetation types

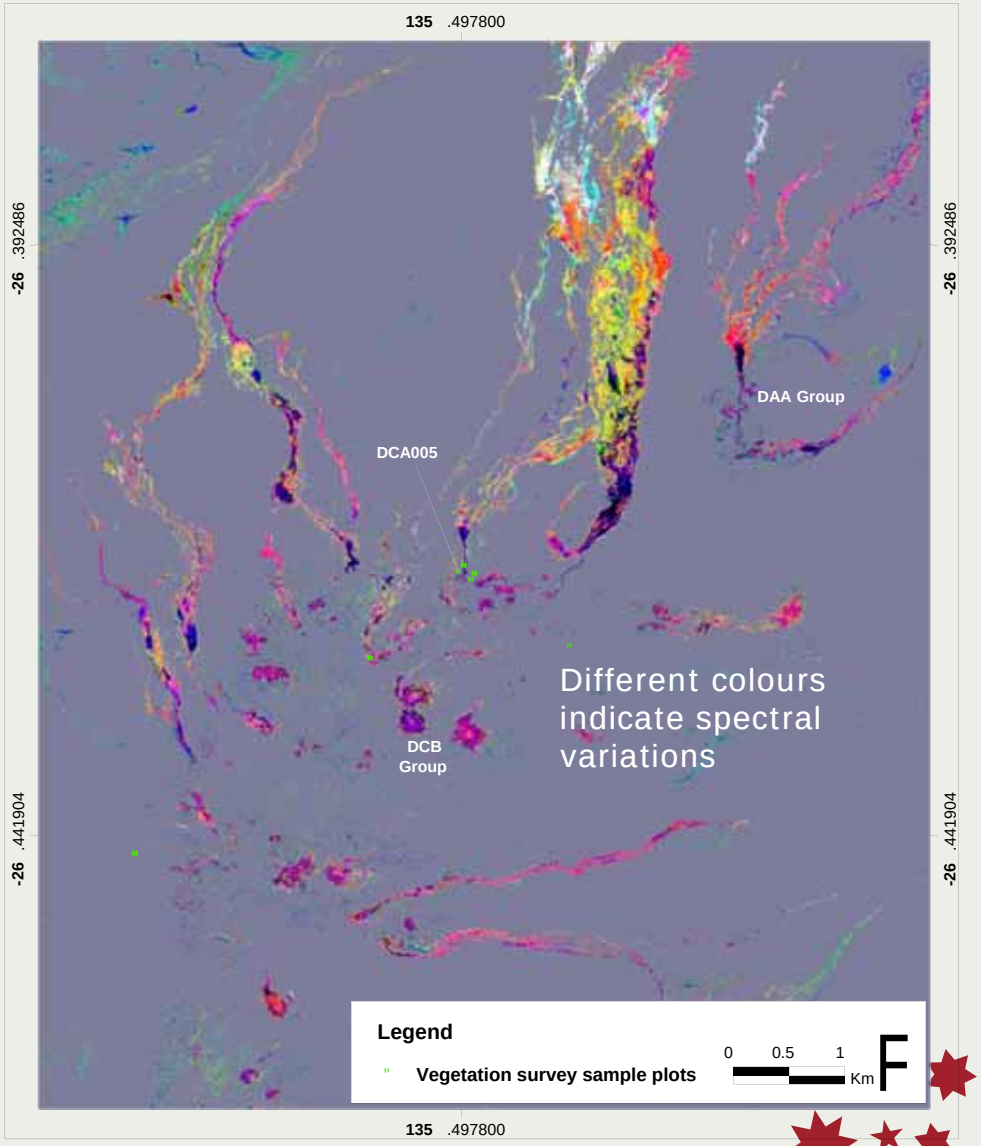






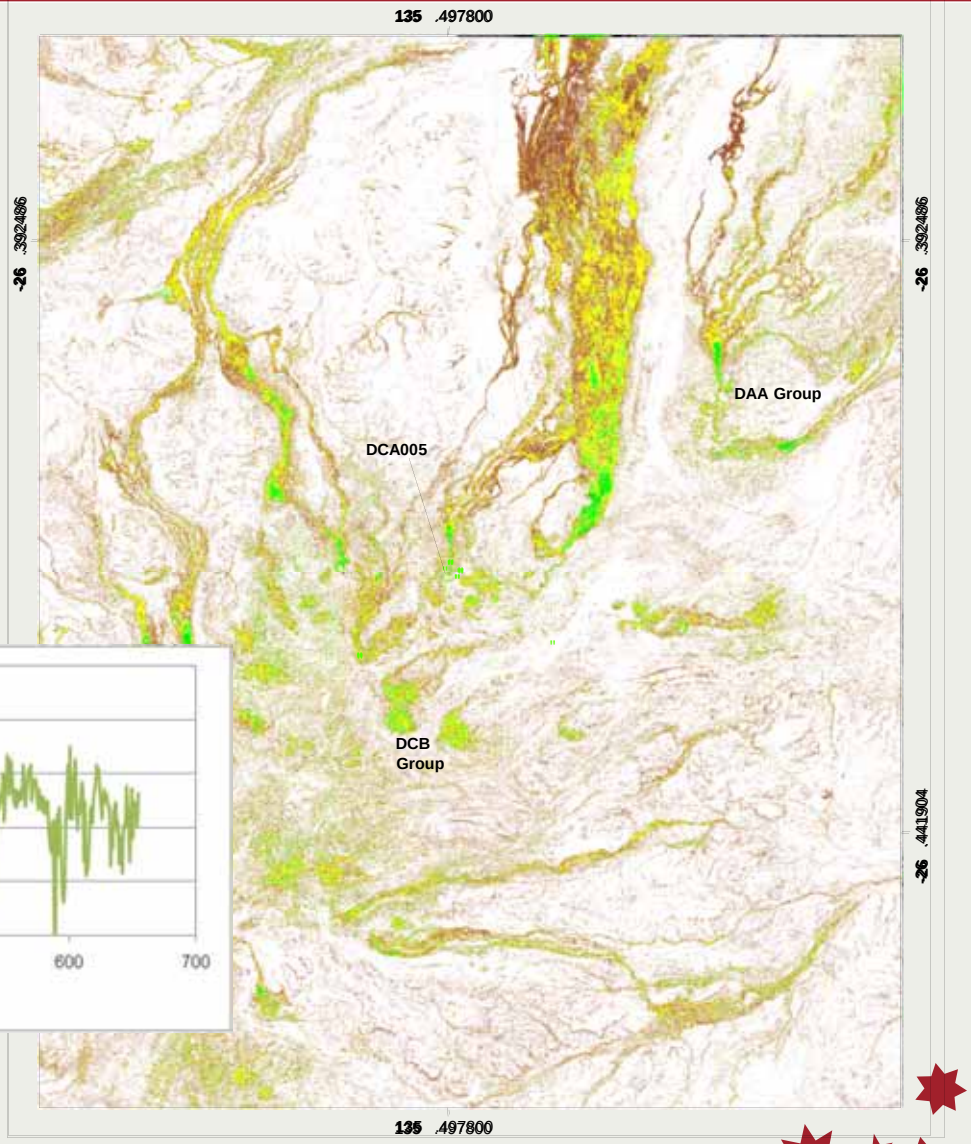


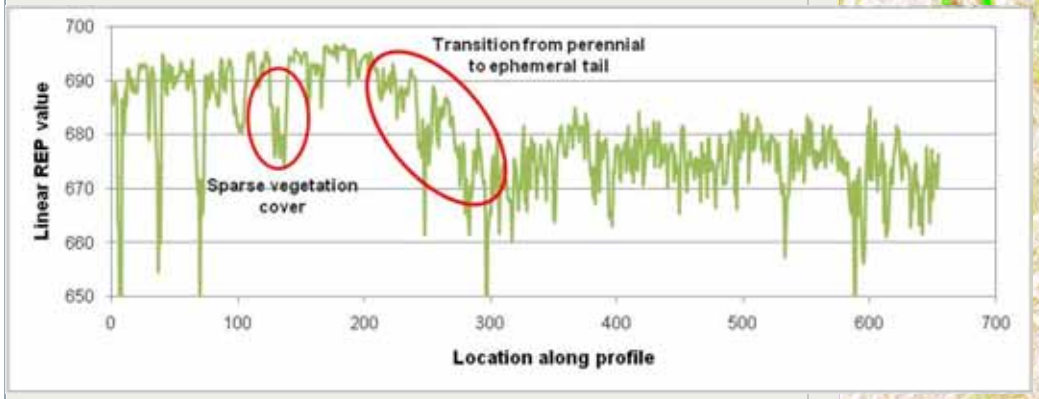
Much variation within wetlands revealed by spectral analysis



PCA analysis of WorldView II

Vegetation density & type differentiated with spectral analysis



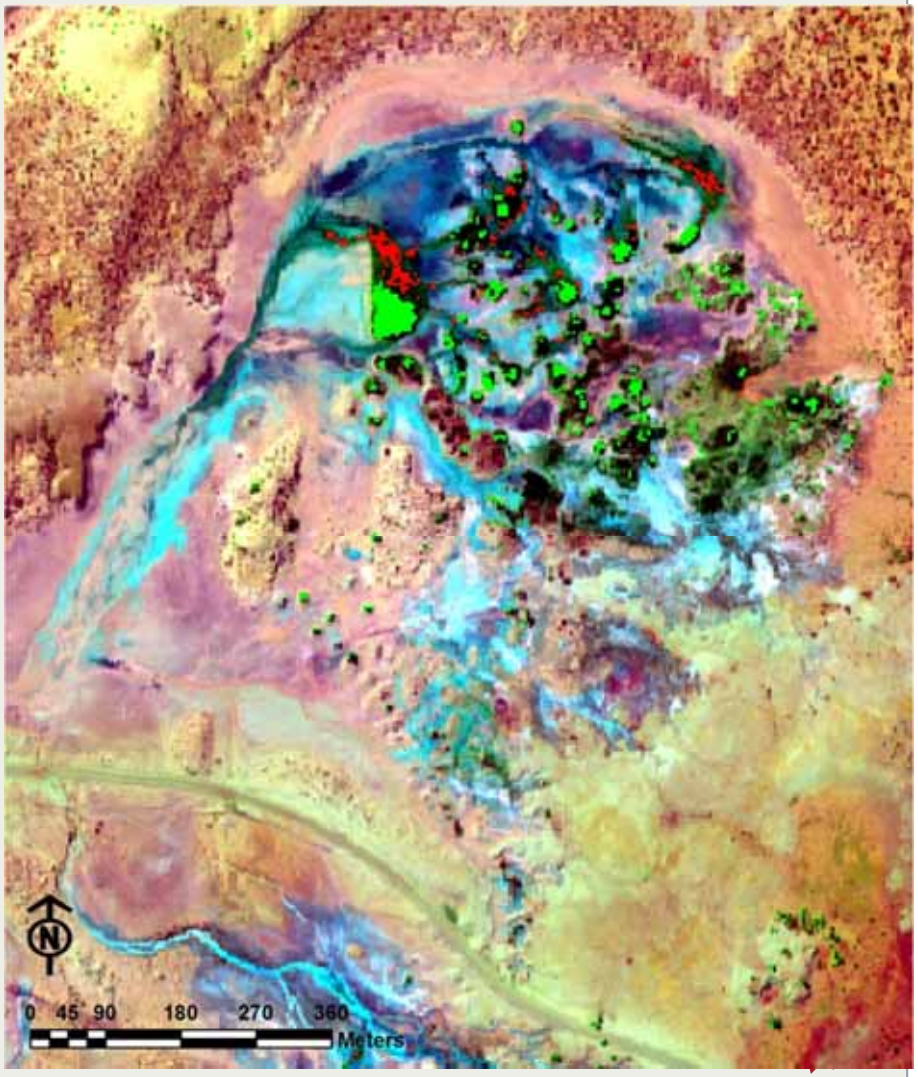


Red-edge of WorldView II

Spatial extent & distribution of key communities & species

- *Phragmites* nearest spring vents

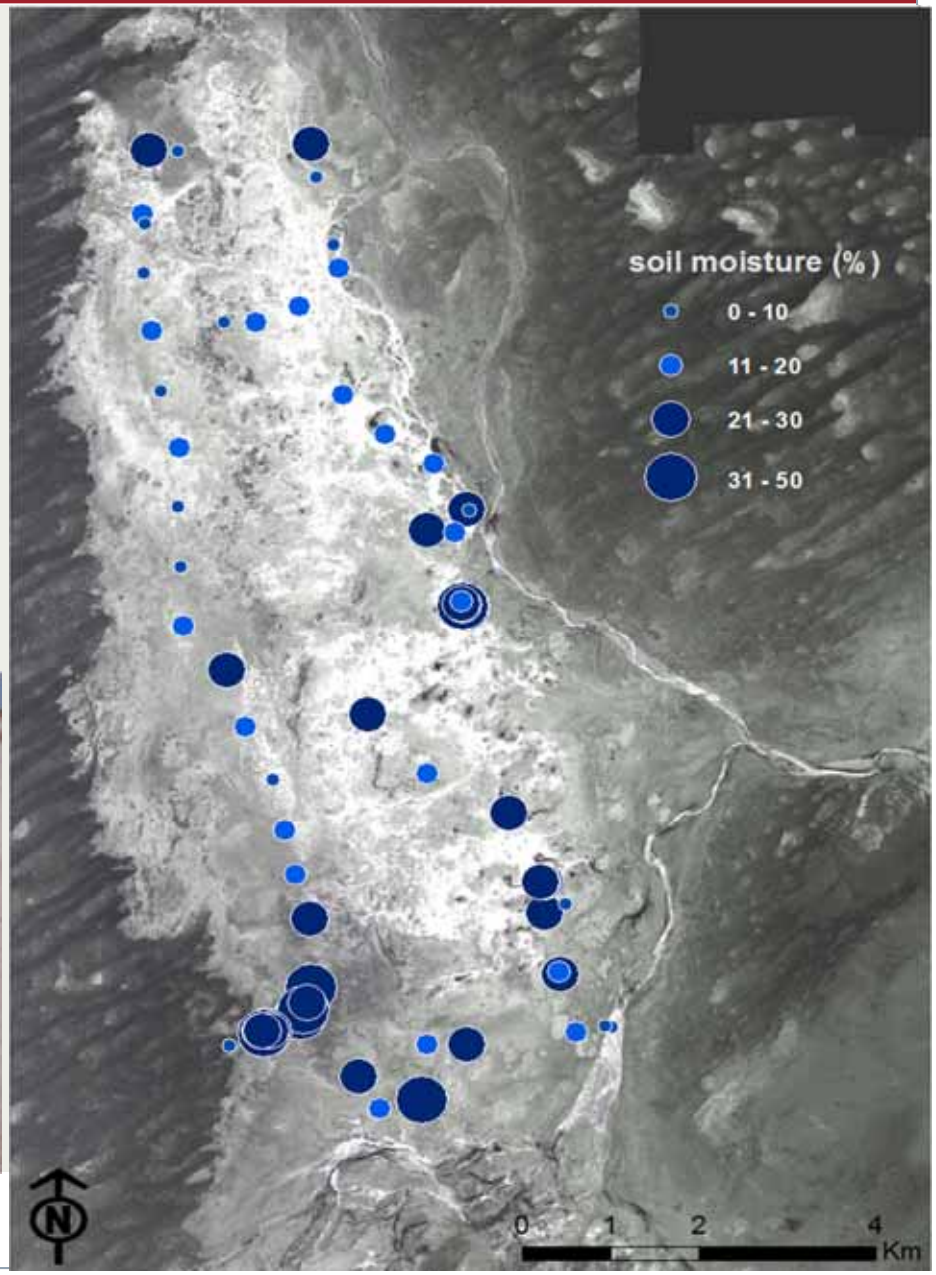
- *Cyperus* & *Fimbristylis* along spring tails



Hyperspectral analysis of HyMap

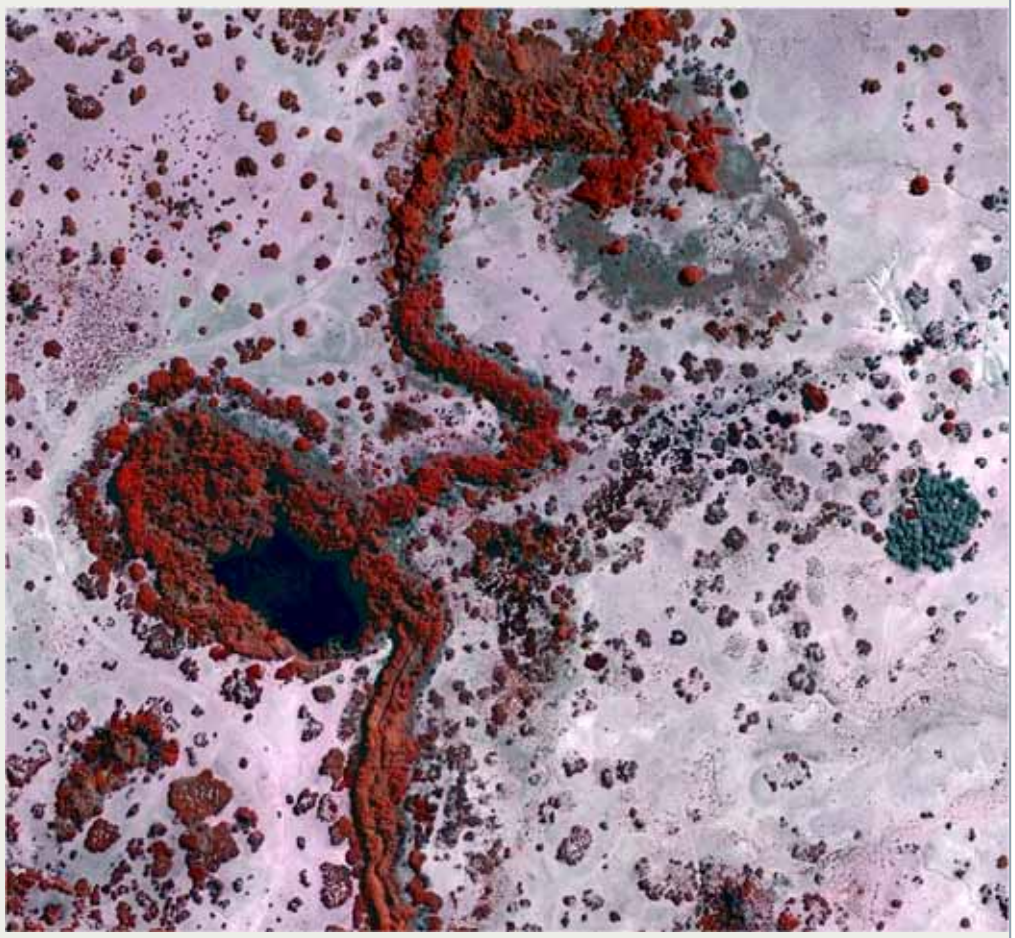
Extensive zones of evaporation & salt deposition

- Soil moisture higher near springs
- Important in water balance models



Digital aerial photography

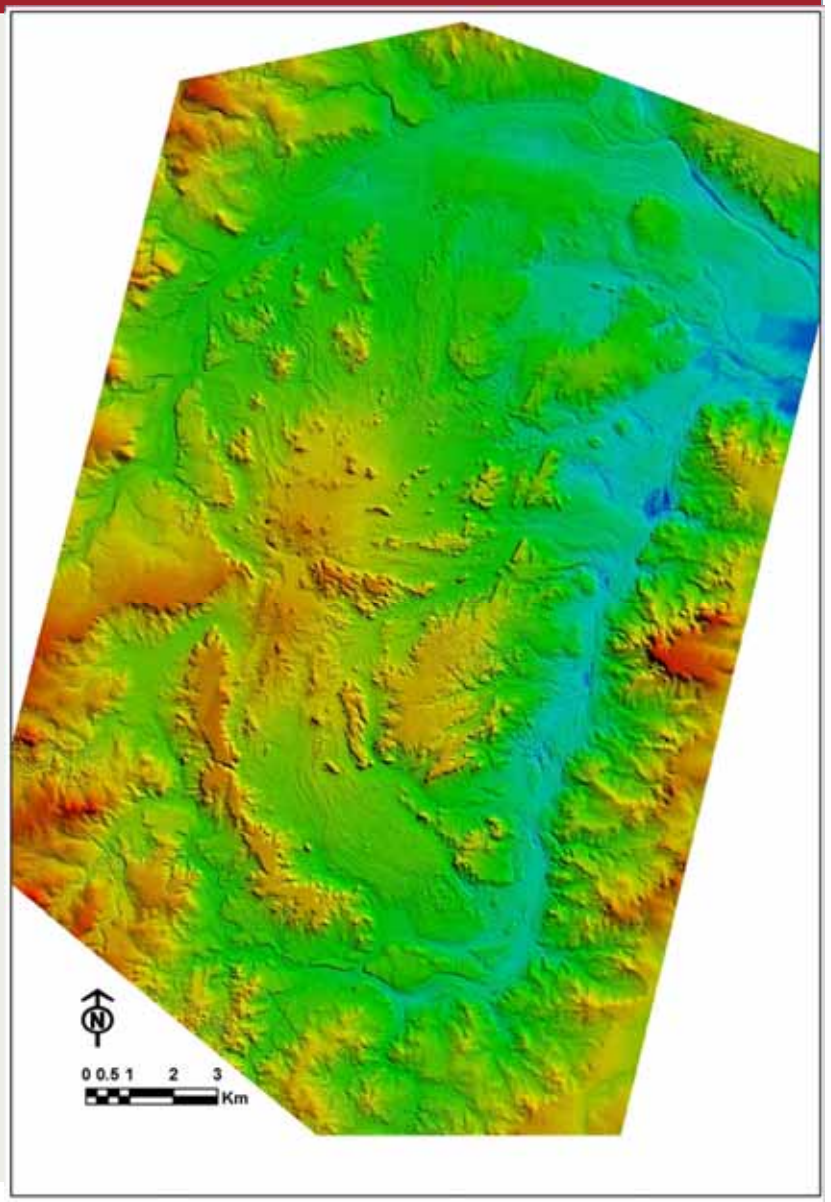
- Highly valuable for validating spectral mapping
- Supplements field sampling



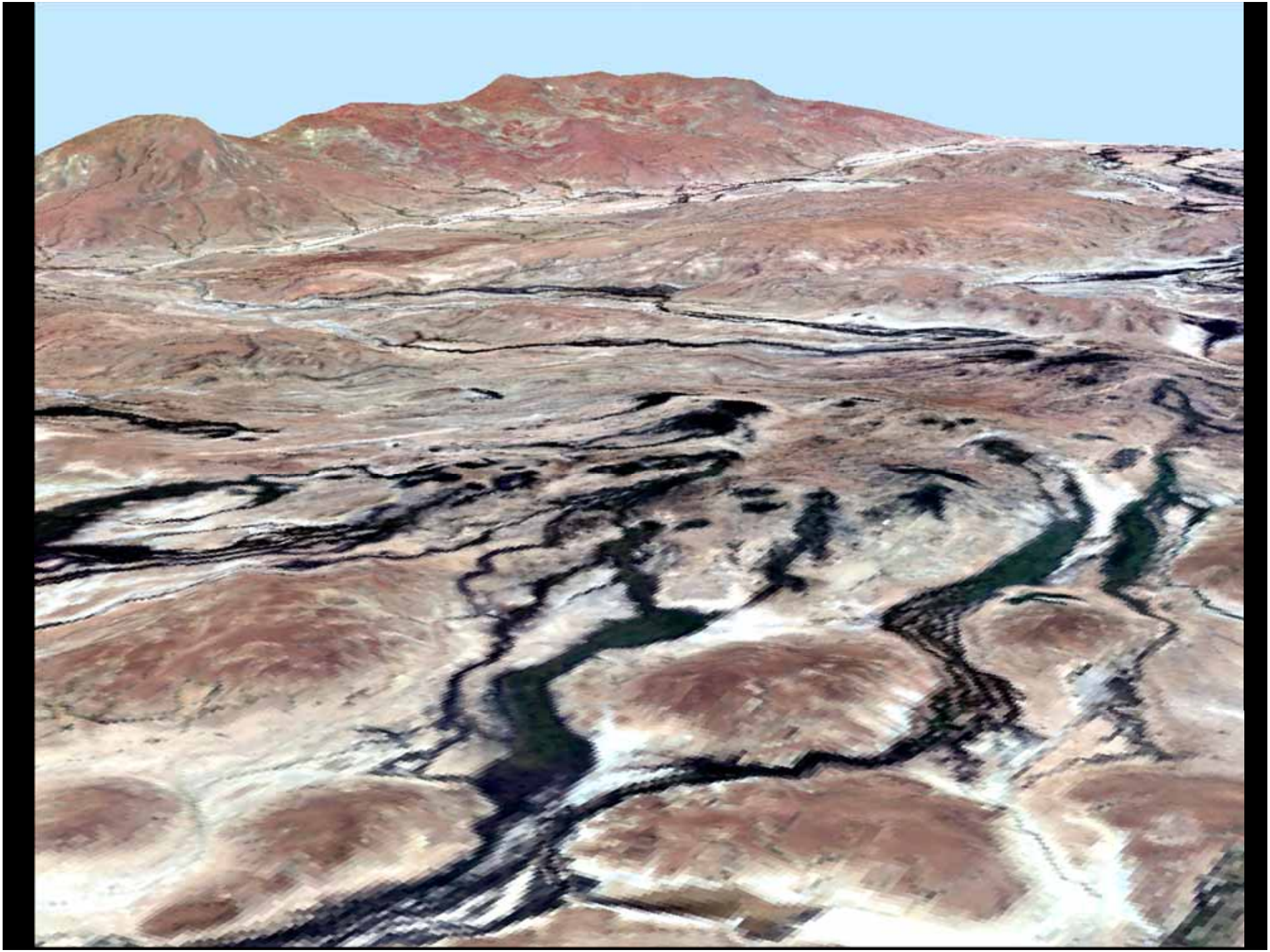
UnltraCam false colour
30 cm, orthorectified

DTM & DSM products

- Used to define boundary of spring discharge
- Provide context for spring spatial distribution, morphology & hydrogeology



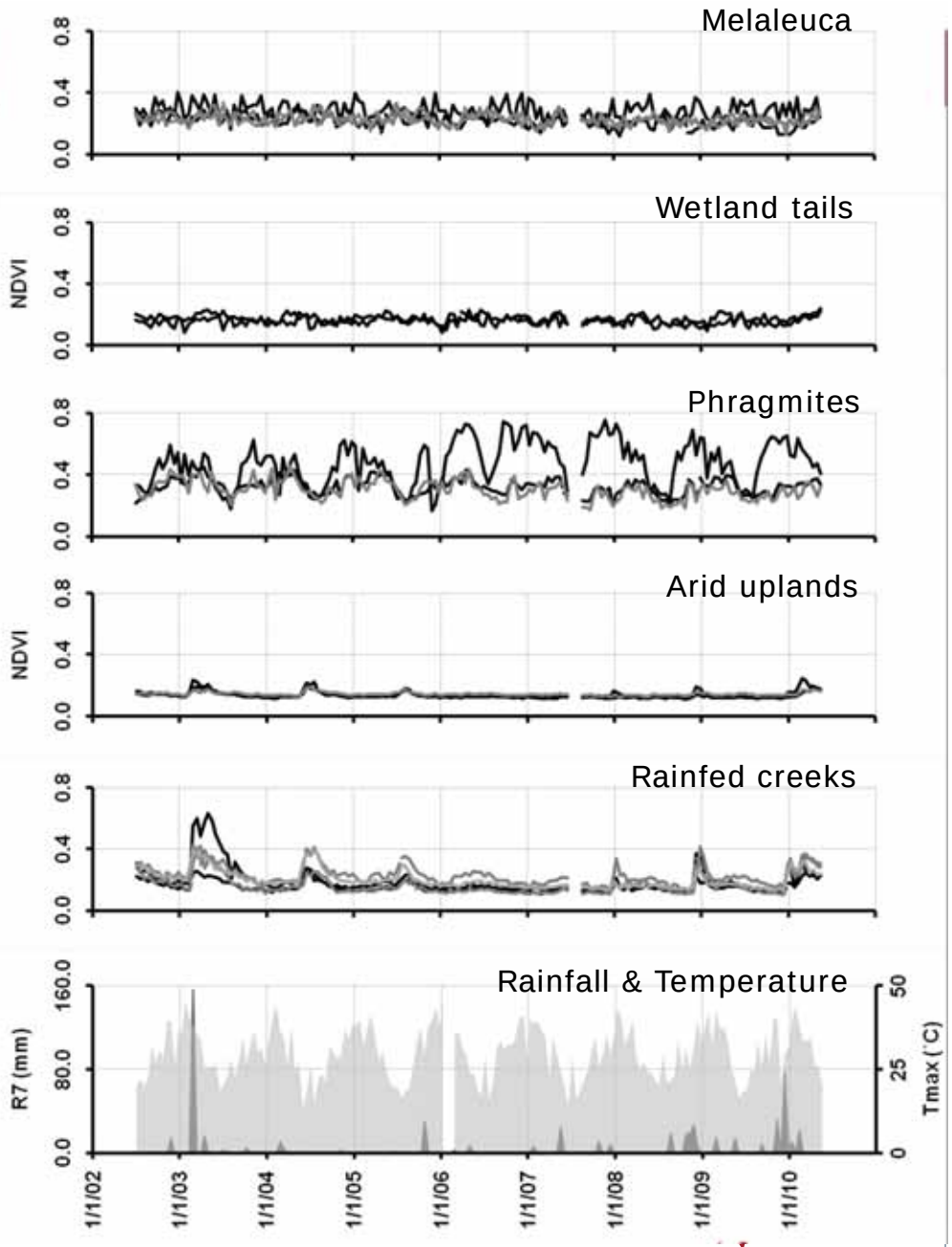
UltraCam 3m DTM April 2011



Spring vegetation changes over time

- Seasonal changes
- Long term trends
- Climatic influences
- Environmental & management effects

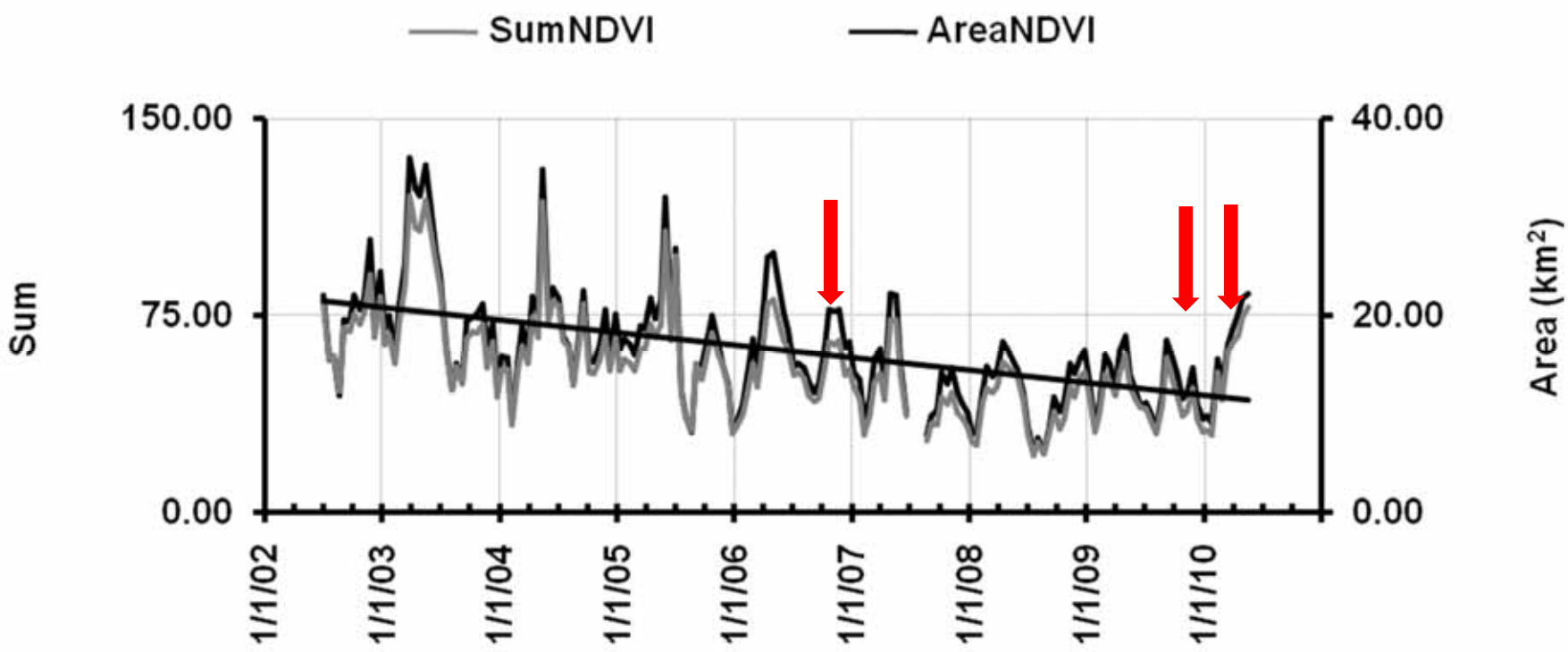
Different wetland communities have characteristic seasonal phenological patterns



MODIS NDVI 16-day composites
2002-2010

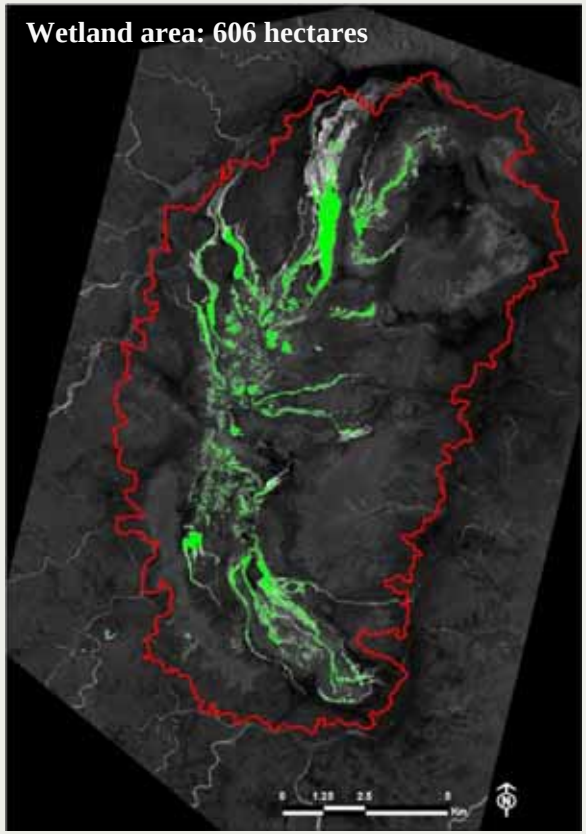
Dalhousie

- Seasonal fluctuations in wetland greenness & area
- 10 year decline in area

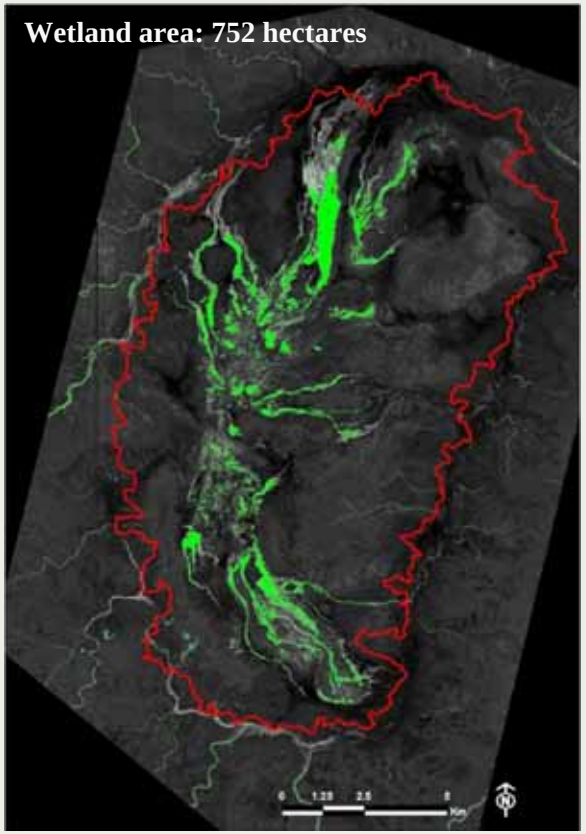


Change over time in wetland vegetation extent

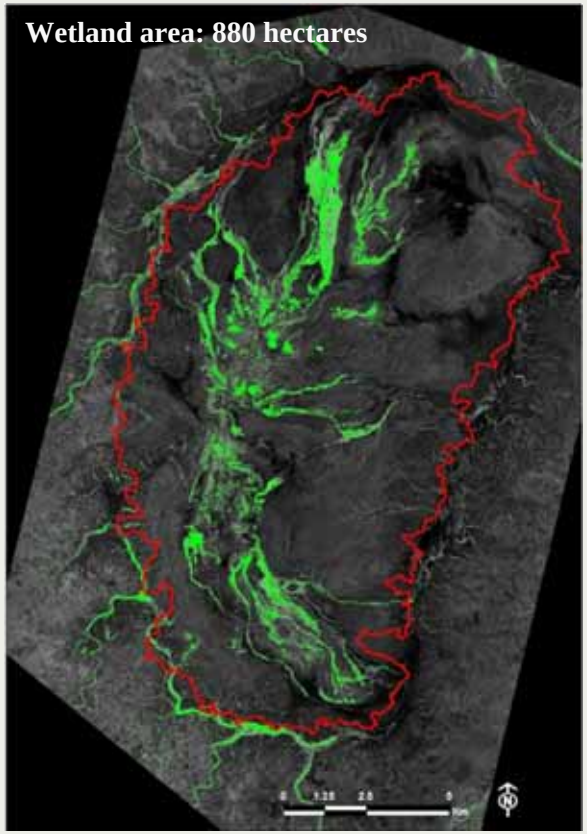
Nov 2006



Nov 2009



Mar 2010



- QuickBird NDVI threshold
- Wetland area correlated with flow volume

Change over time in wetland vegetation extent

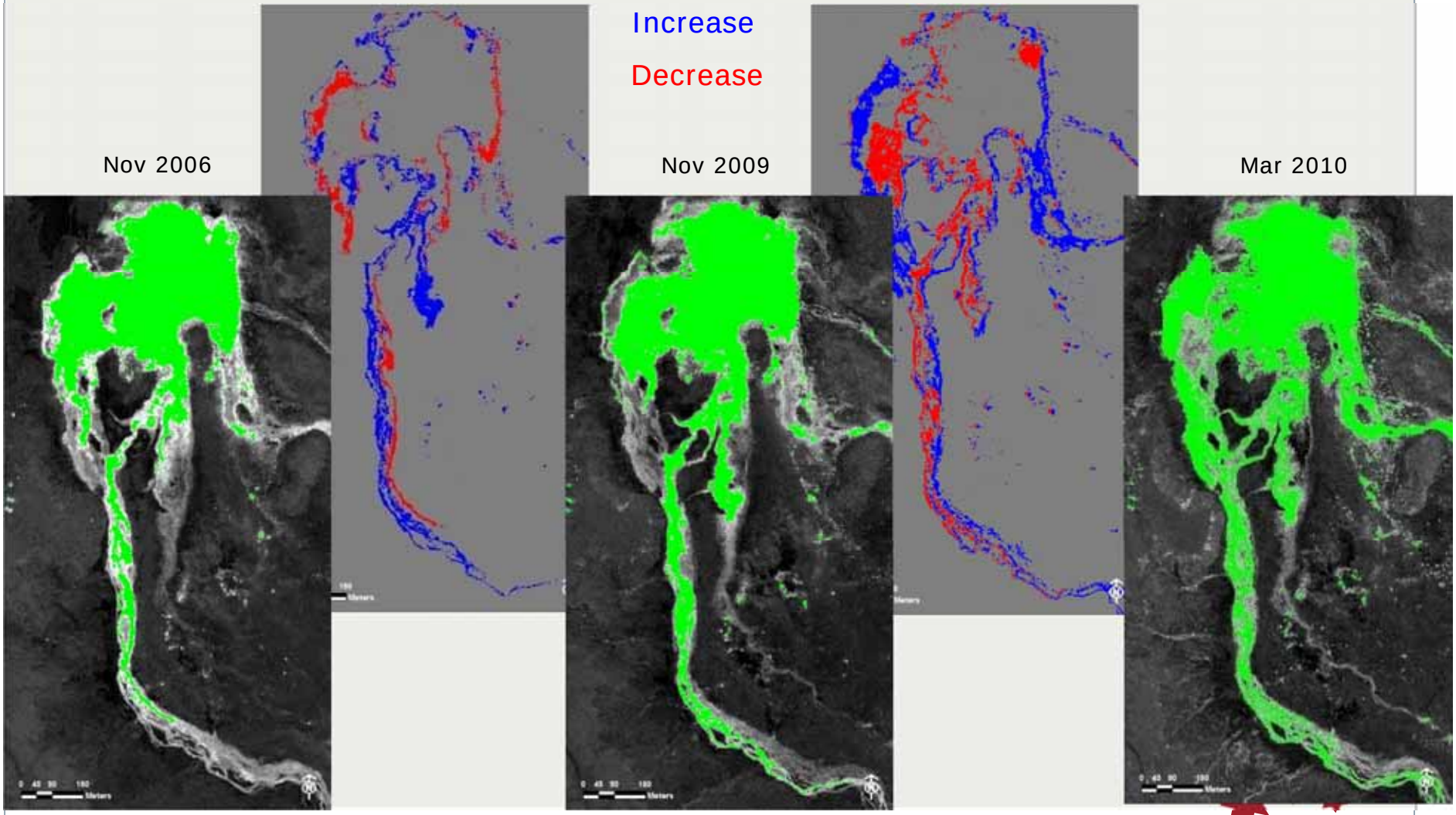
Increase

Decrease

Nov 2006

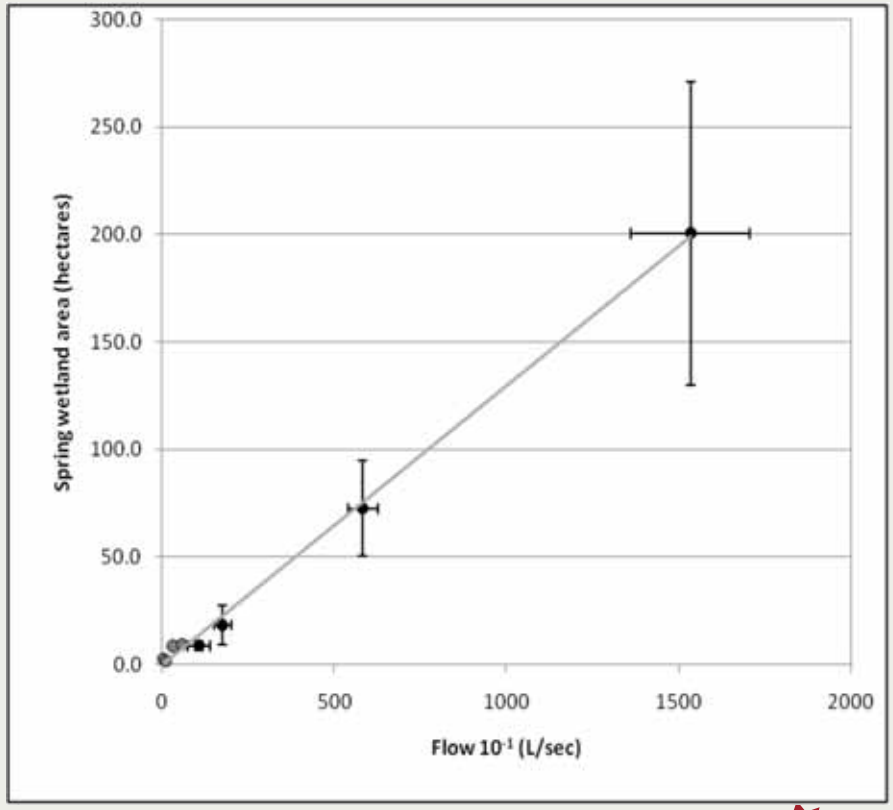
Nov 2009

Mar 2010



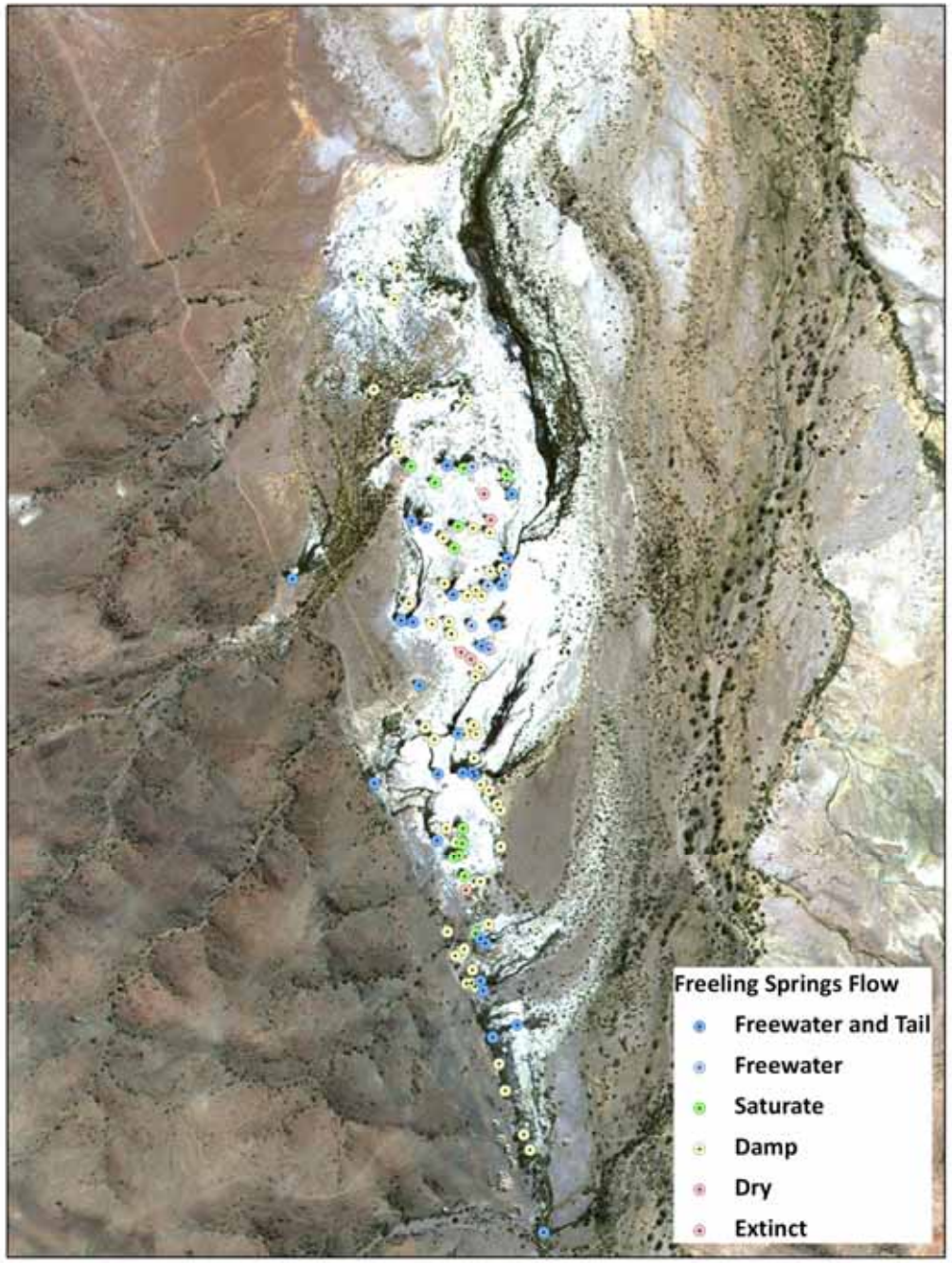
Wetland area is related to spring flow volume

- Wetland area provides a surrogate for spring flow
- Can be mapped from remote sensing
- A tool for monitoring spring flow over time



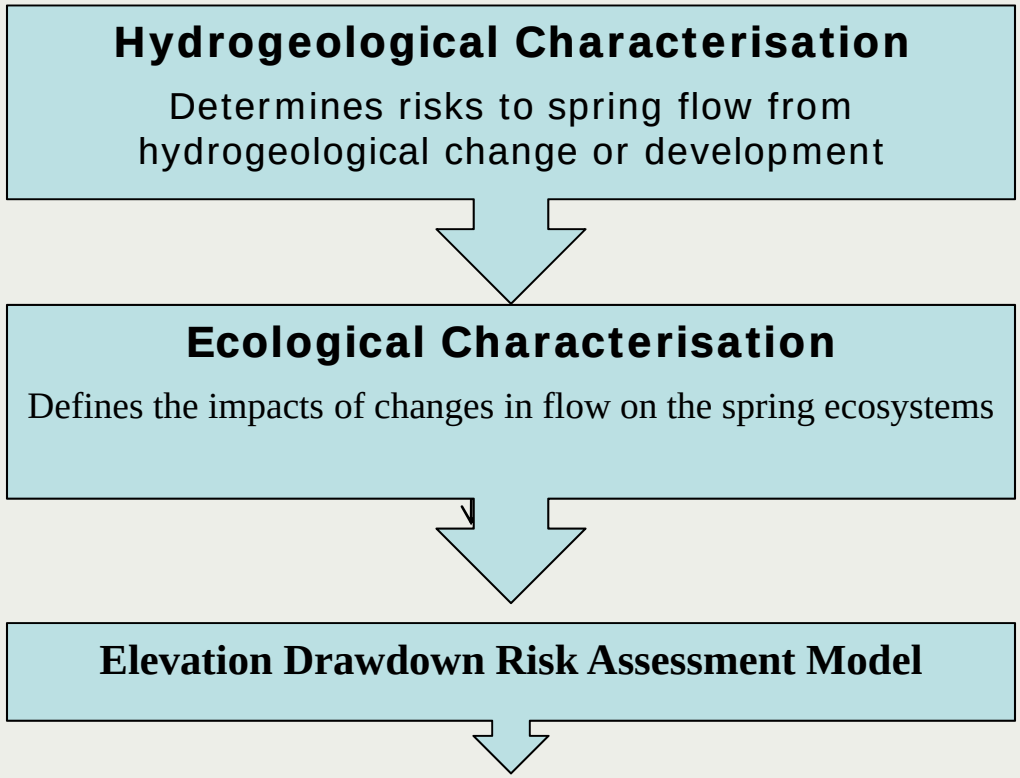
Spring survey

- Informs spring status & classification
- Assists remote sensing interpretation
- Reveals spring hydrogeology & evolution



How is this information being used?

GAB Spring Classification and Risk Assessment



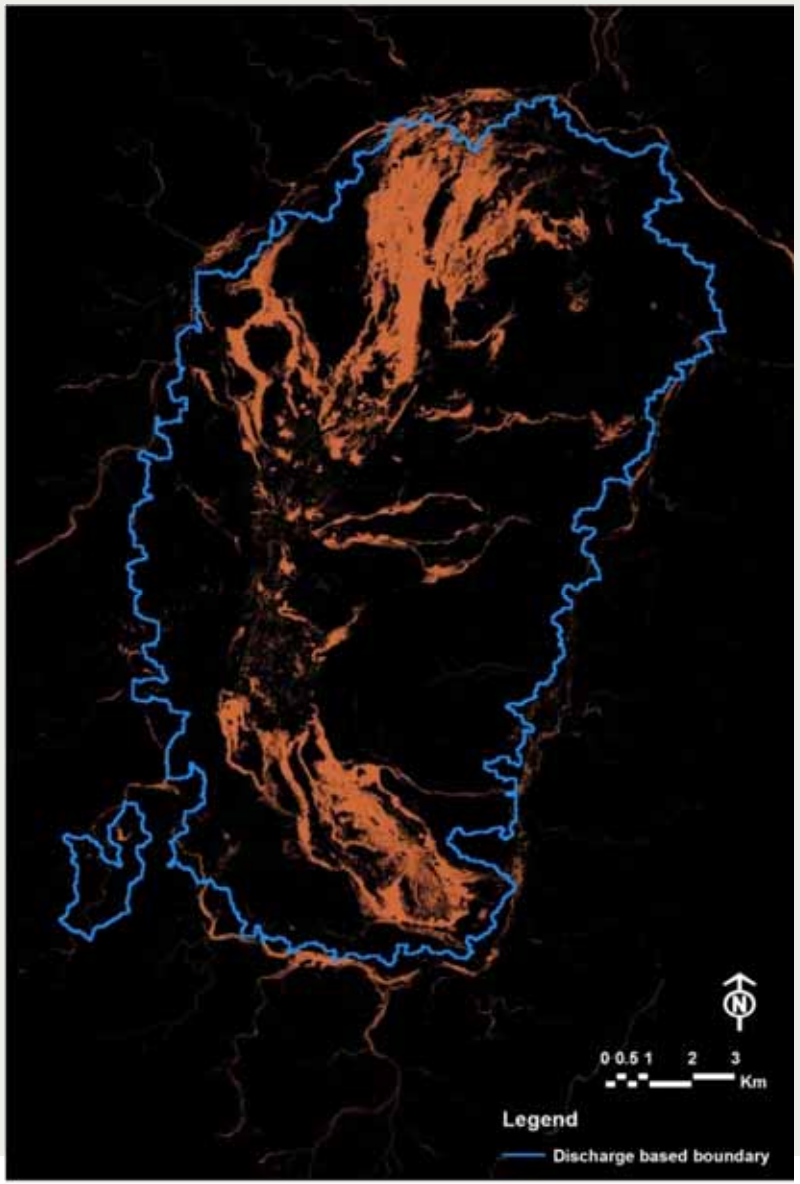
Significant Ecological Threshold

High Value Aquatic Ecosystems mapping

- Definition of areas for protection
- Informing government policy

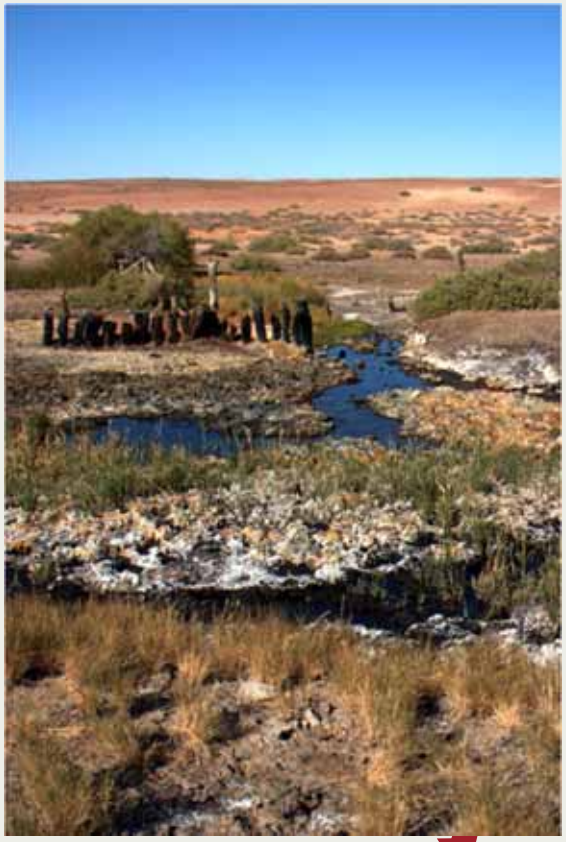
SRTM DEM delineates spring discharge zones

Soil moisture index from HyMap, March 2009



Improved capacity to assess wetland status & impacts

- New inventory, mapping of spring wetlands
- New information about vegetation distribution, diversity & dynamics
- Baseline for monitoring change
- New tools for monitoring changes over time
  - Objective, repeatable, spatially comprehensive
  - Cost effective



Acknowledgements

The Australian National Water Commission
South Australian Arid Lands Natural Resource Management Board
South Australian Department for Water and Department of Environment and Natural Resources.
HyVista - HyMap imagery & digital photography
Airborne Research Australia – LiDAR & hyperspectral imagery
Many field assistants
Traditional owners and custodians of the SA spring country
Pastoralists and graziers of the Oodnadatta and Strezleki Tracks
Witijira Management Board
Marree Arabunna Community
DENR and DFW staff
BHPBilliton
Friends of Mound Springs

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