RECHARGE AND DRYING IN AN ENVIRONMENTAL WATERING SITE OF THE LOWER RIVER MURRAY

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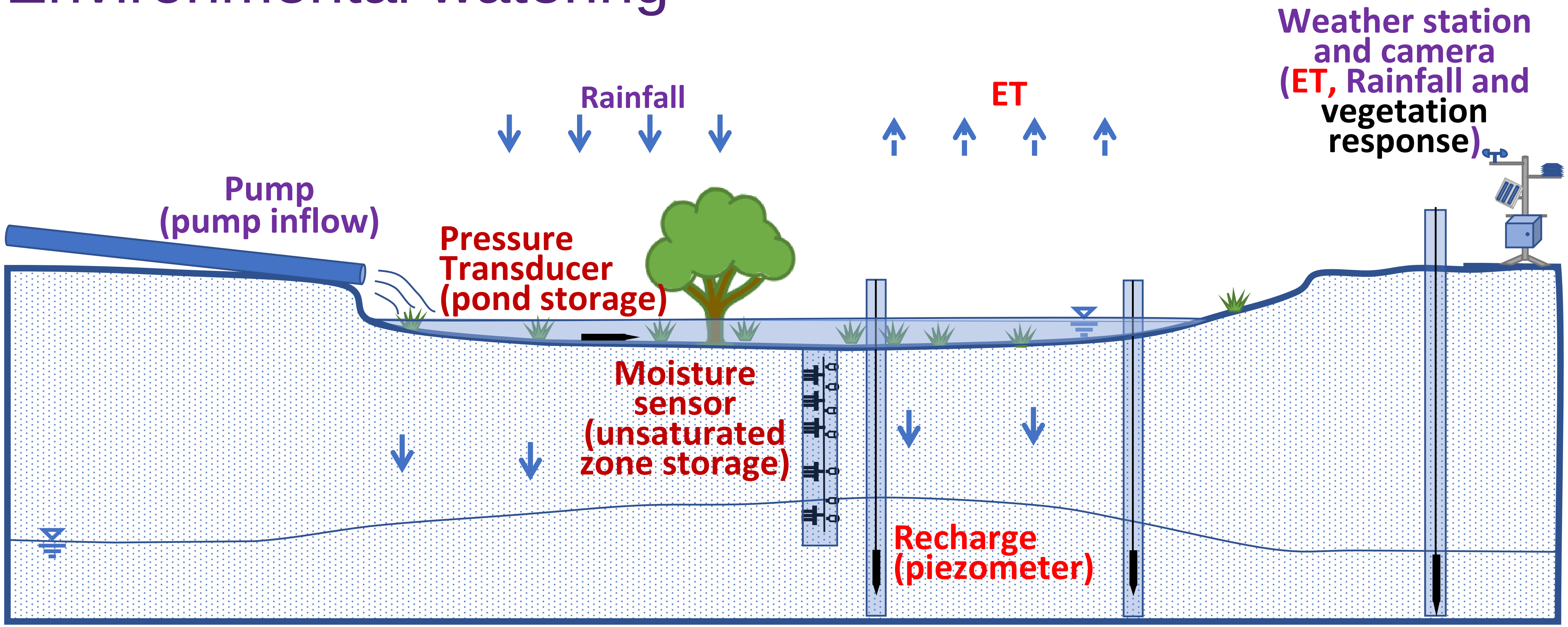
Why?

- Where does the water go with floodplain inundation? This phase looks at the overall mass balance throughout all pathways: evaporation, infiltration and recharge.
- What are the management considerations for environmental water to get the best ecological benefit?
- Can this help us optimise how we deliver water for the environment?
- Groundwater models estimate river salinity and risk of floodplain salinization
  - They are sensitive to inundation recharge rates, but these are poorly constrained by data
  - Need data!

Outline

- Introduction
- Site selection and set-up of the IoT monitoring system
- Field monitoring results
- Large column testing on the wetting and drying of the floodplain soils
- Numerical modelling on the dynamics of water and salt during e-watering
- Conclusion

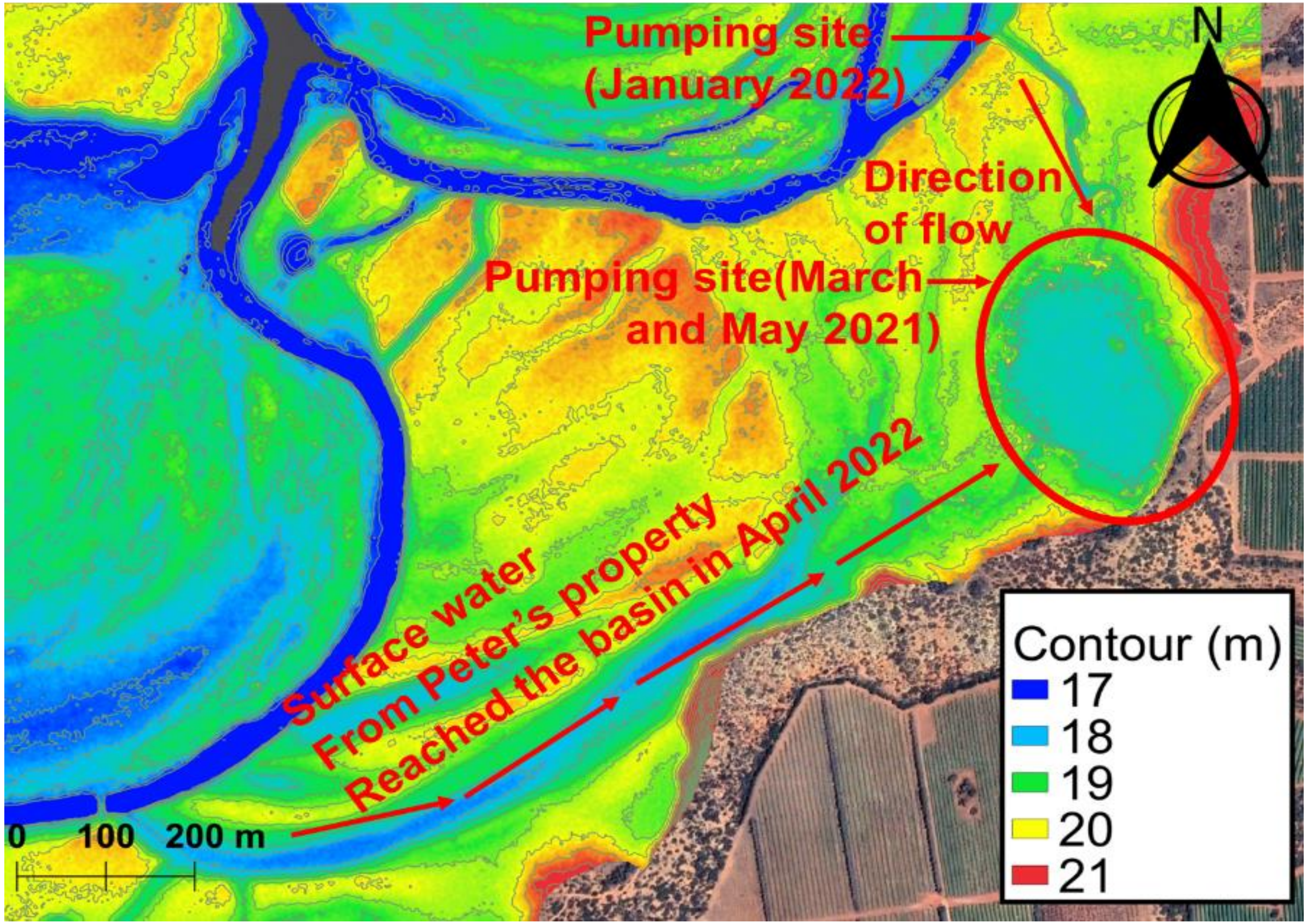
Environmental watering



Mass balance:

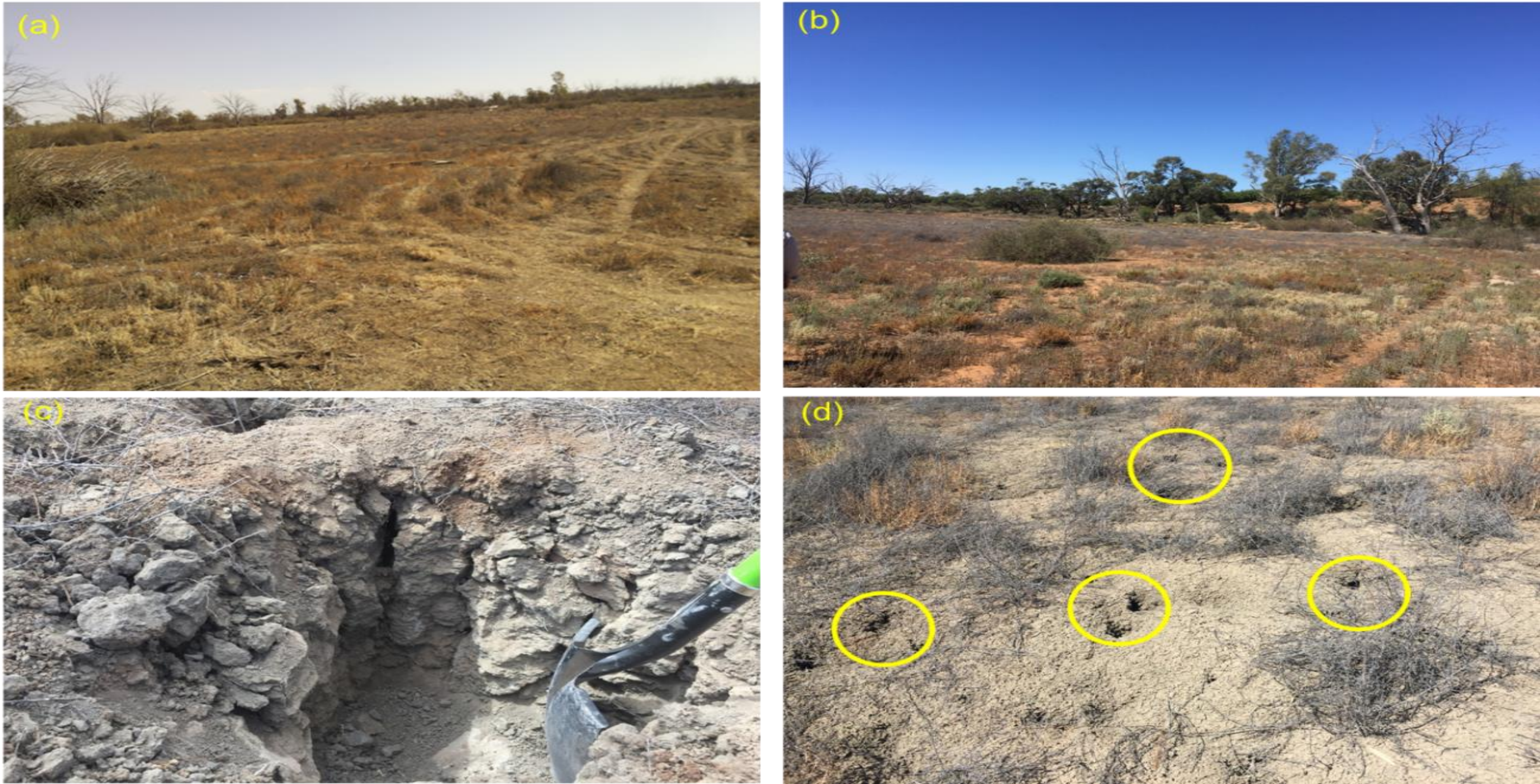
Pond storage (pressure transducer) + unsaturated zone storage (moisture sensor) = Pump inflow (water meter) + Rainfall (weather station) – ET (weather station) – Recharge (piezometer)

Field site at Murtho-Weila connector

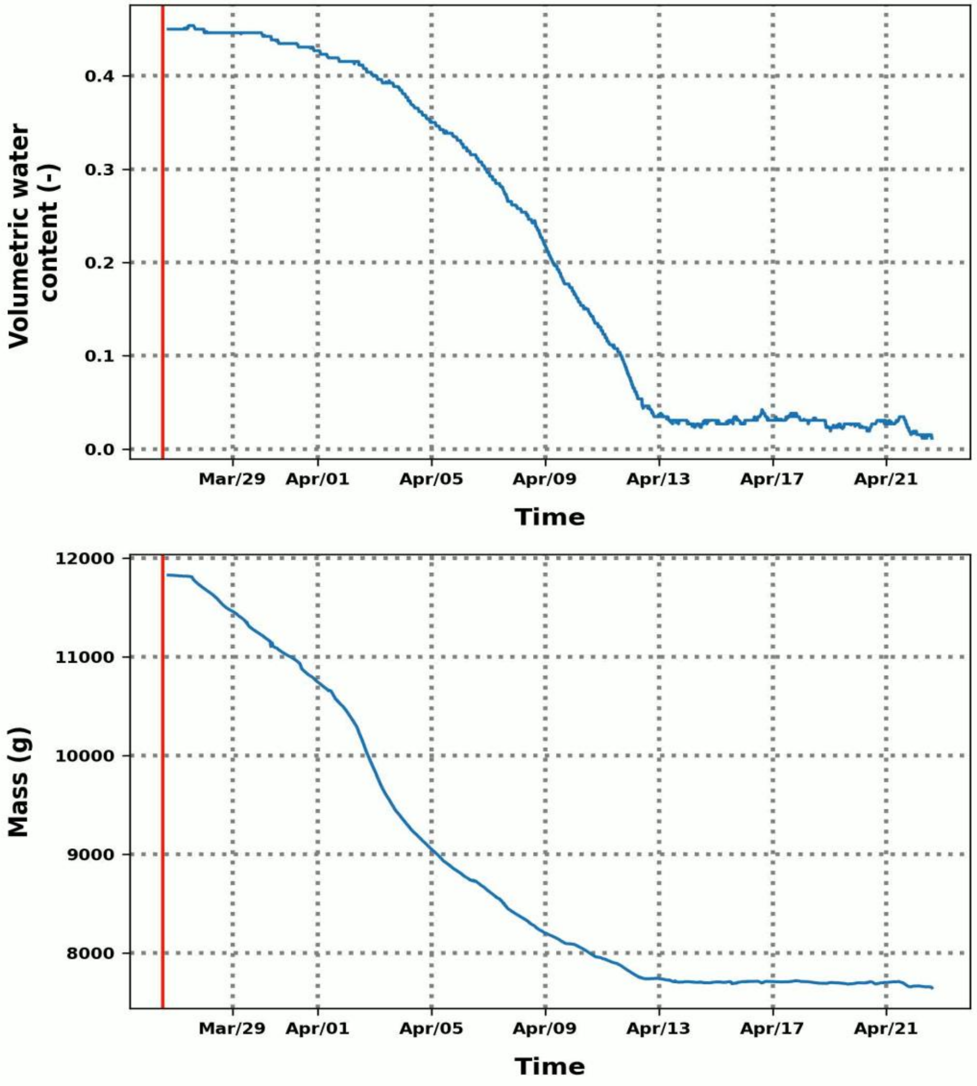


Idealised site for field monitoring

- Circular shape
- Initially dry
- Situated within a private property
- Covered by vegetation


(a)
(b)
(c)
(d)

Desiccation and cracking of the Coonambidgal Clay



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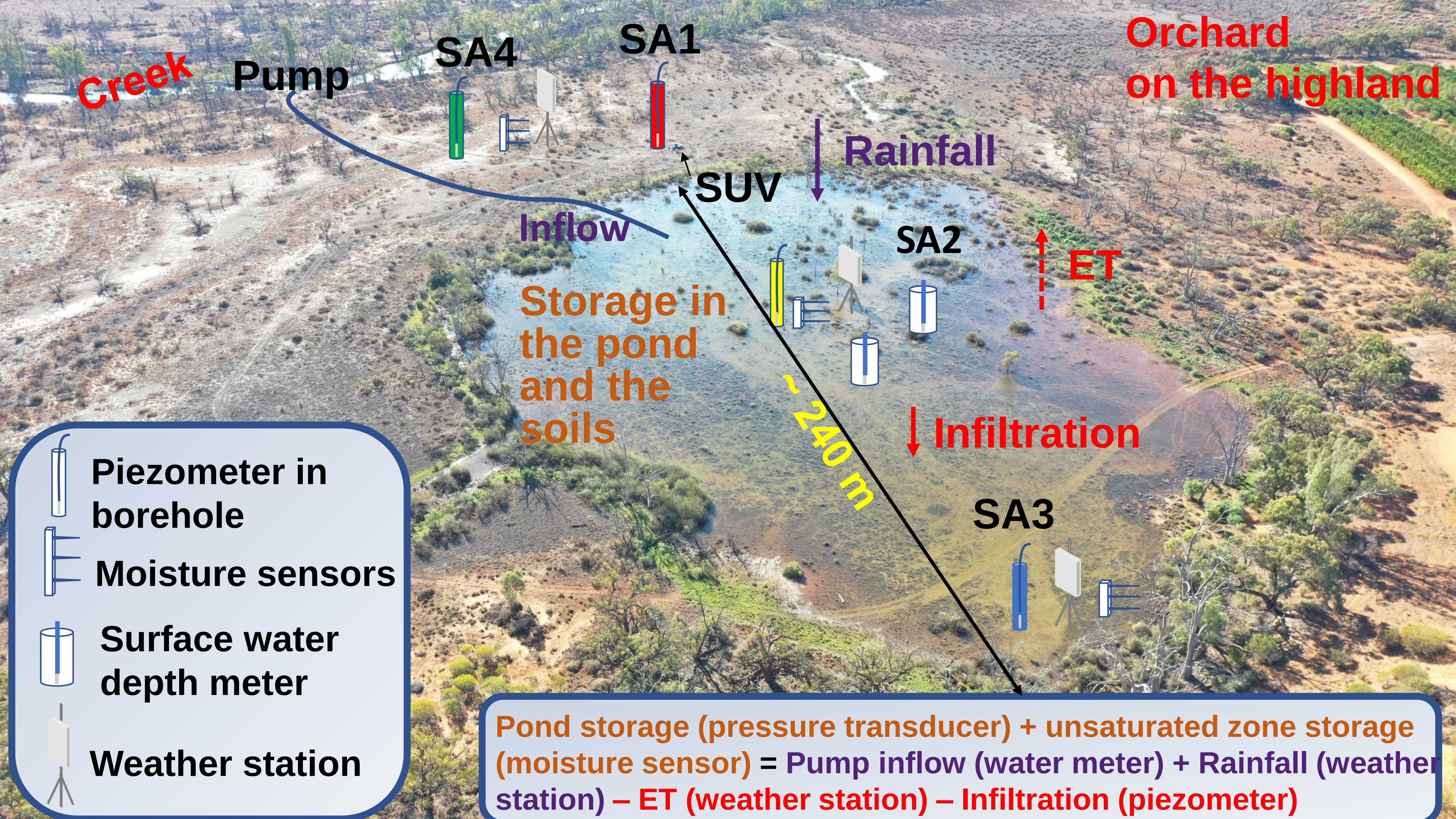
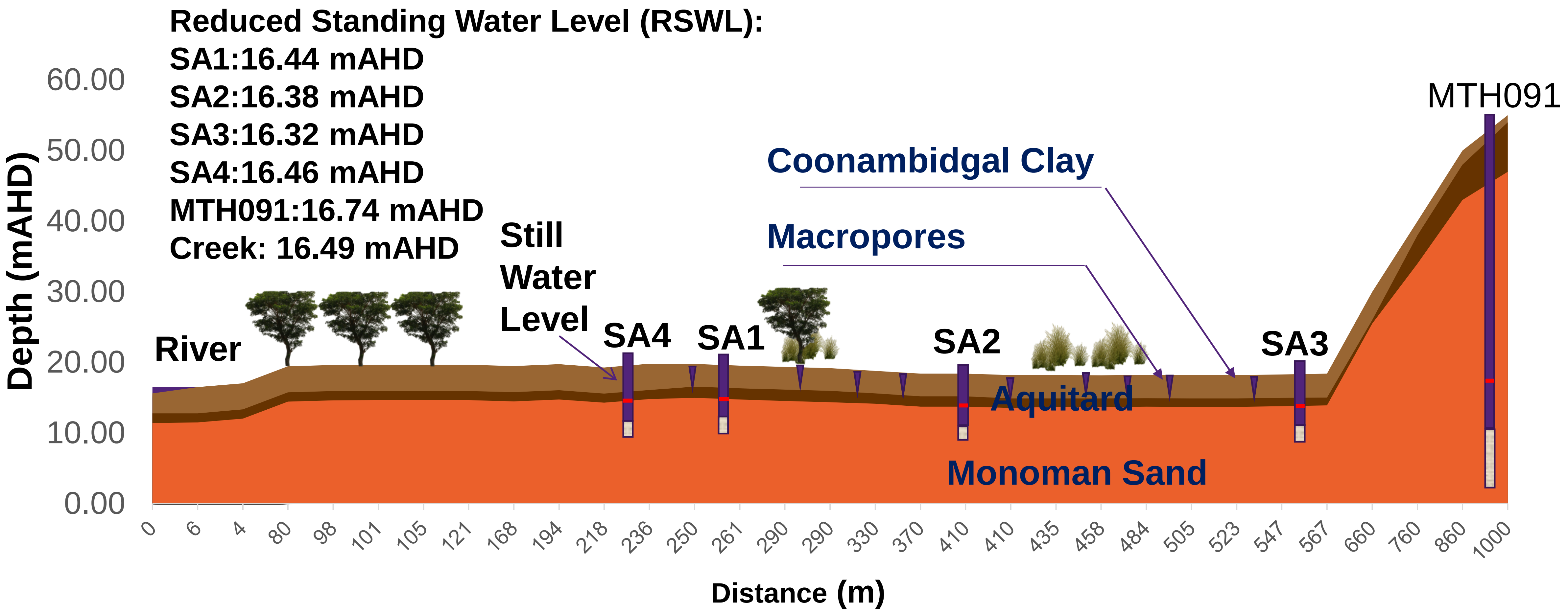
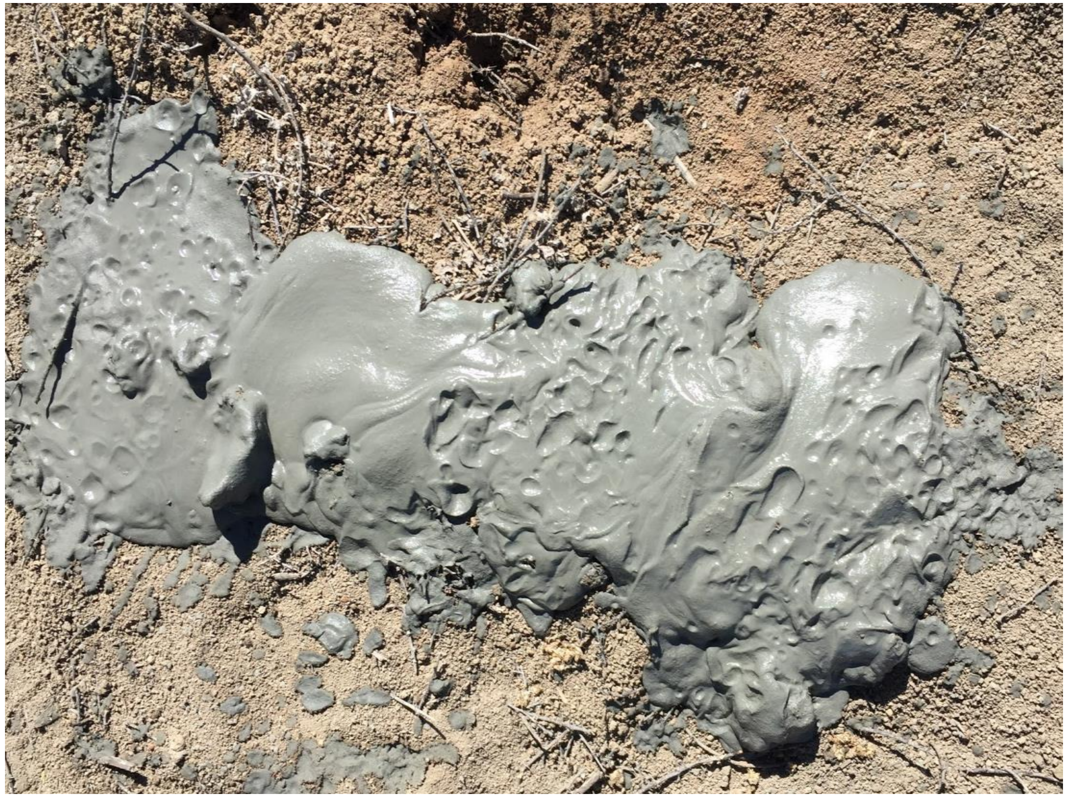

Creek
Pump
SA4
SA1
Orchard
on the highland
Rainfall
SUV
Inflow
SA2
ET
Storage in
the pond
and the
soils
~ 240 m
Infiltration
SA3
Piezometer in
borehole
Moisture sensors
Surface water
depth meter
Weather station
Pond storage (pressure transducer) + unsaturated zone storage (moisture sensor) = Pump inflow (water meter) + Rainfall (weather station) – ET (weather station) – Infiltration (piezometer)

Floodplain cross-section and unconfined Monoman aquifer



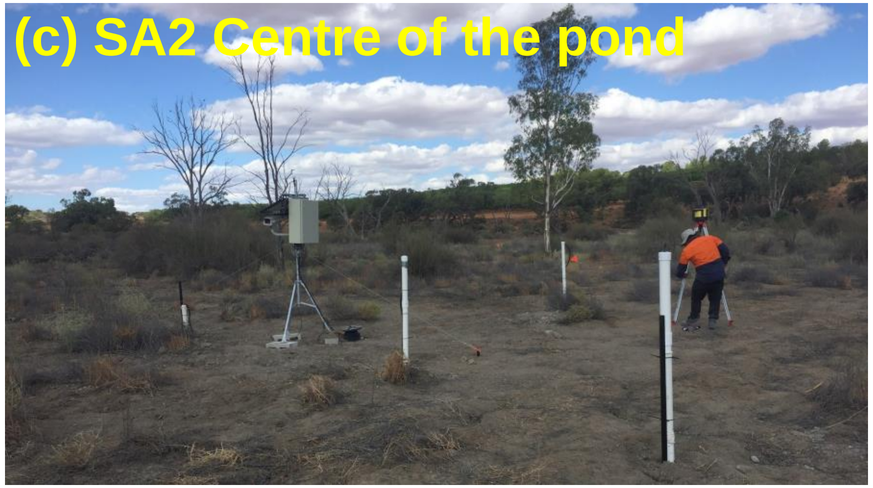
Soil samples extracted during the drillings of bores

Coonambidgal clay



Monoman sand

IoT Instrument deployment



All data are delivered to the web in real time, which is particularly useful during the travel restriction period

Installation of moisture sensor array

Pump set-up

(a) Diesel pump with a capacity of 6 ML/Day

(b) 200-long lay flat hose to convey water to the basin

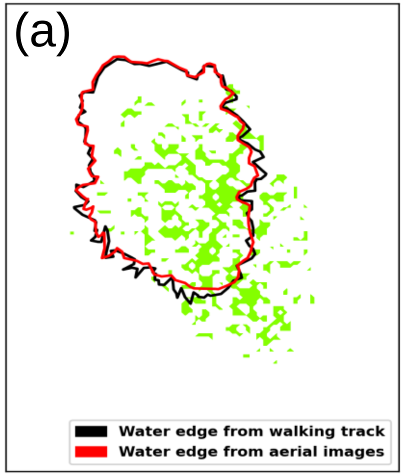
(b) Flow outlet over a geofabric

Changes from underlying flow tunnels to open channels

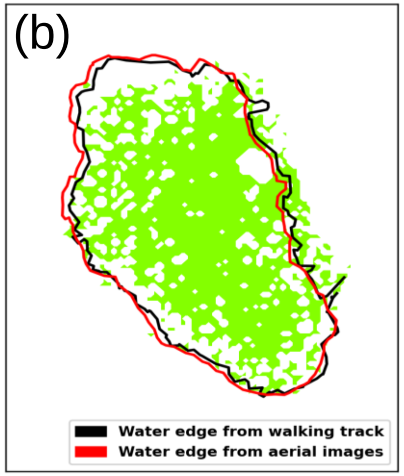
“Water serpent” visible at the onset of the e-watering

Verification of Digital Elevation Model

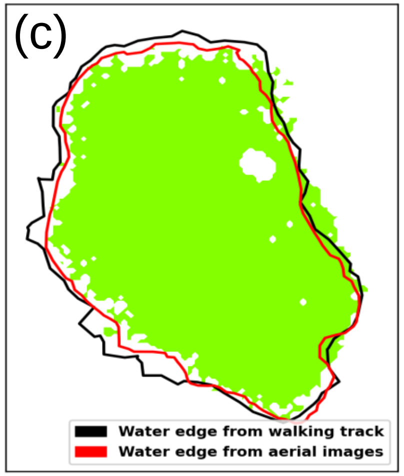
17/Mar/2021
From walking track :13,088 m²
From aerial images: 12,552 m²
From lidar: 6,852 m²



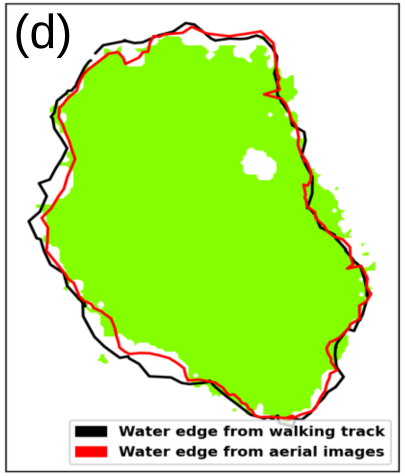
18/Mar/2021 16:00
From walking track :23,070 m²
From aerial images: 23,549 m²
From lidar : 18,496 m²



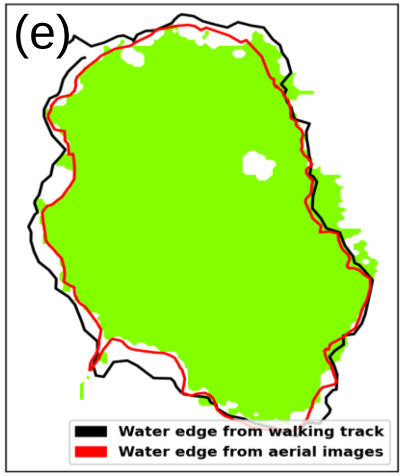
19/Mar/2021 11:30
From walking track :32,362 m²
From aerial images: 31,201,m²
From lidar : 30,224 m²



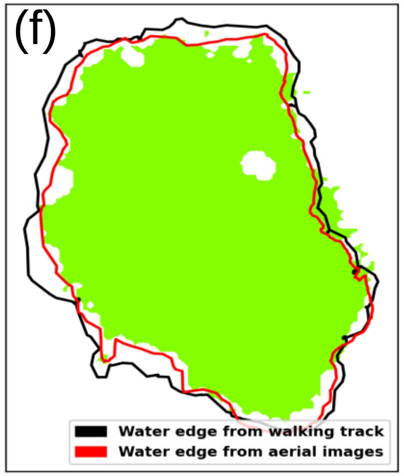
20/Mar/2021 16:00
From walking track :35,615 m²
From aerial images: 33,226 m²
From lidar: 33,476 m²



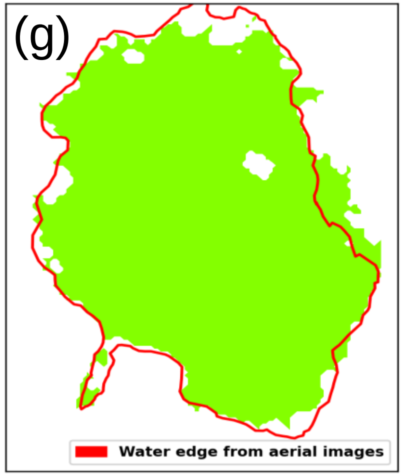
21/Mar/2021 09:00
From walking track :38,915 m²
From aerial images: 34,695m²
From lidar : 35,484 m²

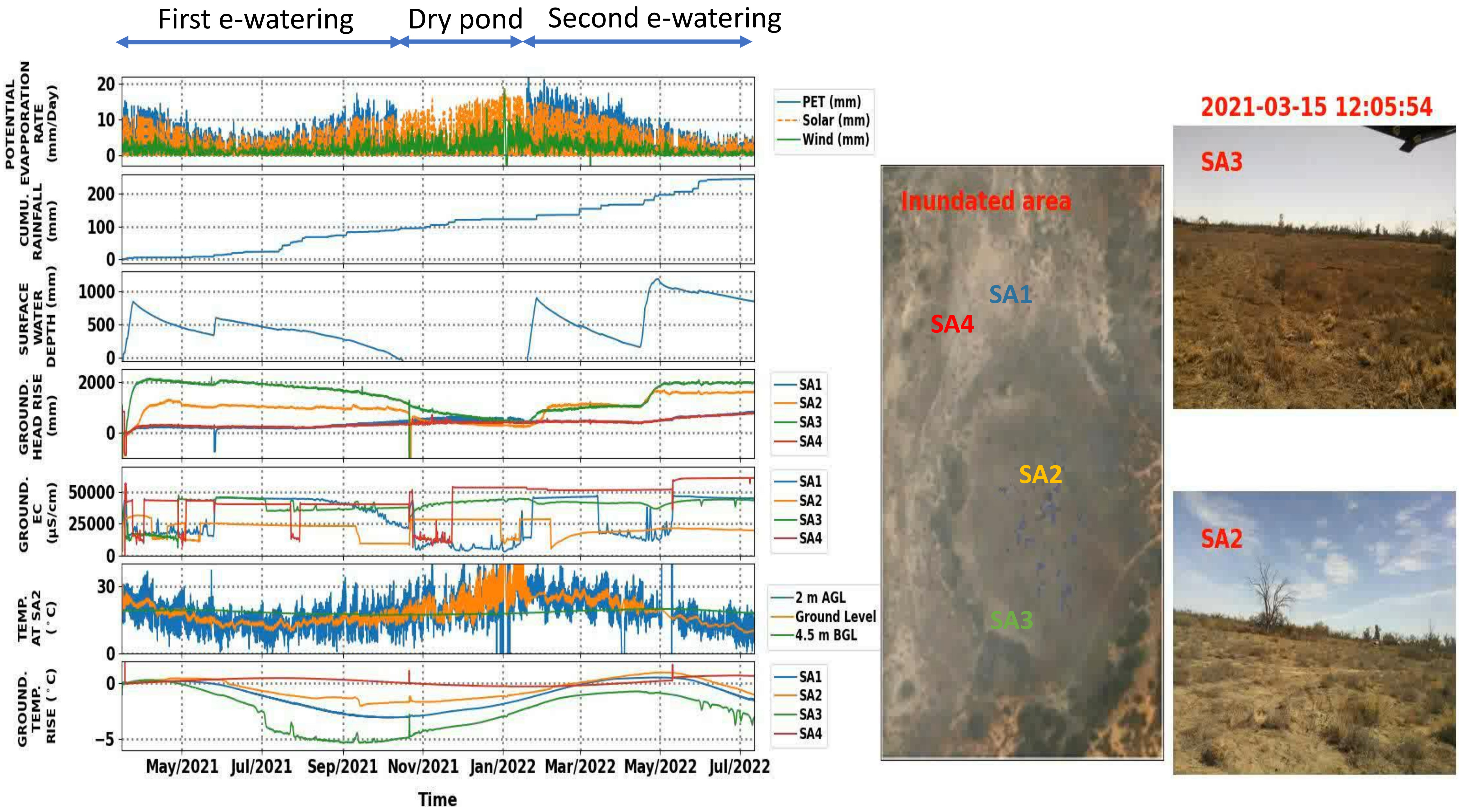


24/May/2021 16:30
From walking track :40,425 m²
From aerial images: 36,020m²
From lidar : 34,252 m²

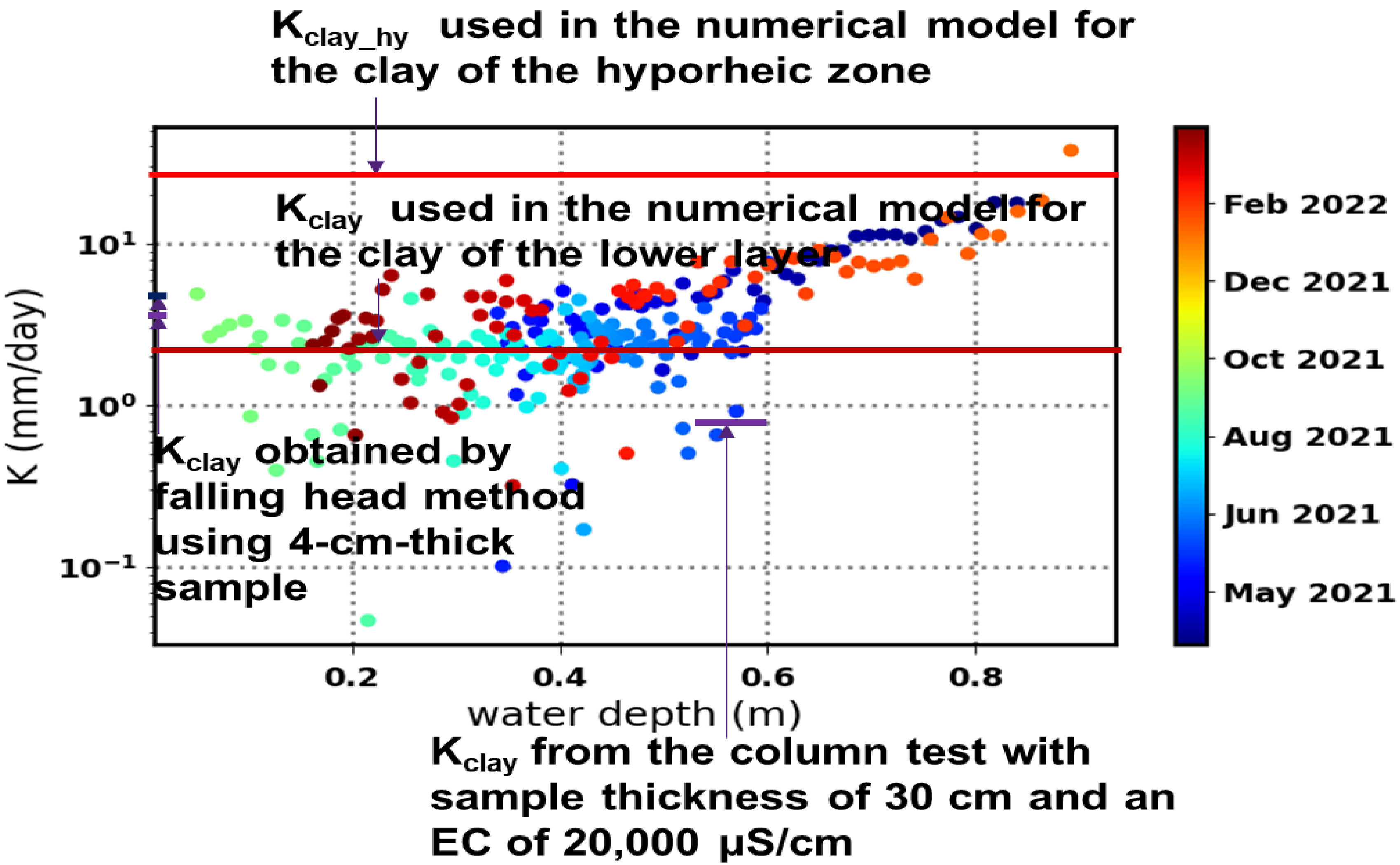


26/May/2021 09:00
From aerial images: 39,129m²
From lidar : 37,868 m²

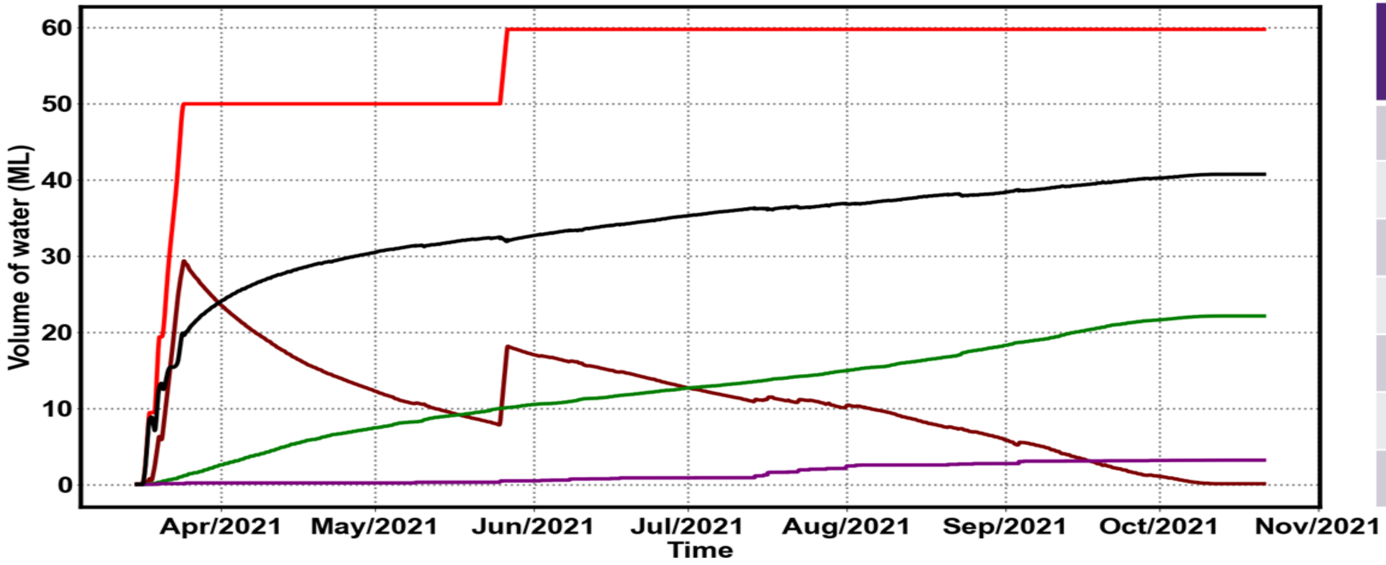



First e-watering
Dry pond
Second e-watering
POTENTIAL EVAPPORATION RATE (mm/Day)
PET (mm)
Solar (mm)
Wind (mm)
CUMU. RAINFALL (mm)
SURFACE WATER DEPTH (mm)
GROUND. HEAD RISE (mm)
SA1
SA2
SA3
SA4
GROUND. EC (µS/cm)
SA1
SA2
SA3
SA4
TEMP. AT SA2 (°C)
2 m AGL
Ground Level
4.5 m BGL
GROUND. TEMP. RISE (°C)
SA1
SA2
SA3
SA4
May/2021
Jul/2021
Sep/2021
Nov/2021
Jan/2022
Mar/2022
May/2022
Jul/2022
Time
Inundated area
SA1
SA4
SA2
SA3
2021-03-15 12:05:54
SA3
SA2

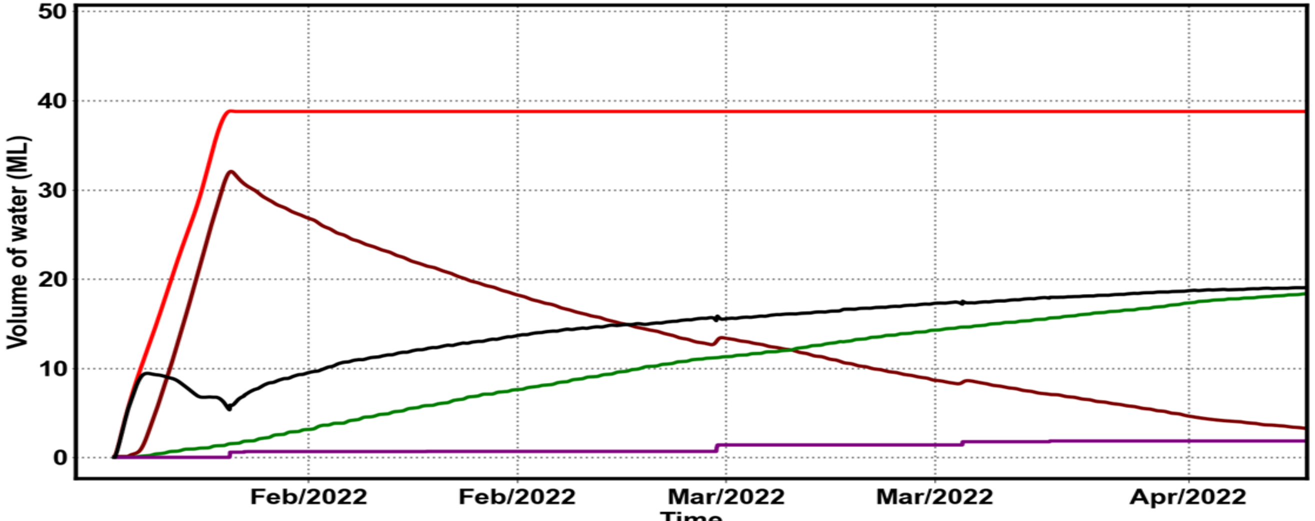
Hydraulic conductivity of the clay versus surface water depth



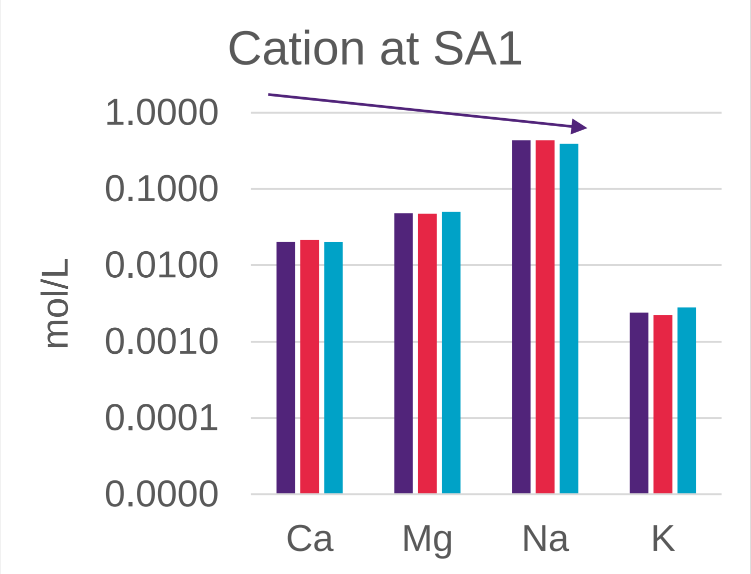
Water balance

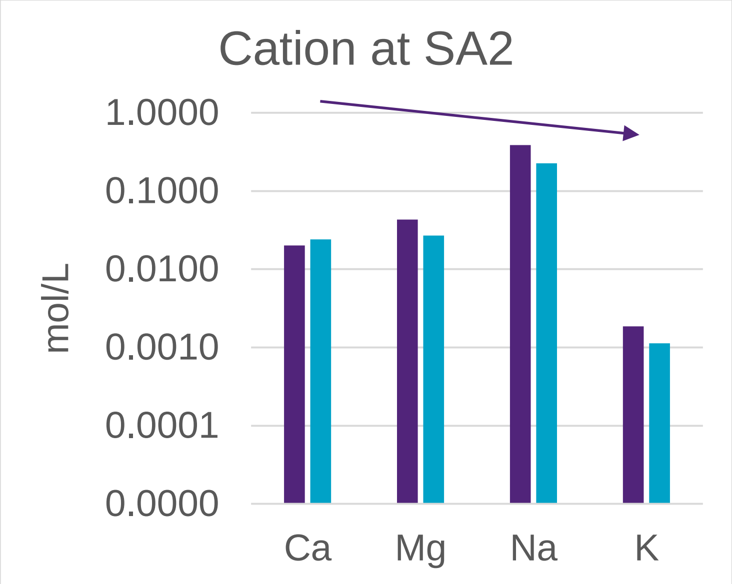


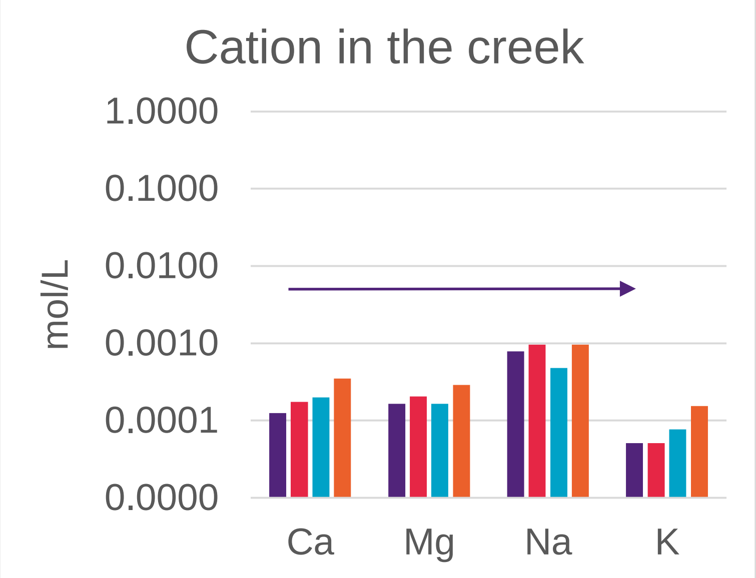
	Volume (ML)	Ratio (%)
In (as of 19 / Oct / 2021)		
Water pumped in	60	93.8
Rainfall	4	6.3
Out (as of 19 / Oct / 2021)		
Storage in the pond	0	0
ET	22	34.3
Infiltration	42	65.6

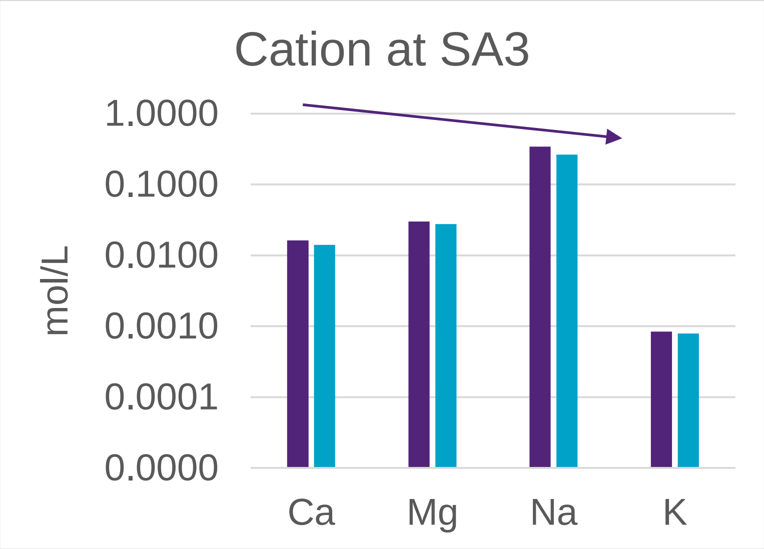


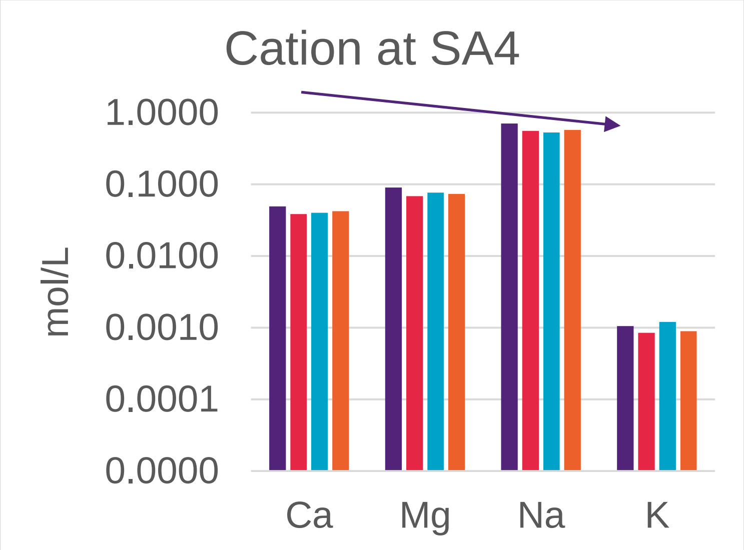
	Volume (ML)	Ratio (%)
In (as of 4 / Apr / 2022)		
Water pumped in	39	96.2
Rainfall	1.5	3.8
Out (as of 4 / Apr / 2022)		
Storage in the pond	4	9.9
ET	17.75	43.8
Infiltration	18.75	46.3

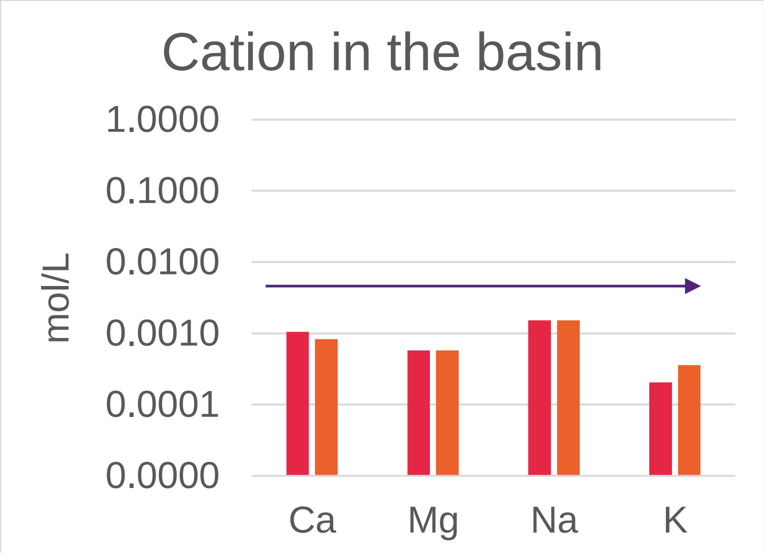






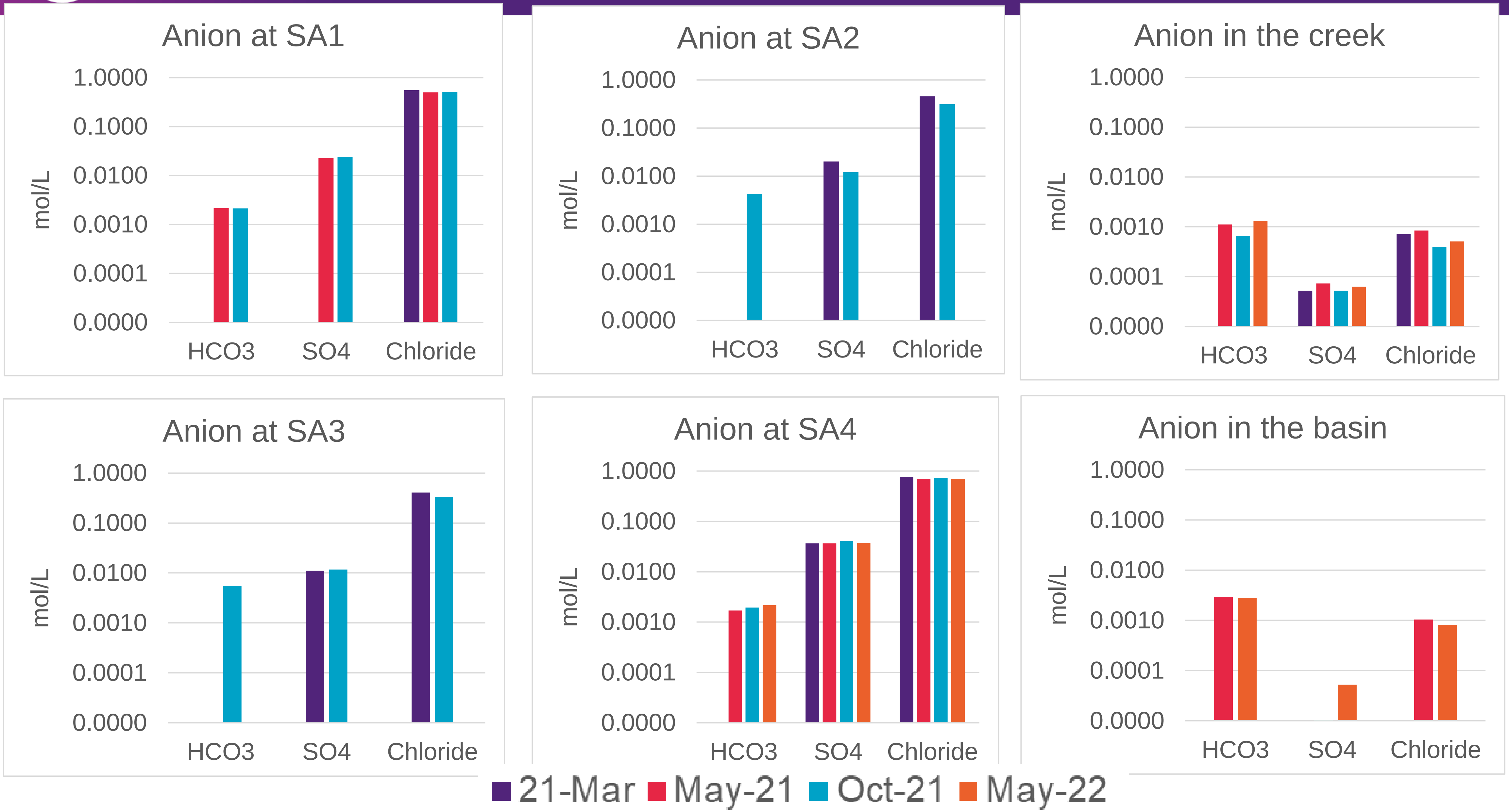






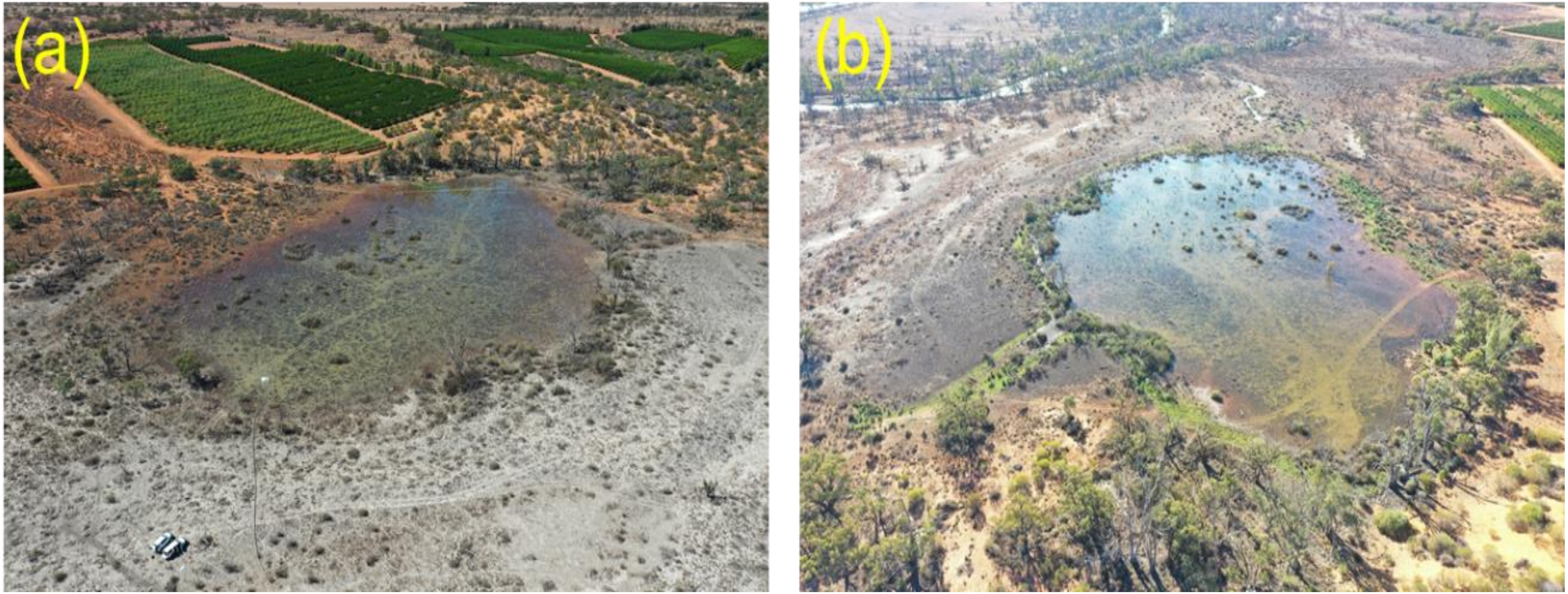
21-Mar May-21 Oct-21 May-22

– Note the Y-axis is in log scale. – Cation concentrations at all bores decrease over time due to mixing.



– Note the Y-axis is in log scale. – Anion concentrations at all bores decrease over time due to mixing.

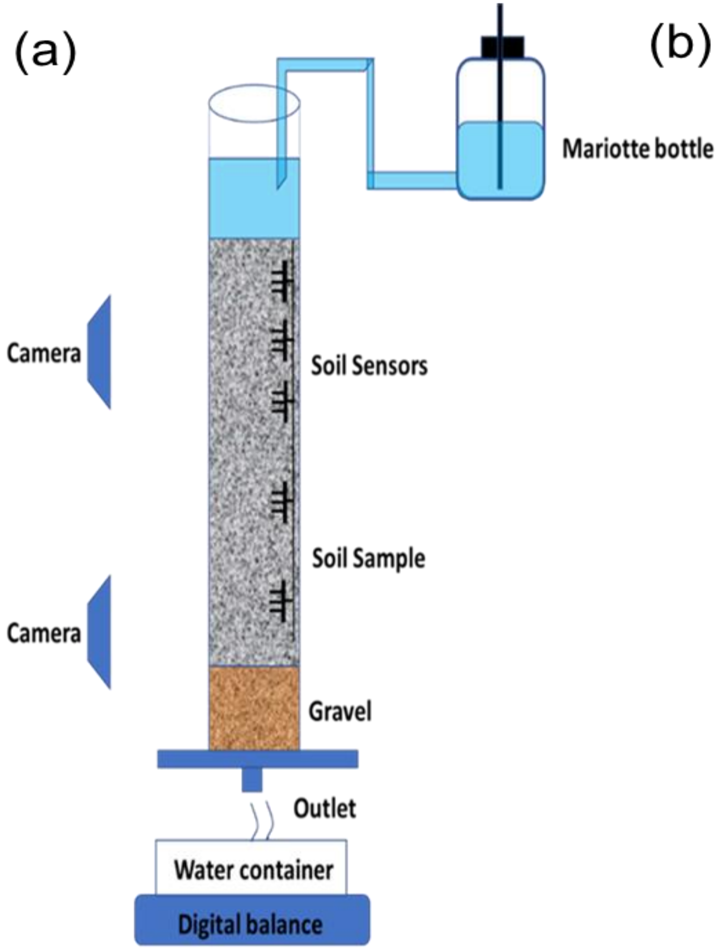
Vegetation Responses

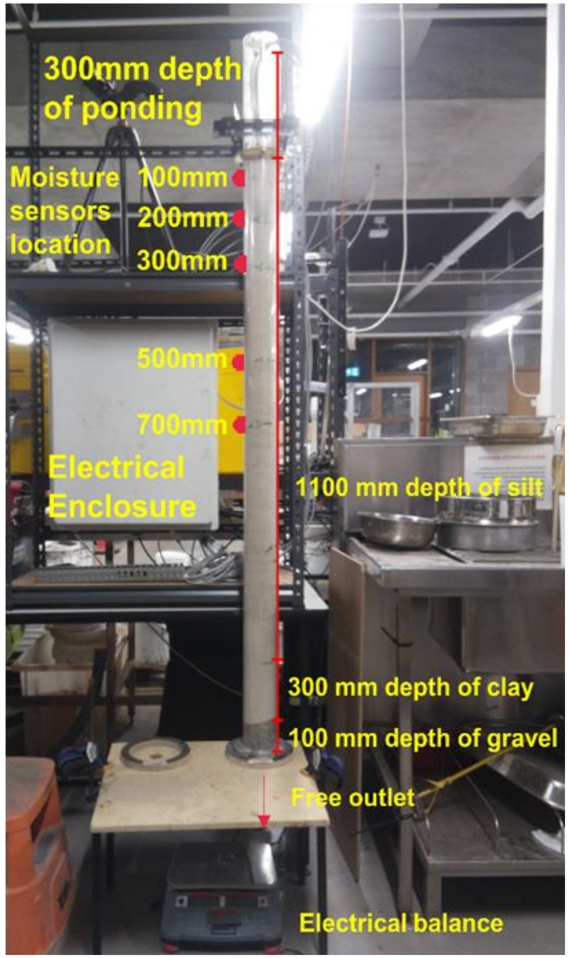


Aerial image of the water-inundated basin on 17/Mar/2021 (a) and 25/May/2021 (b)

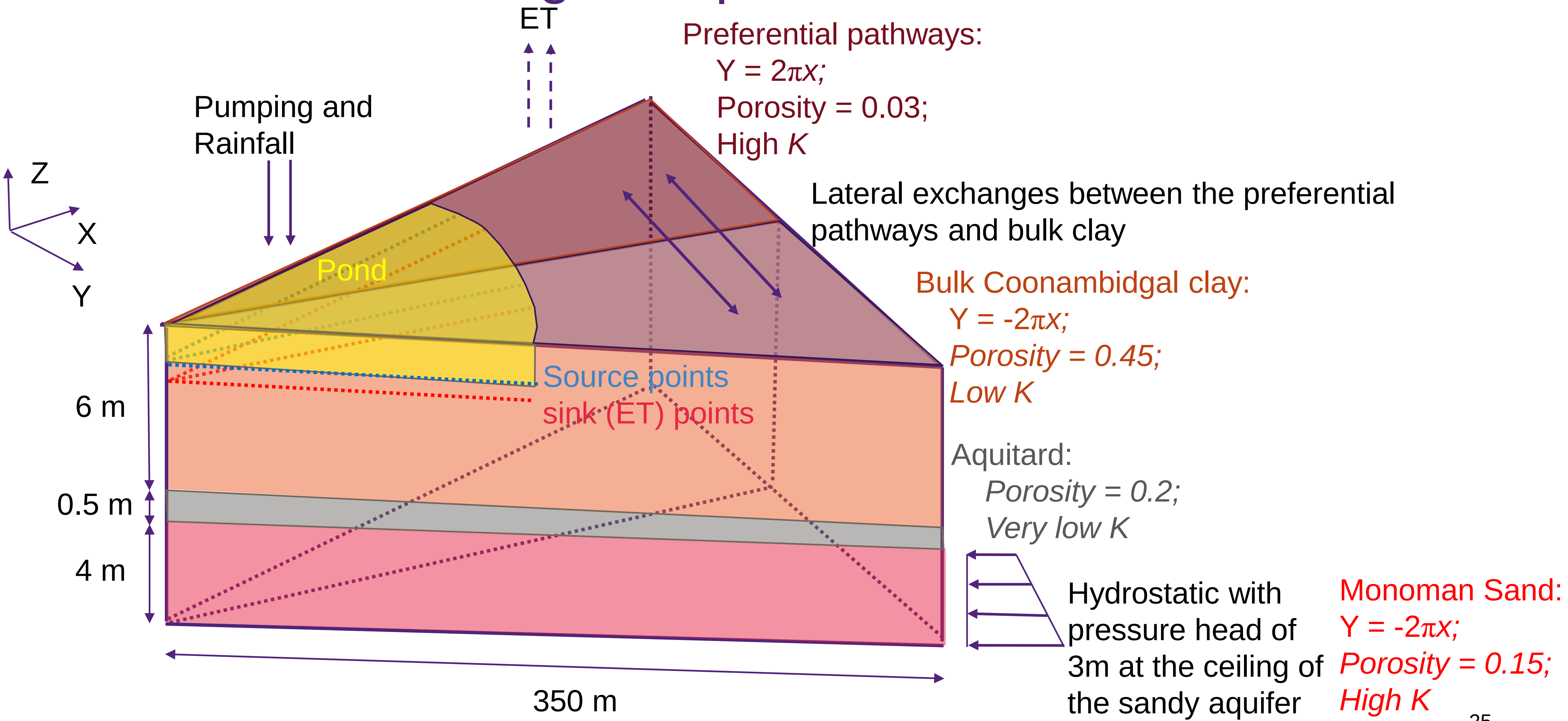
Field condition after depletion of the pond (Oct / 21)

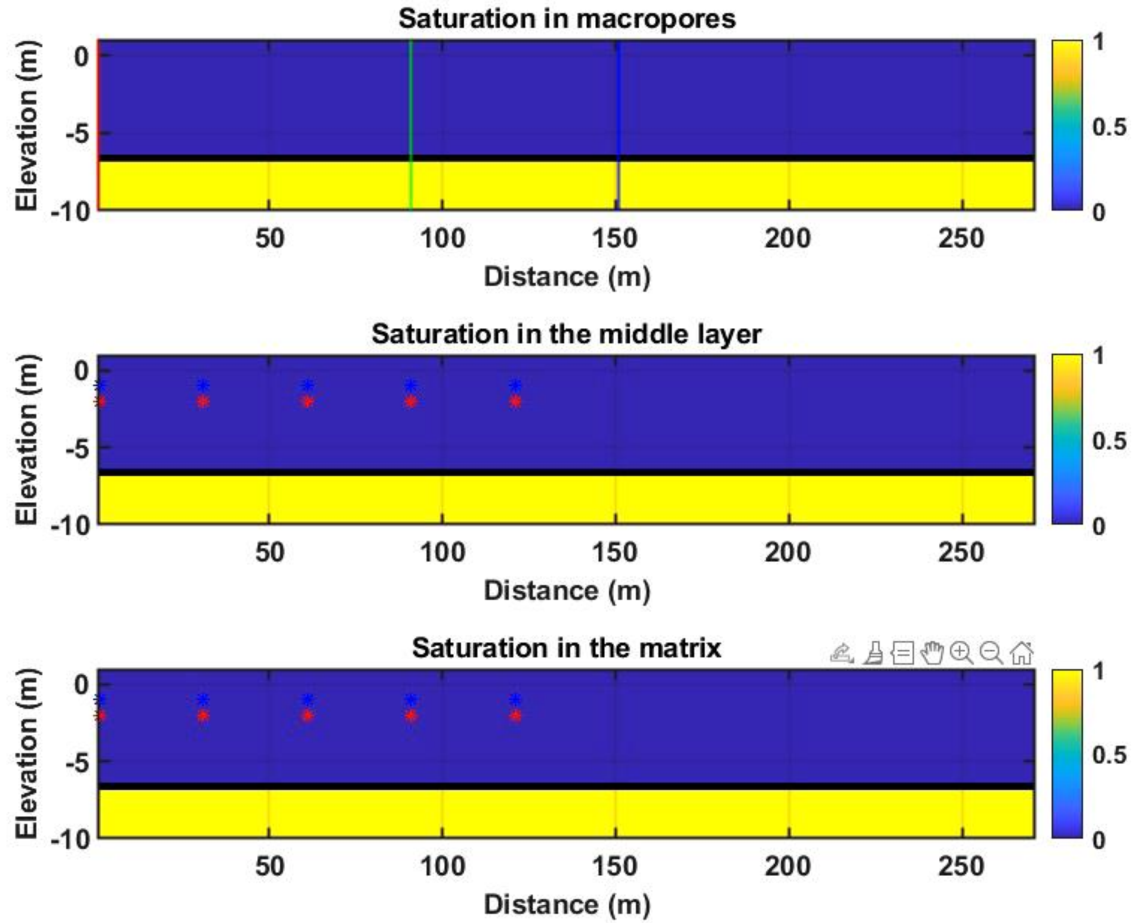
Laboratory column set-up for the wetting and drying of Coonambidgal Clay

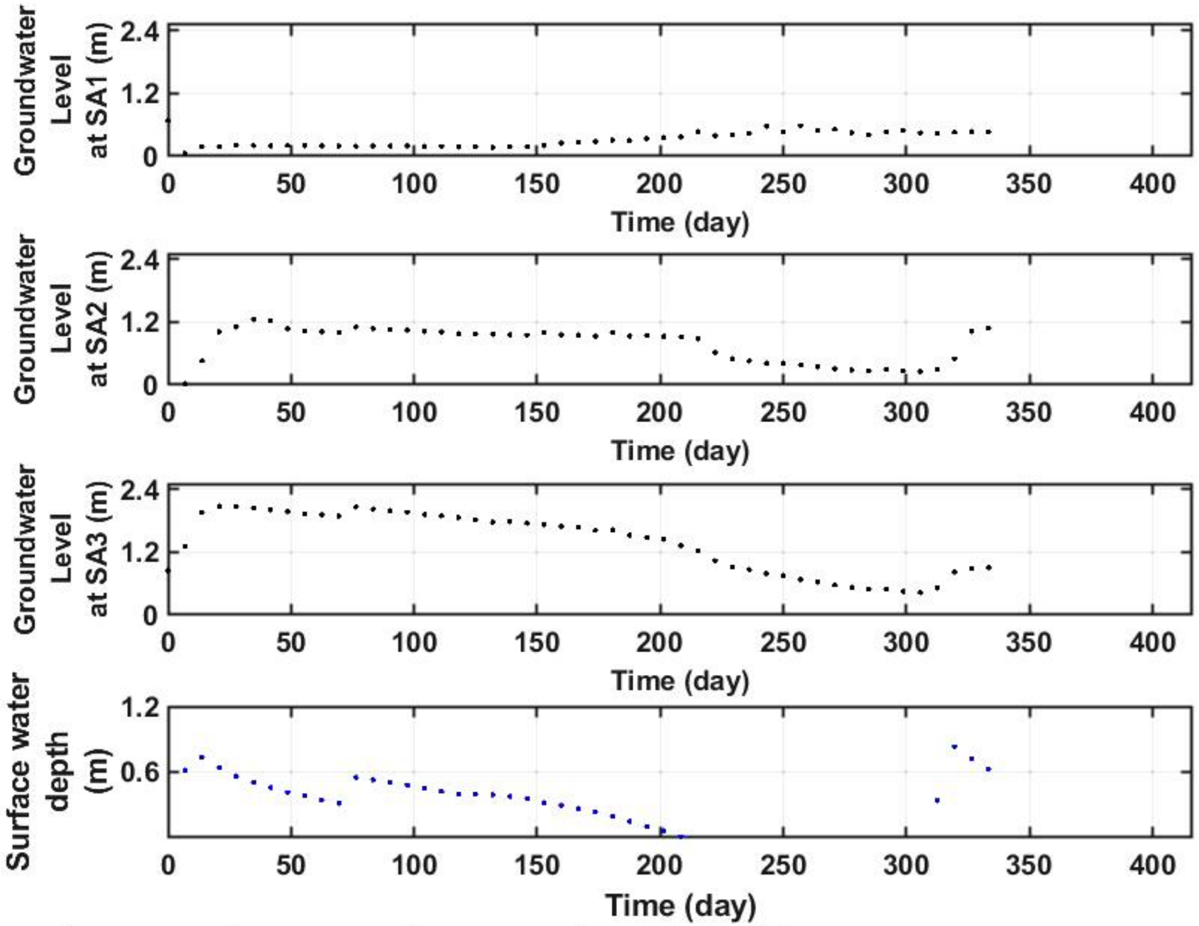


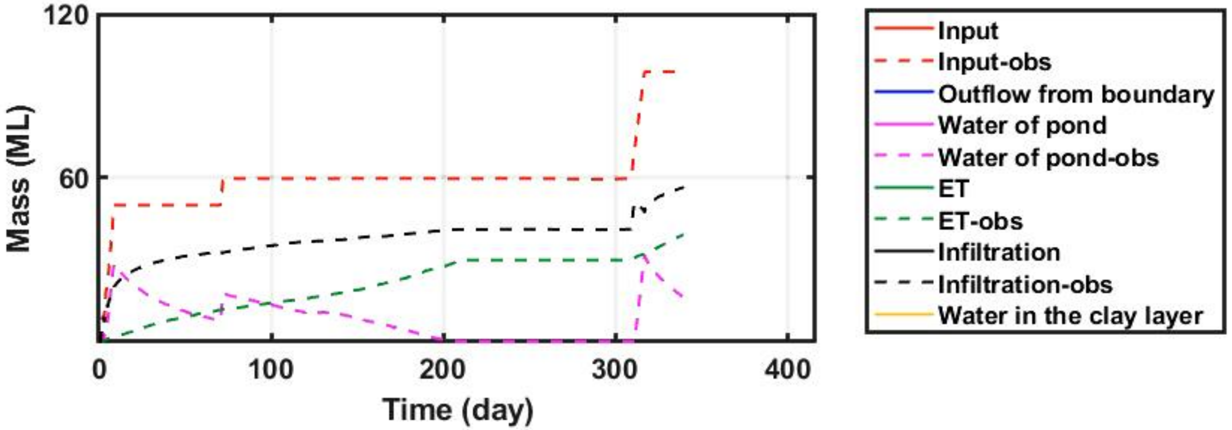


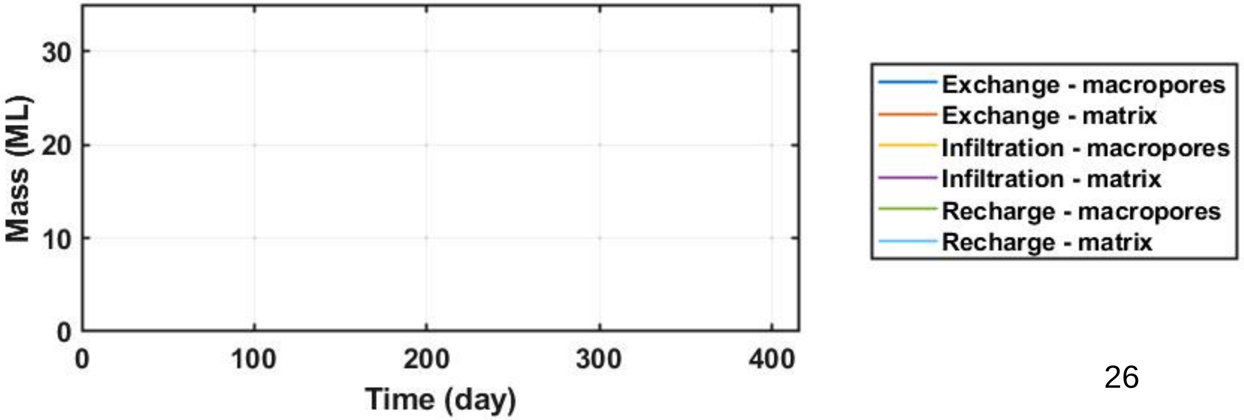
Numerical Modelling set-up




Saturation in macropores
Elevation (m)
Distance (m)
Saturation in the middle layer
Elevation (m)
Distance (m)
Saturation in the matrix
Elevation (m)
Distance (m)


Groundwater Level at SA1 (m)
Time (day)
Groundwater Level at SA2 (m)
Time (day)
Groundwater Level at SA3 (m)
Time (day)
Surface water depth (m)
Time (day)


Mass (ML)
Time (day)
Input
Input-obs
Outflow from boundary
Water of pond
Water of pond-obs
ET
ET-obs
Infiltration
Infiltration-obs
Water in the clay layer


Mass (ML)
Time (day)
Exchange - macropores
Exchange - matrix
Infiltration - macropores
Infiltration - matrix
Recharge - macropores
Recharge - matrix

How representative is the findings from this study to the inundation recharge across the whole floodplain?

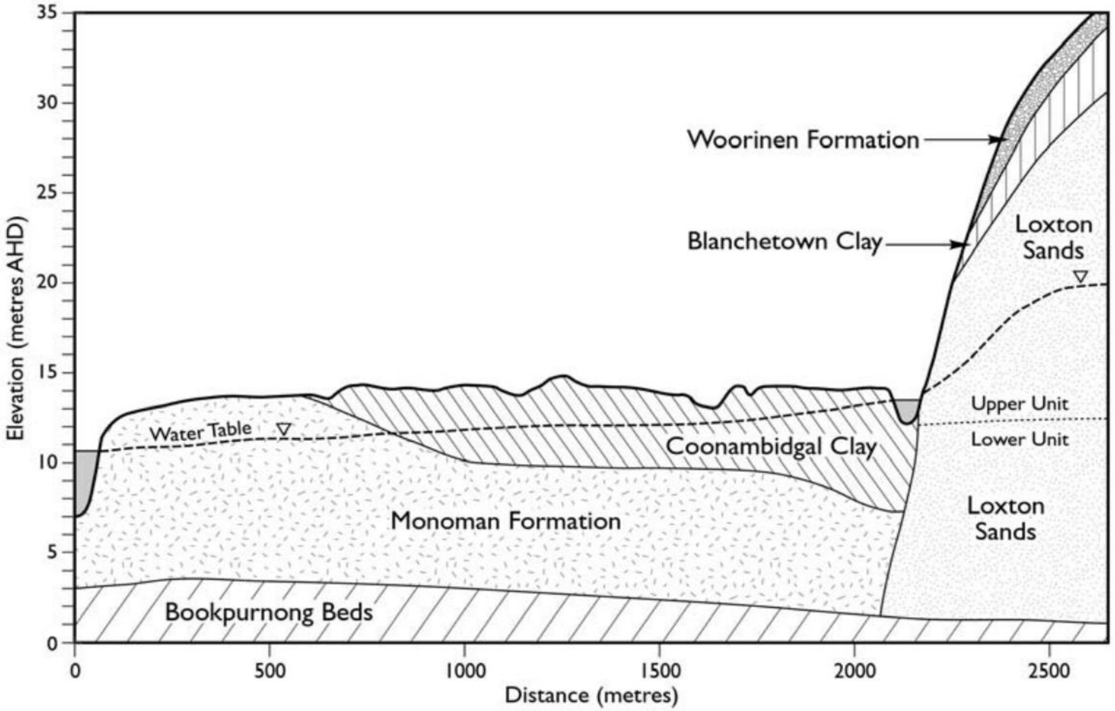
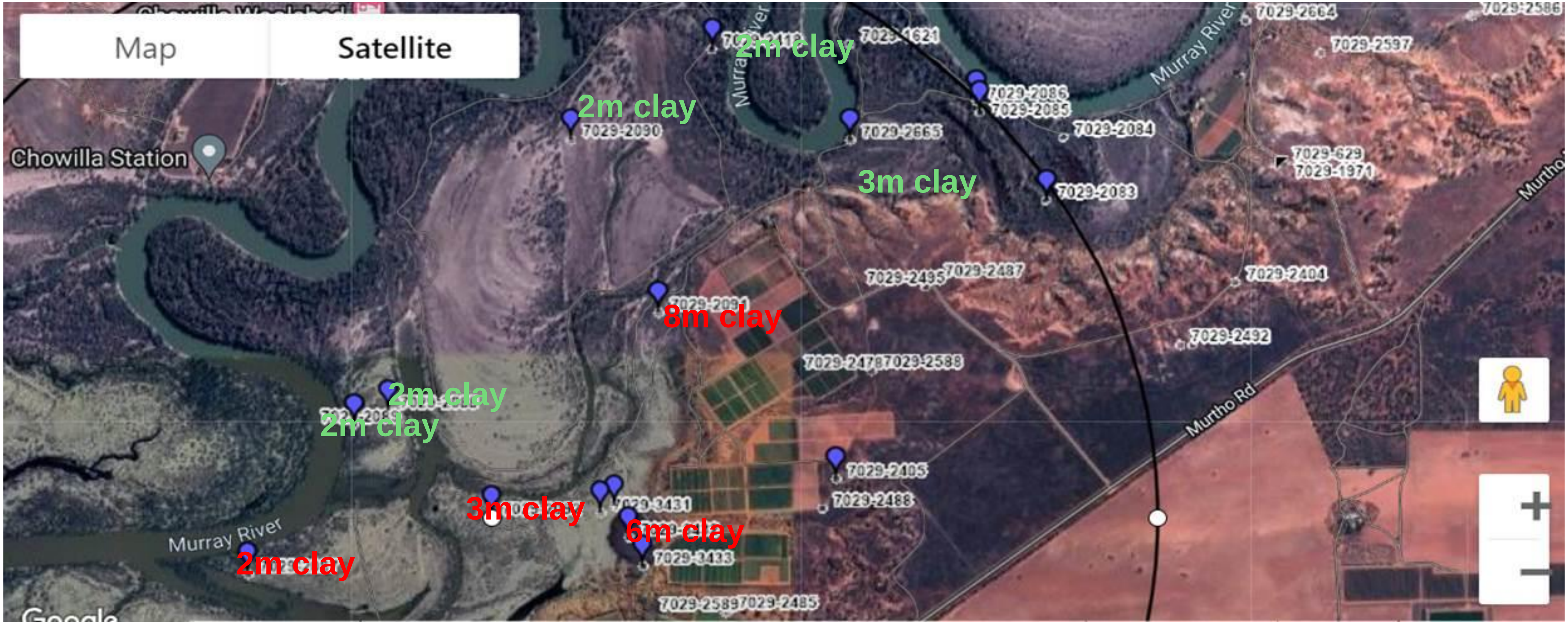


Figure 3 Stratigraphy of Clarks Floodplain, indicating the excised river valley, Monoman Formation alluvial aquifer, and Coonambidgal Clay which overlies much of the floodplain. Increased recharge from irrigation taking place on the highland causes a groundwater mound to form adjacent the floodplain, leading to shallow groundwater and seepage at the break of slope.

- Saline water table in the Monoman Sand tends to be confined in the upper floodplain, while unconfined near the river.
- Inundation recharge to the aquifer could be more significant on the floodplain near the river

Doble, R., Walker, G., & Simmons, C. (2005). Understanding spatial patterns of discharge in semi-arid regions using a recharge-discharge balance to determine vegetation health. *CSIRO Land and Water Technical Report 13/05, July*.

Mapping of the confined/unconfined Monoman Sands



- Green suggests a unconfined aquifer, Red suggests a confined aquifer
- Unconfined aquifer tends to be located near the river, while confined aquifer tends to be situated at the upper floodplain

Conclusion and Recommondation

- The presence of roots and cracks in the 6-m-thick Coonambidgal Clay enhance inundation infiltration. The infiltrated water then transport laterally to the bulk clay
- The ratio of infiltration to ET is 2:1 during the first e-watering, and 1:1 during the second e-watering.
- The Coonambidgal Clay acts as a predominant e-water reservoir for vegetation growth, with a storage capacity much higher than the surface water pond.
- The chemistry, groundwater temperature and groundwater head all suggest recharge to the confined water table. The presence of a aquitard reduces the recharge to the underlying Monoman Sand aquifer to be less than 2 mm/day, and the rate is likely to be further reduced at repeated inundation.
- Future investigations should upscale the analysis to a floodplain level, and focus on inundation recharge near the river bank where the saline aquifer is unconfined.

Thank you for your attention!

If you have further questions, please contact:

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