Using SAR and Coherent Change Detection to Map Erosion in the Quilpie Region, Queensland

Kyran Cook
School of Surveying and Built Environment
University of Southern Queensland
Kyran.Cook@unisq.edu.au

ABSTRACT

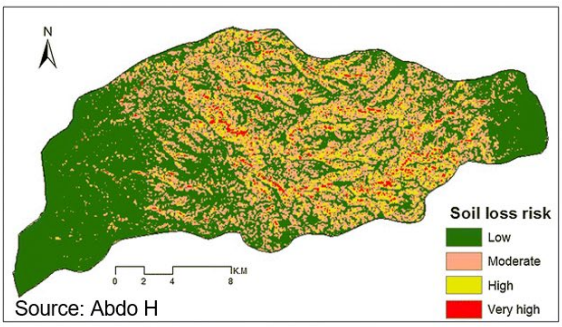
Erosion is a powerful force that has moulded the Earth ever since water has been present on its rocky surface. In its seemingly harmless pursuit, erosion threatens ecosystems, reduces agricultural production and impacts water quality. When trying to investigate erosion, there is no easy way to identify hotspots, only leaving the possibility of predicting where erosion should be occurring. This study aimed to develop a method to identify erosion using Synthetic Aperture Radar (SAR) images in a process called Coherent Change Detection (CCD) and was conducted in the Quilpie region, Queensland. It was found that CCD can be used to positively identify erosion due to rain events but also has false positives due to soil moisture changes. This study used a unique method for removing soil moisture that did limit the false positives, but more work is required to ensure soil moisture does not interfere with the results. Nevertheless, with the results from this study, it is still possible to create a near real-time erosion analysis system for arid regions. This presentation is based on the author's undergraduate Honours research project at the University of Southern Queensland (UniSQ), which was awarded the APAS UniSQ Student Project Prize 2023. The results are reported in a paper entitled 'Mapping Erosion Hotspots: Coherent Change Detection Study in the Quilpie Region', which has been submitted to the journal Remote Sensing.

KEYWORDS: *Erosion, Synthetic Aperture Radar (SAR), Coherent Change Detection (CCD).*

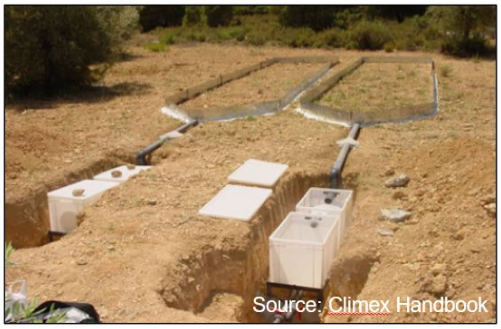
Erosion

Ways to Measure to Erosion

Predictive Models



Observation Analysis



SAR and Coherence

$$\text{Coher}ence = \Upsilon_{geometric} \cdot \Upsilon_{volume} \cdot \Upsilon_{thermal} \cdot \Upsilon_{temporal}$$

Advantages

- Active Sensor
- Can be used in all weather conditions
- Large amounts of data
- Can detect small changes

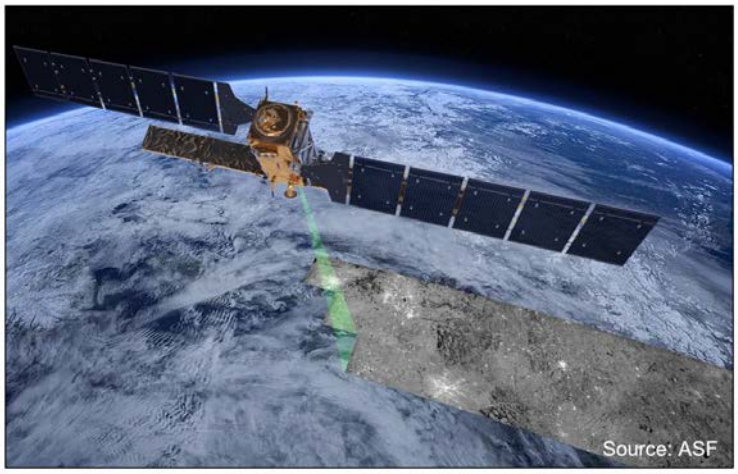
Data

Sentinel-1

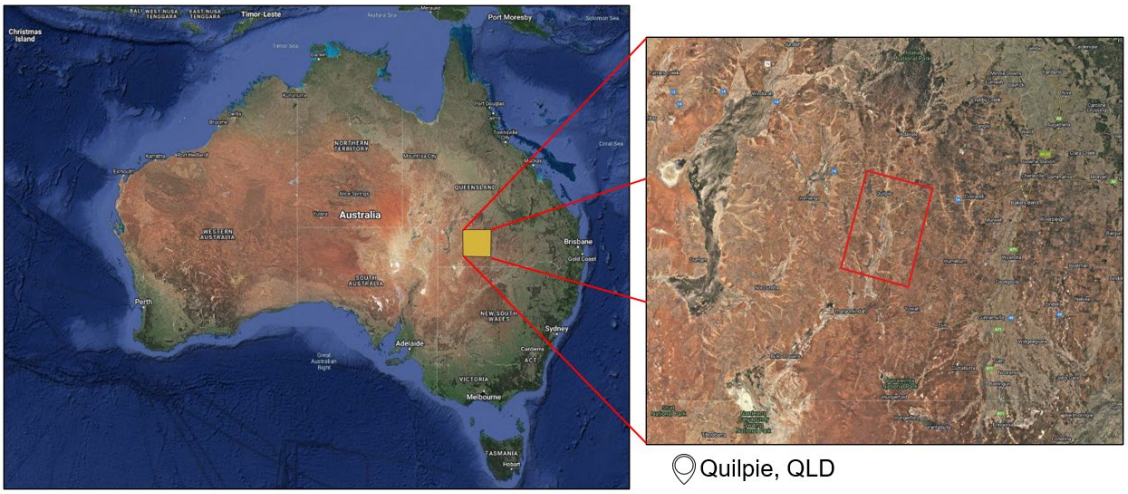
- Resolution: 20m by 5m

Sentinel-2

- Resolution: 20m by 20m
- Band 5 – VNIR
- Band 11 – SWIR



Study Area

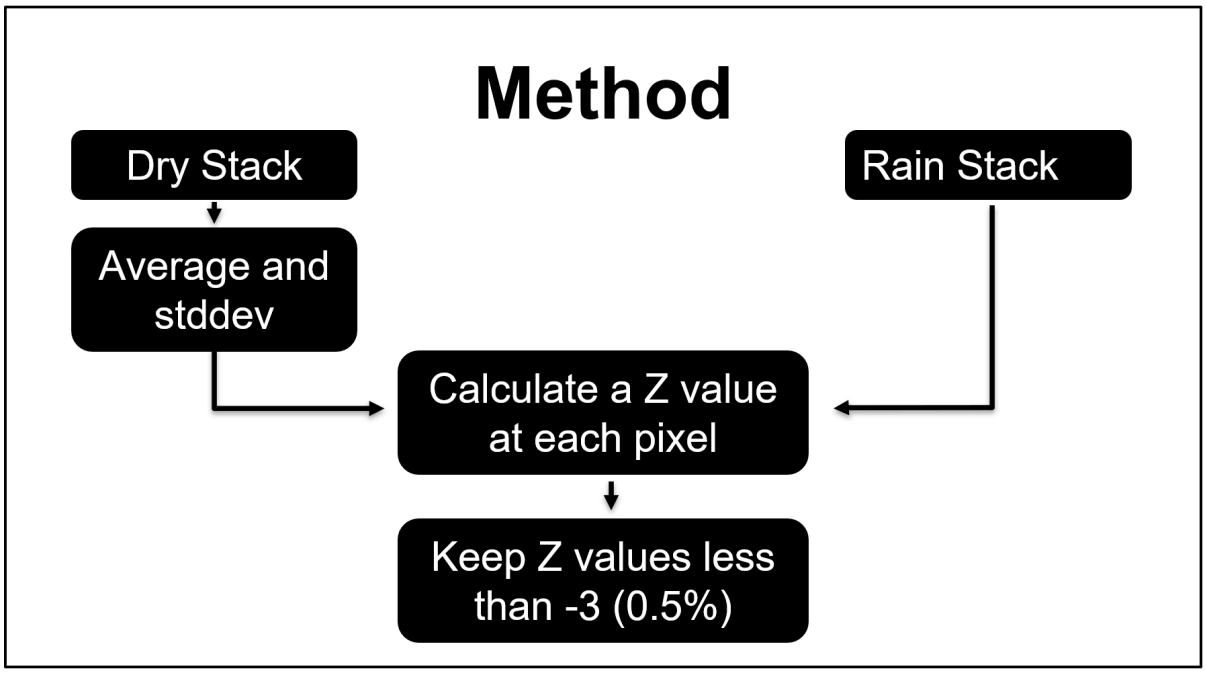


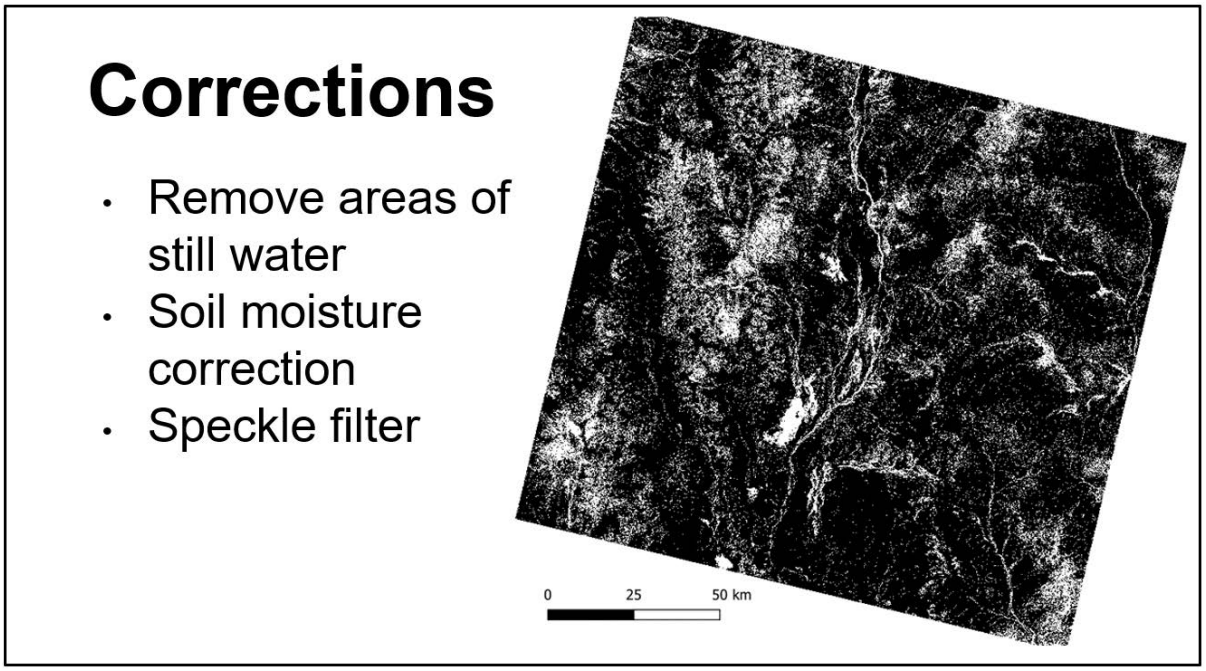
Method

Phase 1: Erosion Identification

Phase 2: Field Study

Phase 3: Time Series Analysis


Method
Dry Stack
Average and stddev
Rain Stack
Calculate a Z value at each pixel
Keep Z values less than -3 (0.5%)


Corrections
Remove areas of still water
Soil moisture correction
Speckle filter
0
25
50 km

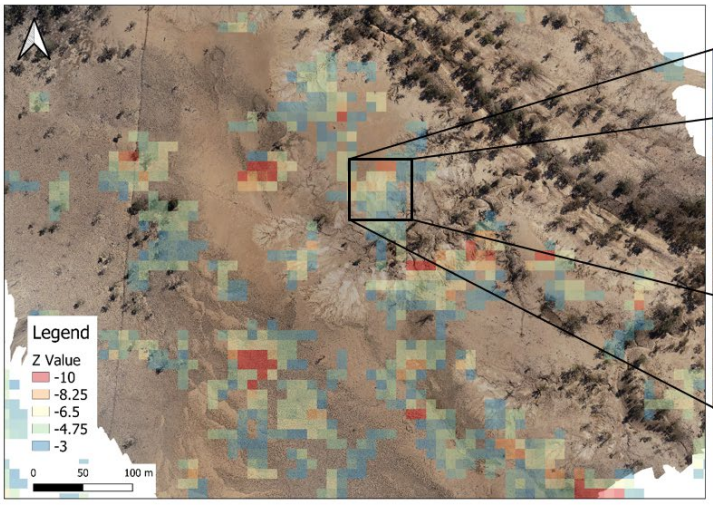
Field Work

Soil Samples
Shear Strength

Site	kPa
1	29.15
2	25.43
3	27.14
4	27.67

50km

Results



Validation

$$Coherence = \Upsilon_{geometric} \cdot \Upsilon_{thermal} \cdot \Upsilon_{volume} \cdot \Upsilon_{temporal}$$

Geometric

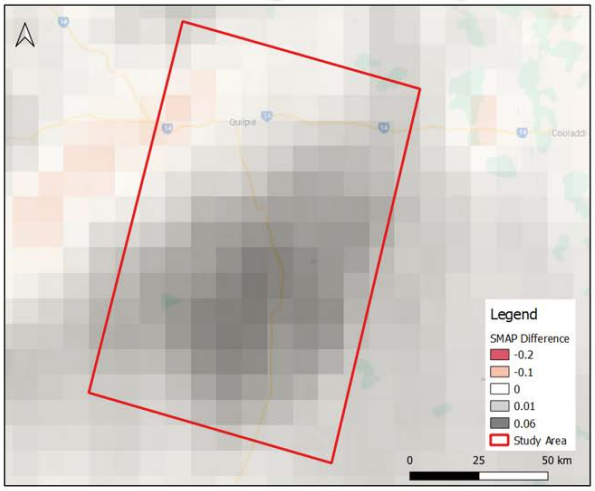
Number	Baseline (m)
SAR 1	81.54
SAR 2	31.47
SAR 3	29.73
SAR 4	32.82
SAR 14	147.65
SAR 15	36.22
SAR 16 Reference	0
SAR 17	58.13
SAR 18	25.01
SAR 32	43.04
SAR 33	23.89
SAR 34	46.06

Thermal

- Thermal factors are difficult to correct for
- Averaging
- Filtering

Validation - Volume

$$Coherence = \Upsilon_{geometric} \cdot \Upsilon_{thermal} \cdot \Upsilon_{volume} \cdot \Upsilon_{temporal}$$



Time Series Analysis

Implications

- More efficient observational erosion analysis
- Possibility of real-time erosion analysis