Performance of Sentinel-2 NDVI for assessing the relationship between vegetation and soil moisture under extreme drought conditions

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Introduction

Initial indications are that the enhanced spatial and spectral resolution of Sentinel-2 MSI would allow for better assessment of vegetation condition, and consequently improved application in conditions of drought

Although NDVI and other indices are well established methods in drought monitoring, little research has examined the suitability of Sentinel-2 (S2). While the utility of Landsat-8 (LS8) NDVI in revealing local scale plant-soil dynamics has been explored, challenges around resolution have emerged.



Visible & NIR - 30m

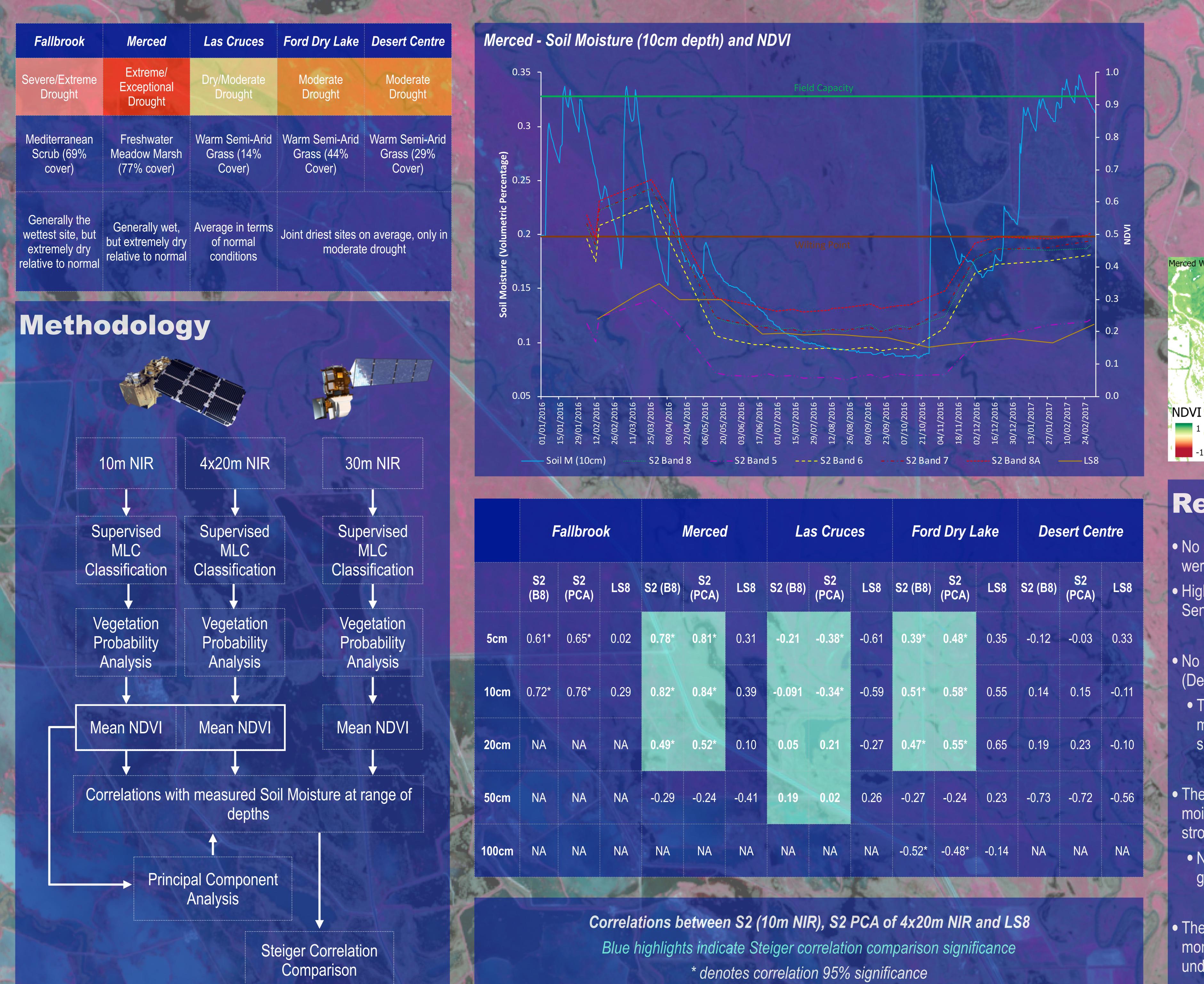
Visible & NIR - 10m 4x20m Narrow NIR

Sentinel-2

The principal aim of this study was to determine the extent to which S2 NDVI time series reflects soil moisture conditions, and whether this offers an improvement over LS8.

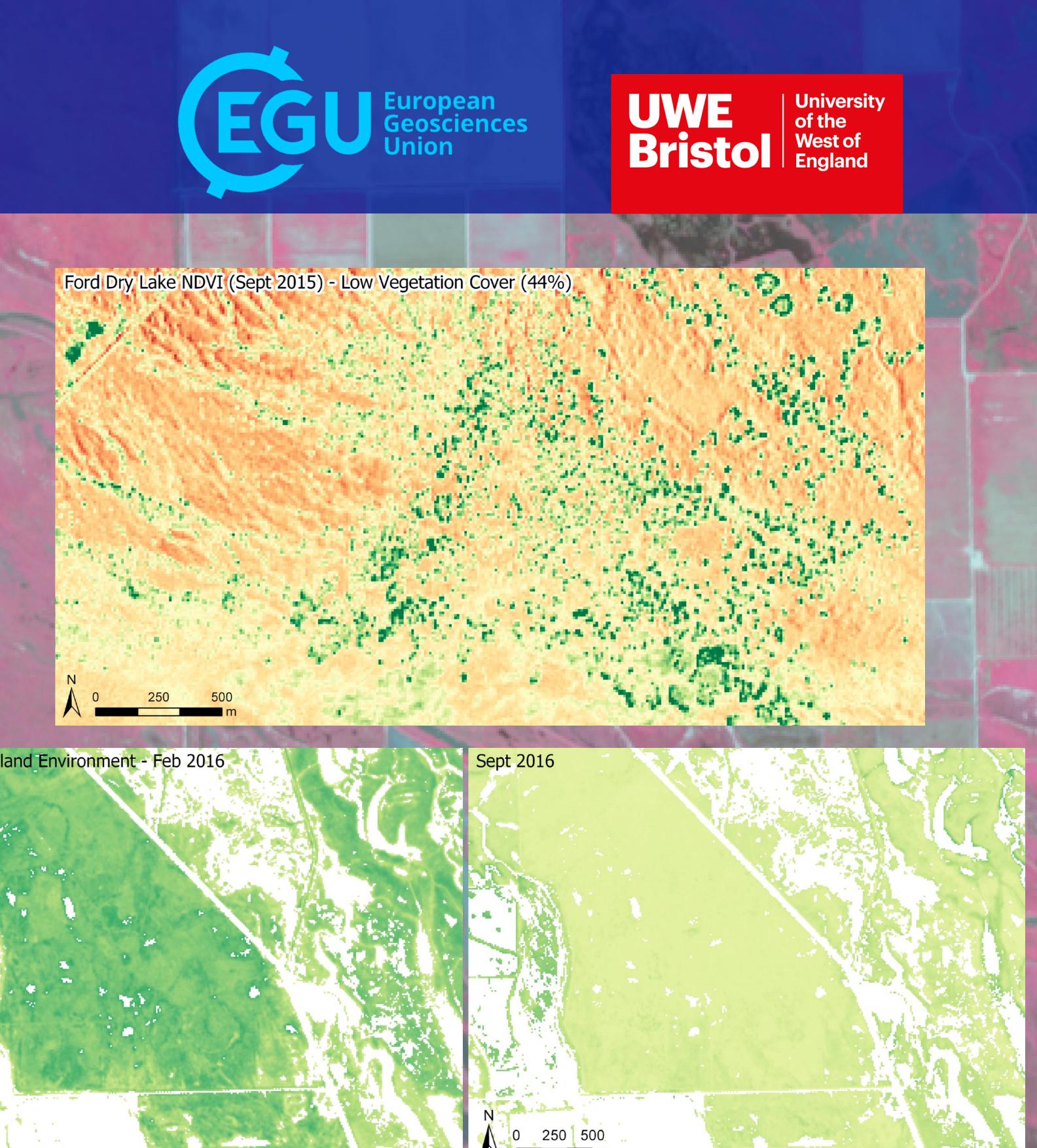
On the basis of exposure to drought over the study period (Jul 2015-Mar 2017), availability of cloud-free imagery and measured soil moisture, five sites in South-Western United States were selected. These sites, normally dry to arid, were classified as being in various states of drought, but in general this represented extension and recession of a significant drought event.

A secondary focus of the study therefore was the performance of S2 NDVI under extreme conditions. As far as we are aware, this represents the first study of this kind using S2.



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Merced			Las Cruces			Ford Dry Lake			Desert Centre		
3)	S2 (PCA)	LS8	S2 (B8)	S2 (PCA)	LS8	S2 (B8)	S2 (PCA)	LS8	S2 (B8)	S2 (PCA)	LS8
	0.81*	0.31	-0.21	-0.38*	-0.61	0.39*	0.48*	0.35	-0.12	-0.03	0.33
	0.84*	0.39	-0.091	-0.34*	-0.59	0.51*	0.58*	0.55	0.14	0.15	-0.11
	0.52*	0.10	0.05	0.21	-0.27	0.47*	0.55*	0.65	0.19	0.23	-0.10
	-0.24	-0.41	0.19	0.02	0.26	-0.27	-0.24	0.23	-0.73	-0.72	-0.56
	NA	NA	NA	NA	NA	-0.52*	-0.48*	-0.14	NA	NA	NA
	- North									1 7	



Results

 No significant correlations between Landsat-8 NDVI and measured soil moisture were found.

 High significant correlations were present between moisture at depths of <30cm and Sentinel-2 NDVI at three sites (Merced, Fallbrook & Ford Dry Lake).

 No significant correlations between Sentinel-2 NDVI and soil moisture at two sites (Desert Centre & Las Cruces).

• These sites were characterised by much lower vegetation cover - suggesting a minimum cover threshold of \approx 30-40% is required for NDVI values to report significant correlations with soil moisture.

 The principal component analysis (PCA) shows that at all sites of significant positive moisture/NDVI correlations, the linear combination of the red-edge bands produced stronger correlations than the poorer spectral, but higher spatial resolution band.

• NDVI calculated using the higher spatial resolution bands may therefore be of greater use in this context than the higher spatial resolution band.

 These results suggest high potential for the application of Sentinel-2 NDVI in drought monitoring, even in extreme environments, thus allowing us to further our understanding of local scale plant-soil dynamics.