21. August 2018

Time series analysis of Sentinel 2 data for the years 2016 & 2017 in the Hout river catchment, Limpopo Basin, South Africa – short summary

Rena Meyer, Wenmin Zhang, Karsten Høgh Jensen

Department of Geosciences and Natural Resource Management, University of Copenhagen, Denmark

Introduction

To support the decision on the right location for field installations, satellite data (from Sentinel 2) were analyzed in order to identify locations of possible river flow within the recent years. Time series analysis of this data was conducted at the 4 sites proposed by UWC as possible field investigation areas.

Brief background of the Methodology

The Sentinel 2 satellite provides high spatio-temporal resolution multi-spectral optical imagery (https://earth.esa.int/web/guest/missions/esa-operational-eo-missions/sentinel-2).

The NDWI (normalized Difference Water Index) is a remote sensing-derived index that relates to open water. It bases on the high absorbability and low radiation of water in the spectrum from visible to infrared. (https://www.sentinel-hub.com/eoproducts/ndwi-normalized-difference-water-index)

The NDWI is defined as (e.g. McFeeters, 2013):

$$NDWI = (B3 - B8)/(B3 + B8)$$

The sentinel bands B3 and B8 correspond to the green and near infrared, respectively. Open water would result in positive and vegetation or land surface in negative values.

As the Hout river is relatively narrow compared to the spatial resolution of the sentinel data, and the water might be shallow and/or have a high content of sediments, the absolute NDWI values were always negative. Therefore the differential NDWI was also investigated. Hereby the NDWI was divided by the $NDWI_{dry}$ during the dry period (average of May-September) (similar to Walker et al., n.d.):

$$\Delta NDWI = \frac{NDWI}{NDWI_{dry}}$$

The following analysis shows the modified NDWI (mNDWI). This index is defined by using short wavelength near infrared spectrum instead of near infrared spectrum and has the advantage of differentiating between dry and wet conditions more clearly but only has a spatial resolution of 20m.

Results

Time series analysis for mNDWI was conducted within the 4 areas that were identified as possible locations for the field investigations (Figure 1). Figure 2 shows the mNDWI variations from January 2016 to June 2018 together with daily rainfall data. At each location two observation points were located into the river and one outside, for reference. Subfigures a-d correspond to locations 1 to 4, respectively. Figures 3 and 4 show the relative change in mNDWI, compared to the dry season average (May-September) for the years 2016 and 2917, respectively. Figures 6 and 7 correspond to Figures 3 and 4 and show the variation in raw mNDWI.

Results for each site:

Site 1: no clear trend in mNDWI following wet and dry season. Peaks during dry season as a result of cloud cover disturbance.

Site 2: clear increase in mNDWI in the wet season and decrease during dry season for 2016 and 2017.

Site 3: clear increase in mNDWI in wet season and decrease during dry season in 2017, but no clear trend in 2016.

Site 4: clear increase in mNDWI in the wet season and decrease during dry season for 2016 and 2017. Site 4 is located upstream from the Hout river dam, and hence less influenced by dam operation.

References

McFeeters, K. S.: Using the Normalized Difference Water Index (NDWI) within a Geographic Information System to Detect Swimming Pools for Mosquito Abatement: A Practical Approach, Remote Sens., 5(7), 1–5, doi:10.3390/rs5073544, 2013.

Walker, D., Smigaj, M., Jovanovic, N., Kingdom, U., Resource, N. and Africa, S.: Ephemeral sand river flow detection from Sentinel-2 imagery : a new methodology, , 1–21, n.d.

Figures

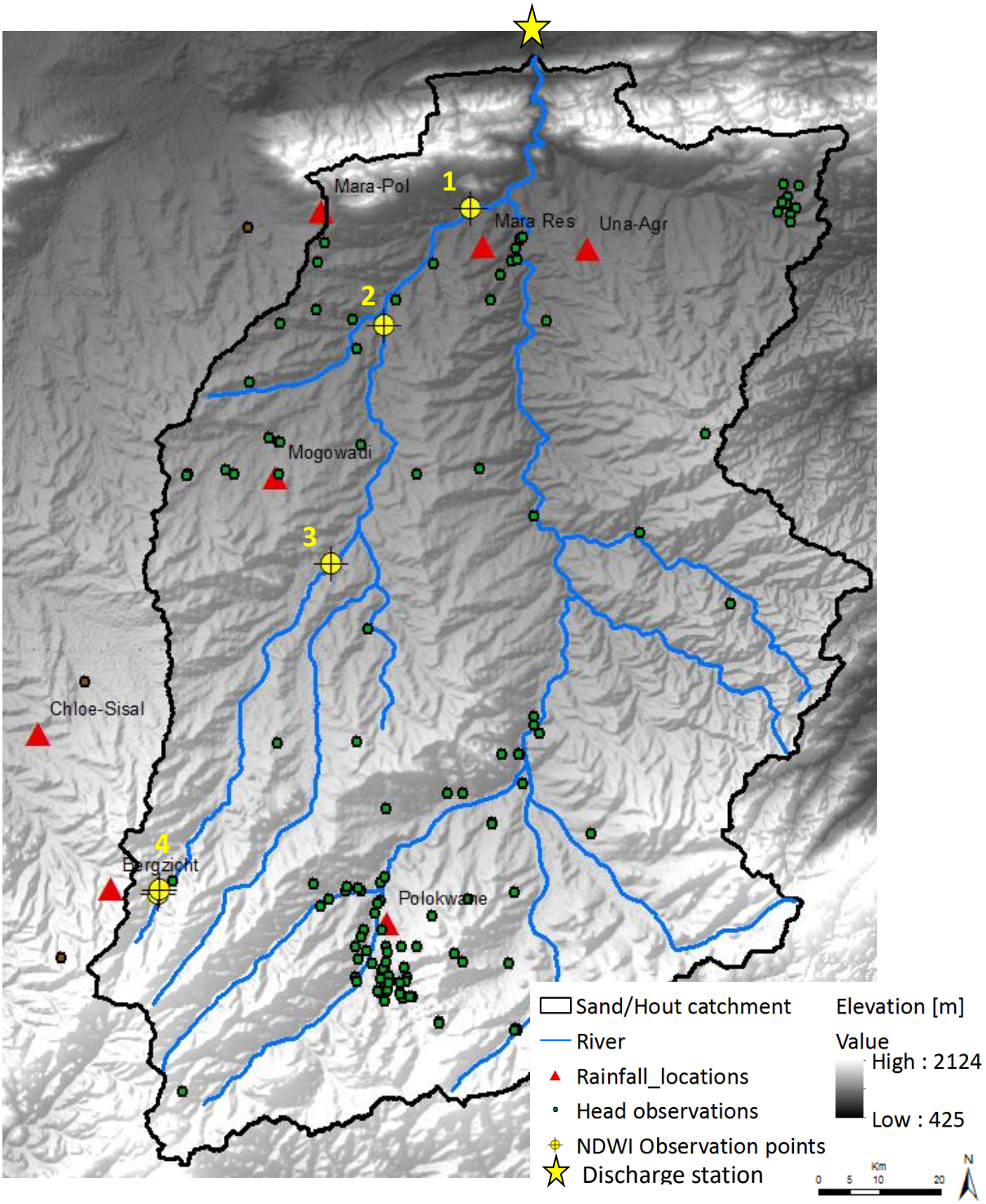

Figure 1: Investigation area of the Hout/Sand catchment and locations of NDWI observation points (1-4).

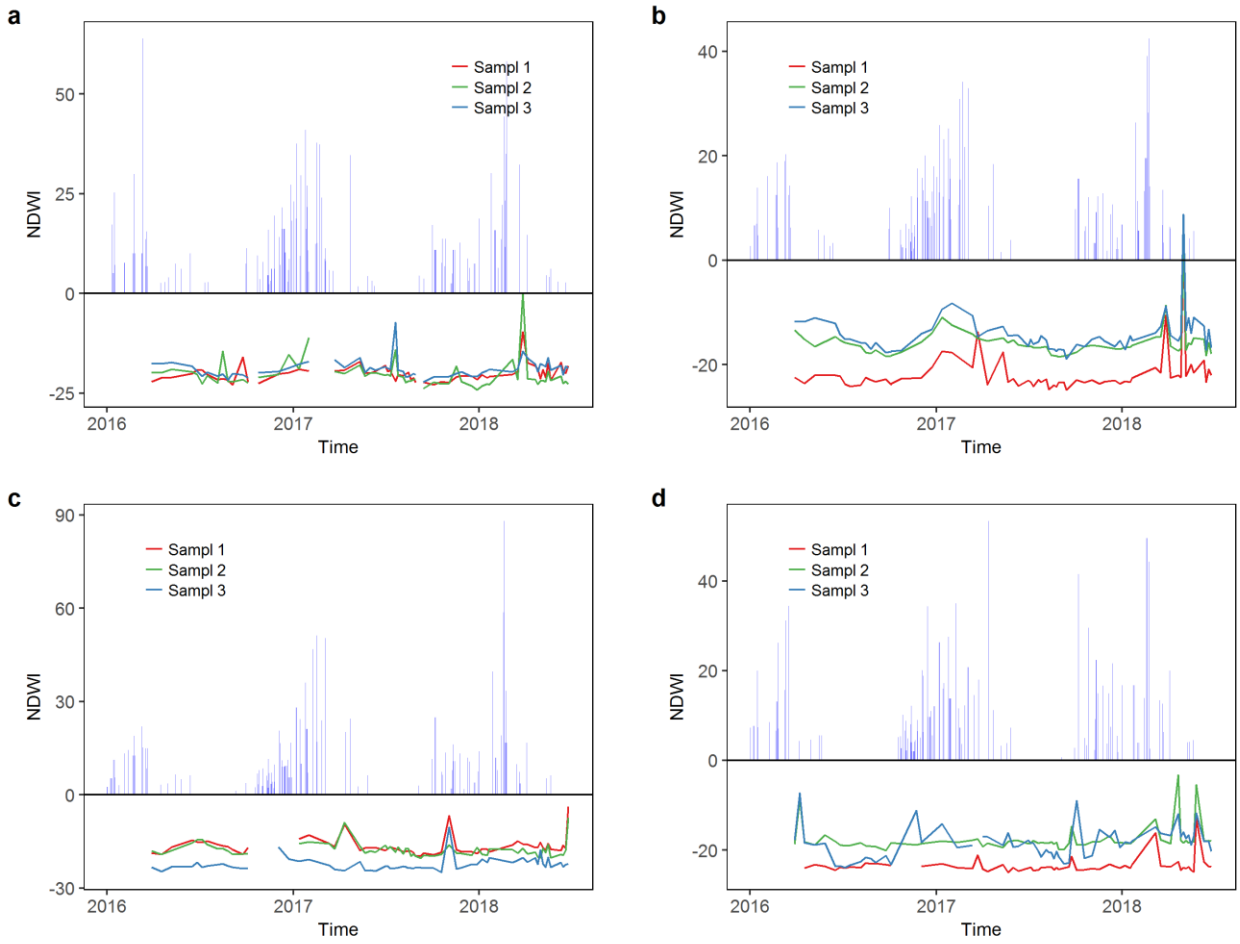

Figure 2: Time series analysis of mNDWI for the period of January 2016 to June 2018. The values of mNDWI were multiplied by 50. The bars represented the observed daily rainfall during the period. Figures a-d correspond to location 1 to 4 on Figure 1.

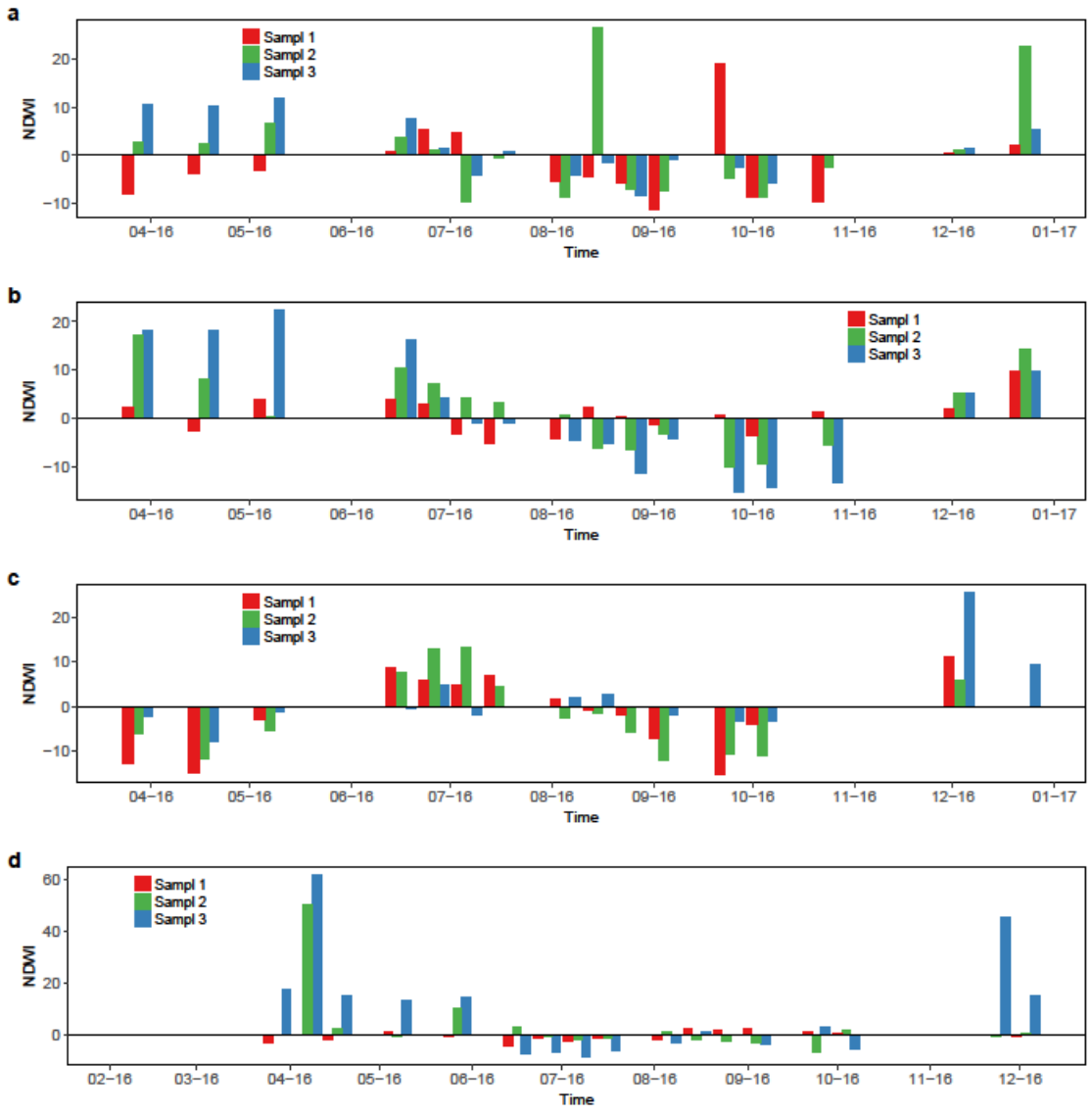

Figure 3: Variation of the differential mNDWI at the four locations (a-d refer to locations 1-4 in Figure 1) for 2016

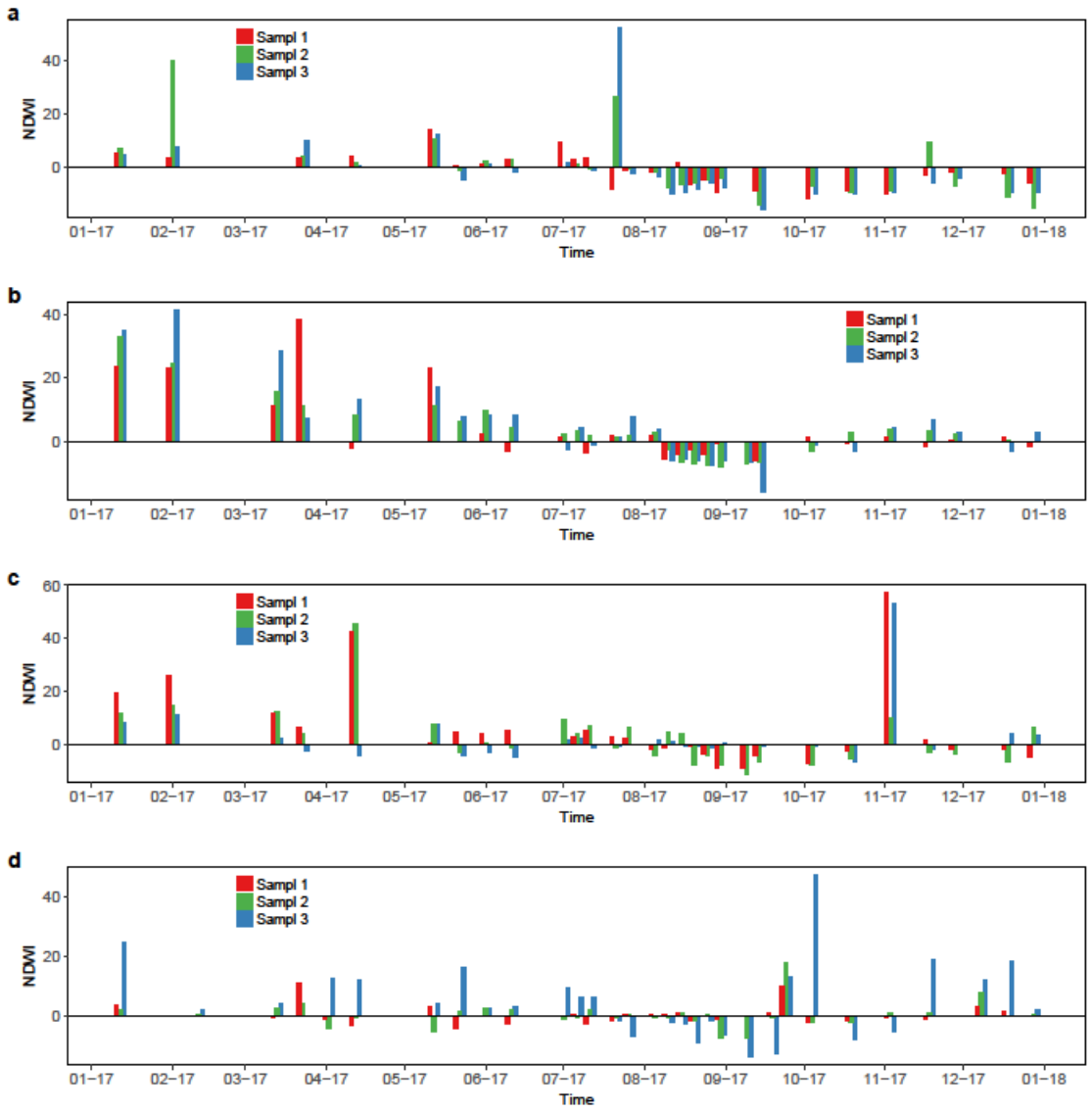

Figure 4: Variation of the differential mNDWI at the four locations (a-d refer to locations 1-4 in Figure 1) for 2017.

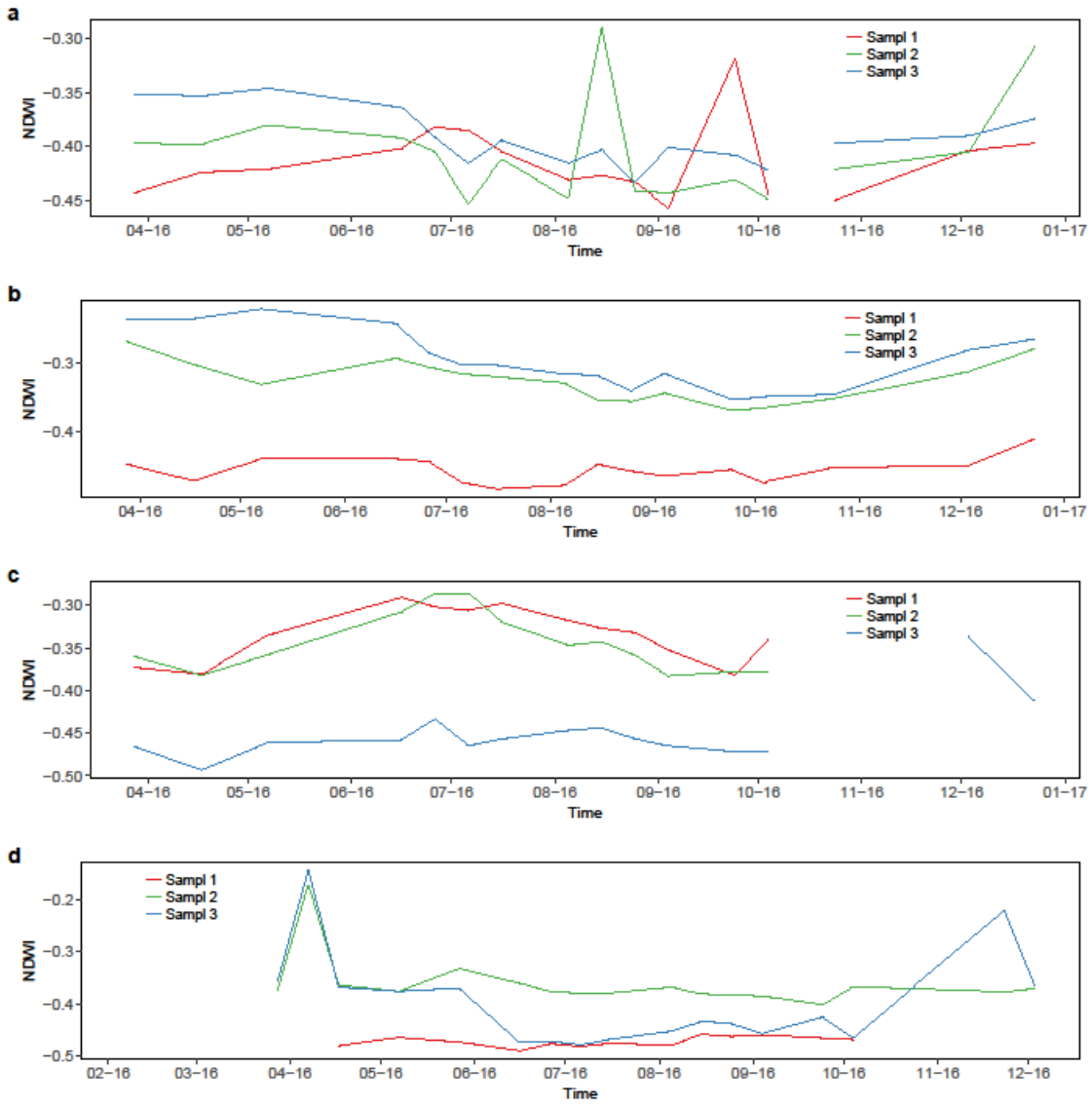

Figure 5: Yearly variation of mNDWI at the four locations (a-d refer to locations 1-4 in Figure 1) for 2016.

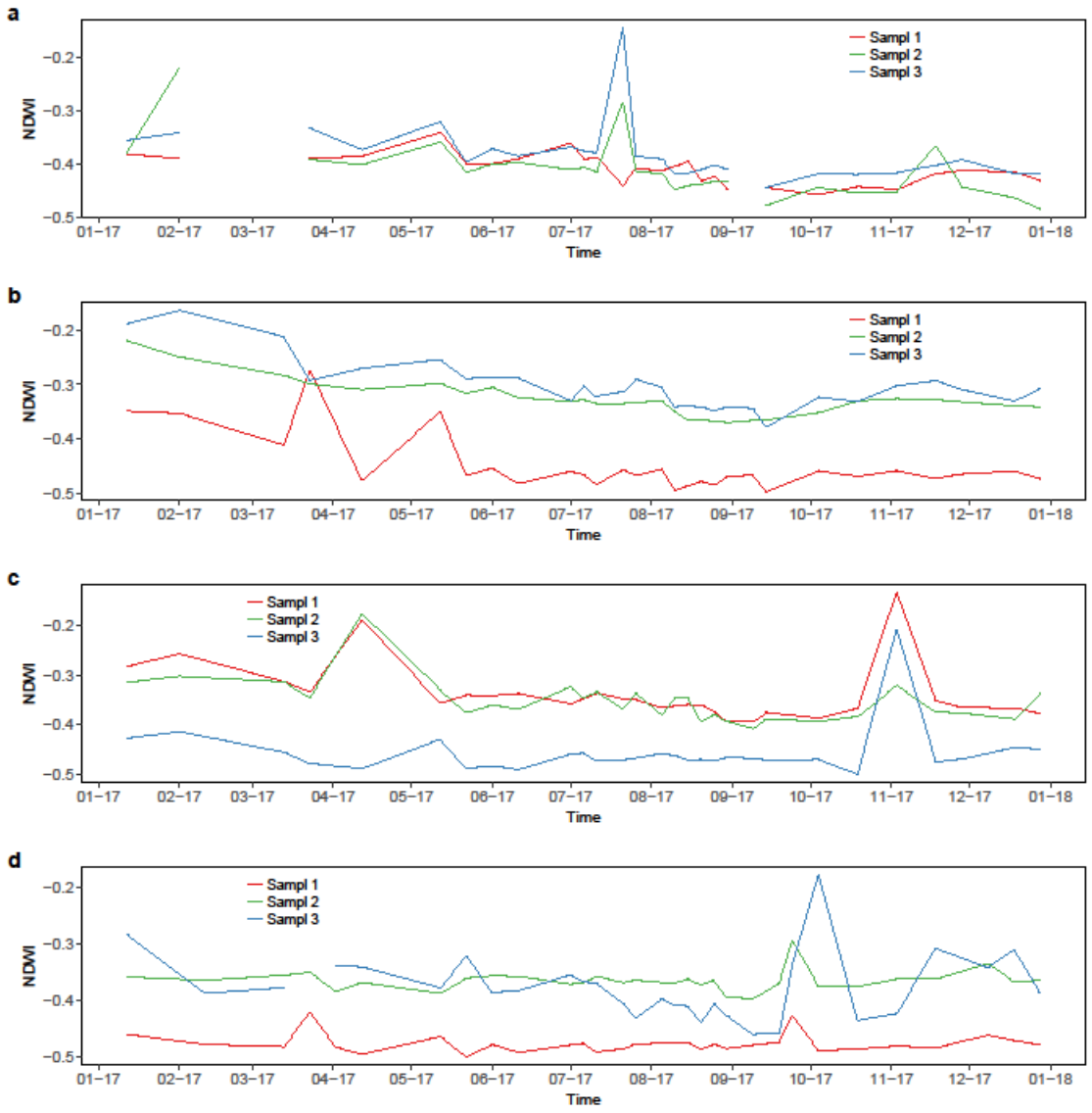

Figure 6: Yearly variation of mNDWI at the four locations (a-d refer to locations 1-4 in Figure 1) for 2017.