REMOTE SENSING-AIDED ASSESSMENT OF WETLANDS IN DEDZA DISTRICT, MALAWI

By

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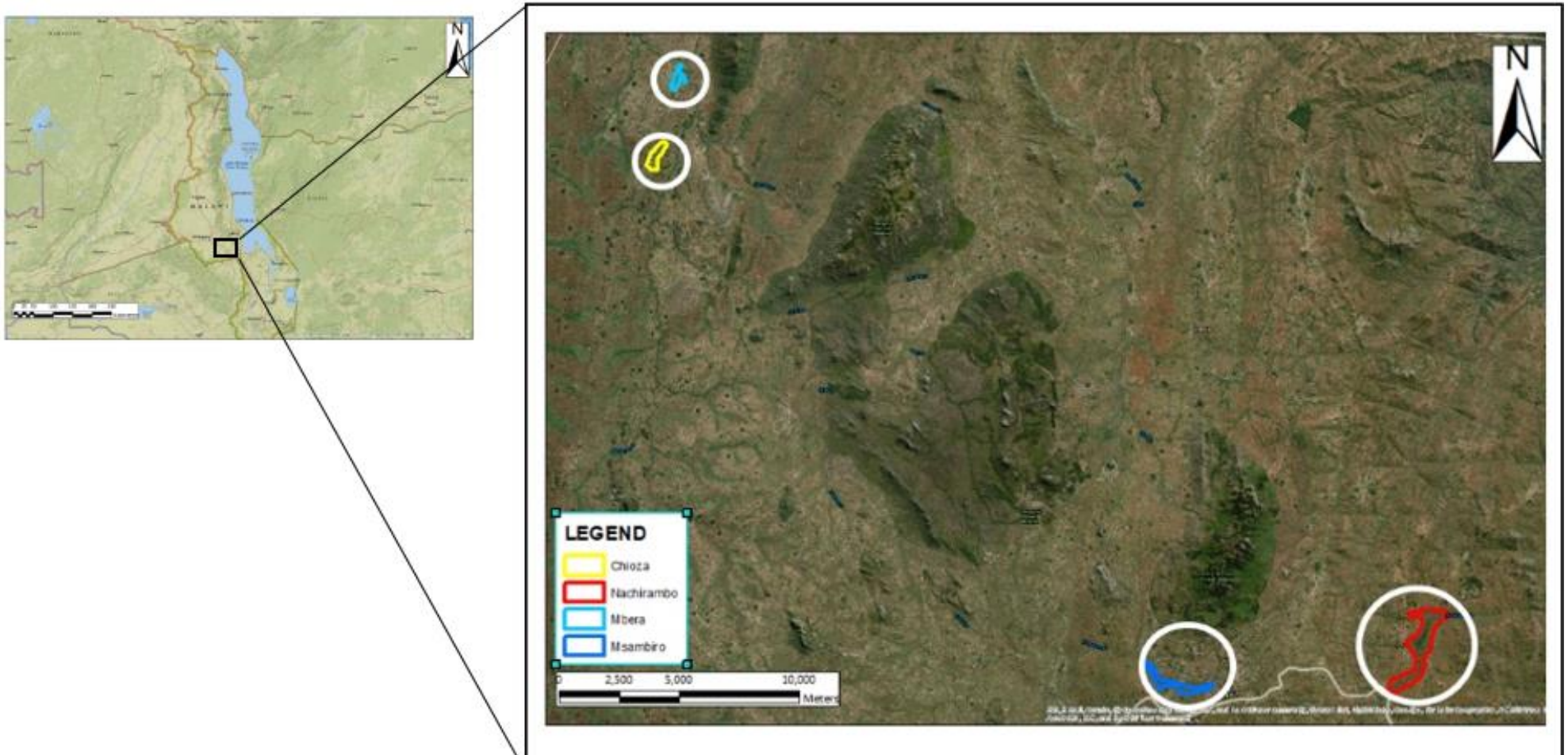
INTRODUCTION (BACKGROUND AND OBJECTIVES)

- Wetlands have played an irreplaceable role in regulating the global climate, maintaining the global hydrological cycle, protecting the ecosystem diversity, and safeguarding human welfare.
- For thousands of years, seasonal wetlands have mostly been utilised as an agricultural site due to their range of ecosystem functionalities which boost growing conditions - rich soil nutrients and supply of water (Finlayson & Max, 2018)
- Thus, they play significant roles in regulating food price in the region, yet the intensive use of these wetlands negatively affects the sustainability of their ecosystem and the wetland-dependent communities (Gupta, 2018)
- The end goal of our research is to develop a satellite-based algorithm to evaluate the degradation and use of wetlands using Landsat imagery data.
- In progressing to achieving the goal, we first investigate physical characteristics (i.e., dominant surface types), that measure the level of degradation and use of the wetlands, using Landsat-derived vegetation indices.

METHODS (STUDY AREA)

The study areas (as shown in figure below) which are within Dedza District in Central Region of Malawi, a landlocked country in Southern Africa; were selected based on the following: accessible from the country capital and suitable for drone use, as well as the differences in the agricultural activities of the wetland areas.



METHOD (DATA PREPARATION AND PROCESSING)

GROUNDTRUTH SURVEY DATA

A recent ground truthing survey was conducted in mid October, 2019 using high-resolution camera (GoPro Hero 7) and handheld GPS units (i.e. Garmin Dakota20 and Garmin 63). This involved visiting nine individual wetland sites and acquiring photographs as well as geographic coordinates of prominent surface types (upland fields, bare soil, crop fields etc) within the sites. These data were used during data analysis to correspond with the data acquired from satellite imageries.

ACQUISITION OF DATA

Optical satellite data required for this research were downloaded from https://earthexplorer.usgs.gov/. Downloaded dataset was Landsat 8 OLI/TIRS C1 Level-2 (Surface reflectance products). Acquisition date for Landsat data was September 29, 2019 (peak of dry season).

DATA ANALYSIS

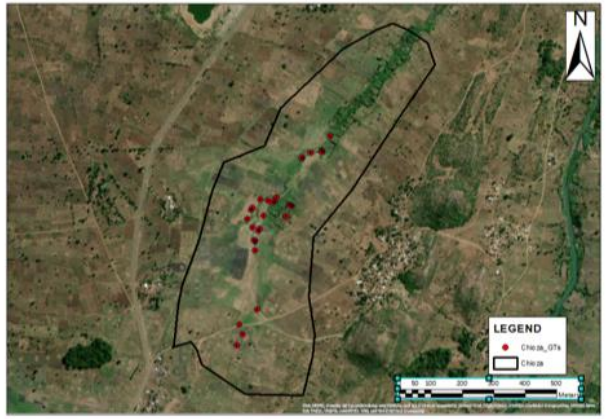
The surface reflectance data was used to calculate Normalised Difference Vegetation Index (NDVI) and Normalised Burn Ratio (NBR); Healthy vegetation shows a very high reflectance in the NIR, and low reflectance in the SWIR portion of the spectrum.

$$\textbf{NDVI} = \frac{\{NIR - RED\}}{\{NIR + RED\}} \qquad \textbf{NBR} = \frac{\{NIR - SWIR2\}}{\{NIR + SWIR2\}}$$

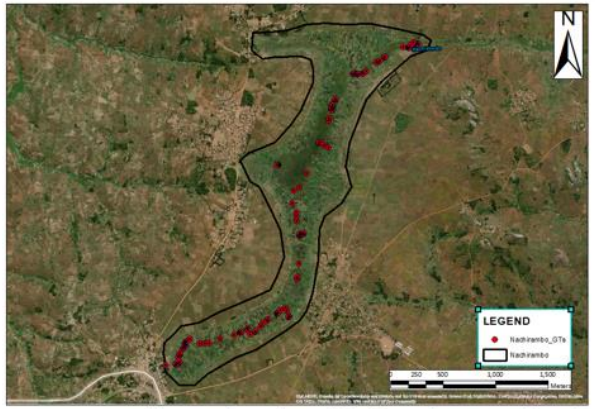
CHARACTERISING SURFACE TYPES

We analysed NDVI and NBR to identify dominant surface types

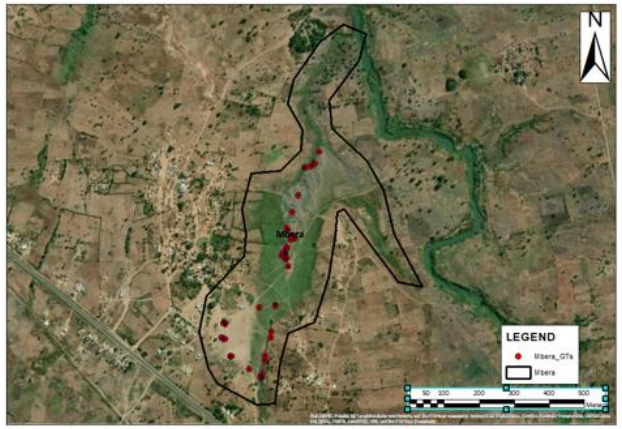
(Gandhi et al., 2015; Dubeau et al., 2017; Zaitunah et al., 2018; Walter & Mondal, 2019)



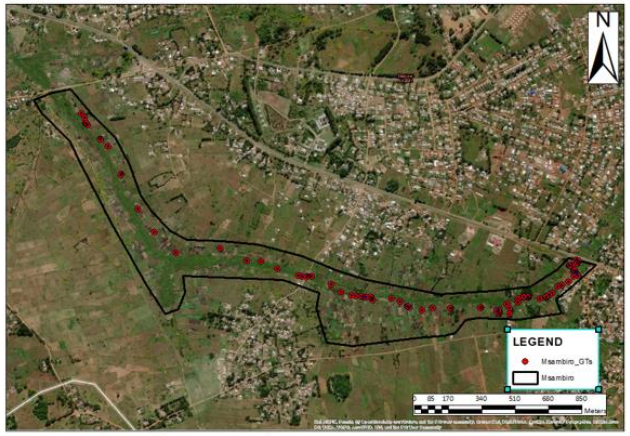
Name: **Chioza (Highlighted Boundary)**
Area Located: **Linthipe (Dedza District)**
Land Size: **29.191 ha**
Description: **Degraded**
Activity: **Grazing**
Topography: **Flat terrain**



Name: **Nachirambo (Highlighted Boundary)**
Area Located: **Bembeke (Dedza)**
Land Size: **261.668ha**
Description: **In active use**
Activity: **Cultivation but grazing within central region**
Topography: **Gentle slope with flat middle**



Name: **Mbera (Highlighted Boundary)**
Area Located: **Linthipe (Dedza District)**
Land Size: **18.186ha**
Description: **Degraded**
Activity: **Grazing**
Topography: **Flat terrain**

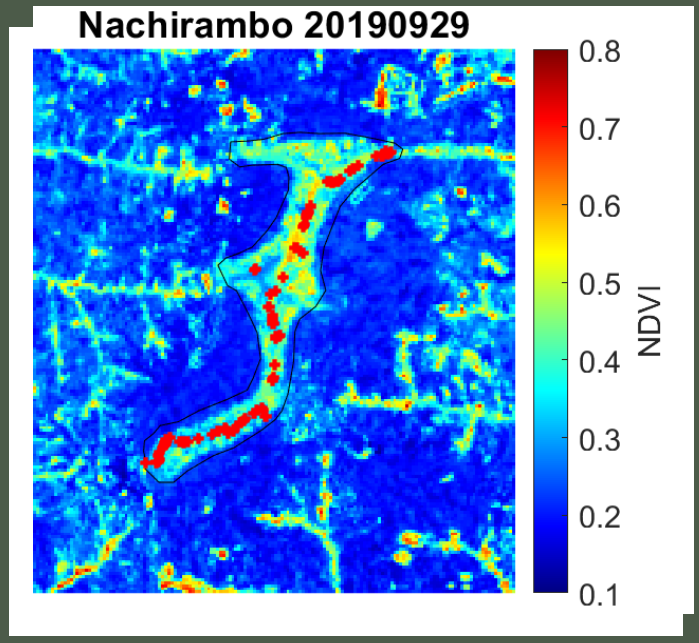


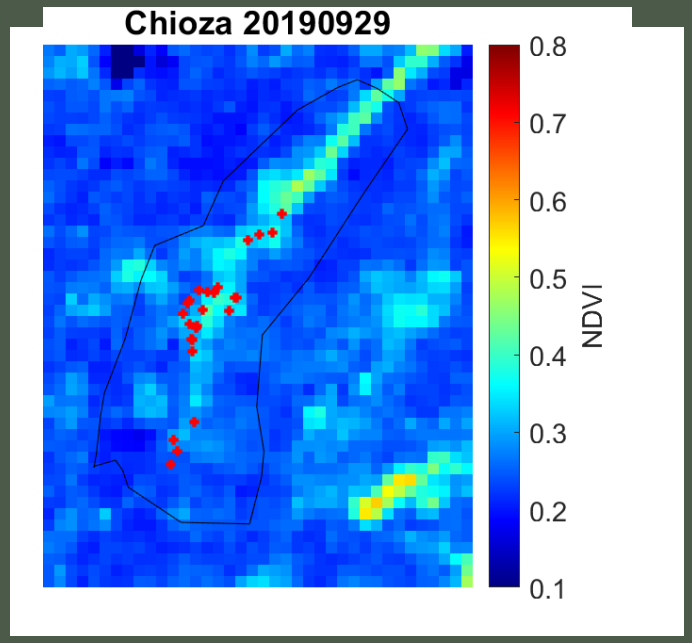
Name: **Msambiro Dambo**
Area Located: **Kapesi-Njuchi (Dedza District)**
Land Size: **Msambiro (68.45ha)**
Description: **In active use**
Activity: **Cultivation**
Topography: **Gentle slope with stream running through the centre**

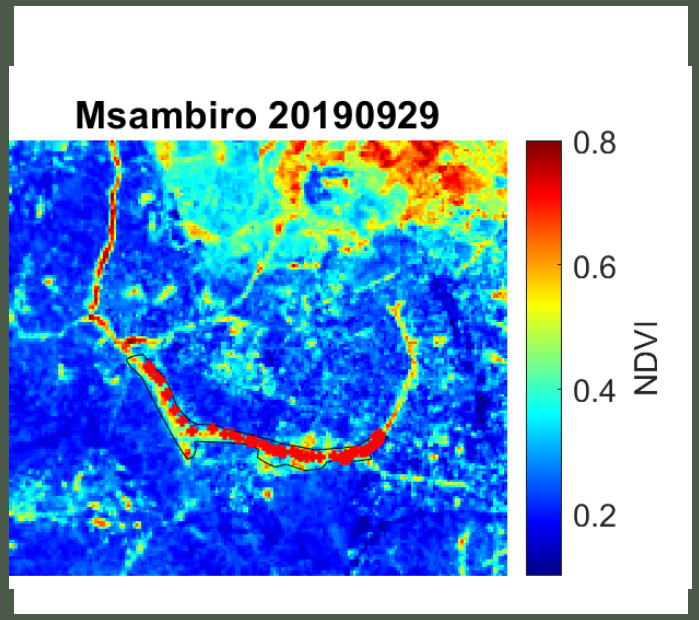
RESULTS

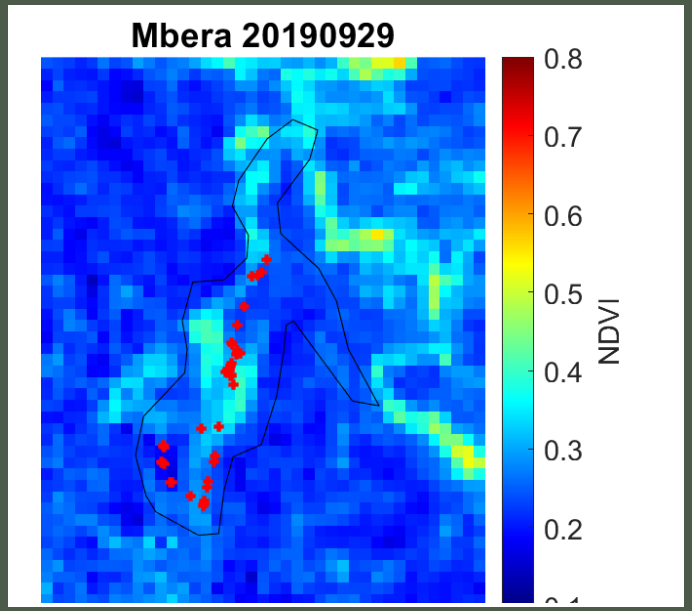
- ESRI Arcmap OpenStreetMap images of four selected wetland sites.
- Selected two wetland sites in active use and the other two sites with extensive degradation.

The boundary of each site is outlined by a black polygon and ground truth data points marked with red dots.









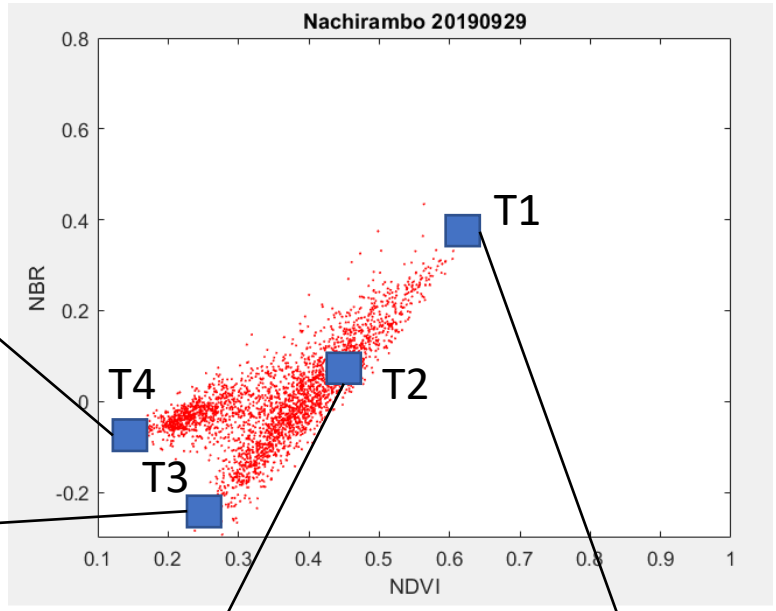
RESULTS

- NDVI maps for selected wetland sites overlaid with ground truth points (red dots).
- NDVI values of Nachirambo and Msambiro are higher than those of Chioza and Mbera.

RESULTS: Characterising surface types - Nachirambo

Upland (dry) fields

Bare soil fields



Vegetable crop fields

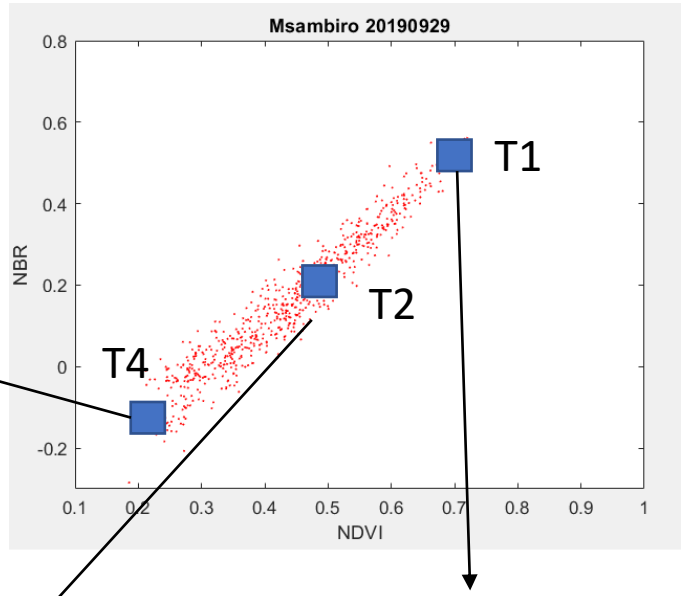
Natural vegetation and grasslands

- In Nachirambo, four surface types can be identified in NDVI and NBR domain.
- The surface types include natural vegetation and grasslands (T1), vegetable crop fields (T2), bare soil fields (T3) and upland (dry) fields (T4).

Red dots in the graph are the data points extracted within the wetland boundary polygon.

RESULTS: Characterising surface types - Msambiro

Upland (dry) fields



Vegetable crop fields

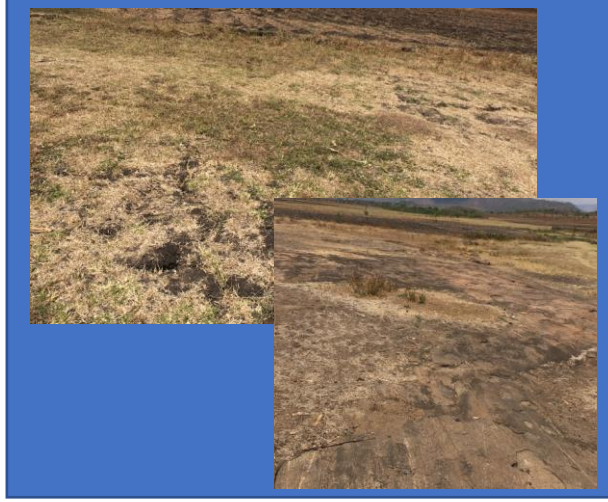
Natural vegetation and vegetable crops

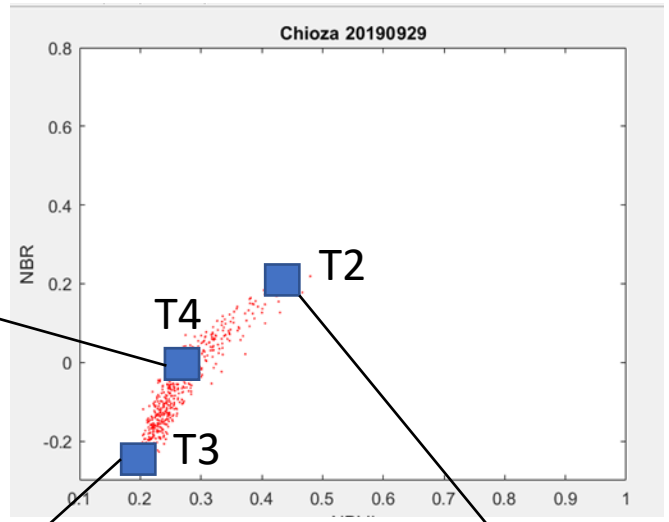
- In Msambiro, three surface types can be identified in NDVI and NBR domain.
- The three surface types found in Msambiro show similar characteristics to those shown in Nachirambo, yet the natural vegetation mixed with vegetable crops shows higher NDVI and NBR (T1).
- Vegetable crop fields (T2) and upland field (T4) show the similar NDVI and NBR characteristics as other sites.

Red dots in the graph are the data points extracted within the wetland boundary polygon.

RESULTS: Characterising surface features - Chioza

Dry grasslands





Bare soil fields

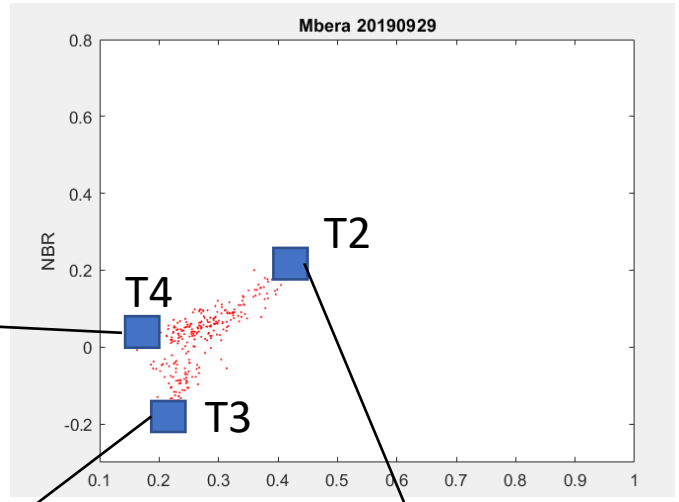
Vegetable crop fields (fenced)

- In Chioza, three surface types can be identified in NDVI and NBR domain.
- In Choiza, vegetable crops (T2) are grown in fenced areas and has the similar NDVI and NBR values found for T2 in Msambiro.
- Bare soil fields (T3) has similar NDVI and NBR values to those found in other sites.
- Dry grasslands (T4) show slightly higher NDVI and NBR values than dry upland fields found in Nachirambo and Msambiro.

Red dots in the graph are the data points extracted within the wetland boundary polygon.

RESULTS: Characterising surface features - Mbera

Dry grasslands



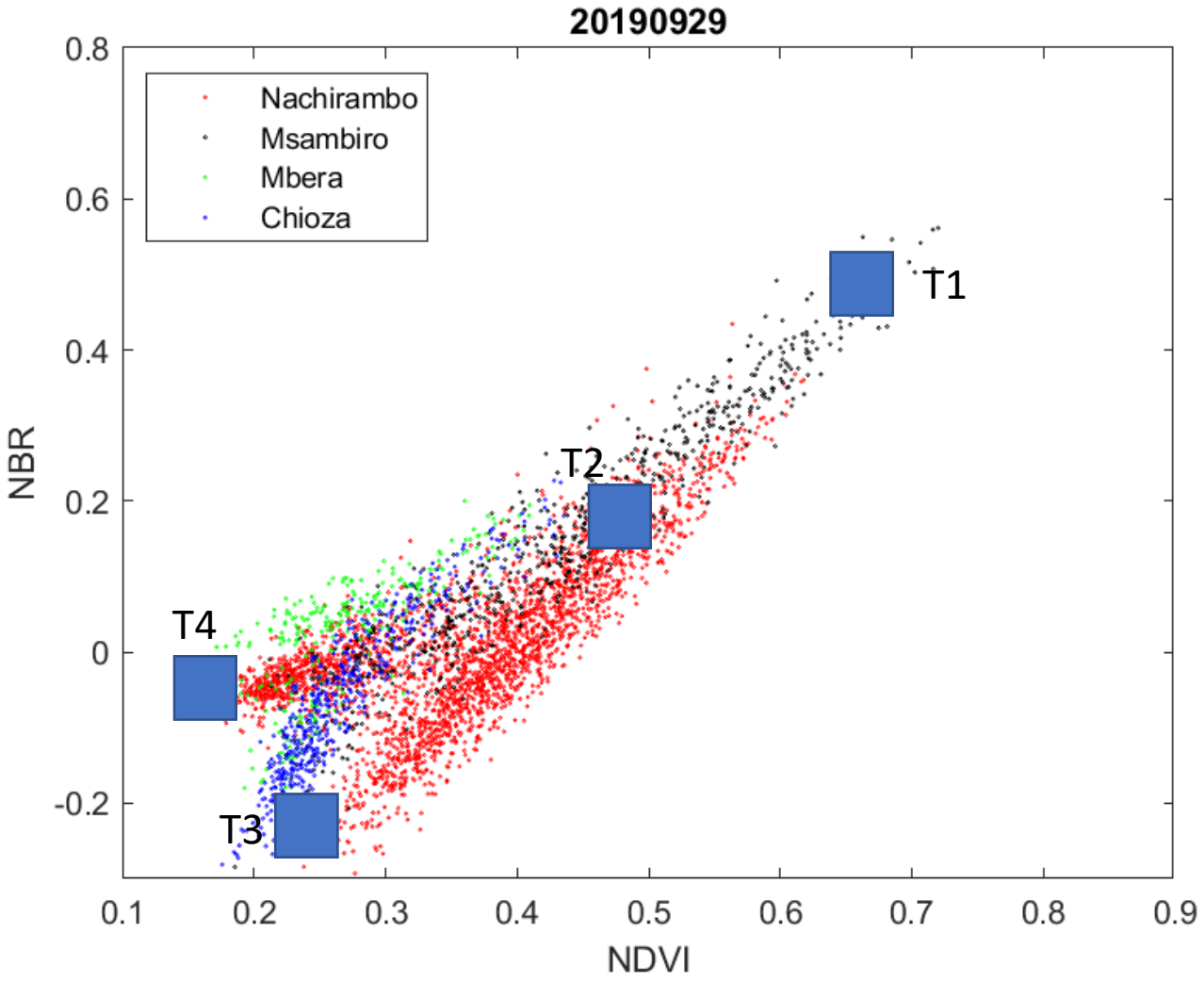
Bare soil fields

Vegetable crop fields

- In Mbera, three surface types can be identified in NDVI and NBR domain.
- Vegetable crops (T2) are grown in fenced areas and has the similar NDVI and NBR values as found in Msambiro and Chioza.
- Bare soil fields (T3) shows similar NDVI and NBR values in other sites.
- Dry grasslands (T4) in Mebera tends to be slightly lower NDVI but higher NBR values than that found in Chioza.

Red dots in the graph are the data points extracted within the wetland boundary polygon.

RESULTS: Characterising surface features – all sites



- The graph shows all the data points from four sites.
- T1: Natural vegetation with grasslands or crops
- T2: Vegetable crop fields (small-scale irrigation from wetlands)
- T3: Bare soil fields (cultivated for plantation)
- T4: Dry (offseason) upland fields or dry grasslands

SUMMARY AND DISCUSSIONS

- Ground truth data were collected at four wetland sites in Dedza District (Malawi) in mid-October 2019.
- Calculated NDVI and NBR from Landsat imagery, acquired 29 September 2019
- By analysing Landsat-derived NDVI and NBR with ground truth data, found four dominant surface types Natural vegetation with grassland or crops (T1); Vegetable crop fields (T2); Bare soil fields (T3); Dry upland fields or dry grasslands (T4).
- These surface types behave consistently in the NDVI and NBR domain across the selected wetland sites.

FUTURE WORKS

- Analyse the characteristics for four surface types during wet season.
- Develop tie-point algorithms to measure the degradation and use of wetlands.
- Explore how to use these algorithms in a large scale monitoring system for identifying wetland degradation and the need for field technical advice to improve sustainability of wetland use

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