The Relationship Between Fishing Canals and Topographic Depressions in a Sahelian Floodplain

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Introduction

Depressions in Northern Cameroon's Logone Floodplain are important natural and socio-economically valuable features. Fish use them to survive the dry season, and fishers value depressions as areas of high productivity. The increased use of canals to fish by draining depressions is threatening the fishery and local livelihoods. Identifying and mapping depressions is a vital step in managing the sustainability of the fishery for local communities.

Objectives

1. Assess remote-sensing techniques to locate depressions
2. Identify and map depressions across the entire floodplain
3. Determine the spatial relationship between the canals and depressions

Fig. 1 Canals link depressions to river (L) and channel water and fish through them (R).

Methods

Assessing remote-sensing techniques:

Depressions from a ground survey (n = 8) were used as training sites in supervised classification of natural and thermal infrared Landsat satellite images. Normalized Difference Water Index (NDWI) was also calculated to identify water bodies. Methods were assessed in the identification of known depressions (n = 12).

Finding depressions across the entire floodplain:

The most successful technique was applied to images of the entire floodplain from different dates (n = 8). A temporal (present in > 50% of images) and spatial threshold ($0.01 < X < 3km^2$) reduced misclassification.

Canal properties associated with depressions:

Canal metrics from a database of canals (n = 1286, 2014) were analyzed to test two hypotheses:

1. A positive relationship exists between depression size and number of canals draining them.
2. Canals linked to depressions are shorter and thinner than canals draining the floodplain.

Results

Supervised classification of the TIR image identified the greatest number of validation sites, with NDWI and natural image performing poorly (Table 1).

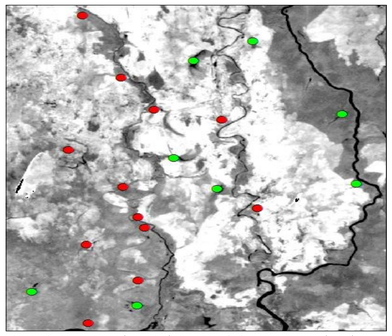


Fig. 2 Training (green) and validation sites (red) on the floodplain

Table 1. The number of validation sites correctly identified by remote sensing techniques.

Remote Sensing Source	Method Used	Classified Validation Sites (Mean ± SD)
Landsat level 1 bands	NDWI	0 ± 0
Landsat natural image	Supervised classification	0* ± 0*
Landsat TIR band	Supervised classification	6.375 ± 2.233

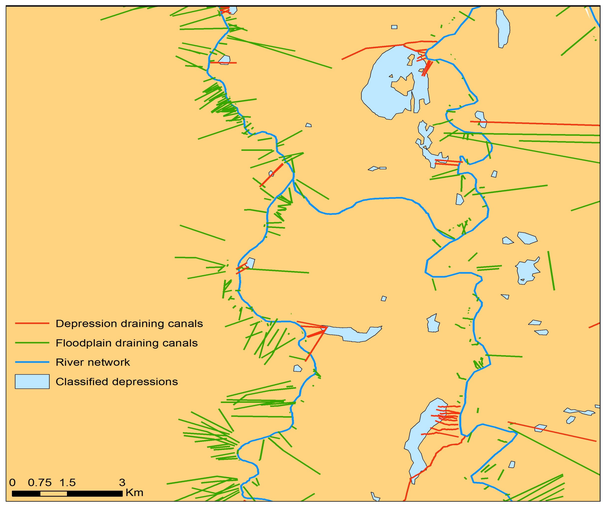
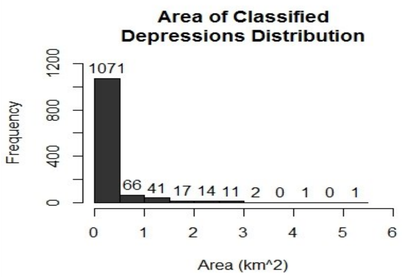
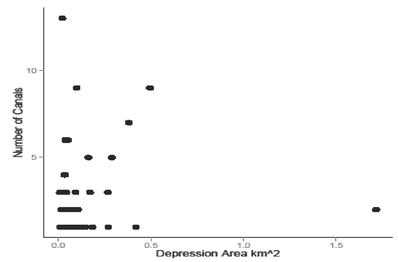


Fig. 3 Some classified depressions have canals attributed to them, further validating

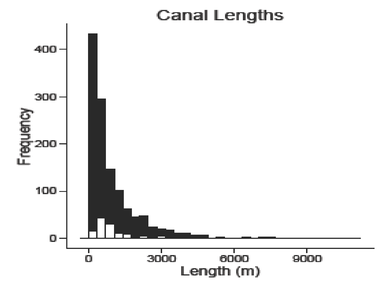
The classified depressions from each image within the thresholds were merged with depressions from the other images to create a dataset with 1224 depressions.

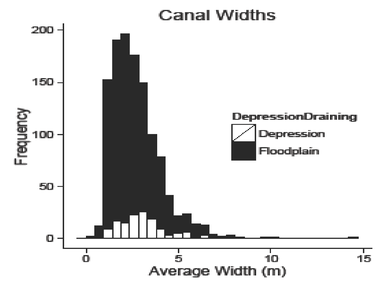


The average area was $0.2531km^2$; minimum area of $0.0086km^2$; and maximum area of $5.0839km^2$. Majority of the depressions fell under 1 km^2.



The number of canals draining a depression did not have a significant linear relationship with canal size (lm, p=0.67). When the potential outlier was removed, the relationship was nearly significant (lm, p=0.09).





Depression draining canals were significantly longer (Mann Whitney, p<0.01) and wider (Mann Whitney, p<0.01) than floodplain draining canals.

Table 2. The size differences between depression and floodplain draining canals. Mean ± SD are shown.

Draining Feature	Length (m)	Average Width (m)
Depression	1223 ± 1216	3.02 ± 1.23
Floodplain	932 ± 1140	2.66 ± 1.33

Conclusion

- Total of 1224 depressions were mapped on the Logone floodplain. Of these, 48 had canals draining them.
- Depression size was not the determining factor for the number of canals draining them. Other potential factors are local governance rules, settlement proximity, and access.
- Depression draining canals were larger than floodplain draining canals which may be a result of the preference for depression draining sites, and thus fishers have invested more time and resources to construct larger structures.
- Supervised classification of the TIR band is a suitable approach for identifying depressions on a floodplain. Factors to consider are i) cloud cover, ii) flood pattern dynamics, and iii) vegetation cover.
- Remote sensing is a promising approach for mapping large areas of difficult access.

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