Land-cover classification focusing on wetlands impacted by subsistence farming using satellite remote sensing

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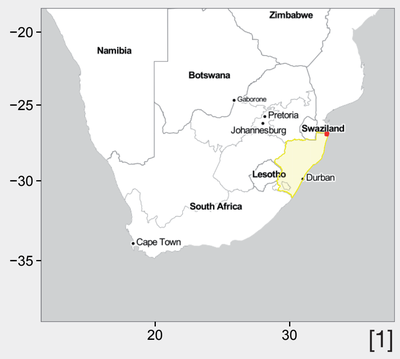

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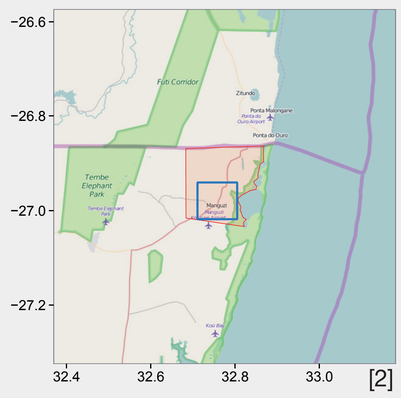


[2]

Study area

350 km² [Fig. 1,2 - red] situated in KwaNgwanase, KwaZulu-Natal [Fig. 1 - yellow], South Africa (Maputaland Coastal Plain / MCP).

Summers tropical, winters sub-tropical [Fig. 3].
Dunal system of sandy soils and undulating terrain with river systems, depression wetlands and coastal lakes.
60% of wetlands in South Africa within MCP, estimations of peatland usage of >4%.

Increasing influence of uncontrolled, sprawled settlement development and forestry plantations leading to wetland degradation and unsustainable subsistence usage.

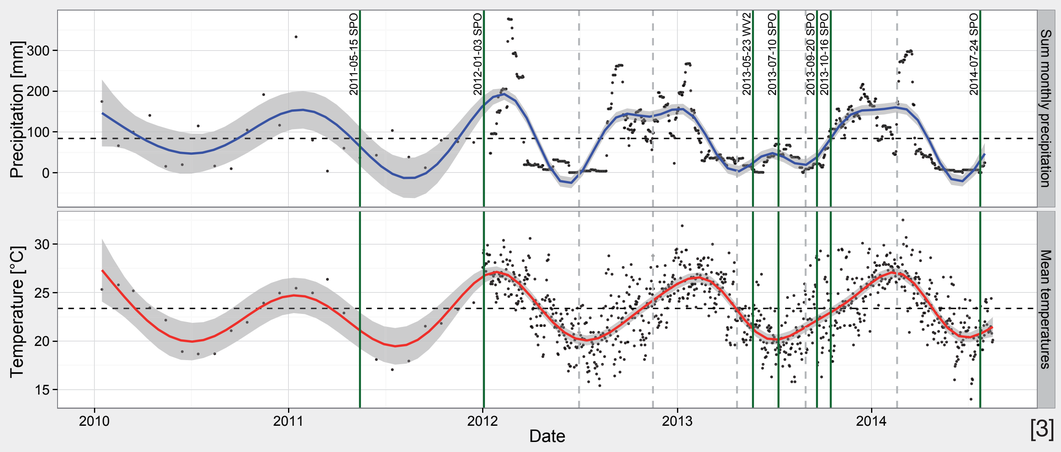
Knowledge about spatial patterns of usage and status of wetlands crucial for interventions.

Wetland and land-cover classification

Wetlands and their use through small scale subsistence cultivation can be delineated and differentiated in specific categories by the use of satellite imagery.

Supervised pixel-based classification approach utilising R implemented Random Forest algorithm on base of multispectral (VIS to mid-infrared), multitemporal (and -seasonal) and multisensory (SPOT 4/5 and WorldView2) satellite data. For wetland specific classification as follows:

1. Development of classification system and training data collection
2. Atmospheric correction of imagery and calculation of indices (NDVI, moisture index, red-edge index, green-red index, etc.)
3. Variable reduction by selection of satellite scenes:
   Climatic setting and variable importance according to preliminary Random Forest analysis



[3]

4. Classification on indices of final set of satellite imagery [Fig. 3 - green]
5. Accuracy assessment through own set of validation data

	Non wetland	Short sedge	Swamp	Tall sedge	Water	Cultivation wetland
Producer's Acc. [%]	95.63	48.26	75.18	44.95	96.11	43.60
User's Acc. [%]	93.42	68.42	63.95	61.89	98.44	30.36

Overall accuracy 87.06% - Cohen's κ of 0.7927

6. Characterization, comparison and interpretation of classes:
   Combination of index response and variable importance measure

Steps (3) to (6) were performed for the general land-cover classification separately with a resulting **overall accuracy of 77.77% (κ = 0.7438)**.

Conclusion on classification

First successful remote sensing classification attempt including differentiated wetland classes in study area.

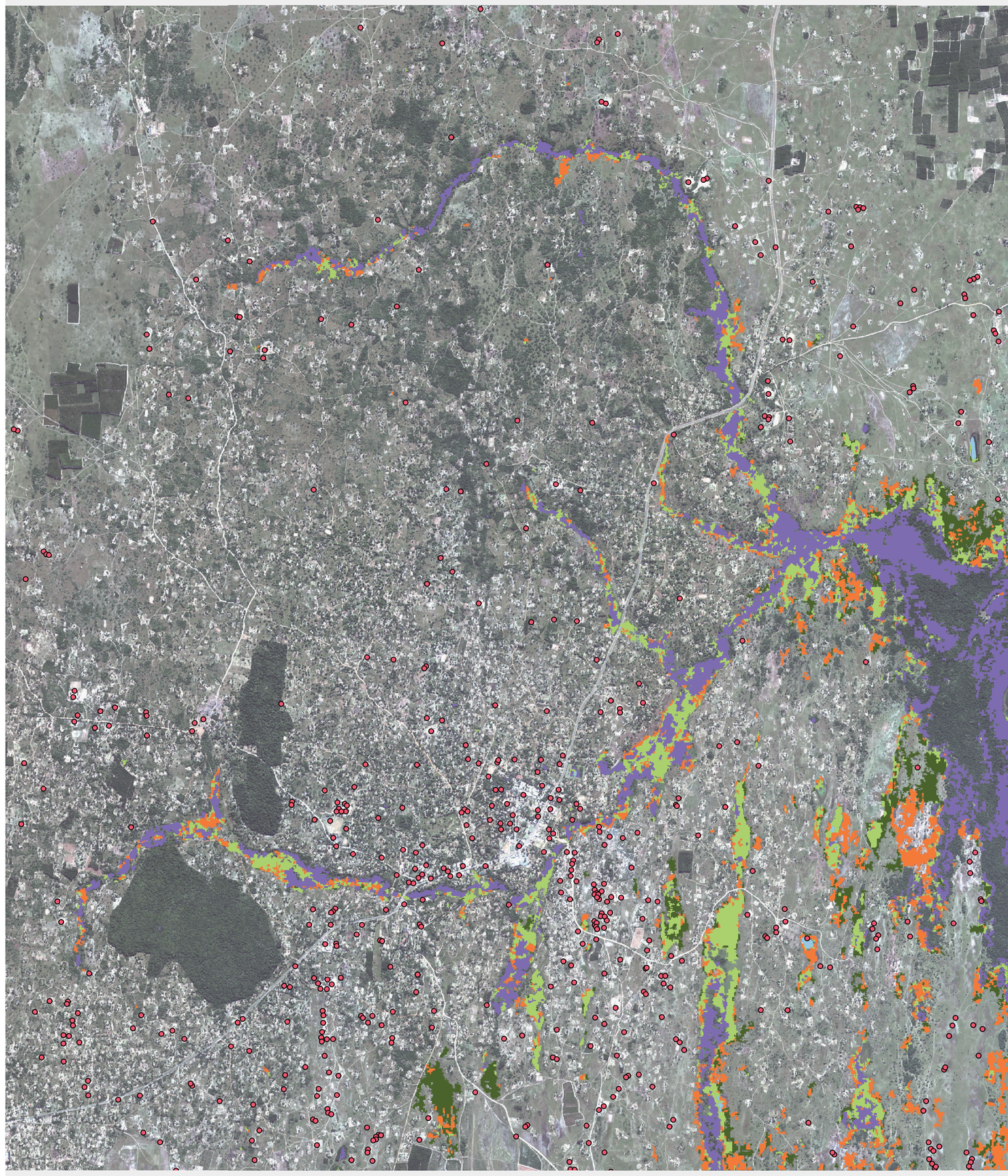
Classification of esp. wetland cultivation reasonable: General occurrences are shown, exact delineation not always successful.

Automated variable selection via Random Forests was not possible but indication of variable importance (i.e. indices at different points in time) was useful for interpretation.

Prospect: Expand set of training data, esp. in forest areas unjustified classified as swamp forest. Addition of additional GIS-layers to classification.

Prospect: Develop hypotheses of spatial patterns considering specific strengths and weaknesses of the land-cover and wetland classification.

Extract of wetland specific classification [Fig. 2 - blue]. Single homesteads/huts as identified through general land-cover classification. WorldView2 satellite imagery as background.



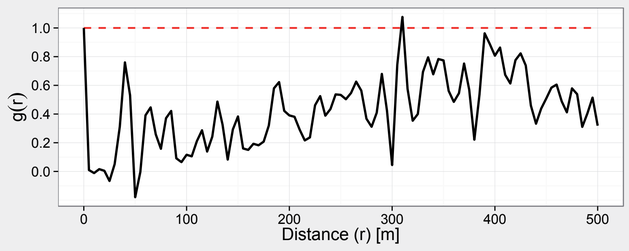
[4]

Spatial patterns and landscape setting of wetlands

The derived classification reflects landscape settings and socio-ecological patterns.

Spatial assessment of occurrence of wetland cultivation and residential features (i.e. classified huts) within a 1000 m buffer around all wetland areas [Fig. 4].

Pair correlation function (ring-variation of Ripely's *K*) to assess statistical deviation from complete spatial randomness (CSR) of features depending on distance.



Spatial inhibition of huts directly next to wetland cultivation (g(r) < 1).

Reaching random distribution and even slight clustering (g(r) > 1) at a distance of 310 m from wetland cultivation.

Conclusion on spatial patterns

Spatial patterns of settlement next to wetlands showed expected inhibition at close range. The rise in spatial clustering coincides with a majority of wetland farmers describing their fields to be in a 3-5 minutes walking distance.

14% of classified wetland areas are wetland cultivation. This number exceeds substantially the literature estimation of 4% and confirms the assumption of pressure on wetlands in the region.

45% of delineated wetlands are used to at least a minimum extent, in roughly half of them (23%) the used area exceeded 50%.

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