GRASS in the Desert? Developing FOSS tools for monitoring desertification

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ABSTRACT:

The use of Change Vector Analysis (CVA) combined with the Tasselled Cap tranform (TCT) is a powerful remote sensing tool to monitor forests and vegetated areas, but its application to arid and semiarid environment is not straightforward.

This question is tackled through the calculation of a new set of TCT coefficients using R and GRASS-GIS for SPOT and Landsat satellites, then applied and tested in change detection analysis on a short (seasonal) and a long (decades) temporal scale.

Results show that the combined procedure is an effective method to detect changes in desert environment. Furthermore, the new TCT allows the use of this combined procedure for studies in arid and semi-arid regions, eliminating the doubts on its compatibility with the area of study.

Further development is the creation of a new GRASS-GIS module to performe CVA, thus enabling the simple usage of this technique, until now not available in most common software.

KEYWORDS: Desertification; Change detection; Grass-GIS; R

GRASS IN THE DESERT? Developing FOSS tools for monitoring desertification

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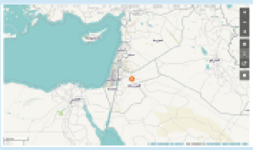
OBJECTIVE

The use of **Change Vector Analysis (CVA)** combined with the **Tasselled Cap Tranform (TCT)** is a powerful remote sensing tool to monitor forests and vegetated areas, but its application to arid and semiarid environment is not straightforward.

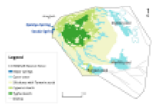
This question is tackled through the calculation of a new set of TCT coefficients using **R** and **GRASS-GIS** for SPOT and Landsat satellites, then applied and tested in change detection analysis on a short (seasonal) and a long (decades) temporal scale.

Further development is the creation of a new GRASS module (**i.cva**) to performe CVA, thus enabling the simple usage of this technique, until now not available in most common software.

CASE STUDY

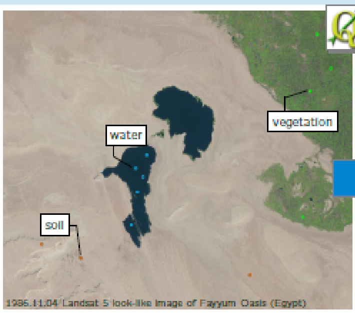


Azraq Oasis (Jordan) is a good case study since it shows a clear seasonal pattern and was subject in the 90s to the complete drying out of the natural springs.



Digitized 1979 map of Azraq Oasis

METHODS

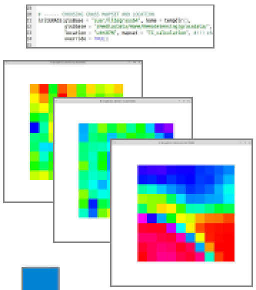


1986.11.04 Landsat 5 look-like image of Fayyum Oasis (Egypt)

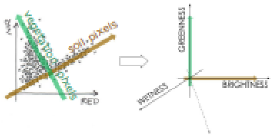
Selection of 20 squares of 100 pixels for three categories of surface cover, for different locations and different seasons of the year (at least 6 images, here shown as an example a location in the Sahara desert in Egypt).

TRANSFORM CALCULATION

Importing the selection in R through Grass, to obtain 2000 pixels for each category.



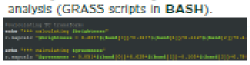
Calculating TCT through adapted Gram Schmidt orthogonalization for each image then obtaining the final transform by average on location and time.



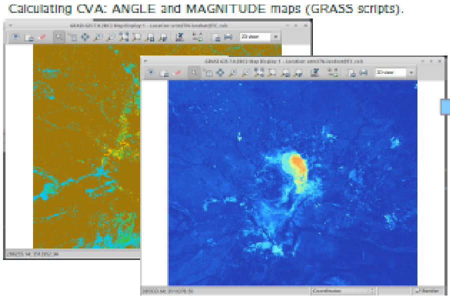
> coefficients

	Band1	Band2	Band3	Band4	Band5	Band6	Band7
Brightness	0.2173057	0.2710413	0.3207298	0.3740671	0.4021062	0.4547037	0.4301290
Greenness	0.1168100	0.1247569	0.0600586	-0.1960024	0.7505128	-0.4024772	-0.3467424
Wetness	0.2356817	0.2437416	0.3420058	0.6294768	-0.1321605	-0.4065922	-0.3801761

Creating the adapted Brightness and Greenness maps for the CVA analysis (GRASS scripts in **BASH**).

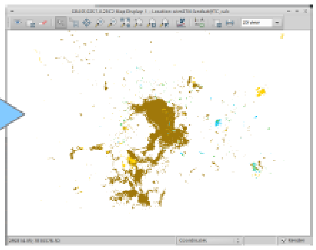


Calculating CVA: ANGLE and MAGNITUDE maps (GRASS scripts).



CHANGE VECTOR ANALYSIS

Obtaining the change detection map by threshold.

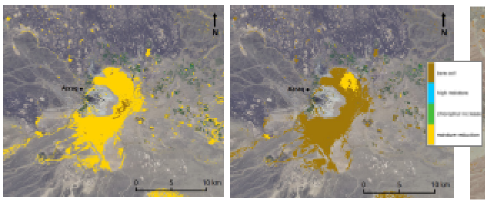


Converting the scripts to a new GRASS module.

WORK IN PROGRESS

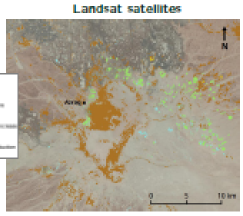
RESULTS

SPOT satellites



Seasonal change in Azraq Oasis (February – June 2013) detected with the existing TCT [left] and with the new desert-adapted TCT [right].

Landsat satellites



30 years change over Azraq Oasis (1984-2013) during the summer season (August) detected with the new desert-adapted TCT.

CONCLUSION

The Change Vector Analysis (CVA) applied to the new Tasselled Cap Transform (TCT) has been proven to be an effective remote sensing method to detect changes in desert environment.

In the same time, the newly calculated TCT coefficients allow the use of this combined procedure for studies in arid and semi-arid regions eliminating the doubts on their compatibility with the area of study.

The integration of the scripts used for the research into the GRASS environment makes this technique easily accessible for other researchers.