

PROCESSING OF MODIS NDVI IMAGERY TO CHARACTERIZE VEGETATION DYNAMICS OF AFRICOVER POLYGONS (VeDAS)



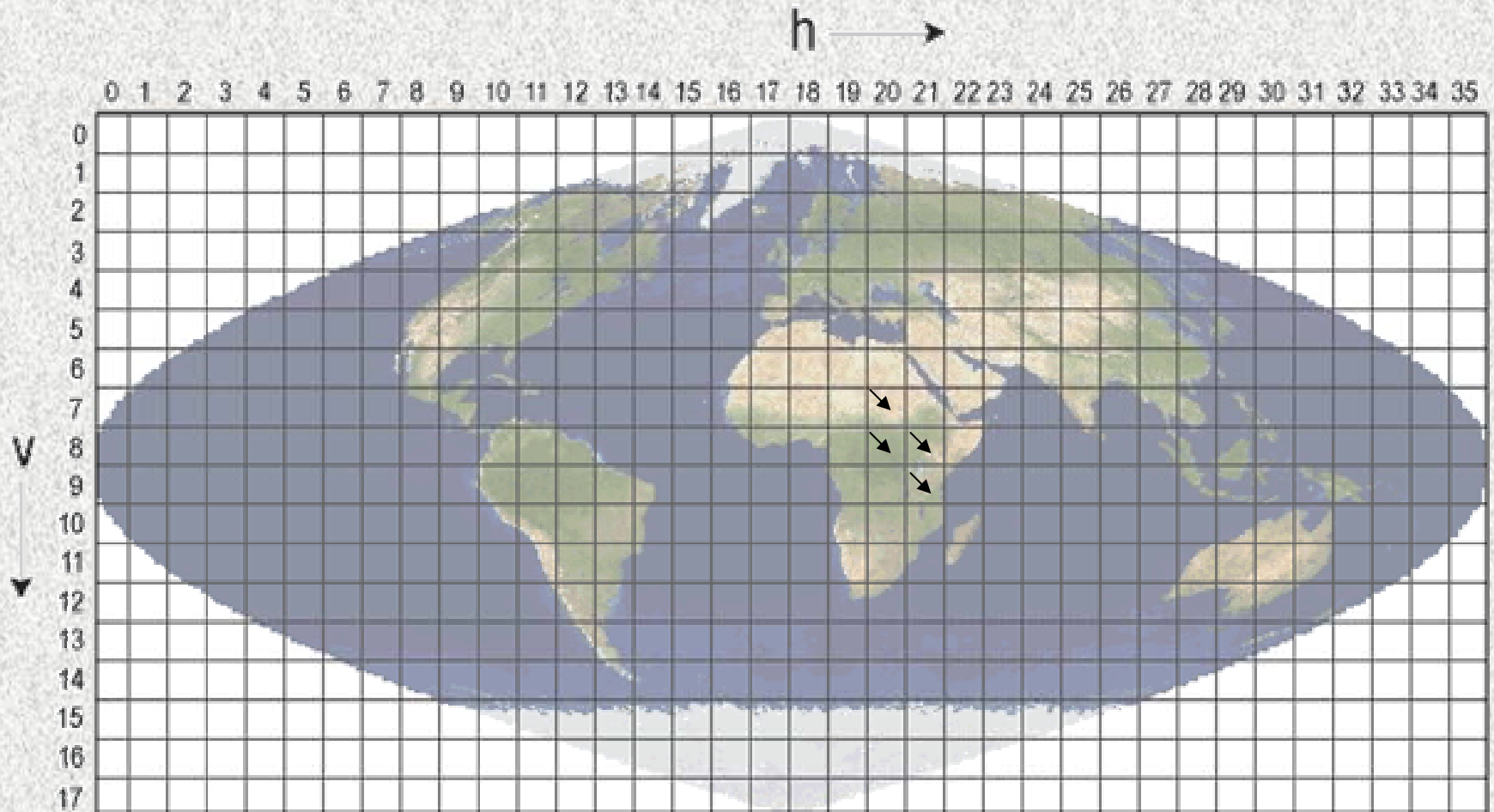
FIRST THREE MONTHS RESULTS

Objective

The project is aimed at developing and testing a methodology suitable to characterize the polygons contained in AFRICOVER maps, and in general any polygon classified with LCCS, in terms of average vegetation dynamics.

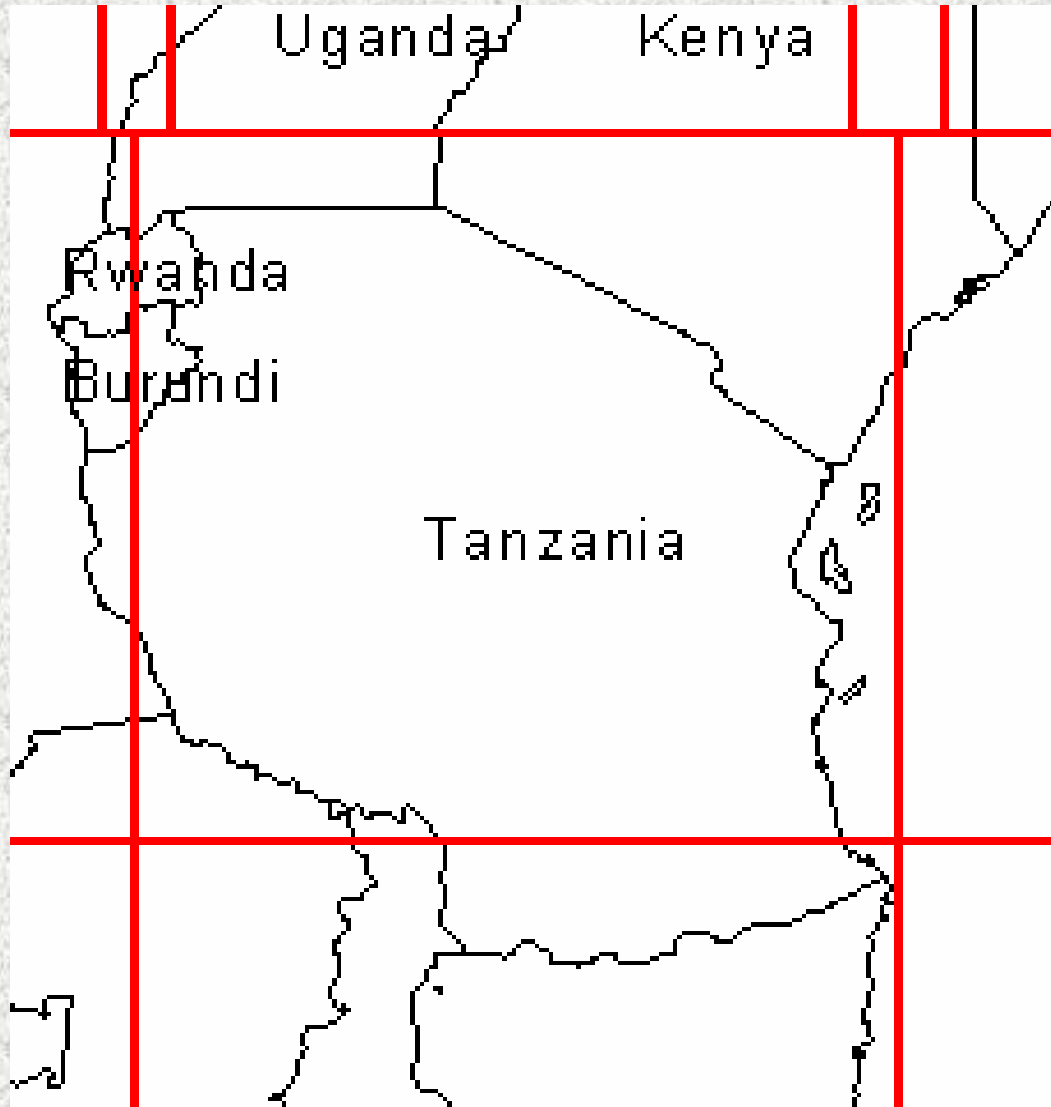
We use MODIS NDVI imagery, which is currently unique in providing the spatial resolution (250 m) and temporal acquisition frequency (16 days) which are necessary to retain average vegetation features of the polygons considered.

MODIS Test Tiles



We will process AFRICOVER maps falling into **four MODIS tiles**

MODIS Test Tile H21V09



The methodology is implemented by an automatic **procedure** written in **Easi-PCI** language.

The procedure was **tested on polygons** from the portion of the **Africover map of Tanzania** corresponding to MODIS tile **h21v09**

Preliminary evaluation of NDVI image quality

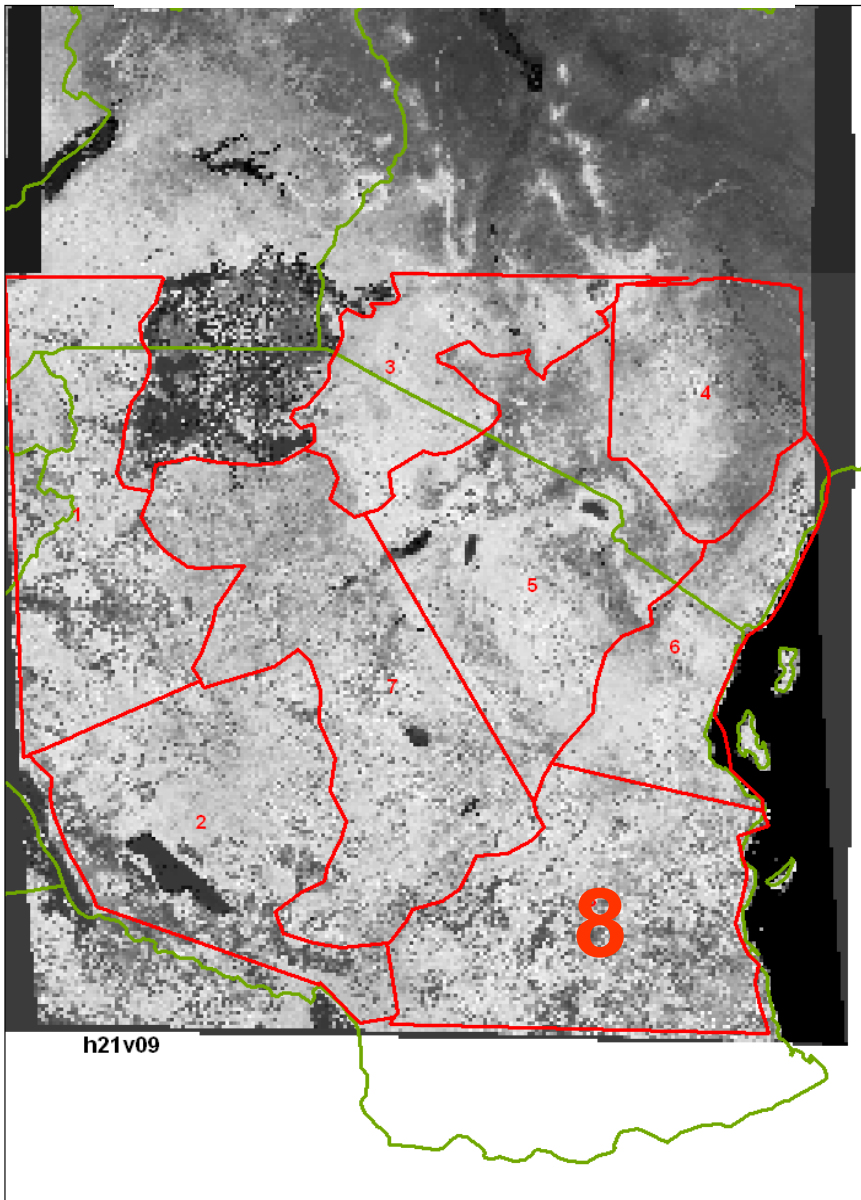
All NDVI and related mask images composed over 16-day periods were acquired from the middle of 2000 to the middle of 2005, with the objective of producing a complete data set for four years (2001-2004).

Using the Quality layers coming with the MOD13 product, the number of bad pixels contained in the different sub-zones was computed.

The percentages of bad pixels were computed as a function of the number of bad periods within an annual profile.

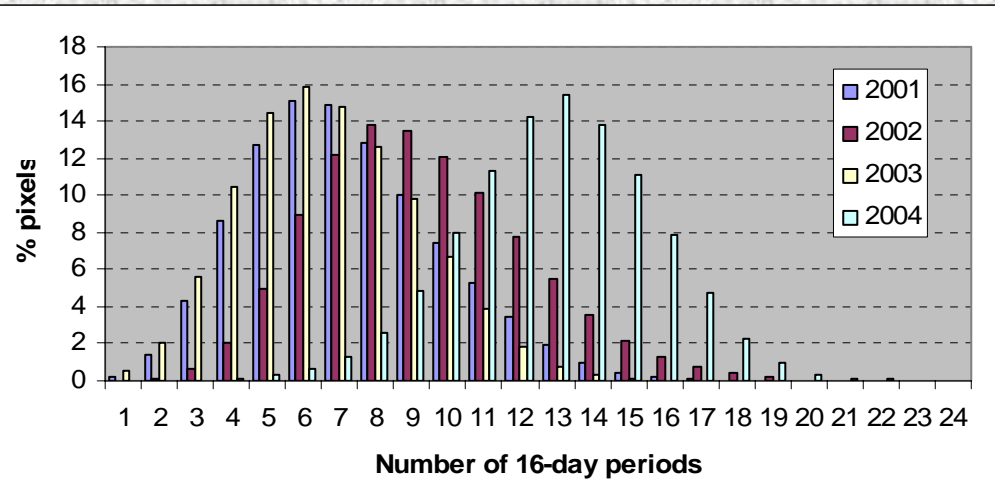
The same was done for the percentages of pixels as a function of the number of consecutive bad periods within an annual profile.

MODIS Test Tile H21V09 and subtiles used for quality tests



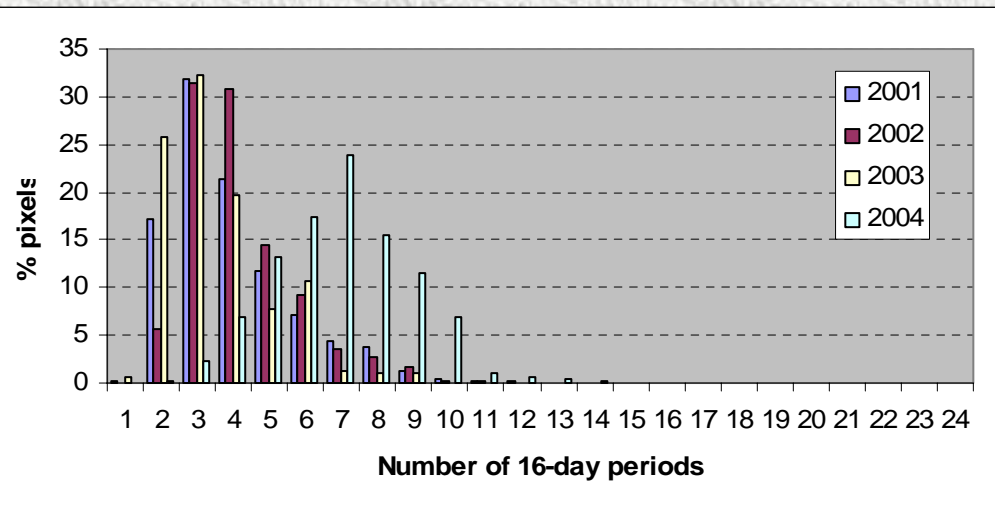
Sub-zone 8 had the worst pixel quality

Pixel quality tests on subtiles for single years



A

Percentages of bad pixels as a function of the number of bad periods within an annual NDVI profile for each study year (A), referred to the most problematic sub-zone depicted in figure 1 (sub-zone 8).



B

Percentages of bad pixels as a function of the number of consecutive bad periods (B), referred to the most problematic sub-zone depicted in figure 1 (sub-zone 8).

Averaging of NDVI imagery to characterize one typical year and pixel quality

A mean NDVI time series was obtained by averaging the 23 images over the available four years.

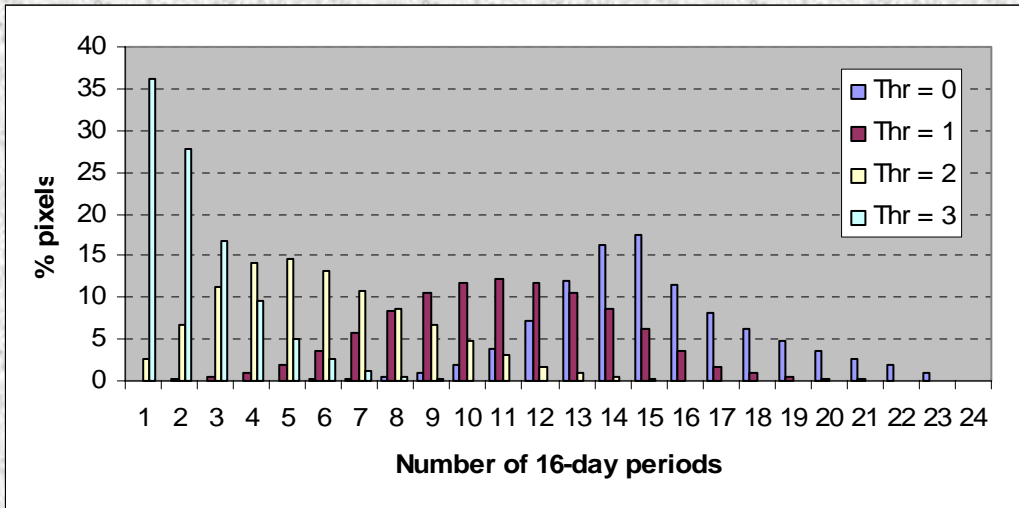
This was preceded by an evaluation of the number of good values which had to be retained while computing the multi-year average of each pixel.

We finally chose to compute NDVI averages using pixels with at least two good NDVI values.

Filling of one-period gaps within the 23 average images was performed by replacing the missing values with the local average computed with the previous and subsequent images.

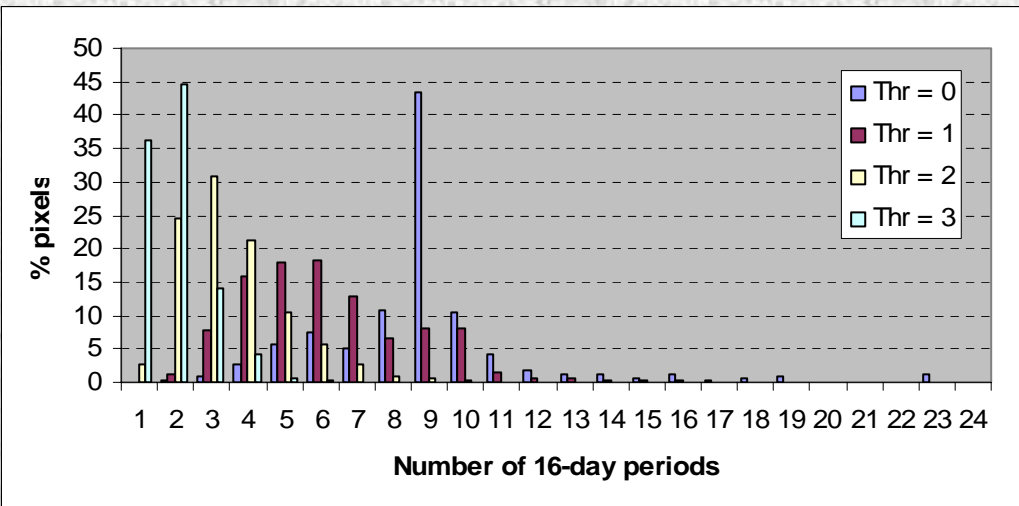
In this way, 23 average images with a relatively low number of missing pixels were produced.

Tests on subtiles for the average year for different quality thresholds



A

The average study year was computed using different numbers of good values over the four study years (Thr=0:all four years were considered, Thr=3:only one year was considered). Both statistics are referred again to sub-zone 8.



B

Percentages of bad pixels as a function of the number of bad periods for the average study year (A), and percentages of pixels as a function of the number of consecutive bad periods (B).

Extraction and preliminary analysis of NDVI profiles of exemplary polygons

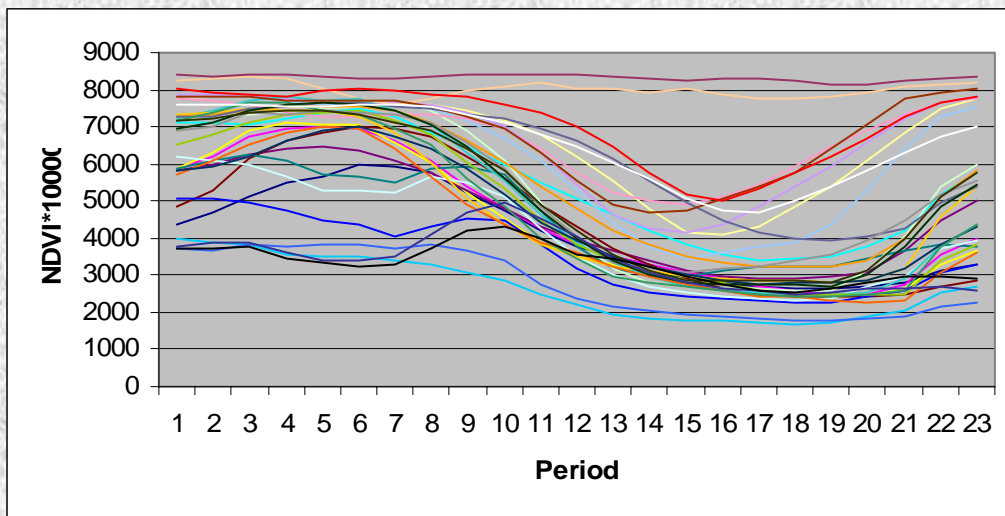
Some exemplary polygons of ecologically important pure VEDAS classes (herbs, herbaceous crops, trees closed, etc.) were selected in different areas of the study tiles.

The total number and percentages of bad pixels within each selected polygon were computed and subjected to statistical analysis similarly to that applied to the sub-zones.

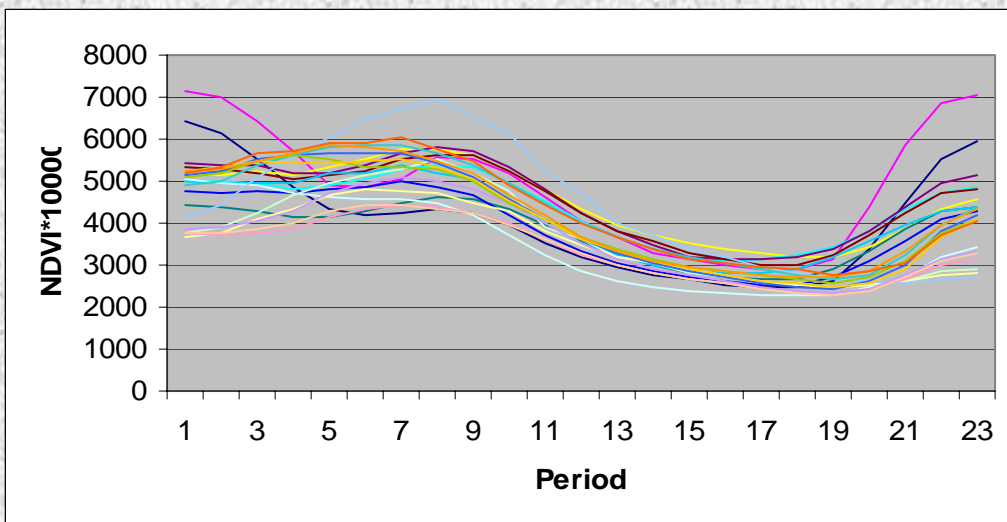
The mean NDVI profiles (23 values) of the polygons containing at least 25 good (i.e. not blank) pixels were extracted

A visual examination of these profiles indicated that a methodology to extract usable NDVI profiles from AFRICOVER polygons is feasible.

Extraction and preliminary analysis of NDVI profiles of exemplary polygons

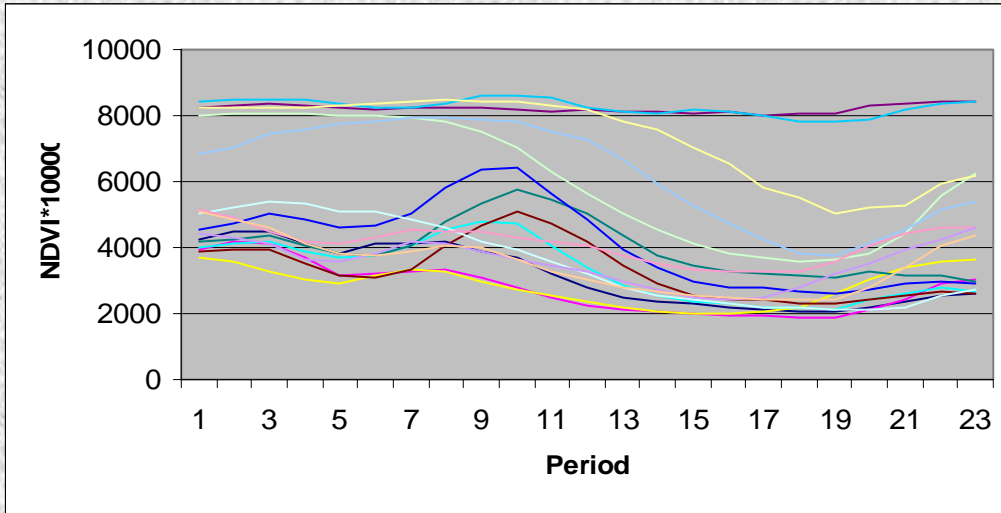


A: Herbs

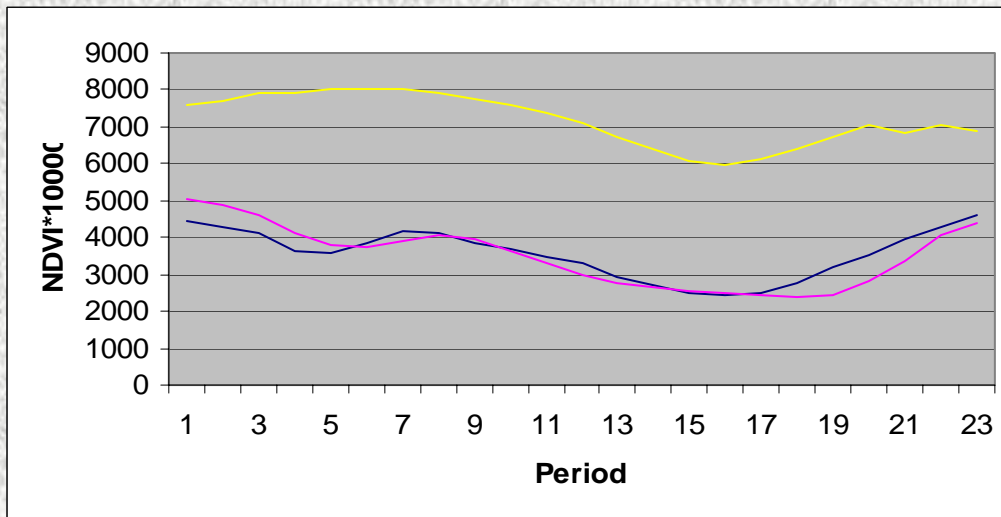


B: Herbaceous crops

Exemplary profiles of selected polygons.



C: Trees closed



D: Others (one tree closed needle leaf, in yellow, and two herbs seasonally flooded)

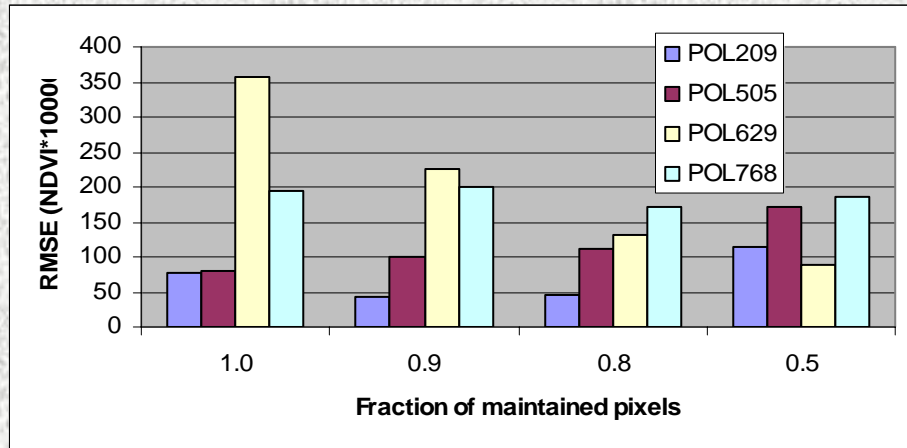
Development and testing of a procedure for purifying polygon NDVI profiles

Each AFRICOVER polygon can contain impurity up to 20% of the total surface; thus a method is necessary to remove or reduce such impurity and to isolate NDVI profiles of the dominant cover type.

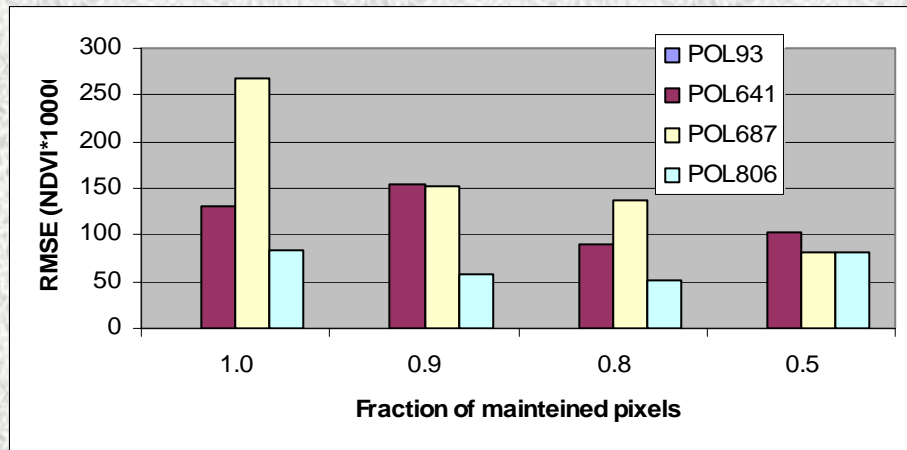
An automatic procedure was developed to purify the polygons from pixels with anomalous multitemporal NDVI profiles:

- The procedure, implemented in Fortran 77 code, computes the average NDVI profile of the examined polygon.**
- It then computes the Euclidean distance of each pixel from the average profile, and the pixel with largest Euclidean distance is removed.**
- The process is iterated until the number of excluded polygons reaches a predefined threshold.**
- The average profile tends to converge towards that of the less anomalous, likely dominant cover type of the polygon.**

Purification and computation of mean NDVI profiles of test polygons



A



B

The efficiency of the purification was evaluated for some example polygons by computing root mean square errors (RMSE) between the average NDVI profile of the majority class in the polygon and the average NDVI profiles found by maintaining different fractions of the original pixels from the corresponding wider (mixed) polygon.

Results for herbs (A) and agricultural areas (B): **the RMSE is minimized** in most cases **when 20% of the polygon pixels is discarded, i.e. 80% of the pixels is kept.**

Purification and computation of mean NDVI profiles of all polygons

The polygon purification procedure was integrated into the EASI-PCI image processing software and was applied to all polygons of pure classes for Tanzania extracted from the study tile.

In all cases, 20% of the polygon pixels were excluded and the average profiles of the remaining pixels were computed, obtaining typical NDVI profiles for each polygon.

All polygon profiles were filtered by a moving average of order 3 to reduce residual irregularities and to obtain smoother, more easily usable profiles.

While applying the filter, all polygon profiles were also transformed into NDVI profiles of 24 values (periods), in order to obtain a better matching between each couple of values and each month.

Activities in progress

- **Visual and automatic checks of all NDVI profiles extracted**
- **Testing of several classification/codification methods for the profiles extracted**
- **Development and testing of aggregation criteria to associate each single profile to sample profiles representing single profile classes.**
- **Processing of additional test tiles, starting from SUDAN, in order to evaluate the applicability of the procedure in different eco-climatic situations.**