Monitoring Spatio-temporal Dynamics of Land Cover/use in Gum Arabic Belt in Kordofan, Sudan by Means of Remote Sensing and GIS

Hassan Elnour Adam[1,2] , Elmar Csaplovics[1]

[1]Technical University of Dresden, Institute of Photogrammetry and Remote Sensing, Germany

[2]University of Kordofan, Faculty of Natural Resources, Forestry and Range Department, Sudan

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Introduction:

Remote sensing is one of the techniques available to monitor forest resources at local, regional and global scales, and to develop and understanding their role in the global ecosystem. Land cover/use change analysis is a necessary step for an interdisciplinary research involving climatology, ecology and socio-economics in assessment of the dynamics of change. This research was conducted in gum arabic belt in Kordofan State, Sudan. Gum arabic is a minor forest product, mainly produced from *Acacia senegal* (hashab) and *Acacia seyal* (Talh), both trees occur widely in the gum arabic belt of Sudan in woodland savannah zone of low rainfall on either clay or sandy (goz) soils. *Acacia senegal* trees are regarded as sustainable in terms of its environmental, social and ecological benefits. The tree is also used in the traditional *Acacia senegal*-based agro-forestry system, which is recognised as one of the most successful forms of natural forest management in the tropical dry lands. The most serious concerns are land degradation, desertification and the spread of deserts southwards in the past four decades. In Sudan, there is great need for timely information on the agricultural and forestry resources.

Objectives:

The objective of this study is to classify, investigate and analyse the spatial and temporal dynamics of land cover/use over 35 years (1972- 2007) in gum arabic belt using supervised image classification method and vegetation indices.

The research was carried out in Kordofan State in Sudan, which is situated in gum arabic belt. The belt is situated at latitude between 12˚ and 14˚ N and covers one fifth of the Sudan. The vegetation cover is dominated by *Acacia senegal*.

(Source:Mahmoud, 2004)

Location of the study area in gum belt

Material and methods:

Multi-temporal remotely sensed data of MSS (1972), Landsat TM (1985), Landsat ETM+ (1999) and ASTER (2007) data has been utilised to analyse the historical dimension of vegetation changes.

Supervised classification (maximum likelihood classification) was carried out by selecting training samples for each information class from visual interpretation of imagery supported by field measurement.

Classification accuracy: is the most important aspect of assessing the performance and reliability of a classifier by comparing the ground truth pixels and the classified pixels.

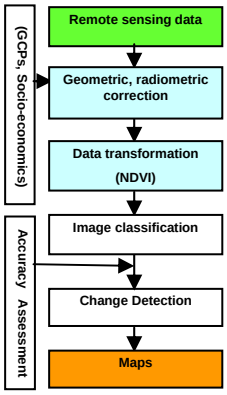
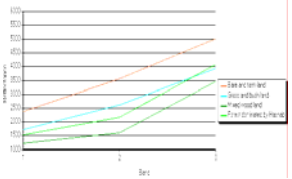


Chart of Research methodolgy

Imageries and ancillary data were processed to determine the land use/land cover classes for the recent and reference image.

Post-classification method was used to detect changes in land use/land cover classes in the area, the method focus on the analysis of differences of land use/land cover classes of four independently classified images.



Comparison of spectral reflectance for different vegetation types (VNIR of ASTER)

NDVI is a ratio of the red and near infrared reflectance

NDVI = NIR - RED / NIR + RED

- Where: NIR = Near Infra-red Band
RED = Red Band

NDVI is useful for assessing the health and density of vegetation.

Results:

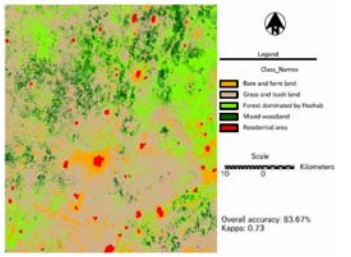
Five land cover/use classes were extracted by maximum likelihood classification method.

The results indicate that the forest dominated by *Acacia senegal* covers 23.12 %, while bare and farm land, grass and bush land, mixed woodland and residential areas cover 16.65%, 48.32 %, 10.17% and 1.73%, respectively.

The land cover changes in period from 1999 to 2007, show a considerable recovery and improvement in land cover (*Acacia seneagl* (1.86%) and mixed woodland (2.81%)) in the gum arabic belt, due to the good rainy seasons and afforestration programme.

Since the inception of the drought years during the 70's and 80's, gum arabic belt vegetation has decreased significantly, due to the reduction in hashab stock caused by cutting of trees and expansion of farmlands on the expense of forest lands.

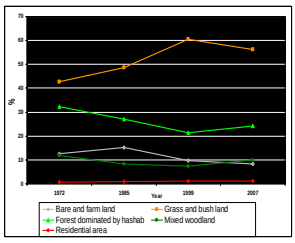
LULC map from ASTER 2007



Land cover/use classes distributions during 1972 – 2007

Class	Y1972	Y1985	Y1999	Y2007
Bare and farm land	12.65	15.10	9.73	16.65
Grass and bush land	42.67	48.64	60.45	48.32
Forest dominated by Hashab	32.16	27.01	21.26	23.12
Mixed woodland	11.85	8.38	7.36	10.17
Residential area	0.66	0.87	1.21	1.73

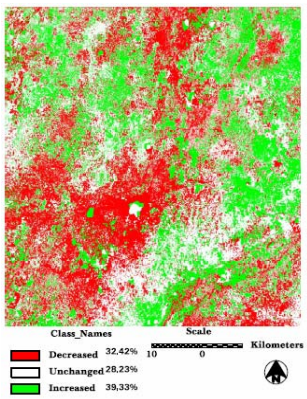
Representation of areas covered by the classes on the year 1972, 1985, 1999 and 2007



The vegetation change pattern from 1972 to 2007 shows a positive change (39.33%), negative change (32.42%) and no change (28.23%).

Traditional *Acacia senegal*-based agro-forestry system

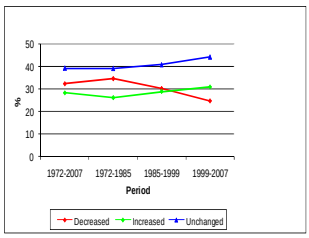
Vegetation change pattern 1972 – 2007



The change detection trend indicates the positive land cover and use change from 1972 to 2007.

The gum arabic land use system in Sudan has often been cited as a good example whereby environmental quality and economic development can be achieved.

Change detection trend over time



Conclusion:

* The study concluded that, using of the traditional *Acacia senegal*-based agro-forestry as one of the most successful forms of natural forest management in the gum belt will give successful land cover recovery.
* The study has provided some insight into the application of remote sensing and GIS techniques in changes at the ecosystem level.

Contact address: hassan_adam@hotmail.com