Report on NAG54811

Deforestation and Degradation in Southern and Central African Savannas

Period 2

PI: Stephen D. Prince

Department of Geography, University of Maryland, College Park, MD 20742-8225

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Abstract

The second period of activity on Degradation and Deforestation of Southern Central Africa has been concerned with development of a new method to map degradation, using the concept of reduced primary production. The new version of the Global Production Efficiency Model (GLO-PEM) has been applied to the AVHRR satellite record for an 18 year period (1982-1998) for Africa and compared with estimates of potential production derived from rainfall and a biogeochemical model (CEVSA). An extended visit to the southern Africa region in mid-1999 gave an opportunity to field test the new mapping method, to strengthen existing regional contacts, and to identify new data sets with improved spatial resolution.

The AVHRR record has also been used to derive information on surface conditions, including leaf area index, cover, and green fraction. A Soil Vegetation Atmosphere Transfer (SVAT) model has been used to interpret the impact of changes in the land surface properties on the lower atmosphere.

Our results were presented at the SAFARI2000 meeting in Gaborone, Botswana and to government, research groups and NGOs in South Africa, Zimbabwe, Botswana, and Zambia. A paper is being presented at the American Geophysical Union's winter meeting in San Francisco. The considerable interest that has been aroused in the region by these activities has led to the planning of an integrated assessment of land degradation in the Southern Africa Development Community (SADC) region.

See: http://www.inform.umd.edu/Geog/LGRSS/Projects/degradation.html

Publications

Published:

1. Prince, S. D., Brown de Colstoun, E., Kravitz, L. (1998) Desertification of the Sahel? Evidence from remotely sensed rain-use efficiencies. *Global Change Biology*,4(4), 359-374.
2. Prince, S. D., Geores, M. E., and Boberg, J., Coping strategies in the Sahel and Horn of Africa: a conceptual model based on cultural behavior and satellite sensor data. in *GIS solutions in natural resource management* , edited by Morain, S., pp. 235-250, OnWord Press, Santa Fe, 1999.
3. Prince, S. D., and Geores, M. E., Global vegetation production and human activity. in *GIS solutions in natural resource management* , edited by Morain, S.A., pp. 183-192, OnWord Press, Santa Fe, NM, 1999.

In preparation:

4. Mapping regional degradation using potential and actual net primary production
5. Integrated Assessment of Land Use/Land Cover Change in Southern Africa

Mapping degradation at a regional scale

The main progress in this period has been to create a continuous map of degradation using a model of net primary production (NPP) with very high spatial resolution (8km). This map has been compared with two maps of potential production, one developed using a simple relationship of production and rainfall, the other using a biogeochemical model. The rainfall technique depends on the assumption that NPP is directly related to rainfall, and is restricted to those areas where the rainfall is <1000mm. The potential production model is not restricted to semi-arid areas and is therefore able to include the coastal areas of Mozambique and southern Democratic Republic of Congo that were excluded from the rainfall approach. This technique using potential NPP is also applicable to the entire continent and world, and we are investigating its properties as a global indicator of human activity as represented by reduced NPP.

The results of the two methods agree to a large extent – perhaps not surprising as the CEVSA model is driven with the same rainfall data that we are using directly – but the addition of the higher rainfall regions using the potential production model greatly enhances the reliability of the predictions in the wetter regions. Comparisons with the ISRIC map of desertification indicates general agreement, but with much improved detail and quantitative information.

We are exploring the impact of land use on the degradation of the region as indicate by our maps. Clear patterns emerge in Zimbabwe, Malawi and Zambia, as well as in the salt-pan grasslands of Botswana and Namibia. Comparison with the Landsat TM archive has identified large areas where intensive land use has altered the land surface to an extent that not only does it show up on the regional maps of degradation, but also the impact on the fluxes of heat and moisture are significantly altered over large areas.

Radar

We have acquired an extensive archive of SIR/C radar data for the region and have integrated a list of field sites where woody biomass is being measured in the field. These sites include some in Zambia, Zimbabwe, Malawi, South Africa, and Botswana. The SIR/C quick look images have been distributed to the field teams to locate their plots prior to analysis.

Regional Contacts and Projects, maps and records

Land Use and Land Cover

Through our contacts with regional groups we have obtained maps showing various forms of degradation for Zimbabwe, Botswana, Malawi and Mocambique. These are very important sources since they provide some degree of validation for our products and also enable us to work with the local authorities and research groups to apply the new results to the socio-economic and biophysical aspects of degradation in the region.

Socio - Economics

Detailed study sites have been selected in Zimbabwe (communal lands countrywide and specifically the and the Save river catchment), Botswana (grazing practices and the IMF/World Bank ranch projects), Zambia (NE Tan_Zan corridor and the Gwembe Valley), South Africa RSA (Mpumalanga)

SAFARI2000

We have maintained contact with the SAFARI2000 project and attended the Gaborone, Botswana meeting in August 1999.

Plans for final 6 months of funding period

1km AVHRR and high resolution rainfall data

Through our contacts with groups in the region who are working on degradation, we are negotiating a collaboration that would include acquisition of the AVHRR 1 km data set for the entire southern Africa record (from 1985). This collaboration, together with another with the Southern Africa Development Community that will produce a very high resolution gridded rainfall archive for the region, will enable us to bring the resolution of the degradation map down to approximately 10 km or better, compared with the current 0.5° map.

High resolution remotely sensed data

Through collaboration with Dr. Sasan Saatchi and his colleagues at JPL we have made an extensive request for JERS radar data covering the entire southern Africa region. It is hoped that this will be analyzed to create a mosaic of JERS data covering the region, to join the existing central Africa mosaic. We have obtained early release copies of the Landsat TM mosaic for Africa and will develop methods to analyze these two regional maps to detect degradation, starting in our detailed study sites.

Integrated Assessment of Land Use/Land Cover Change in Southern Africa

The purpose of this final part of the project is to do an integrated assessment of land use/land cover change in Southern Africa by combining empirical knowledge of Southern African land cover change obtained through measurements of physical processes with an understanding of the human systems that give rise to the changes. Through the use of climate data and satellite imagery of vegetation much is known about land cover. The human processes behind land cover are not as well known. Socio-economic statistics reveal the context within which land use and land cover decisions are made, however, they do not demonstrate the decision-making process.

In order to get at the decision-making process it is necessary to identify the stakeholders, and find out how they make decisions. This requires particular attention to how stakeholders define the options open to them, how they assess the costs and benefits of possible decisions, how they deal with uncertainty, and what they view as fair.

There are different classes of stakeholders for most land use decisions. Stakeholders for the purposes of this project are people who have the power to act in a way that will affect land cover decisions either directly or indirectly. Because public policy has such an important role in land use and land cover decisions, the stakeholders targeted in this study are those who carry out land use policy.

The study sites have been identified as places where land degradation has occurred or is likely to occur. This project is centered around the variable definition of degradation, and how land use decisions are impacted by that definition. The study site decision is based on a review of satellite data on land cover, and use of the rain use efficiency index. Much of the land degradation is attributable to unavailability of water, but is exacerbated by unsustainable land use.

The process for conducting an integrated assessment requires gathering available data on the human and biophysical systems at work in the study site, identification of stakeholders, and holding focus groups with stakeholders where they have the opportunity to discuss land use decisions.

Focus groups use a semi-structured format in which general topics are introduced, both directly and through the use of scenarios. Through use of this format stakeholders have the opportunity to explain how they would reach a decision on the land use issues, centering around the questions mentioned above. The focus group process has both an information gathering and an information dissemination role.

Land use in Southern Africa is subject to many constraints, including international environmental mandates. Existing analysis of land cover issues in not always available to the appropriate decision-makers. One of the incentives for policy makers to participate in this process would be access, not just to raw data, but to value added products which could inform the decision-making process.