CONSULTATIVE GROUP ON INTERNATIONAL AGRICULTURAL RESEARCH

Land decline in Land-Rich Africa

A creeping disaster in the making

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Executive Summary

The objective of this study was to identify areas of land degradation in sub-Saharan Africa as observed from space by tracking the greenness of the vegetation signal expressed as Normalize Differenced Vegetation Index (NDVI). A series of additional databases was used, and, through a step-wise amalgamation of these, conclusions were drawn about the type of (agro) ecosystems under threat. The datasets (based on 8x8 km^2 pixels) of weather and NDVI (as a proxy for net primary productivity of the land) were averaged annually from monthly observations over the last two decades of the 20th century. This is likely to have captured reduced agricultural productivity as well as loss in native vegetation cover. The logical framework to analyse and interpret the dynamics of the vegetation cover in sub-Saharan Africa (SSA) presented here allows for easy re-assessment as better of more data become available.

First, sub-Saharan Africa was divided in three zones, dry (mean annual precipitation, MAP < 800 $mm.yr^{-1}$), sub-humid (800 $mm.yr^{-1}$ < MAP < 1300 $mm.yr^{-1}$) and humid areas (MAP > 1300 $mm.yr^{-1}$), yielding three zones of similar geographic extent. In a second step we identified the regions where the annual vegetation correlates positively and significantly to changes in mean annual rainfall conditions. For those with positive correlation, vegetation dynamics are affected by climate change (or cycles) and these are not suitable to identify human induced degradation. This excluded less than 2% from further analysis.

Subsequently we looked at the slope and the significance of the vegetation index (NDVI) over time. Areas not showing a decline or increase in the NDVI, either in absolute or in relative terms, were considered stable vegetation covers. Nearly 50% of the vegetation cover in sub-Saharan Africa is experiencing a greening trend. A large fraction of this area is found in the pastoral zone below the 500 mm isohyets which has recently been reported as the "greening of the Sahel" over the period evaluated. By and in large part, this greening is due to improved rainfall in the Sahel as reflected in the positively correlation between NDVI fluctuations and rainfall. Those areas were excluded from further analysis of human induced land degradation. The remaining area with increasing NDVI might have been subject to $C0_2$ or NOx fertilization. The areas that show a consistent and significant decline in NDVI (or land degradation) over time amount to around 2.13 million km^2 or 10% of the SSA land mass. The characteristics of this area were analyzed in more detail.

Over 60 million people live on land that is losing its ability to produce green biomass due to human actions. For each rainfall zone, the mean population densities in areas with declining vegetation were more or less the same as for the rainfall zone as a whole. However, within the degrading areas, the large majority of the affected areas are thinly populated, irrespective of the rainfall zone. This would suggest that these are marginal areas with limited carrying capacities to start with. As population pressure increases, more fragile areas will be taken into cultivation causing degradation with below average population densities. These regions are likely to get worse and eventually may be best taken out of cultivation or abandoned. However, this study also identifies some degrading areas with high population densities. Often these are regions with high agricultural potential and in urgent need of remediation.

FAO data was used to delineate areas with topographical and soil constraints. Of the 2.13 million km^2 with declining vegetation, around 10,5 thousand km^2 is topographically unsuitable for agriculture but nearly 0.67 million km^2 are on soils that are considered unsuitable. Most likely farmers are occupying such marginal land due to land scarcity, but society should have an interest to avoid this. Nearly half of the remaining degrading land is on soils that are of rather poor quality. These soils may not easily be ameliorated and might never gain the resilience that good farm land requires.

Differentiation of the degradation areas according to land use type was done using the land use/land cover map of GLC2000. Of the 0.67 million km^2 that are not suitable for agriculture, 105 thousand km^2 are actually being farmed and probably should not be. Means should be found to offer alternatives to these farmers so that land can be restored over time. Of the 1.46 million km^2 that are degrading but suitable for cultivation, 0.3 million km^2 are actually farmed (agriculture and forest/cropland) and are likely over-exploited or poorly managed. Moreover, half of the suitable agricultural areas are on poor soils. These are areas where considerable research efforts should be made to identify the immediate and proximate causes of declining ground cover and develop more sustainable farming practises. A quarter million km^2 is under grassland, largely in the dry areas and most likely being over-grazed. Nearly 1.09 million km^2 are under woodland/shrubland, and forest/savanna, which each might be losing native trees as land use intensifies. Finally, 0.25 million km^2 is dense forest which is most likely being deforested.

The fraction of the land showing significant decline in vegetation cover is relatively modest (around 10%). This would correspond with the fraction of SSA with 'very severe' land degradation symptoms in the GLASOD assessment of late eighties. However, it is unlikely that any direct comparison between these two studies can in fact be made. It is more likely that these areas are additive, as the very severely degraded land from the GLASOD study would not likely show great further vegetation decline. The creeping additional loss of 10% over the last 20 years of the past century, if the pace is not stopped, translates into serious trouble for SSA in the course of the current century. In the absence of any instruments for monitoring the rate of land degradation on the ground in SSA, satellite-based systems offer the best hope for tracking the state of this vital natural resource on this vast continent. A systematic research effort should be made to verify the validity of the findings reported here and to refine the analytical tool and interpretation of the results. As more and better data-bases are placed in the public domain the current study should be updated periodically. As it stands today, the study can be used to offer guidance to the research community as well as to the donor community and policy makers:

- The current mapping exercise should be used to identify application domains, areas with common climatic, vegetation, physiographic and soil and land use characteristics that appear to be threatened by human induced land degradation. Based on this stratification, research organizations should be able to select pilot research sites where in-depth research can be undertaken to assess the total cost of land degradation (including the valuation of loss of ecosystem services) and design sustainable land management options that will maximize social benefits from the use of the land.
- Research should be undertaken to study the institutional arrangements around land access and tenure within the application domains in order to find means that will allow sustainable land management systems to be established equitably. In some cases this will be possible only through payment for ecosystem services (PES) for which the level and

beneficiaries need to be determined. The use of such instruments should be an integral part of the strategy to preserve the land for future generations.

However, some of the regions identified in this study deserve immediate attention from the donor community and policy makers:

- Identify those agricultural regions where soil and terrain conditions seem so unfavourable that immediate action is required to restore the land to its natural condition. Donor agencies could offer incentives that lead to vacating such lands by offering alternative pathways out of poverty.
- Identify areas in the humid tropics where population pressures are low but NDVI change is high as such areas are likely being deforested. Where this is taking place on poor or unsuitable soil or terrain, these practices lead to denudation and should be stopped as the land is of little agricultural use and restoration of such land is a very slow process.
- Identify areas of favourable soil and terrain where population pressure is high and degradation is in full progress. These likely are relatively resilient regions that have served as breadbaskets of Africa and require immediate attention from the development community. These are areas where fertilizer markets and land conservation measures could function and where they are likely to be profitable.