An economic valuation of sustainable land management through agroforestry in eastern Sudan

Assessing the socio-economic and environmental dimensions of land degradation

Gedaref State was previously known as the food basket of Sudan. Over several decades unsustainable agricultural practices that combined near-monocropping with low nutrient replenishment have led to significant degradation of soils, which are no longer able to sustain farmer livelihoods. This study found that adopting an integrated sustainable land use and forest restoration scenario could reverse the current land degradation trend.

Background

Land degradation and deforestation threaten Sudan's prospects for long-term food security, sustainable development, and peace. According to UNEP (2007), the rapid erosion of environmental services occurring in several key parts of the country are among the root causes of decades of social strife and conflict. Agriculture is the largest economic sector in Sudan, and is at the heart of some of the country's most serious environmental problems. In particular, disorganized and poorly managed mechanized rainfed agriculture, which covers an estimated area of 6.5 million hectares, has been exceptionally destructive – leading to large-scale forest clearance, loss of wildlife, and severe land degradation. It is therefore imperative that these current trends are reversed through appropriate land use management interventions.

SLM valuation scenario

The analysis focuses on a watershed of 720'000 hectares in the southern part of Gedaref State. The integration of *Acacia senegal* trees with

Study area
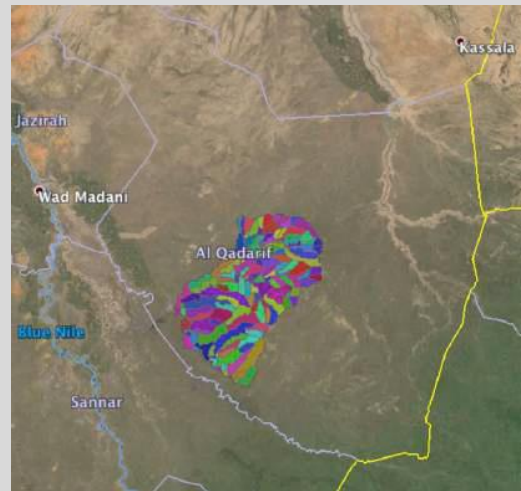
Watershed where the valuation work took place within the state of Gedaref, Sudan.

sorghum crops at a 6 x 6 meter spacing – allowing machinery to pass unhindered – was evaluated as a potential sustainable land management strategy on 20% of the agricultural land area in the watershed.

The typical soil – vertisol – found in eastern Sudan (left)
A barren hill (right).
Photography: Aymeric Ricome

A. senegal is a high quality gum arabic producing tree species, traditionally integrated into a crop and fallow system. It has soil nitrogen enhancing properties and international demand for its gum, make it a promising species to integrate in agricultural systems for both environmental and economic health. In parallel, consideration was also given to reforesting baren hills, covering 2% of the river basin area, with Luban gum trees such as *Boswellia catering*, *Boswellia frererana*, and *Boswellia papyrifera*. Currently these hills are not used for productive gains and have no competing land use, thus their reforestation would incur little to no opportunity costs.
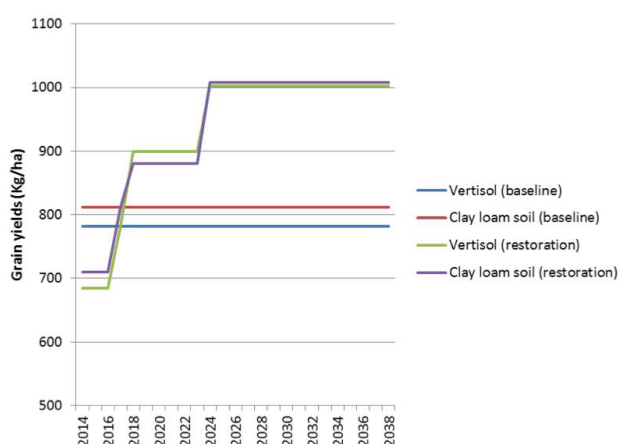
Predicted evolution of the sorghum grain yields (kg/ha) under the baseline and SLM scenarios

Method

The valuation of both proposed integrated sustainable land management and forest restoration scenarios were undertaken using an ex-ante cost benefit analysis. An assessment of the ecosystem services and economic impact of restoration scenarios was carried out using valuation techniques which included a productivity change approach, and replacement and avoided damage cost approaches. The analysis built on high-resolution remote sensing, GIS, and biophysical soil and water assessment tools, allowing for rigourous estimates of the impact of land use change on agricultural yields, groundwater infiltration, water runoff, and carbon sequestration.

Results

The analysis presented here provides encouraging results. Notably, reversing the current trend in land degradation through agroforestry and reforestation of heavily degraded land using native legume trees provides substantial net benefits to Sudanese farmers and society alike:

Yearly net benefit of 895 SDG[*]/ha to the farmer, totaling 1.4 billion SDG over 25 years through

- improved yields as a result of nitrogen fixation and soil moisture (800 SDG/ha/yr)
- Arabic gum production (430 SDG/ha/yr)
- Fuelwood production (15 SDG/ha/yr)
- Implementation costs only (350 SDG/ha/yr)

Reforestation of barren hilly land on 2% of the surface area in combination with A. Senegal agroforestry on 21% of farming land, will lead to approximately 37 m3/ha/yr of additional infiltrated groundwater amounting to a benefit of 1,400 SDG/ha/yr.

Additional 10 tons/ha/yr of below and above ground carbon sequestration amounting to an avoided damage cost of 7.3 billion SDG (1.3 billion USD) over the 25 year time horizon for the global community.

Recommendations

1. Reinforcement of tree tenure security, especially for tenant farmers
2. Subsidies for planting and managing *A. senegal* for 1-2 years until the trees provide sufficient income to offset their management cost
3. Access to extension services and credit at favourable rates, as currently granted by the Sudanese government to *A. senegal* plantations
4. Continued phasing out of distortionary economic policies - such as high export taxes on gum arabic and monopolistic marketing practices - combined with other efforts to address supply chain bottlenecks

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[*] Sudanese pound. 1 SDG = 0.175 USD in 10/2014