Local knowledge of the impacts of eucalyptus expansion on water security in the Ethiopian highlands

Citation: Pagella, T., Cronin, M., Lamond, G., Sida, T. and Sinclair, F.L. Local knowledge of the impacts of eucalyptus expansion on water security in the Ethiopian highlands. In: Wolde Mekuria. (ed). 2013. *Rainwater management for resilient livelihoods in Ethiopia: Proceedings of the Nile Basin Development Challenge science meeting, Addis Ababa, 9–10 July 2013*. NBDC Technical Report 5. Nairobi, Kenya: International Livestock Research Institute.

For the full version please follow this link: http://hdl.handle.net/10568/33929

Local knowledge of the impacts of eucalyptus expansion on water security in the Ethiopian highlands

T. Pagella[1], M. Cronin[2], G. Lamond[1], T. Sida[2,3] and F.L. Sinclair[1,2]

1 *School of the Environment, Natural Resources and Geography, Bangor University, Deiniol Road, Bangor, Gwynedd, Wales, LL57 2UW*

2 *World Agroforestry Centre (ICRAF), U.N. Avenue, Gigiri, PO Box 30667, Nairobi 00100, Kenya*

3 *Ambo University, Department of Natural Resource Management, Ambo University, PO Box 03, Code 19, Ambo, Ethiopia*

Corresponding author: t.pagella@bangor.ac.uk.

Abstract: Lack of long-term hydrological monitoring makes it difficult to determine impacts of changing land use on the water dynamics for many catchments in Africa. Here we use local ecological knowledge (LEK) to explore the impacts of rapid expansion of eucalyptus agroforestry on water security in the Ethiopian highlands. Local knowledge about the impacts of changes in tree cover was collected from farmers (n = 30), extension staff (n = 2) and timber merchants (n = 2) in five *kebeles* within the Jeldu *woreda*. Jeldu has undergone significant land use change over the last forty years. The area was heavily deforested 20 years ago and farmers associate this time with a major change in the water dynamics. Recently the development of a new road to Goja, the main town, opened up the area as a source of timber for Addis Ababa. This has resulted in a substantial expansion of eucalyptus plots adjacent to roads on the upper plateau and in riparian areas where growth is accelerated. Poorer farmers have been displaced on to the sloping land (which used to be woodland) where there is now evidence of rapid soil degradation. The key findings were that farmers identified significant trade-offs at the plot scale between eucalyptus and adjacent crop fields. They also identified indicators suggesting the sudden increase in eucalyptus cover had accelerated declines in water availability at landscape scales. The study showed the value of using LEK for exploring immediate landscape scale dynamics in the absence of hydrological monitoring. Whilst there is a degree of uncertainty surrounding the impacts of eucalyptus, this research demonstrated local awareness associated of problems associated with unregulated expansion of eucalyptus woodlots on the water regulating capacity at immediate landscape scales in the Ethiopian highlands.

Media grab: Local knowledge of farmers highlights negative impacts of eucalyptus on water security in the Ethiopian highlands

Introduction

Ethiopia is entering a period of increasing water scarcity due in part to poor water resource management and environmental degradation caused by deforestation (Tadesse 2009). As natural vegetation is cleared for agriculture and other types of development there are often negative impacts on water regulation and sediment transport (Wood and Armitage 1997). Integrating trees back into agriculturally productive landscapes (through agroforestry

interventions) can address these issues (Schroth and Sinclair 2003). In common with many parts of Ethiopia, the Jeldu *woreda* lost much of its natural tree cover in the 1980s. Since that period eucalyptus (*Eucalyptus globules)* has been used to address local timber and fuel security. Recent improvements in infrastructure have opened up the *woreda* as an area for supplying timber to local towns and Addis Ababa. Eucalyptus enjoys a mixed reputation in Ethiopia but there is increasing recognition of its potential negative impacts on stream flow (cf. Albaugh et al. 2013).In the absence of long-term monitoring, this study used local knowledge (knowledge held by farmers and resource users concerning their daily interactions with their natural environment, based primarily on experience and observation) to explore the impacts of land use change. The objective of this study was to explore local knowledge of the impacts of changes in tree cover (particularly eucalyptus expansion) in a head water area in the Ethiopian highlands.

Methods

Study site: The Jeldu *woreda* is in the Eastern Blue Nile catchment, in Oromia Region (9°15'54" N; 38°04'54" E) and represents a high to intermediate rainfall (1200 mm year-1), high altitude (2500–3200 masl), rain-fed, mixed crop–livestock system. The most common crops were potato, wheat and barley (Bayala et al. 2011). Potato was the most widely grown crop both for consumption and cash generation for small households. The *woreda* has nine *kebeles* (administrative units), of which five were selected as study sites; two located in the upper plateau (Seriti Dhenku, Chilanko) two on valley sides to valley bottom (Kolu Gelanand Shikute) and one in the lowland zone of the *woreda* (UrgaEreri). The main town of Goja is in the Chilanko *kebele* which sits on a plateau with a new road running along the central spine. The river Meja runs along the southern edge of the *woreda* down into the Blue Nile.

Local knowledge about impacts of changing tree cover on water security was acquired using systematic methods. Knowledge elicitation involved a combination of participatory mapping and semi-structured interviews coupled with formal representation using knowledge based systems software that allowed evaluation of knowledge as it was acquired (Sinclair and Walker 1998; Walker and Sinclair 1998). Detailed knowledge was acquired by repeated interviews with a purposive sample of 30 farmers in five *kebeles*, mainly in the headwater areas (n = 17). Repeated interviews with the same people were important for obtaining deeper explanatory knowledge and resolving inconsistencies. Two types of farmer were interviewed—model farmers (farmers who were part of collectives) and non-model farmers. In addition, scoping interviews were held with local timber merchants (n = 2) and development agents (n = 2).

Results and discussion

Land use change

Farmers identified two main phases of land use change in the *woreda*. Twenty years ago, land adjacent to the road was used for arable production and the steeper slopes were covered with natural woodland. As the population expanded into the area and requirements for timber and fuel increased, much of this woodland was cleared and then converted into arable land.

The recent development of a new road to Goja, the main town of Jeldu *woreda*, opened up the area as a source of timber for Addis Ababa (Figure 1). This had resulted in a substantial expansion of eucalyptus plots; with 75 and 80% of the eucalyptus being exported to Addis Ababa. Timber merchants from the local town of Ginchiwere arranging short-term leases of fields from farmers and taking harvests from these plots every 3–7 years for fuel wood and timber. These leases tended to be with non-model farmers. As formal credit and saving institutions were scarce in the area, farmers also used eucalyptus woodlots as insurance against critical cash shortages, particularly as the eucalyptus was said to require less labour compared to arable production. Eucalyptus expansion was only viable in the upland *kebeles* (nearer Addis Ababa) as the cost of fuel for transportation made it less cost effective in other parts of the *woreda*. The eucalyptus plots needed to be located near to roads (for ease of extraction) or planted adjacent to the streams (to enable faster and straighter poles—which were more valuable for timber and had shorter rotations). Eucalyptus had expanded to cover approximately 20–40% of the land area in the upper *kebeles*. As a result of this, some non-modal farmers had been displaced onto the steeper slopes (see Figure 1).

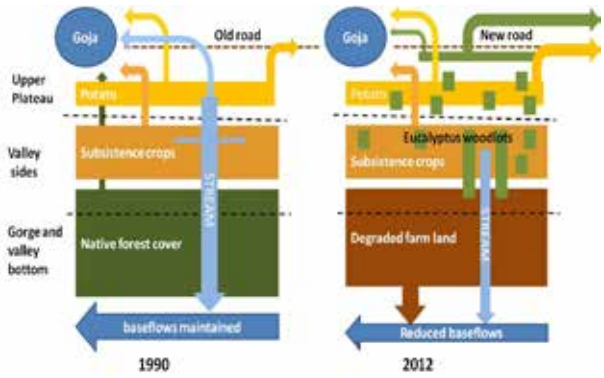

Figure 1. Changes in land use in the Jeldu woreda between 1990 and 2012.

Impacts at plot and farm scale

Farmers had detailed understanding of trade-offs between eucalyptus and their crops through their daily interactions. Small-scale eucalyptus woodlots compete with crops for green water (rainfall that is stored in the soil and is available to plants). Farmers recognized that eucalyptus grew fast (in relation to other tree species) and observed lower yields in areas immediately adjacent to their crops. The area affected increased with the maturity of the trees. Rising prices for potatoes had resulted in some model farmers removing eucalyptus. Although the area of effect was smaller for juvenile eucalyptus farmers said this was the time of greatest requirements for water.

Impacts on immediate landscape in upland-midland kebeles

Farmers described a number of impacts associated with the initial loss of tree cover 20 years ago. One impact was that water availability had decreased. The farmers across the *woreda* provided indicators of this. The farmers knew that 14 years ago the water driven grinding mill in Kolu Gelan closed because of insufficient water supply. Farmers also reported that drops in base flow had caused the water level to remain low enough for people to cross the river Meja all year round (even in heavy rain)—20 years ago farmers could only cross the river until June (at the beginning of rain season). The loss of original tree cover has also destabilised the slopes and contributed to substantial erosion/nutrient loss. The farmers estimated that the fields in these areas would be exhausted within five years. There was a widespread belief that the loss of tree cover had affected rainfall patterns. Farmers stated that deforestation had caused decreased air humidity because of less evapo-transpiration from vegetation canopies; this resulted in a drier atmosphere that led to reduced rainfall. Where there was no vegetation, any moisture-carrying wind would pass over the area and not settle. Lack of vegetation cover resulted in increased wind speed, which cleared rain-forming clouds.

In the *kebeles* in the headwater areas, farmers identified a secondary impacts associated with the increase of eucalyptus. Eucalyptus woodlots planted near springs had caused them to dry up during the dry season and had further reduced overall stream flow—to the point that farmers had to use small check dams to allow livestock to drink. Some springs were always seasonal but the duration of dry periods had increased during the period that the eucalyptus cover had expanded. Farmers had to move further down the slope to collect water as the springs on the upper slopes had dried up. This had caused a noticeable decrease in drinking water availability in Goja town (the water available in dry season was no longer sufficient to support Goja's population). Eucalyptus was also associated with decreased water quality from the headwaters. The increase of overall eucalyptus cover was associated with a decrease in rainfall.

The knowledge of landscape processes was less immediately obvious to farmers. Eucalyptus expansion had been very rapid and unplanned. Farmers agreed that it took longer for them to be aware of the implications of this and by that time the eucalyptus was well established. Model farmers had more opportunity to diversify and were more likely to remove eucalyptus. Non-model farmers, although aware of the potential problems, were committed to eucalyptus in the short term.

Impacts on immediate landscape in lowland *kebele*

Farmers in the lowland *kebele* were aware of the impacts of loss of tree cover from 20 years ago but were less aware of the impacts of eucalyptus. The main problems identified by farmers in this area related to decreased water quality. There had been a noticeable increase in sedimentation of the river during the wet season which had reduced water quality downstream. Increased sedimentation had also added to destabilization of the riverbank of Meja causing loss of agricultural land through bank collapse. Farmers did not volunteer information of eucalyptus in these areas

Potential solutions

Given growing awareness of the problems associated with unplanned eucalyptus expansion, farmers' attitude was that an increase in native tree cover (especially around riparian areas and springs/headwaters on the upper slopes) would bring protection to and maintain springs and streams.

Farmers were able to identify a number of native tree species that could potentially displace eucalyptus. There was an interest in species that were reasonably fast growers or had other qualities that made them suitable for their farms; for example, farmers wanted species that could grow on degraded soils, comparable to eucalyptus.

An immediate recommendation from farmers was to return to *Hagenia abyssinica*. This is a relatively fast growing tree (providing timber in about 10 years compared to seven years for eucalyptus). It was preferred by farmers especially because of its ability to improve soil fertility through leaf fall and decomposition and was considered 'water friendly' by farmers, making it more appropriate for riparian areas although it would struggle on degraded soils.

Table 4. Alternative tree species suggested by farmers

S/N	Local name	Latin name	Most appropriate uses
1	Heto	Hagenia abyssinica	T, SC
2	Wadesa	Cordia africana	T, MP
3	Lafto	Acacia sieberiana	FW, SF, CC
4	Garbi	Acacia lahai	FW, SF, CC
5	Shewshewe	Chamae cytisuspalmensis	FD, SF
6	Bekenisa	Croton macrostachyus	T, FW

T = Timber, SC = soil conservation, MP = Multipurpose, SF = Soil Fertility, FW = Firewood, CC = Charcoal, FD = Fodder.

Conclusions and recommendations

These insights demonstrate the value of local knowledge to explore impacts of environmental change in unmonitored catchments. The farmers interviewed in Jeldu had detailed explanatory knowledge of the impacts of changing tree cover on their water security. At an immediate landscape scale (within the sub catchment), there were clear indicators of increased water stress—caused by a combination of reduced tree cover, unplanned eucalyptus expansion and increased population. The beneficiaries of the eucalyptus largely lay outside the *woreda* in the towns on the roads to Addis Ababa. Conversely the dis-benefits of the decreased water security flowed downstream to the west of Jeldu into the Blue Nile. Whilst there is a degree of uncertainty surrounding the impacts of eucalyptus, this research identified clear issues associated with unregulated eucalyptus expansion on the water regulation at immediate landscape scales in the Ethiopian highlands.

Acknowledgements

This research was carried out through the CGIAR Challenge Program on Water and Food (CPWF), which is funded by the UK Department for International Development (DFID), the European Commission (EC), International Fund for Agricultural Development (IFAD) and Swiss Agency for Development and Cooperation (SDC).

Appreciation also extends to our partners at the International Water Management Institute (IWMI) and the International Livestock Research Institute (ILRI).

References

Albaugh, J.M., Dye, P.J. and King, J.S. 2013. Eucalyptus and water use in South Africa. *International Journal of Forestry Research* 852540: 11.

Bayala, J., Kuria, A., Nangole, E., Malesu, M., Muthuri, C., Mithoefer, D., Radcliffe, A. and Sinclair, F.L. 2011. *M4h Initial Rainwater Management Strategy Assessment for Trees—Progress Report*. Nairobi, Kenya: World Agroforestry Centre (ICRAF).

Dixon, H., Doores, J.W., Joshi, L. and Sinclair, F.L. 2001. *Agro-ecological knowledge toolkit for windows: Methodological guidelines, computer software and manual for WinAKT*. School of Agricultural and Forest Sciences, University of Wales, Bangor, UK.

Schroth, G. and Sinclair, F.L. (eds). 2003. *Trees, crops and soil fertility: Concepts and research methods*. Wallingford: CABI Publishing.

Sinclair, F.L. and Walker, D.H. 1998. Acquiring qualitative knowledge about complex agro-ecosystems. Part 1: Representation as natural language. *Agricultural Systems* 56(3):341–363.

Tadesse, D. 2009. Review of early experiences, current challenges and opportunities among the Nile Basin riparian states. Workshop report: Climate change and transboundary water resource conflicts in Africa. Institute for Security Studies.

Walker, D.H. and Sinclair, F.L. 1998. Acquiring qualitative knowledge about complex agro-ecosystems. Part 2: Formal representation. *Agricultural Systems* 56(3):365–386.

Wood, P.J. and Armitage, P.D. 1997. Biological effects of fine sediment in the lotic environment. *Environmental Management* 21(2):203–217.