

Research Application Summary

Characterizing land cover changes in Agago sub catchment, northern Uganda

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Abstract

The Aswa catchment is one of the most important catchment of the Upper Nile Water Management Zone owing to its vastness, covering most of northern Uganda. Although the pace of land cover change in this catchment is increasingly gaining recognition, there is paucity of information on the underlying drivers. Thus, this study was designed to quantify the patterns and magnitude of the land cover changes in Agago sub catchment. The study analysed Landsat imagery for 2000, 2010 and 2018 to determine land cover change over the years. These satellite images were obtained from earth explorer, <http://earthexplorer.usgs.gov/>. Results showed that grassland dominated the sub catchment. Grasslands increased from 40.37% in 2000 to 47.53% in 2010 and then reduced to 32.25 in 2018. The decline in grassland has been associated with expansion in small scale farming. Small scale farming increased four-fold between 2010 and 2018, possibly due to increase in population, which meant more land has been cleared for agriculture, probably exacerbated by and the government of Uganda's efforts to promote agriculture in the region.. The results of this study are expected to guide both interventions and policies that promote sustainable land management in the study area.

Key words: Agriculture, Aswa catchment, grassland, land cover, northern Uganda

Résumé

Le bassin versant d'Aswa est l'un des plus importants bassins versants de la zone de gestion des eaux du Haut Nil en raison de son immensité, couvrant la majeure partie du nord de l'Ouganda. Bien que la dynamique du changement du couvert terrestre dans ce bassin versant soit de plus en plus reconnue, il existe peu d'informations sur les facteurs sous-jacents. Ainsi, cette étude a été conçue pour quantifier les modèles et l'ampleur des changements de couverture terrestre dans le sous-bassin d'Agago. L'étude a analysé l'imagerie Landsat pour 2000, 2010 et 2018, afin de déterminer le changement de la couverture terrestre dans le temps. Ces images satellites ont été obtenues de Earth Explorer, [http:// earth explorer.usgs.gov/](http://earthexplorer.usgs.gov/). Les résultats ont montré que les prairies dominaient le sous-bassin. Les prairies sont passées de 40,37% en 2000 à 47,53% en 2010, puis réduites à 32,25% en 2018. Le déclin des prairies a été associé à l'expansion de l'agriculture à petite échelle. Cette dernière a quadruplé entre 2010 et 2018, peut-être en raison de l'augmentation de la population, ce

qui signifie que davantage de terres ont été défrichées pour l'agriculture, probablement exacerbée par les efforts du gouvernement ougandais pour promouvoir l'agriculture dans la région. L'étude devrait guider à la fois les interventions et les politiques qui favorisent la gestion durable des terres dans la zone d'étude.

Mots clés: Agriculture, bassin versant d'Aswa, prairies, couverture terrestre, nord de l'Ouganda

Background

Previous studies have demonstrated that land cover change analysis has been globally used to understand environmental changes (Olang, 2011; Lekha, 2018). Land cover determines the capacity of soil retention which plays a key role in the natural regulation of the ecosystem services such as carbon sequestration, watershed protection, among others. Therefore, land cover changes cause alterations in ecosystem services which affect the functioning of biological systems as 90% of carbon in the vegetation goes up to atmosphere (Serneels and Lambin, 2001). As indicated by Niehoff *et al.* (2015), Lambin *et al.* (2001), land cover changes have contributed to global climate change through emissions of greenhouse gases due to high rate of deforestation.

Many sub-Saharan African countries are experiencing unprecedented rate of vegetation clearance as land use changes rapidly. These trends are attributed to pressure on land resources as populations seek to improve their livelihoods through increased agricultural production (Houghton, 1994). In Uganda, dramatic land cover changes have been observed especially in northern parts of the country. The changes have been associated with human activities and breakdown in traditional justice system and laws governing environmental management. The Aswa catchment represents one of the most important catchment of the Upper Nile Water Management Zone owing to its vastness covering of most of northern Uganda. However, the region is experiencing rapid land cover changes arising from notably the deforestation of the natural forest (Nyeko, 2012). Additionally, as the post conflict reconstruction efforts take effect in northern Uganda, the need to catch-up and increase household income and ensure food security by households has heightened the rate of land conversion in the catchment. However, the patterns and magnitude of these changes and transitions have barely been quantified. Consequently, this study analyzed land cover change dynamics in the Agago sub-catchment of northern Uganda.

Materials and methods

Description of the study. The study was undertaken in Agago sub catchment (Fig. 1) which is a sub-section of Aswa catchment located in the Upper Nile Water Management Zone in Northern Uganda. The area covers approximately 5169.44 km² covering five districts of which Pader is 18.84%, Agago 47.23%, Otuke 5.60%, Abim 23.58% and Kotido 4.75% of the total area. The vegetation cover of the area comprises of woodlands and savannah grasslands (Nyeko, 2012). Over one million people derive their livelihood from the natural resources through activities such as agriculture, livestock production and charcoal burning (IUCN, 2011; Nyeko, 2012).

Data and satellite imagery processing. The study used Landsat images of 30 metres resolution for the path 171 and row 58 and of bands 4,3 and 2. The images were for the year 2000, 2010 and 2018 and were downloaded from the link <http://earthexplorer.usgs.gov>. The imageries were scrutinized to ensure they were cloud free (less than 10% cloud cover), and then projected to World geodetic

system (WGS-84 UTM zone 36 N). The pre-processing and processing of the images was done using ENVI and ArcGIS 10.1. Satellite images were interpreted and analyzed using ArcGIS 10.1 by adopting an unsupervised classification method.

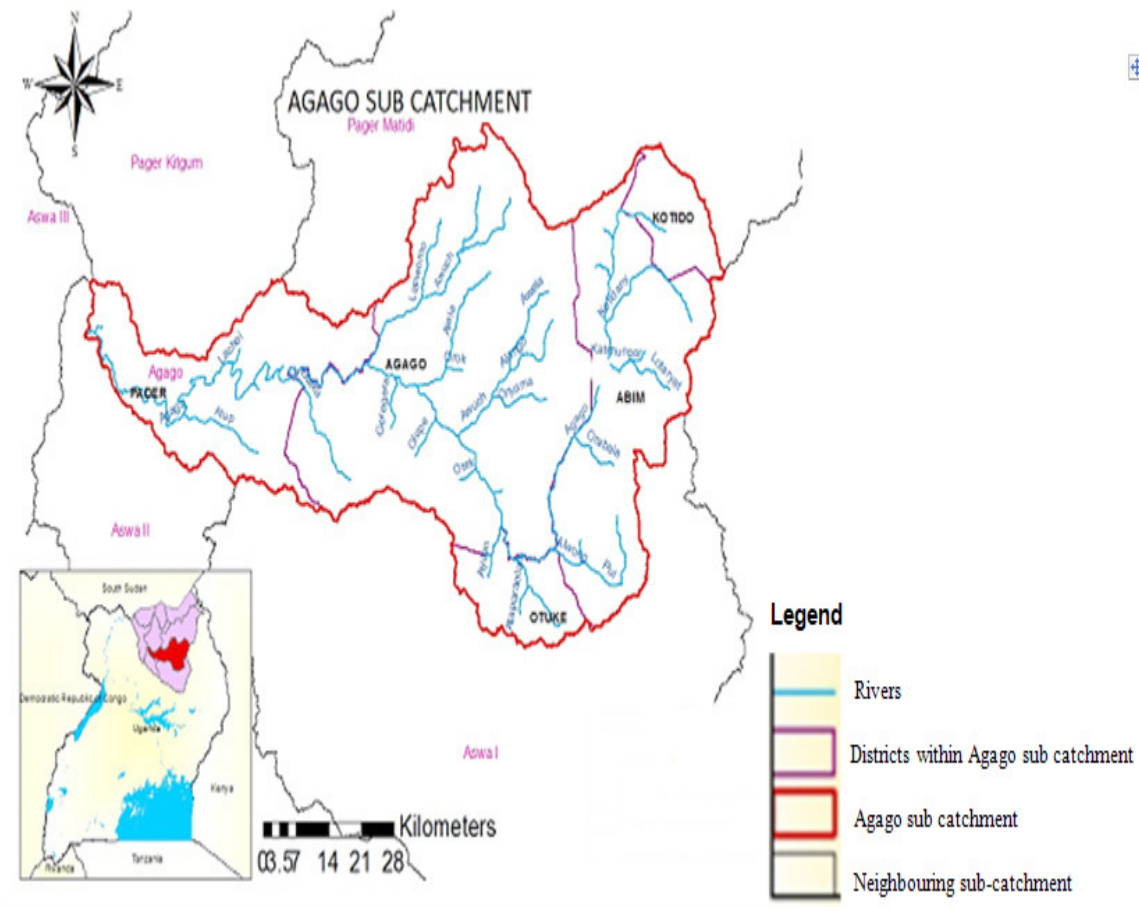


Figure 1. Map of the study area.

Results

Land cover change pattern in Agago sub catchment (2000-2018). Five land cover types were identified including built up area, grassland, small-scale farming, wetland and woodland (Table 1). Results showed significant land cover changes in Agago sub catchment during the last 18 years (Figs. 2, 3 and 4). The patterns of land cover change are shown in Table 1. Results show that in 2000, grassland dominated the sub catchment by 40.3%, followed by woodlands (22.0%), wetlands (21.4%), small scale farming (9.9%) and, built up area which covered 6.2% of the land area. In the period 2000-2010, grassland increased to 47.5%, built up area and small scale farms increased by 8.6% and 14.3%, respectively. On the other hand, there was a decline in wetlands (16.7%) and woodlands (12.7%). During 2010-2018, wetlands and woodlands decreased to 11.5% and 1.7% respectively, while grasslands declined to 32.2% of the total land area. There was continued increase

in built up area (9.8%) and small scale farming (44.6%) during 2010-2018.

Table 1. Land cover changes in Agago sub catchment

Land cover type	2000		2010		2018	
	Area (km ²)	%	Area (km ²)	%	Area (km ²)	%
Built up area	322.47	6.24	446.11	8.63	508.40	9.83
Grassland	2087.02	40.37	2457.28	47.53	1667.45	32.25
Small scale farming	514.40	9.95	741.01	14.33	2305.79	44.60
Wetlands	1106.32	21.40	864.00	16.71	596.58	11.54
Woodlands	1139.36	22.04	661.19	12.79	91.37	1.77
Total	5169.58	100.00	5169.58	100.00	5169.58	100

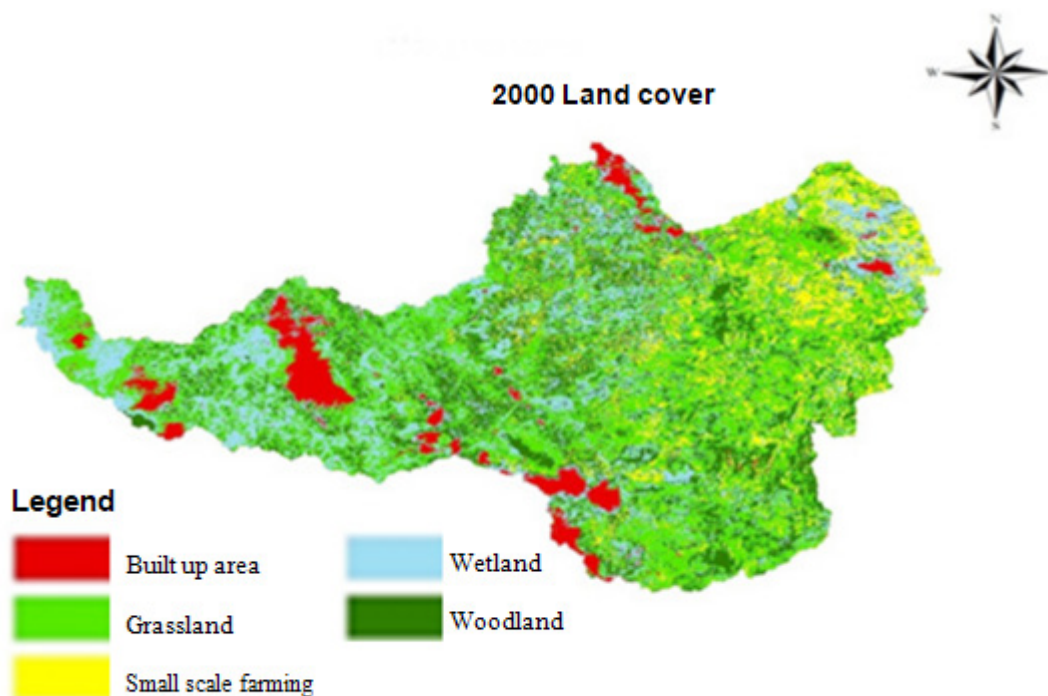


Figure 2. 2000 Land cover classification for Agago sub catchment.

Discussion

The most striking observation from this study is the decline of woodland from 22.04% to 1.77% of the total land area (a twelve fold decrease), and the increase in small-scale farming from 9.95% to 44.6% of the total land area (a fourfold increase over the 18 year period). These results are in agreement with those of Nyeko (2012) who observed a similar trend in the deforestation of natural forests in Uganda.

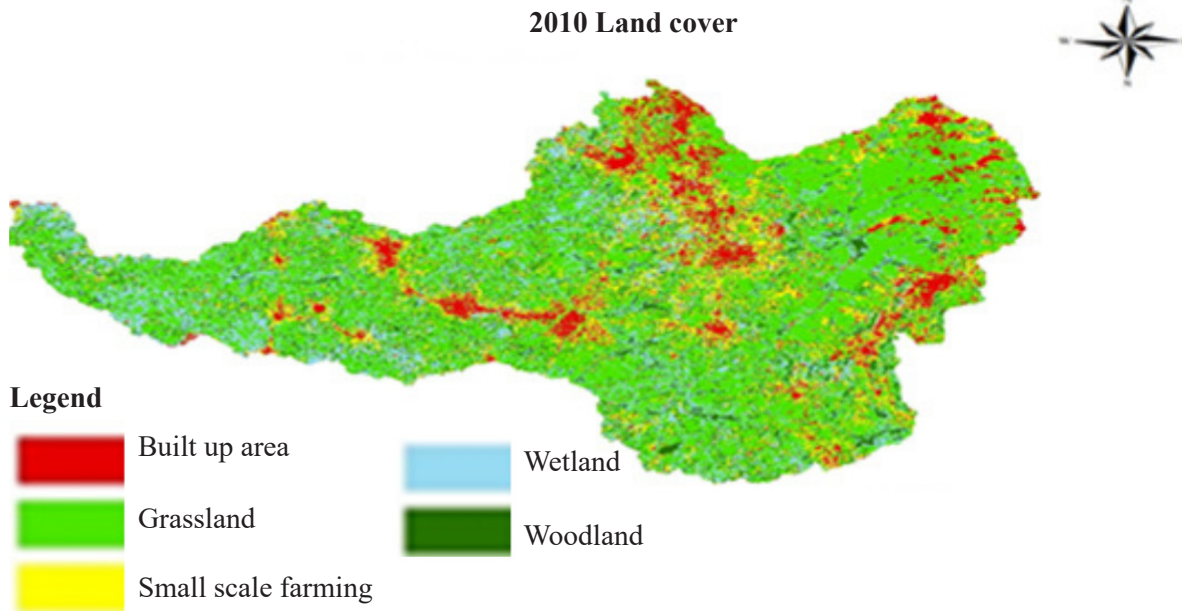


Figure 3. Land cover classification of Agago sub catchment for 2010.

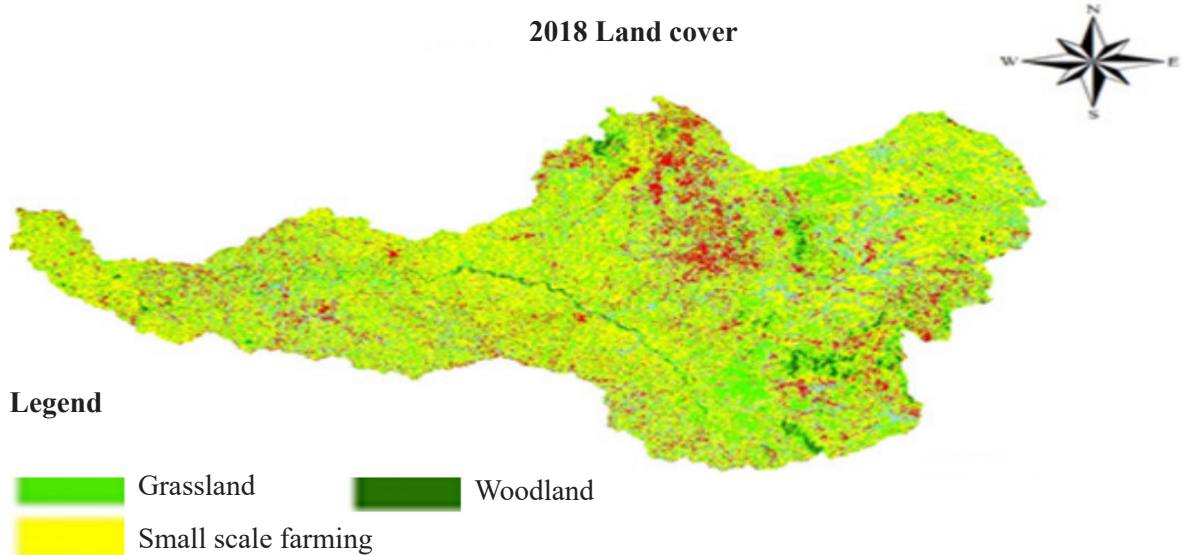


Figure 4. Land cover classification for Agago sub catchment for 2018.

Kiggundu *et al.* (2018) on the other hand, observed a twofold increase in built up area, which was attributed to the restoration of peace and stability in the study area as people settled in their various villages and trading centers. Similarly, grassland areas increased from 40.37% in 2000 to 47.53% in 2010 and then reduced to 32.25% in 2018. These results depict minimal disturbance that allowed regeneration of vegetation as people were confined to Internally Displaced People’s (IDP) camps. In 2018, the IDP camps had been dissolved and it is evident that there was massive clearing of vegetation to pave way for small scale cultivation when people resettled in their areas of origin.

This observation was made by Owona (2008) in a study carried out in northern Uganda. Upon resettlement, there was increase in constructions as government agencies like Ministry of Works, Transport and Communications, and Uganda National Roads Authority supported road construction and development of trading centres in the area. The increase in small scale farming is attributed to the increase in population, which has meant that more land is cleared for agriculture. In addition, the expansion of agriculture in the region is attributed to the Government of Uganda support to the agriculture sector through the National Agricultural Research Organization (NARO), and specifically through projects such as Plan for Modernization of Agriculture (PMA), and Northern Uganda Social Action Fund (NUSAF I, II and III), which seek to increase agricultural production and therefore food security in the region. Further, the restoration of peace and stability in the region has facilitated extensive agricultural practices that have resulted in conversion of woodlands and grasslands to smallholder croplands.

Conclusion

The results indicate trends in land cover change arising mainly from anthropogenic activities, especially agricultural activities and settlement. In particular, small scale farming has dramatically increased between 2010 and 2018, possibly due to increase in population, and the Government of Uganda efforts to promote agriculture in the region. However, the extensive nature of agricultural practices is perhaps one of the main causes of decline in woodlands and grasslands in the region. There is therefore need to promote agricultural intensification that increases total factor productivity as opposed to clearing more land to achieve perceived yield increase. The intervention should take a participatory approach by involving the local communities who are the most affected by the depletion of the natural resources.

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