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Large-scale agricultural investments, land use and land cover change in Uganda

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Abstract

Agriculture is one of Uganda's key growth sectors aimed at achieving socio-economic transformation and middle income status by 2040. This strategy has attracted Ugandan and foreign investors to the sector resulting in land use and land cover change. The investments have exerted pressure on agricultural land including those considered non-arable and kindled land use and land cover changes in Kanungu, Nakasongola and Nwoya districts. Lack of data on such changes hampers interventions to mitigate the negative effects that affect land productivity, food and nutrition security as well as household livelihoods. In this regard, we examined the effects of large-scale agricultural investments (LSAI) on land use and land cover changes from 2000 – 2020 in the three districts. An exploratory research design involving mixed methods enabled data collection. Land use land cover changes were examined using LandSat ETM7 of 2000 and Sentinel-2 images of 2020 complemented by questionnaire survey and key informant interviews conducted in 2018 and 2019. The images were processed, verified and assessed for accuracy and land use land cover changes displayed in Sankey diagrams. Results revealed that by 2020, LSAI accounted for land use and land cover change of 6.4% in Nwoya, 7.9% in Kanungu and 1.7% in Nakasongola districts; while grasslands, bushlands and woodlands declined. LSAI and related activities like increased built up

areas created spatial changes in the distribution and pattern of land use and cover types.

Key words: Agricultural investments, interviews, land use land cover change, LandSat ETM7, Sankey diagrams, Sentinel 2

Introduction

Agriculture is the largest sector in most sub-Saharan African economies supporting employment, food supply and export earnings (Dercon & Gollin, 2014). Agriculture covers approximately 38% of the global land surface and agricultural land provides the largest share of food supplies and essential ecosystem services (Stephens et al., 2018). Land is an indispensable resource in agricultural production (Viana et al., 2022) and it is crucial in developing countries where more than 80% of the rural households depend on farming, natural resources and other land-based activities for livelihoods (Akinyemi and Mushunje, 2019)

As human population grows, land scarcity increases and people are compelled to encroach on land that was hitherto considered non-arable (FAO, 2020). The drive to satisfy the multitude of human needs and demands triggers land use and land cover (LULC) change that curtails land productivity and outputs. Globally, the most common causes of LULC change are unsustainable agricultural practices (Mwanjalolo *et al*., 2015; Bufebo and Elias, 2021). According to Lambin and Meyfroidt (2011), between 1980 and 2000 more than half of new agricultural land in the tropics was forest land. Tropical Africa alone lost 32% (19.8 million hectares) of forest cover between 2000 and 2010 due to agricultural expansion and urbanisation (Ssekuubwa, 2018). In the same period, Uganda lost 16.5% of the forests and woodland cover to agriculture (Josephat, 2018). Decrease in forest cover and surge in other land use types has coincided with increased demand for farmland, nature conservation and other investments in Africa. Between 2000 and 2020, agribusiness investments in African farmland increased (Oberlack *et al*., 2021) due to growth in agribusiness, especially large-scale agricultural investments, which prompted conversion of forests, woodlands and grasslands into plantations of agricultural crops.

According to Aabø and Kring (2012) and German (2015), agricultural investments can limit access to land which negatively affects community livelihoods. In Ghana, for example, local communities lost about 17,000 ha of land to pave way for biofuel crops production (Schoneveld *et al*., 2011). The land matrix indicates that Africa is the most affected continent in the world with nearly 14 million hectares of land owned by or leased to national and foreign investors. This represents about 559 land acquisition deals out of the global 1,889 agriculture-related land deals concluded by 2020.

Interest in farm land in Africa by investors is expected to continue due to demand for food linked to global human population growth that is expected to reach 9 billion by 2050 (FAO, 2020) and partly due to increased demand for biofuels (Nolte *et al*., 2016). Increase in agribusiness investments in Africa's land has been attributed to three inter related factors. Firstly, the global demand for renewable fuels led to an upsurge in biofuel investments (Ansoms, 2013; German *et al*., 2013 and Cramb *et al*., 2017). Secondly, in 2007, the demand for biofuels accounted for 40%-60% increase in the price of cereals which further escalated in 2008 with a ripple effect on other commodity prices (Rosegrant, 2008; Woolcock, 2014). Thirdly, sovereign wealth funds and private equity firms have also emerged as key actors in land acquisition in Africa. Acquisition of land in this manner has become an alternative for falling values of stocks and enables the shareholders to diversity their asset portfolios, spread risks and increase profits (Visser, 2015; FAO, 2020).

Efforts by the government of Uganda to transform the agriculture sector from subsistence to commercial farming (Government of Uganda, 2007) has increased investments in the sector. However, studies in Mozambique (Zaehringer *et al*., 2018) and Ghana (Schoneveld *et al*., 2011) revealed that investments in agriculture do not necessarily generate positive outcomes. For instance, conversion of large forested areas and grasslands into agricultural lands resulted, instead, in environmental degradation, land use changes and pollution.

Over the last two decades, studies have focused on drivers of land use change and consequences of agricultural investments on GDP (James, 2015; Aabø and Kring, 2012; Zaehringer *et al*., 2018; Oberlack *et al*., 2021). No study has been undertaken in Uganda, to examine the effect of LSAI on land use land cover change, land acquisition and related local community perception. An earlier study by Sserwajja (2014) assessed the processes that underpinned land grabbing, diverse land grab types, actors involved and their roles in facilitating the expropriation of community land in Amuru district. The study also interrogated the agrarian transformations and socio-economic consequences and the mechanisms employed by the local communities to block and resist the expropriation of their land. Kiiza *et al*. (2017) assessed the influence of land use land cover change in the context of degradation of fragile ecosystems in the Lake Bunyonyi catchment, while Kigundu *et al*. (2018) examined land use and land cover changes in the Murchison Bay and proposed practical measures to regulate land use, water use rights and conserve the wetland-dominated environment.

Assessment of land use and land cover changes is vital in understanding LSAI because scholars such as Tura (2018), Osabuohien (2014), and Ykhanbai *et al*. (2014) reported that large-scale land acquisition has spread to countries with relatively weak land governance and poor legal protection for customary land rights that exacerbate land use and land cover changes. In this study, large-scale agricultural investment refers to acquisition of large tracts of land through leasing or purchasing (Osabuohien, 2014), by public and private sector actors, including governments and transnational corporations mainly in developing countries, for the production and export of food (Abesha *et al*., 2022). For purposes of this study, we define LSAI as investments utilising more than 100 acres of land though there are a few investments with less acreage but substantial capital investments that were considered due to the type of production.

A study by Kusiima *et al*. (2022) focused on loss of grasslands, bushlands, and tropical high forests due to human activities that reduced landscape heterogeneity and compromised ecosystem services. Furthermore, Njagi *et al*. (2022) reported that political decisions and government policies related to land tenure and reforms, socio-economics, and demographic changes were drivers of land use and land cover changes. None of these studies focused on LSAI, the land acquisition process, land use land cover changes. Moreover, they were undertaken outside our study districts thus revealing a gap in research that motivated the study. To fill this gap and address the problem, the study examined the effects of LSAI on land use and land cover changes in Kanungu, Nakasongola and Nwoya districts in 2000 and 2020. Thus, the research questions addressed in this study were: How did LSAI influence land use land cover changes? Which methods did LSAI companies use to acquire land? How did the local communities perceive LSAI?

Materials and methods

Study areas

The study was conducted in Kanungu, Nakasongola and Nwoya districts of Uganda (Fig. 1). The districts were purposively chosen because agriculture is a dominant land use activity and about 96% of the population is involved in crop production (UBOS, 2013). According to the statistical abstract of Uganda Investment Authority 2015, the districts had a number of LSAIs: five in Kanungu district, 13 in Nakasongola district, and 15 in Nwoya district, which also guided selection of the sites.

Kanungu district (0° 572 03 S and 29° 472 03 E) covers an area of 1328 km^2. It is bordered by Rukungiri district to the north and east, Rubanda district to the southeast, Kisoro district to the southwest and the Democratic Republic of Congo (DRC) to the west (Government of Uganda, 2016). It receives an annual rainfall of about

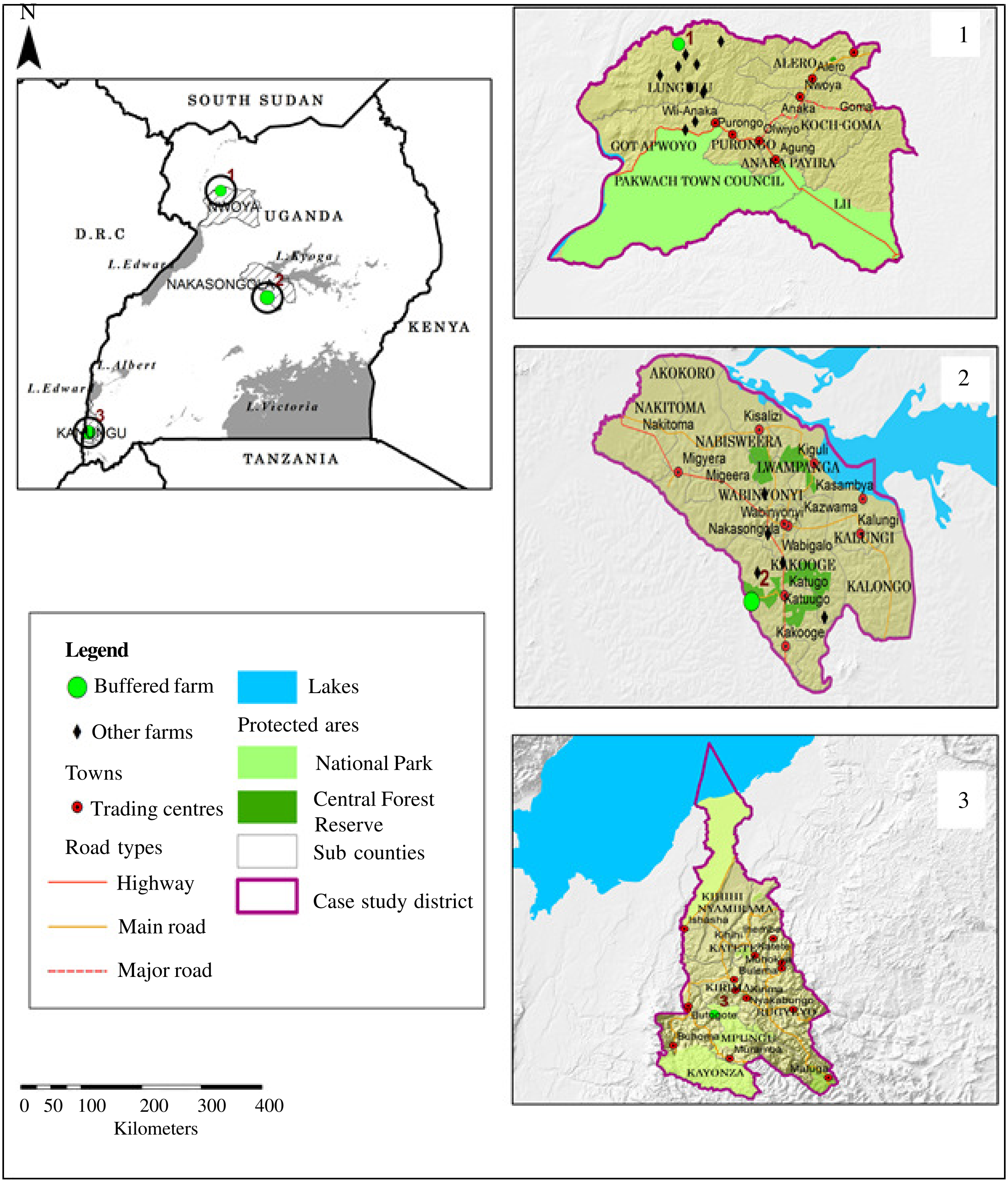

Figure 1. Map of Uganda showing the study districts.

1,200 mm and the average temperatures range between 15^0C and 20^0C. The soils are greyish brown and reddish sandy loams. The population is 277,300 with a density of 198 persons per km² (UBOS, 2017). Land is held under customary tenure (Hartter et al., 2015) and the average household land holding is 2.8 acres which is equivalent to 0.95 acres per adult (Broegaard *et al.*, 2022). The soils are degraded thus resulting in poor yields and chronic poverty (Government of Uganda, 2016).

Nakasongola district (1° 20'N and 32° 26'E) has an area of 3,510 km². It is bordered by Apac district in the north, Lira district in the north east, Kayunga district in the east, Masindi district in the west and Luwero district in the south**.** It receives an annual average rainfall of 875 mm to 1,000 mm and an average temperature of 30°C to 32°C (Twinomujuni and Rwabwogo, 2011). The district is underlain by the Buruli catena with inferior nutrient status consisting of 12% clay content in the upper layer, low organic carbon (1%) and deficient in phosphorus and exchangeable bases. Agriculture is the main economic activity and the main crops grown are coffee, cotton, maize cassava, beans and bananas while some farmers rear livestock. The population is 181,799 people with a density of 55 persons per km² (Uganda Bureau of Statistics, 2014) and an average household land holding of 11.9 acres (Broegaard and Ravnborg, 2022).

Nwoya district (02°382 N and 32°002 E) covers an area of 4,736.2 km^2 and is bordered by Omoro district to the east, Oyam district in southeast, Kiryandongo and Buliisa districts in the south, Nebbi district in the west and Amuru district in the north. It receives a mean annual rainfall of about 1,500 mm (Mwungu *et al.*, 2019) and an average annual temperature of 18°C-30 °C (Bamanyaki and Muchunguzi, 2020). It has fertile loamy soils that support production of cassava, maize, rice, tobacco, cotton and simsim (sesame). Customary land tenure is dominant and few people have freehold land titles. The population is about 133,506 people, the density is 10 persons per km² and the average land holding is 18.1 acres per household (UBOS, 2017).

Study design

This study employed an exploratory research design with mixed methods consisting of qualitative and quantitative approaches. The qualitative approach provided insights into and deepened understanding of the respondents' views (Surbhi, 2018). On the other hand, quantitative approach enabled analysis of empirical data to establish the cause and effect relationship between study variables (Östlund *et al.*, 2011; Borgstede and Scholz, 2021). The mixed methods approach enabled maximum use of context as a means of documenting and gaining deeper understanding of the knowledge generated by study (Martin *et al.*, 2006). The approaches helped to explore how LSAI influenced land use and land cover changes and respondents' perceived effects of LSAI farming activities on local communities' livelihoods. To enable comparison of the outcomes of agricultural investments in the districts, questionnaire interviews and geospatial analysis generated empirical data.

Sampling

To enable a detailed analysis of the effect of LSAI on land use and land cover changes, a buffer from the investment/boundary of 25 km radius in Kanungu and Nakasongola districts and 50 km radius in Nwoya district was established to delineate the impact of LSAI on the adjacent smallholder farming households. The buffer was based on the fact that an agricultural project can have a spill-over effect within a radius of 25 km. A multistage random sampling procedure was applied according to the procedures of Sarandakos (1988) and Sedgwick (2015). In the first stage, a random sample of 20 villages were selected. In this regard, a community was defined as a group of people with common characteristics and a certain degree of cohesion living in the same area (spatial unit) and sharing beliefs, tradition, values, cultural and historical heritage (Scherzer *et al*., 2020). In Uganda, a village is an administrative unit with clearly delineated boundaries, leadership and interconnected pathways (Marron, 2019).

Probability proportionate sampling was applied to the total population in order to randomly select communities from each parish (Abdulla *et al*., 2014). In the second stage, respondents were selected from each village using probability proportional to size (PPS) method (Abdulla *et al*., 2014). With this, the village population as a proportion of the total population was derived. In the third stage, respondents aged 18 years and above were selected randomly from a list of individuals in the village with the help of local community leaders. Each entry in the sampling frame was numbered using the random number generated in Excel (Marsaglia, 2003; Abd-Alhameed *et al.*, 2006). Using this approach, a total of 1,200 respondents, that is 400 per district (Table 1), were selected consisting of farmers and local community members. To minimise response bias and distortion of questions and answers, the questionnaire was pretested and the question wordings and focus improved. In addition, the respondents were randomly selected and the research assistants fluent in the local languages and familiar with the research areas were engaged in data collection.

Satellite data collection

To ascertain land use and land cover changes, satellite imagery was acquired, processed and analysed. The images provided information on the major land uses and land cover, the size of land under LSAI, the size of land on which the use has changed and the current land use type. To examine land use and land cover changes over time, two satellite multi-temporal datasets that characterise land use and land

Table 1. Number of respondents (*n=400*) per district

Research location	Ward/sub-county	No. of respondents	No. of people declining consent*	No. of replace-ments*	Final sample	
					Number of respondents sampled	% of s ampling target
Kanungu	Kayonza	47	–	9	62	131.9
	Mpungu	20	–	1	13	65.0
	Kinaaba	14	–	2	12	85.7
	Kanungu TC	26	–	1	16	61.5
	Rugyeyo	36	–	7	43	119.4
	Kirima	30	–	4	21	70.0
	Butogota	18	–	1	14	77.8
	Kanyantorogo	33	–	5	47	142.4
	Kambuga & Kambuga TC	47	–	12	57	121.3
	Katete	12	–	3	12	100.0
	Kihihi TC	34	–	11	47	138.2
	Nyanga	13	–	2	8	61.5
	Nyakinoni	15	–	2	8	53.3
	Kihihi	31	–	5	27	87.1
	Nyamirama	25	–	1	12	48.0
Nwoya	Alero & Lungulu	177	–	48	171	96.6
	Anaka Town Council	50	–	14	46	92.0
	Anaka Payira	35	–	10	35	100.0
	Koch-Goma	38	–	8	37	97.4
	Purongo	100	–	53	99	99.0
Nakasongola	Kakooge	145	–	12	143	98.6
	Kakooge TC	56	–	17	57	101.8
	Nabiswera	20	–	–	16	80.0
	Nakasongola TC	71	–	36	72	101.4
	Wabinyonyi	108	–	16	106	98.1

cover changes in 2000 and in 2020 were used. For 2000, Landsat ETM7 (30 m) dataset was selected while for 2020, Sentinel-2 (20 m) images were used. The images were downloaded from the United States Geological Survey (USGS) (https://earthexplorer.usgs.gov/) geo-portal captured in December-February during the dry season with similar spectral reflectance. The images had less than 20% cloud cover. The specifications of the satellite images, the path and row, year of acquisition and spatial resolution are presented in Table 2.

Table 2. Satellite specifications of the spatial data imagery used in the study areas

Study Area	Landsat sensor	Path & Row	Image date	Cloud cover (%)
Kanungu district	Landsat 7 (ETM)	173 & 060173 & 061	Jun, 2000	3.0
	Landsat 8 (Oli)		May, 2020	5.0
Nakasongola district	Landsat 7 (ETM)	171 & 059172 & 059	July, 2000	4.0
	Landsat 8 (Oli)		May, 2020	5.0
Nwoya district	Landsat 7 (ETM)	172 & 058	Apr, 2000	3.0
	Landsat 8 (Oli)		Jun,2020	4.0

Image processing

The images were pre-processed and interpreted using ENVI remote sensing software version 5.0. The Landsat imagery were upgraded from 30 m to 10 m spatial resolution to harmonise the pixel variations. The harmonised image bands were enhanced to improve visualisation and distinction of spectral features. Both images were atmospherically corrected using the dark object subtraction method to remove haze. In addition, the images were geometrically corrected and co-registered. Image composites for 2000 and 2020 were then developed to enable interpretation. For the pre-processed images, the areas of interest were masked out for faster rendering and then analysed using a hybrid of unsupervised (ISO data) and supervised (maximum likelihood) methods because of the heterogeneity of land use and land cover types.

Image accuracy assessment

A confusion matrix was developed to define the producer and user accuracies for each class (Table 3). The overall Kappa statistics and accuracy, based on Jiang and Liu (2011), for each classified image were computed from the corresponding error matrix with a total of 600 points collected from different land use and land cover (LULC) types per study district in 2000 and 2020. The confusion matrix was performed by comparing error values for each class generated using the ground truthing data. The accuracy points were used to develop the image error matrix. An overall accuracy (OA) of over 80% was obtained for images of 2000 and 2020 (Table 4).

Image post classification

A majority filter was performed on the classified images to remove noise and negligible pixels in the final land use and land cover maps. In addition, the classified images were post-processed using change detection method.

Table 3. Summary of User Accuracy (UA) and Producer Accuracy (PA) assessment of land use and land cover in the study districts in 2000 and 2020

	Districts and Year											
	Kanungu				Nakasongola				Nwoya			
	2000		2020		2000		2020		2000		2020	
LULC types	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%	UA%	PA%
Built-up area	80.6	93.1	88	86.3	81.7	78.4	93.6	78.4	91.7	75.9	91.3	75
Bushland	83.0	89.8	95.8	88.5	95.4	71.9	95.9	87.0	97.8	89.8	98.4	96.9
Grassland	71.4	70.2	88.2	89.6	81.6	90.9	83.1	93.7	71.4	75.5	71.4	75.5
Large-scale farming	100	77.2	94	97.9	82.8	57.1	83.9	77.6	93.6	71.0	93.6	84.6
Open water	91.8	74.7	92.6	89.3	92	95.8	92.6	87.7	87.5	64.8	90.4	71.2
Small-scale farming	67.9	74.5	90.6	80	92.9	82.5	92.6	89.3	67.9	69.1	67.9	69.1
Tree plantations	87.0	78.5	94.4	91.1	54.8	85.1	84.5	83.1	80	95.2	80	95.2
Tropical rain forest	91.1	82.3	87.5	94.2	-	-	-	-	92.4	73.5	95.4	77.4
Wetland	80.4	93.8	82.7	95.6	82.4	87.5	80.6	100	80.4	93.8	84.5	95.2
Woodland	84.3	91.5	86.4	87.9	94.8	96.5	90.3	92.9	70.5	84.3	84.3	84.3

Table 4. Accuracy and Kappa statistics of land use/cover classification

	District					
	Kanungu		Nakasongola		Nwoya	
Year	2000	2020	2000	2020	2000	2020
Overall accuracy (OA) %	82.7	89.8	82.8	88.2	79.2	83
Kappa statistics	0.81	0.88	0.79	0.87	0.77	0.81

Questionnaire interviews

Research assistants were recruited and participated in questionnaire pre-testing and revision. Field guides fluent in the local languages in the study districts were recruited to work with the research assistants. The LC 1 Chairpersons helped the field guides to locate households that were randomly selected for the interviews. The research assistants were introduced by the LC 1 Chairpersons to the respondents, the purpose of the study was explained and consent to be interviewed sought. The respondents who declined to be interviewed were left and the next respondent selected. The research assistants administered the questionnaire in local languages but wrote the answers in English. Questions included on relationship with foreign agricultural investors in the area, number of people employed on the farms, place of origin, effects of LSAI, how much land was hired by the investors, and any land related conflicts among others. Where the respondent did not understand a question, the research assistant repeated it for clarity. Considering the length of the questionnaire, each research assistant administered five copies only per day and each interview lasted about one hour.

Key informant interviews and field observations

The key informants were purposively selected and included the District Agricultural Officers, Production Officers, Local Council I and III Chairpersons, members of the Local Area Land Committees, large-scale agricultural investors and local community members working on the LSAI farms. The interviews were based on the methodology of Kitchin and Tate (2000). Key informants were asked to explain the dynamics of land tenure, agricultural investments and labour in their communities and the consequences of such dynamics. Investors were asked about agro-inputs, how much land was appropriated and used. To supplement information gathered from interviews, field observations were made during ground truthing to document the changes in the environment/agricultural landscape, and GPS coordinates of the farms captured. The key informant interviews were conducted in Kanungu and Nwoya districts only as

COVID-19 pandemic lock down restrictions made it impossible to collect data in Nakasongola district within the study time frame.

Data analysis

Image analysis for land use and land cover change

A cross tabulation method and formula by Malaviya *et al.* (2010) were applied to determine the rate of land use and land cover change per district. The formula is expressed as:

$$r = \left[\frac{1}{t_1 - t_t}\right] x \left[\ln\left(\frac{A_2}{A_1}\right)\right] x \ 100 \quad \text{..........} \quad (1)$$

Where: r is the rate of land use/cover change, and A_1 and A_2 are the land use/land cover types at time t_1 and t_2 respectively.

Analysis of interview responses

The responses were edited, coded and entered in SPSS and NVivo to create a data. The NVivo programme enables coding and retrieval of data as statements in different data files are linked (Kristi and Bazeley, 2019). NVivo also made it possible to establish themes, improve accuracy and speed of data interpretation (Hilal and Alabri, 2013). In addition, it facilitated content analysis based on patterns of related information thus making it possible to derive meaning from the interview transcripts. Coding helped in distilling data, sorting and comparing of information. Qualitative data on local communities' perception of the LSAI effects of land use and land cover changes were subjected to content and narrative analysis (Elo *et al*., 2014; Bengtsson, 2016). This approach enabled objective, systematic and qualitative description and understanding of the contexts of LSAI as well as perceived land use and cover changes.

Results

Questionnaire response rate and respondent's profile

The response rate to the questionnaire interviews conducted in each of the three study districts out of the expected 400 respondents were as follows: in Kanungu district 399 (99.7%), Nakasongola 394 (98.5%) and Nwoya 389 (97.3%). The respondent's profile is presented in Table 5.

Land acquisition and ownership

Interviews with farmers revealed that the investors acquired land using different methods. In Kanungu district for instance, most of the LSAI companies purchased

Table 5. Respondents profile (values are % responses)

Respondent's characteristic	Description	Kanungu (*n=399*)	Nakasongola (*n=394*)	Nwoya (*n=389*)
	Household head	49.6	68.8	63.8
	Spouse of household head	30.8	17.8	27.2
	Son/daughter of household head	17	11.2	7.7
	Others	2.5	2.3	1.3
Gender:	Male	47.9	54.8	46
	Female	52.1	45.2	54
Age (years):	<25	18.5	24.4	22.9
	25-40	40.6	39.1	40.2
	41-55	23.6	19.8	21.9
	>55	17.3	16.8	14.9
Poverty level:	Non-poor	22.1	35.5	13.9
	Less poor	34.1	40.1	30.3
	Poorest	43.9	24.4	55.8

land from individuals with leasehold tittles while the local-owned farms had freehold tittles. Purchases of land in Kanungu involved signing agreement as a proof of purchase and ownership witnessed by the LC 1 Chairperson. In Nakasongola district, investors acquired land by signing leasehold agreements with land owners. There were three types of land ownership in Nwoya district; firstly, some foreign companies that managed Farms NW4, NW5 and NW7 rented land from local land owners under leasehold/sub-lease agreements for a period of 10 years (Table 6). Most of the land acquired through this method was not titled and the owners were in the process of titling them. Secondly, some investors rented land and they were required to help the land owners to process freehold titles. There are also companies (e.g. Farm NW3 in Nwoya district) that purchased land and obtained leasehold titles for 49 years. The other form of land acquisition was forceful eviction of the occupants (land grabbing). According to local oral accounts by Local leaders of Lebnec village and the Local Land Committee member in Lungulu sub-county, Nwoya district a *prominent person* from Acholi region grabbed 3,000 ha of untitled land from the local community. When the affected people refused to vacate the land, the police and army were deployed to evict them and one person was allegedly killed in the process. The land was later titled and rented to Farm NW5 (Nwoya district) for large-scale growing of sun flower, beans, rice and cotton.

Table 6. Land ownership by operational size

District	Name of the farm	Size		Ownership of commercial farm	
		Operational	Land (acres)	Venture type	Type of operation
Kanungu	Farm K1	Large	500	Local	Mechanised and labour intensive
	Farm K2	Small	30	Local	Labour intensive
	Farm K3	Small	-	Local	Labour intensive
	Farm K4	Small	18	Foreign-lease	Labour intensive
	Farm K5	Medium	500	Foreign-lease	Labour intensive
	Farm K6	Large	5000	-	Mechanised and labour intensive
	Farm K7	Small	20	Foreign-lease	Labour intensive
Nakasongola	Farm N1	Large	1920	Joint venture	Labour intensive
	Farm N2	Large	2880	Foreign	Mechanised and labour intensive
	Farm N3	Large	540	Foreign-lease	Mechanised and labour intensive
	Farm N4	Large	992	Local	Mechanised and labour intensive
	Farm N5	Large	670	Foreign	Mechanised and labour intensive
	Farm N6	Large	527	Foreign	Labour intensive
	Farm N7	Large	500	Foreign	Mechanised and labour intensive
Nwoya	Farm Nw1	Large	3471	Joint venture	Mechanised
	Farm Nw2	Medium	1208	Local	Labour intensive
	FarmNw3	Large	5000	-	Mechanised
	Farm Nw4	Large	7413	Foreign	Mechanised
	Farm Nw5	Large	12000	Foreign	Mechanised
	Farm Nw6	Medium	2000	Foreign	Mechanised and labour intensive
	Farm Nw7	Large	7000	Foreign	Mechanised and labour intensive
	Farm Nw8	Large	1700	Local	Mechanised

Quantification of land use and land cover changes

Overall, agricultural activities greatly impacted land use and land cover (LULC) in Kanungu, Nakasongola and Nwoya districts (Fig. 2). In Kanungu district, the land use and land cover types that increased were built-up areas 0.2% (275.9 hectares), plantation forests 0.7% (957 ha), bushland 8.2% (10,998 ha), and large scale farming increased from 9.8 ha in 2000 to 1,094.6 ha in 2020. In contrast, grasslands decreased by 5.7% (7,699 ha), small scale farming by 3.8% (5,071.5 ha) and woodlands by 0.9% (1,155.9 ha). Despite the decrease in small scale farming, it was still the predominant land use and land cover change agent. Similarly, built-up areas increased from 48.3 hectares to 275.9 hectares.

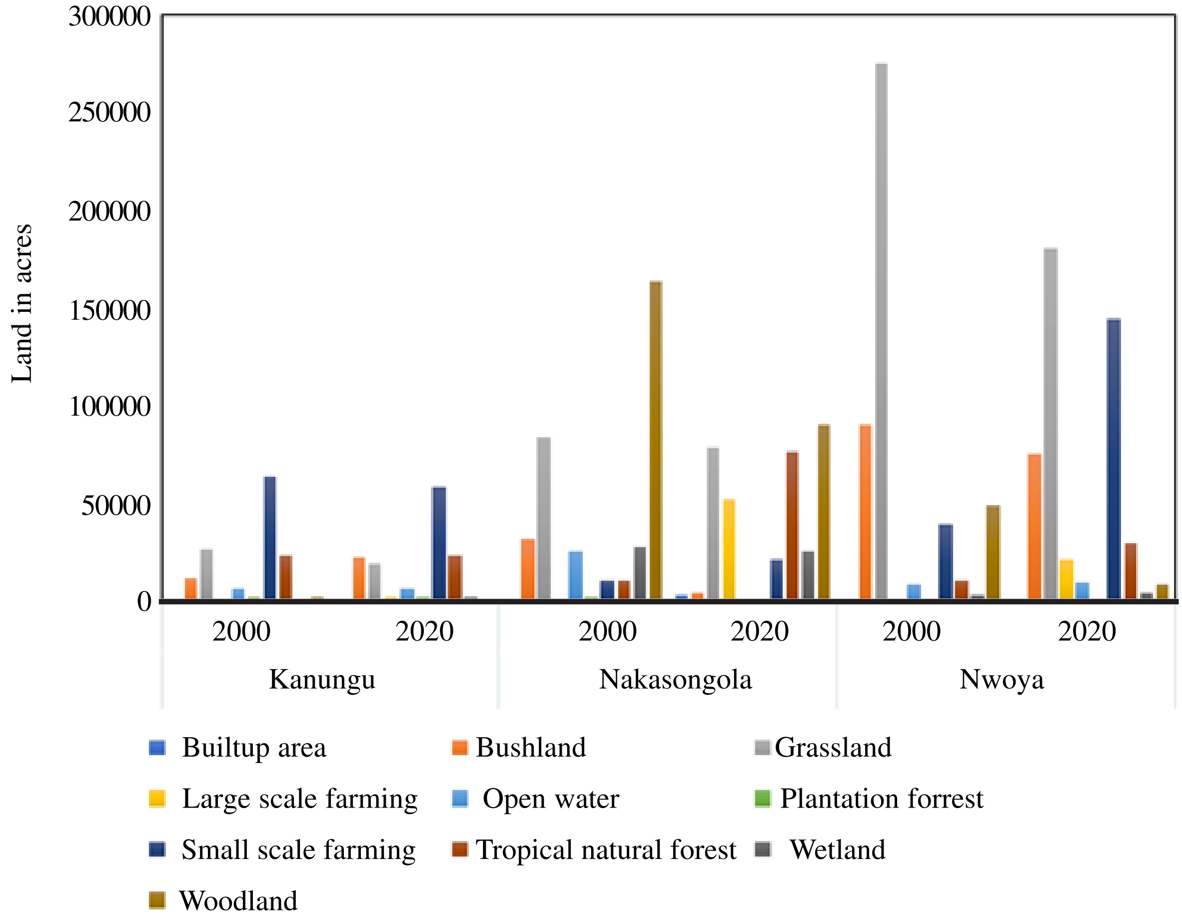

Figure 2. Overall changes in land use/cover in Kanungu, Nakasongola and Nwoya districts.

The land use and land cover changes in Nakasongola district in 2000 and 2020 showed an increase in the area under small-scale farming by 3.1% (1,1043 ha), arable land by 14.7% (51,540.2 ha), and built-up area by 0.9% (3,133.9 ha). Net decreases were recorded for wetlands by 0.5% (1,763.6 ha), grasslands by 1.5% (5,145.8 h), bushlands by 7.9% (27,860 ha), and woodlands by 20.9% (73,415.8 ha).

For Nwoya district, results revealed increases in large scale farming by 4.5% (21,155.9 ha,) small scale farming by 22.4% (10,6079.6 ha), tropical forest by 4.2% (20,011.4 ha) and built-up areas by 0.1% (320.2 ha). In contrast, grassland area decreased by 19.9% (94,261.3 ha), woodland by 8.7% (4,0984 ha) and bushlands by 16% (14,370.4 ha) (Fig. 2). Net increase in acreage of land use and land cover types were observed in areas dominated by small-scale farming, large-scale farming and tree plantations. Figure 3 (Sankey diagrams) also shows land use and land cover changes in Nwoya district as recorded in 2000 and in 2020 signifying a highly segmented landscape characterised by patches of small-scale farms.

Results revealed an increase in land under large-scale farming in all the districts (Fig. 3). In Kanungu district, land under large-scale farming increased from 9.8 ha in 2000 to 1,094.6 ha in 2020 (Fig. 2). The change is visualised in the images presented in Figures 2 and 3 of the same years. In Nakasongola district, there was a marked increase in land under large-scale farms from 18.7 ha in 2000 to 51,558.9 ha in 2020, which represented the largest change amongst the districts (Fig. 2). Nwoya district also experienced a big increase in the area under large-scale farming from 57.9 ha to 21,213.8 ha. Nevertheless, Nwoya experienced a large increase in land area under small-scale agriculture compared to areas under large-scale farming.

The contribution of LSAI to land use and land cover changes

The evolution of land uses between 2000 and 2022 represents land gains and losses experienced across all the land use types in the three districts. The gains and losses show land conversion from one land use type to another. Small-scale farming and large-scale farming gained more land than other land use types (Fig. 4); while land was lost from grasslands, bushlands and woodlands (Table 7). Results further indicate that small-scale and large-scale farming spread into bushlands, grasslands and woodlands. In Kanungu district, small-scale farming gained land from grassland (7,536.48 ha), bushlands (6,888.61 ha), tropical natural forest (663.50 ha) and woodlands (59.12ha). Large scale agriculture gained land from small-scale agriculture by 1,009.24 ha, from grasslands by 57.60 ha and bushlands by 5 ha. Built-up areas gained land from grasslands by 53.5 ha and bushlands by 1.6 hectares (Table 7). In Nakasongola district, large-scale agriculture gained 23,613.6 ha from woodlands, 14,596.7 ha from grasslands, 5,057.8 ha from small-scale agriculture, 4,457 ha

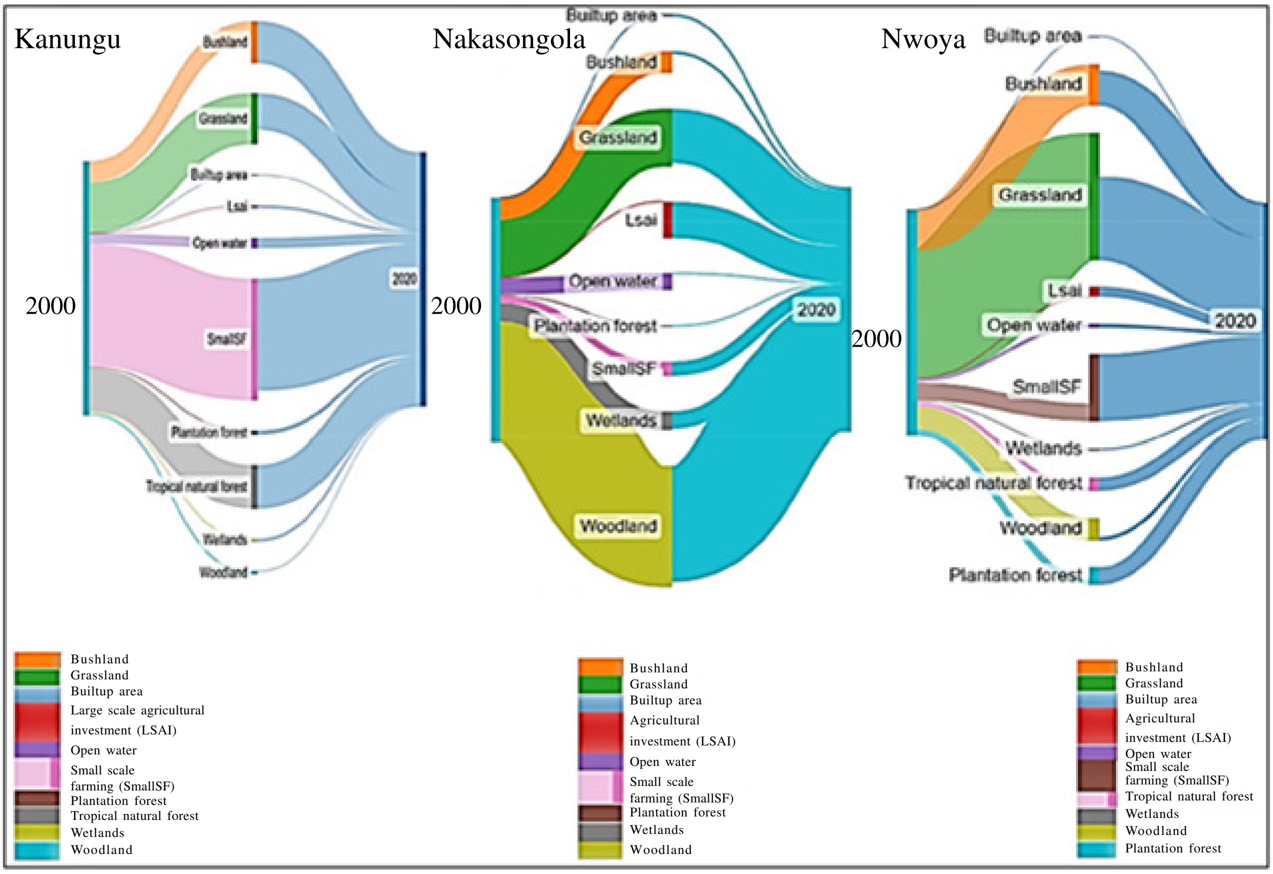

Figure 3. Sankey diagrams showing land use changes in Kanungu, Nakasongola, and Nwoya districts following LSAI between 2000 and 2020.

from bushlands and 2,262.6 ha from wetlands. Results further revealed that small-scale agriculture gained 13,073 ha from wetlands, 5,104.9 ha from grasslands, 1,440.6 ha from woodland and 323.2 ha from bushland. In Nwoya district, large-scale farming gained 2,688 ha from bushland, 17,527 ha from grasslands, 778 ha from woodland and 176.63 from small-scale farmlands.

Key informant perception of land acquisition by LSAI

In Kanungu district, the LC 3 chairman for Butogota sub-county expressed the desire to have investors to improve the local economy by creating jobs for the youth and providing market for agricultural produce especially coffee and tea. In Nwoya district, land was generally held under customary tenure and few communities had acquired customary land titles. However, the fertile land attracted agricultural investors to the district. Majority had bought, leased or rented land that was formally owned and avoided areas with customary tenure for fear of triggering conflicts with the owners.

Table 7. Areas (ha) of land converted to LSAI in the districts between 2000 and 2020

Change (2000 -2020)	Kanungu Area Change (ha)	Nakasongola Area Change (ha)	Nwoya Area Change (ha)
Built-up areas→Large-scale farming	n.a	0.83	n.a
Built-up areas→Small-scale farming	4.43	1429.76	n.a
Bushland→Built-up areas	1.62	323.2	42.24
Bushland→Large-scale farming	4.99	4457.37	2688.85
Bushland→Small-scale farming	6888.61	315.2	15272
Grassland→Built-up areas	53.47	2539.75	16.33
Grassland→Large-scale farming	57.6	14596.65	17527.4
Grassland→Small-scale farming	7536.48	5104.88	89761.5
Open water→Large-scale farming	n.a	10.04	n.a
Open Water→Small-scale farming	n.a	398.22	18.97
Plantation forest→Large-scale farming	n.a	126.79	n.a
Plantation forest→Small-scale farming	441.22	13.6	n.a
Small-scale farming→Large-scale farming	1009.24	5057.33	176.63
TNF→Built-up areas	n.a	8.26	n.a
TNF→Large-scale farming	22.76	n.a	n.a
TNF→Small-scale farming	663.5	187.63	2399.9
Wetland→Built-up areas	n.a	12.14	n.a
Wetland→Large-scale farming	n.a	2262.61	n.a
Wetland→Small-scale farming	28.21	13073.88	9.29
Woodland→Large-scale farming	n.a	23613.61	778
Woodland→Small-scale farming	59.12	1440.59	13940.7

n.a = not applicable, TNF= Tropical natural forest, →represents loss of area by land use type on the left to land use type on the right

There was mixed reaction by the local people about the presence of LSAI based on the hope that they would introduce modern farming practices. They appreciated the introduction of agricultural equipment for hire, servicing local people's farming equipment, providing spare parts for farm equipment, employing the youth and supporting the process of land titling. In addition, a number of trading centres had sprung up and there were groceries and food for LSAI farm workers.

With regard to improved farming methods, it was reported that LSAI introduced changes in smallholder farmers' agricultural practices in Kanungu and Nwoya districts. In Nwoya district, the respondents stated that the investors allowed the smallholder farmers to hire the tractors to plough their land, used sprayers and combine harvesters, and paid for the services after sale of crops. This enabled local farmers to increase the acreage under crops and improve on agronomic practices such as fertilisation of soil which increased the yields. In Kanungu district, the investors helped farmers to improve coffee and tea production and introduced agricultural commodity bulking that improved the prices and incomes.

With respect to increase in land prices, the respondents expressed concerns that the price of land had shot up due to LSAI. In one case, a land dealer in Butogota town in Kanungu district stated that the investors offered better prices and local people preferred to sell their land to them. In Nwoya district, despite the anticipated benefits from LSAI, local community members complained that the price of land had sky rocketed because of the high demand attributed to arrival of the investors. For instance, the price of an acre of land increased from UGX 500,000 to more than UGX 800,000 by 2019. According to an oral account by one of the village chiefs in Nwoya district, the price hike motivated many people to lease or sell land to the investors and they migrated to Gulu city and other urban centres.

There were reports of increased incidences of land grabbing and land conflicts in Nwoya district. The respondents reported that the price hike triggered conflicts over land as powerful and politically connected individuals forcefully evicted some local community members and grabbed land which was then rented to the investors at UGX 80,000 per acre according to an oral account by Rwot (Chief) of Lebnec. During data collection, a stand-off was witnessed between local people and an Indian investor who was stopped from opening up land that local community members claimed belonged to them. Consequently, the investor sought protection from the army and police. There were also claims that an army general who owned large tracts of land had deployed soldiers to drown out any dissent against land grabbing.

Key informants' perception of land-use challenges due to LSAI

There were reported cases of evictions in Nwoya district due to elite capture following increase in the value of land that attracted politically well-connected individuals. A local community leader Alingiri village in Nwoya district commented as follows: "*one of the big farms in connivance with high level government officials and an army Brigadier, evicted families from a big piece of land and used the army to protect the farmworkers from the angry residents"*. During fieldwork in Lungulu sub-county, soldiers deployed to protect the farms were seen. It was also alleged that during one of the eviction cases, a church was raided and demolished and during the scuffle '' *a child disappeared and has since not been seen"*.

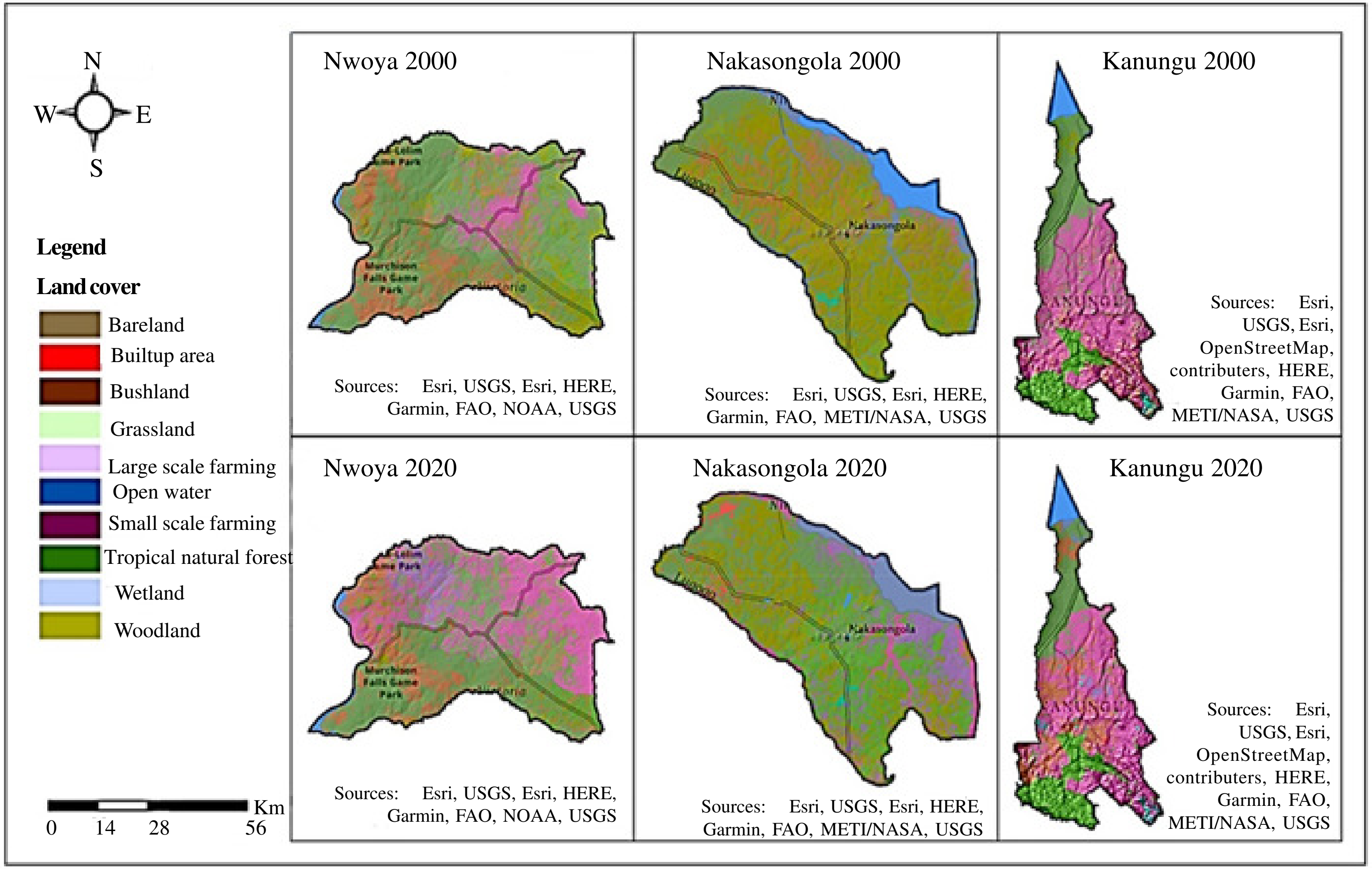

Figure 4. Land use/cover changes between 2000 and 2020.

During data collection in Nwoya district, it was observed that most of the houses were grass thatched. However, local community members complained that the areas where they used to cut thatch grass were no longer accessible because they had been rented out or bought by investors who converted them into commercial farms. Agricultural activities had converted about 7,594.08 ha of grasslands in Kanungu district, 19,701.53 ha in Nakasongola district, and 107,288.9 ha in Nwoya district. Majority of houses in Kanungu and Nakasongola districts had corrugated iron sheets suggesting that thatch grass was not a major problem.

It was reported in Nakasongola and Nwoya districts that rangelands that were used by pastoralists for free range grazing of livestock were no longer available as most of the land had been converted or set aside for crop growing. This was a major challenge to pastoralists who could not easily change to crop growing as a livelihood activity. Pastoralism is a major occupation and key economic activity in Nakasongola district thus denying the pastoralists access to grazing areas adversely affects their livelihoods. In Nwoya district, local people practiced crop growing alongside livestock rearing. However, livestock rearing was on the decline due to decrease in grassland areas used for livestock grazing.

Discussion

Land acquisition for LSAI

This study found that LSAI activities had increased in the three districts over the last 20 years and large tracts of land had been designated to agri-business. Such increase in land acquisition by the LSAI has been similarly reported in Ghana (German and Schoneveld, 2012), Ethiopia (Ali *et al*., 2019) and Zambia (Lay *et al*., 2021). Although this gives evidence of increase in LSAI in Uganda, the methods used to acquire land were inappropriate especially in Nwoya where forceful evictions of lawful occupants were reported. This caused displacement and suffering of the affected people, loss of land and source of livelihoods. Despite cases of land conflicts manifesting due to land grabbing, landlords renting land to investors have benefited from land registration as investors require titled land for tenure security. Some landlords have used part of the proceeds from land rent to embark on titling other parcels of land. This has triggered mass registration of land owned by the communities that are adjacent to LSAI farms in Nwoya district.

Land use and land cover changes due to LSAI

This study has revealed that large-scale agricultural investments (LSAI) can ignite land use and land cover change as agricultural activities expand into areas that were predominantly grassland, savanna woodlands, wetlands and rangelands. The results are consistent with other reports that agricultural investments can account for land use changes (Zaehringer and Atumane *et al.*, 2018; Zaehringer *et al.*, 2018). The LULC are also attributed to other activities related to agricultural investments such as road construction, adoption of modern farming methods from the investors, arrival of immigrants seeking employment on the investors' farms, and the allure of business opportunities arising from LSAI (Herrmann, 2017).

Contrary to reports from other countries indicating that agricultural investments are responsible for changes in land use, this study found that small-scale agricultural investments account for the largest proportion of land use changes. In the three districts, large areas of land have been converted from forests, woodlands, wetlands and grasslands to small-scale agricultural lands. Increase in population and escalation of small-scale farming in Kanungu district in particular is largely responsible for LULC. According to the National Housing and Population census of 2014 (Uganda Bureau of Statistics, 2014), the population of Kanungu district grew at rate of 1.7% per annum from 204, 732 people in 2002 to 252,144 in 2014 and it was projected to reach 274,900 in 2020 with a density of 198 persons per km^2. Continued promotion of commercial tea and coffee growing and strict protection of Bwindi Impenetrable National Park in the district implies that there is limited land to meet the needs of the increased population. The situation has contributed to land fragmentation that can only support small-scale farming.

In Nakasongola district, population increase has driven conversion of land to small-scale agriculture practiced mainly by immigrants from Bugisu sub-region and northern Uganda. Migration of people from northern Uganda was triggered by the LRA insurgency and insecurity from late 1980s to 2006. However, increase in agricultural investments also greatly influenced land use and land changes that affected majorly wetlands and woodlands. There is a likelihood that the population in Nakasongola will experience the environmental effects of wetland conversion in future. In Nakasongola district, the size of built up areas increased in consonance with the demand for agricultural land and growth in human population from 127,064 in 2002 to 181,799 in 2014 and it was projected to increase to 213,000 in 2020 with a population density of 55 persons per km^2 (Uganda Bureau of Statistics, 2014).

In Nwoya district, it was noted that the population had increased following the end of LRA rebel insurgency and insecurity in 2006. In 2002, the district's population was 41,000 people and it increased to 133,500 in 2014 and 214,200 in 2019. The increase in population was due to return of peace and security and resumption of small-scale farming that accounted for land use change in the district. The resumption of security to the region encouraged the local population to return to their former homes from the internally displaced people's (IDP) camps. The returnees were also motivated to engage in agriculture which partly accounted for conversion of grasslands, wood lands and bushlands into farmlands, hence accounting for land use change. The returnees also got engaged in business especially selling agricultural produce which triggered the establishment of trading centers. In Nwoya district, increase in LSAI influenced smallholder farmers' adoption of modern farming practices and cultivation of commercial crops such as rice, chia, cotton and sunflower that have ready markets. This development coupled with availability of fertile soils and affordable price of land for rent and purchase influenced land use and land cover changes in the district.

The increase in human population in Kanungu by 23.2%, Nakasongola by 43.1% and Nwoya by 225.5% (Uganda Bureau of Statistics, 2014) and crop production accounted for most changes in land use and land cover in the three districts over the 20 years. The change to small-scale crop farming occurred at the expense of grasslands, bushlands, natural forests, woodlands, open water areas, and wetlands. At the same time, the size of built-up areas has also increased. These findings are consistent with the findings of Lambin and Meyfroidt (2011), Krishna (2021) and Kamran *et al.* (2023) who reported that increase in human population triggers a corresponding increase in area of land under crop production which is often gained from other types of land use.

Agricultural investments are multi-layered in terms of size and business model employed by different investors. Increase in agricultural investments kindles new land-use practices and reshapes the local peoples' livelihoods. Increase in the size of built-up areas indicate increase in settlements that are often associated with bustling agricultural business and improved access by roads that also facilitate transportation of agricultural produce to markets and migration of labour in search of jobs as noted in Lebnec village in Lungulu Sub- County in Nwoya district. In 2017, during initial field visits to the study districts, there was no trading centres established between Lungulu and Farm Nw3. However, during data collection in 2019, four trading centres had been established along the road leading to Farm Nw3. It was also observed that small-scale agricultural lands were being converted gradually to large scale agricultural investments. The gradual transition of smallholder farms into LSAIs is a threat to food production and livelihoods of the local resource poor people. In Nwoya district, people were forcefully evicted from land that was acquired for LSAI. In Kanungu district, it was noticed that some people converted land that was designated for food production to growing of coffee and tea. This, too, negatively affects food security of the local people. On the flip side, it was noted that LSAI had employed workers on the farms, which improves the livelihoods of the people in the area.

Conclusion

Land under large-scale farming in Kanungu district increased from 9.8 ha in 2000 to 1,094.6 ha in 2020, from 18.7 ha in 2000 to 51,558.9 ha in 2020 in Nakasongola district, and from 57.9 ha in 2000 to 21,213.8 ha in 2020 in Nwoya district; accounting for considerable changes in land use and land cover. In Kanungu, Nakasongola and Nwoya districts, foreign LSAI companies leased land from individuals for periods from 10-49 years while others rented untitled land from local land owners under leasehold/sub-lease agreements. Some LSAI individuals acquired land through forceful eviction of the occupants (land grabbing). The local communities perceived the presence of LSAI in their areas in terms of improved economic conditions as the LSAI companies offered attractive prices for land, the springing up of trading centres and boosting of local trade. They also foresaw benefits from the LSAIs through hiring of agricultural equipment, servicing of farming equipment, provision of spare parts for farm equipment, employment of youth on the farms, and support to acquire land titles. On a negative note, they linked LSAI to rise in cases of land grabbing. As a result of LSAI, land area under grasslands decreased by 5.7% (7699 ha), small scale farming by 3.8% (5071.5 ha) and woodlands by 0.9% (1155.9 ha). The size of built-up areas increased from 48.3 hectares in 2000 to 275.9 hectares in 2020.

Policy recommendations

It is, therefore, recommended that government of Uganda buys into international frameworks and develops policies that protect locals, for instance, the United Nations' guiding principles on land acquisition that emphasize acquisition of prior consent of the bonafide occupants before an investor buys land. Also, the Africa Union's Guiding principles on large-scale land-based investments in Africa, and the Committee on World Food's guiding principles on responsible investment in agriculture and food systems in order to avoid conflicts between investors and local communities over land. The National Agriculture Policy 2013 and NDP III 2020/21-2024/25 do not explicitly state the consequences of LSAI and agricultural modernsation on land use dynamics. On top of that, they do not specify how to guard against threats posed by agricultural expansion into landscapes and ecosystems that include water and biodiversity. One way of overcoming such a policy deficiency is to integrate mechanisms for coordinating LSAI activities in the Agriculture Policy and Investment Code Act. In this way, the expansion of LSAI into other land cover types such as bushlands, grasslands and forests will be regulated.

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