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ARTICLE

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Survival versus sustaining: A multidisciplinary inquiry of the environmental dilemma in rural Uganda

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Abstract

The livelihoods of the majority of Uganda's population depend on declining environmental resources. The sustainability of the natural environment requires that the people who are interdependent with it, as well as the structures of governance and leadership around them, understand the implications of resource degradation and take deliberate steps towards restoration. The interdependency of human and environment conditions in Uganda requires multidisciplinary attention and this paper reflects a contribution to this end. Socio-cultural perceptions and relations with a vulnerable environment are put into dialogue with the physical status of environmental resources in Alebtong District, Uganda. Southern epistemological perspectives are considered in relation to Western scientific paradigms. Culturally responsive socio-cultural research data are related to MODIS NDVI data, using time series analyses and NDVI as a proxy for productivity. The research confirms the declining availability and condition of natural resources and the acknowledgement of local influence on this condition. Despite this, deliberate community and governance efforts towards conservation and restoration varied from non-existent to insufficient. The causes for this inconsistency revolve around conflicting priorities. This paper demonstrates and discusses

the difficult trade-offs in decision-making about natural resources that rural communities face, and supports new partnership models as a route to improvement.

KEYWORDS
community based, degradation, environmental resources, multidisciplinarity, rural livelihoods, sustainability

1 | INTRODUCTION

The economy and livelihoods of people in the majority of countries in sub-Saharan Africa are directly interdependent with arable land, fisheries, mining, forestry and wildlife (e.g., Angelsen et al., 2014; Charlery, 2015). These resources provide employment and raw materials; some are directly exported for income, some consumed and some sold locally.

It is estimated that the environmental and natural resources sector directly contributes USD 791 million to the Uganda's GDP, and employs over 90% of the total rural population (Yaron et al., 2004). This implies that the sustainable use of environmental resources is vital for the continued support to the livelihoods of millions, that are mostly poor. Of equal importance, natural resources constitute the environment for socio-cultural conditions, public and ecological health. Physical environments have direct correlation with social practices, for example, the extent of community cohesion and organisation through interaction in hospitable public spaces. Trees, open clearings and proximity to water have long been critical gathering places for communities in Uganda. Public health in rural Uganda is underpinned by, and often sustained by, local cultural practices which rely on the medicinal and domestic uses of natural resources (Biara et al., 2020; Rana et al., 2021).

Despite these critical interdependencies, natural resources are being rapidly degraded. For instance, trends indicate a general annual forest loss of 122,000 ha between 1990 and 2015 and 250,000 ha per year between 2010 and 2015 (MWE, 2015). These figures imply that by around 2040, Uganda will have lost all its forest cover (NEMA, 2017) if no conservation and restoration actions are taken. Available data for wetlands show a consistent decline of 33.8% between 1990 and 2015 with a projected annual loss of about 846 km^2 (NEMA, 2017). This decline has been attributed to the desire to derive livelihoods from wetlands through extractive practices. Studies on land productivity in Uganda and the East African region show that productivity per unit area is generally low and declining compared to other parts of the world (e.g., Amone et al., 2017; Karugia et al., 2013; Kyomugisha, 2008; Tittonell & Giller, 2013). These trends point to an urgent call for action to ensure the sustainability of rural livelihoods and contribute to the realisation of the Sustainable Development Goals, in particular SDG 1 (No Poverty), SDG 2 (No Hunger) and SDG 15 (Life on Land).

To address this critical and complex challenge requires a genuine engagement with the socio-cultural and environmental factors at play. In other words, engagement with the local people dependent on these resources, the governing bodies that aim to support them and the lands, water systems and plant life that is struggling to live, adapt and continue to regenerate. A wealth of research exists in relation to each of these forces of influence (e.g., Ahimbisibwe et al., 2019; Kakuba & Kanyamurwa, 2021; Twinomucunguzi et al., 2021) but no existing research in Uganda has put these forces of influence into dynamic relation.

This study investigates the relationship between the physical status of the environment and the human experience and awareness of it. We ask questions of both the physical environment and the people who interrelate with it daily. In particular, we ask about the state of the selected environmental resources compared to 10 years before. We inquire about the level of awareness of this trajectory of change, and its consequences. We compare community perceptions and reports with physical evidence. And finally, we investigate what actions from local communities and

their leadership take place in support of sustainability. To address these multi-faceted questions, the study takes up a multidisciplinary methodology; acknowledging the importance of social and political knowledge in relation to ecological data. While ecological research leans on a positivist paradigm of objective data collection and analysis that is often untethered from researcher perspective, socio-political or cultural contexts; the socio-cultural aspects of this research requires a clear articulation of researcher positionality, perspective and approach to the ethics of research participation. To this end, we begin the report of this research with a description of our theoretical and methodological framework. We then describe the range of methods used before focusing in the second half of the paper on the results and discussion.

2 | FRAMING THE RESEARCH THROUGH THEORY AND PLACE

The concept of a cohesive methodology confounded a team of collaborators from different disciplines, cultures and sectors. Instead, we reached for a common set of principles and a shared approach. This project is based on a shared acceptance of the limitations of our own disciplinary knowledge and related research methods. The world is not disciplinary and yet we were each trained to be disciplinary experts. In conjunction, the global knowledge economy tends to be driven by disciplinary hierarchies of production. Our individual mastery of areas of social or ecological science is insufficient to fully understand or genuinely contribute to the urgent major challenges to sustainability today, indeed, this devotion to mastery and siloed knowledge production has been increasingly blamed for the global multi-layered crisis of today (climate, health, inequality) (Perry, 2020; Singh, 2018). At the same time, 'partial knowledges' put together, or a weaving of plural disciplinary expertise, requires a different type of mastery and forces sharp edges and complete pictures to bend, fray, or blur to accommodate another knowledge. In other words, in the work that follows you will not find 'perfect science', there is no space for a 'complete' portrayal of any individual theory or concept, practice or process. You will find an interplay of sciences and with it a plurality of perspectives.

Three theoretical tools drawing from distinct culturally and disciplinary traditions are introduced and taken forward throughout the remainder of this article. A poverty trap model from a socio-economic perspective has been taken up alongside political ecology and finally, these are considered in relation to Ubuntu, a Southern African epistemological stance. The 'poverty trap.' is a self-perpetuating condition whereby an economy, caught in a vicious circle suffers from persistent underdevelopment (Matsuyama, 2008). Poverty traps have been used to explain many phenomena such as the increasing loss of biodiversity in developing countries (e.g., Barrett et al., 2011; Naughton-Treves et al., 2011), degradation of common property resources (e.g., Delacote, 2009) and soil degradation among smallholder farmers in Africa (e.g., Tittonell & Giller, 2013). However, poverty is a human condition and thus not a sufficient framework on its own to understand the interplay of humans with non-human eco-systems. Thus, these conceptual tools enable we take up the construct of the poverty trap and consider in relation to Ubuntu. Ubuntu describes an African perspective that centres the essential interconnectivity of all beings, suggesting collective agency (Mbiti, 1990). It has been taken up increasingly to support environmental research and activism, often with the expanded concept of eco-Ubuntu (e.g., Etieyibo, 2017; Terblanché-Greeff, 2019). Put together, these conceptual tools enable us to consider the interrelation between economic, cultural and environmental issues and similarly supports the multi-faceted possibilities for change.

In extension of the awareness of interconnectivity between humans and the environment and the local and global, political ecology enables us to position this work in relation to a wider frame of governance and geopolitics. It supports an analysis of the 'political forces at work in environmental access, management and transformation' (Robbins, 2011). This lens prompts us to consider the ways in which political practices are transferred, transformed and applied across different contexts. In the case of this study, we look particularly at the relationship between traditional, local, district level and national governance practices. Political ecology can be used to better understand the influence of governance on practice. However, the community-based nature of this research highlighted the complex

and highly elusive relationship between communities and their governance (Svarstad & Benjaminsen, 2020). The framework of political ecology served to highlight the forces of geopolitics in environmental engagement, but was not sufficient to explain the day-to-day relationships and decision making of community members with their surroundings. Thus, we engage in a weaving of perspectives to approach an understanding of the complexity but also the possibilities surrounding the challenges of environmental resource management and sustainability in rural Uganda.

To contextualise this common conceptual ground, the paper now frames the research through describing the physical location and the community that lives there.

The study was carried out in two sub-counties (Apala and Abia) of Alebtong district in Northern Uganda (Figure 1). Alebtong lies between: 02 18 N, 33 18E geographical coordinates. According to the National Population and Housing Census of 2014, Alebtong has a population of 227,541. In Apala sub-county, there are 19,621 people; while in Abia sub-county, there are 23,436 (UBOS, 2016). The district lies in the greater Lango rangeland sub-region, characterised by open savanna in some areas, thick closed canopy forests and woodland vegetation in other areas and receives one long rainfall season throughout the year. It is situated within the annual cropping and cattle-farming systems that are primarily found in Northern Uganda. Agriculture is the major economic activity in Alebtong district. The majority of farmers are small holders who grow mainly annual crops and rear livestock as a means of livelihood. The annual crops grown include maize, sweet potatoes, beans, cassava and groundnuts (UIA, 2020).

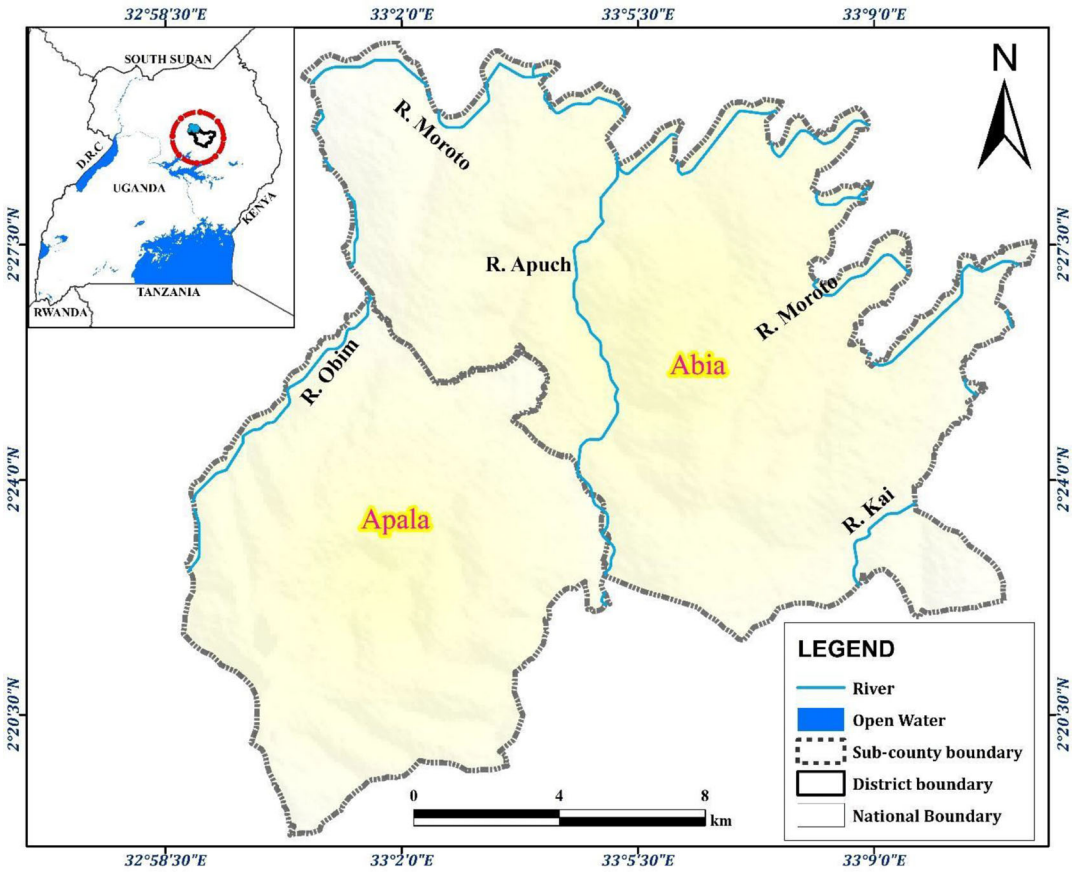

FIGURE 1 Map showing the location of Abia and Apala in Albetong District and the location of these study sites within Uganda.

The people of Alebtong district are Lango, an ethnic group with a distinct culture. They speak Luo which is part of the larger Nilo-Saharan languages related to other Luo languages in Uganda and Kenya. Traditionally, the Lango maintained taboos and traditions that supported conservation of environmental resources. For instance, they did not settle in and around swamps and rocky areas because they feared evil spirits which were believed to live in swamps. The Lango are a known cheerful, good-natured, polite, hospitable and social society (Driberg, 1923). The People of Alebtong, just like the rest of the community in Northern Uganda, were under social strife for nearly 20 years between 1985 and 2005 during the Kony rebel insurgence. During this time, households lost property and were displaced into concentration camps. However, they have since returned home and life is very gradually normalising.

It is within this community that we situate this study. We engaged approximately 500 community members and their leadership using a diversity of approaches detailed in the next section.

2.1 | Methods

The study focused on three environmental resources: trees, wetlands and land in relation to their surrounding communities of people. Land productivity was used loosely to refer to soil fertility as perceived by the local communities in Alebtong. Productivity was judged qualitatively as high, low or declining based on the community's experience. A range of methods, spanning and extending disciplinary traditions, were used to generate information on the status of local natural resources, the responsibility for them and any actions taken in the event that they were perceived as degraded. Roaming group discussions (RGDs), home visits and key informant interviews (KIIs) provided the main sources of qualitative data. Community fora and photo elicitation were used to contextualise and enrich information obtained through RGDs and KII. A normalised difference vegetation index (NDVI) was used to provide an independent assessment of the trends in the state of environmental resources, and finally an accuracy assessment process using digital mapping supported the NVDI. The methods employed in this study are summarised below with the broader methodological approach fully described in Bananuka et al. (2023). Two research assistants with mastery of the local language were recruited for each sub-county to assist in translation.

2.1.1 | Roaming group discussions

Two RGDs of 2 km each for each sub-county were undertaken. Each group comprised of, a community leader, four members from the community chosen by the community leader on the basis of knowledge of the local area resources, a language interpreter and two researchers. Other community members through curiosity and at free will joined in, during the walk and offered to participate in the discussion. RGDs emerged as an adaptation to suit local area conditions which involve community activities being largely outdoor. Whenever the group grew to greater than 15 participants, it was divided into subgroups of seven members with one researcher. There were three subgroups in Apala and two subgroups in Abia. A total of 40 participants participated in the RGDs. During the walks, short stopovers were made whenever we encountered wetlands, large trees and crop gardens. At the stopovers, residents were interviewed on the changes in resources by then, compared to 10 years ago; who was responsible for resource management, if they were aware of the implications of the trends they observed and what they were doing about it. Discussions were recorded using voice recorders and later transcribed. Additionally, photographs and short video clips showing the nature of wetlands, trees, gardens and charcoal kilns were captured and later used in the forum and photo solicitation sessions described below. In Abia sub-county, the roaming groups crossed Otongojiri and Akukuro villages, whereas in Apala sub-county, we walked through Acan Pii village and Atinkok villages. In the analysis, the main ideas from the discussions were identified, while noting significant outlier responses.

2.1.2 | Home visits

Home visits were proposed by community leaders as a way to capture detailed information about decision making regarding resource use at family level. In consultation with community leaders, we invited 10 families to participate that included a range of female-headed households, male-headed households and child-headed households. Family size varied between 5 and 10 members. During the visits, discussions with members of the family were held as a group but the family head took the lead. The other members of the family provided supplementary or additional information on resource status, who was responsible for the then state of the resource and implications of the then state on their livelihoods.

2.1.3 | Forum and photo elicitation

About 100 participants drawn from two sub-counties of Apala and Abia where the RGDs had been conducted, were invited to participate in a community forum and photo elicitation activity that was held at a local church building in Alebtong town Council. Despite inviting only 100 participants, we recorded an attendance of 400 participants. This level of engagement is in part explained by the cultural practice of communities in northern Uganda, where people are always eager to come together and share perspectives when an opportunity arises. The purpose of the forum and photo elicitation was threefold: (i) to explore the observations made during the RGDs with a wider audience; (ii) to enhance community ownership of the observations made in the field and (iii) to offer immediate feedback from the research team to the community.

After a presentation of the emerging themes observed by the research team, the forum was divided into eight smaller groups of 50 participants (including a nominated group leader) to discuss and respond to each proposed theme. Groups were then asked to respond, through discussion, to four aspects of the human-environmental relationship: (1) Perception (their perceived state of the resources now); (2) History (their perception compared to 10 years ago); (3) Accountability (who was responsible for the management of the resource?) and (4) Action (and what actions are being taking if any?). The discussions and further elicitation of information relating to the photographs and short videos revolved around two points: First, whether or not the group members could recognise the photo/video, and where it was taken from. Second, we explored what messages were carried by the images, and what learning might be prompted.

2.1.4 | Key informant interviews

Uganda is divided into geographical areas (called districts) designated as decentralised and therefore semi-autonomous. Within this institutional arrangement, administrative areas at successive levels democratically elect their leaders, and can enact ordinances and bye laws that should be locally effective (The Local Government Act, Chapter 243). The local leaders, as a result, are responsible for the ordinances and bye-laws that should reflect local priorities, aspirations and needs. This political arrangement, in theory, should empower local communities and their leadership and result in firm commitment to sustainability as a result of their direct involvement in decision making. Due to this role that local governance plays in the sustainability of local resources, the perspectives of the local political and technical leadership from the Alebtong District was sought. A total of seven district political and technical leaders responsible for agriculture, rural development and environmental management participated in this study as key Informants. These include: two Chairpersons of local Administrative councils, the Secretary for gender and information, the Chief Administrative Officer, the Chairperson of Local Council V and the District Environment Officer. In these semi-structured interviews, we sought to establish the perceptions of the leaders about the state of the selected resources and the level of responsibility assumed by them for these conditions.

2.2 | Analysis and meaning making

The process of analysis of the above range of data involved three main stages. First, some data were analysed in participatory practices with the partner communities. This process was mediated by the research team, but the engagement equally influenced the researchers' perception of the data. Second, the qualitative data were analysed through collaborative discussion among the research team, critical engagement with the emerging theoretical perspectives and finally, a process of data organisation and thematic coding. Below, we detail the physical and quantitative data generation and analysis.

2.2.1 | Time series analysis of spatial data

To corroborate information obtained from the community-led approaches about tree resources, wetlands and land productivity, the normalised difference vegetation index (NDVI) was used as a proxy indicator of vegetation cover and productivity changes in space and time. We carried out trend analysis following De Bie et al. (2008) methodology for temporal analysis of image time series using NDVI time series data from the moderate resolution imaging spectroradiometer (MODIS) (De Bie et al., 2008). MODIS NDVI data (MOD13Q1, Version 05, 16-day, 250 m resolution) were downloaded from Earth Explorer website (https://earthexplorer.usgs.gov/).The dataset has one image for every 16-day period in a year, summing to 23 images per year. The analysis was done for 16 years (January 2001–December 2016). Accordingly, a total of 368 images were downloaded. The downloaded images were staked/combined to create a single image with 368 bands. We carried out unsupervised classification on the stacked image using the iterative self-organising data analysis (ISODATA) clustering algorithm of Erdas Imagine (De Bie et al., 2008). The classification enabled us to create classes of similar NDVI values over the analysis period (De Bie et al., 2008; De Bie et al., 2012; Khan et al., 2010; Nguyen et al., 2012). The mean NDVI values of created land cover classes were exported to R software. The exported data included NDVI values for each class over the 16 years of analysis. This is the time series data on which trend analysis was carried out (e.g., Grogan et al., 2016; Verbesselt et al., 2010). The time series data for each class were plotted against time to determine how vegetation productivity had changed for each land use category. Positive and negative NDVI trend implies increasing and decreasing productivity respectively.

2.2.2 | Ground-truthing points and accuracy assessment

In order to calculate the accuracy assessment for the NDVI-derived land cover map, we used Google Earth imagery as the reference maps. A total of 120 points was collected from Google Earth imagery of 2016 with 30 points in each land cover class. The map accuracy was calculated as percentage of points where classified land cover category matched with land cover category from Google Earth Imagery using an error matrix. From the error matrix, overall accuracy and the Kappa coefficient were calculated following techniques by Eastman (2003) and Olofsson et al. (2014).

3 | RESULTS

The results below provide summaries and examples of the data generated through the methods detailed above. Taken in isolation, the results below could underpin many arguments, however, here they are intended as a critical contribution to the discussion of findings and claims that follow from them. To this end, this section portrays a layer of information as well as the diversity of data taken up

3.1 | Tree resources in Alebtong

Specific tree species identified in this study include Shea nut tree (*Vitellaria paradoxa*), *Albizia coriaria*, *Ximenia Americana*, *Mangifera indica*, *Afzelia Africana*, *Acacia hockii*, *Annona senegalensis*, *Combretum collinum and Milicia excelsa*.

From all qualitative data generation and analysis methods (RGDs, home visits, forum and photo elicitation and key informant interviews), it emerged that the most important tree species in the community, the Shea nut tree (*Vitellaria paradoxa*), had declined both in abundance and size of tree. The decline was attributed to increasing incidences of charcoal burning by the community.

Data revealed that the number of different tree species had declined in the landscape. From the community's perspective:

I. they were no longer common
II. large and mature trees were not common
III. they walk longer distances to encounter them in the landscape than it was 10 years ago.

With specific reference to the Shea nut tree, community members stated the foregone opportunities as a result of the declining abundance, including:

i. available edible oil used for cooking at home
ii. cash incomes (cost for a bottle of 300 mLs at time of the study was Ugandan Shillings 3000, equivalent to USD 3 per litre)
iii. nutrition in households which used to make homemade oil which they believed was more nutritious than imported oil
iv. medicinal benefits attributed to the Shea nut tree and seed oil
v. ability of the atmosphere to 'process rain' leading to reduction in crop yields from rain fed agriculture. Within the cultural context of the study area, this is interpreted to mean that trees contribute to rain making

Community participants identified those responsible for the current status of the Shea nut tree in their landscape as members of the their own communities. Participants shared that they and their neighbours were driven by the need to survive, thereby extracting the tree for charcoal was preferred for fast return. On the contrary, other benefits obtained from the Shea nut tree relating to climate regulation, cooking and medicinal oils, took much longer to appear. Additionally, it was observed that charcoal made from this tree was of high quality and therefore on high demand by traders from urban areas. The use of the tree for charcoal was a trade-off from its use for shea butter, but an unsustainable one, because charcoal making kills the tree.

In relation to governance, the area leaders reported that a bylaw existed in the area that prohibited making charcoal from locally important tree species such as Shea nut tree. However, this was difficult to enforce as the practice was widespread and people resisted it. In his response to why people do not comply with the bylaw that restricted cutting down trees for charcoal, the Chief Administrative officer (CAO) said

> …Actually that resistance is due to lack of alternatives for basic survival…..

Participants listed other useful tree species in addition to *Vitellaria paradoxa* or the Shea nut tree in their surroundings that have become scarce. This information is corroborated by the NDVI analysis, which shows that the productivity of woodland areas worsened after 2005, when the trend reversed from positive to negative (Table 2).

Table 1 shows details of the tree species that were perceived to have declined in the last ten years.

Community participants are aware of possible actions to halt further loss of trees and increase tree cover in their landscape. The following measures were stated across our community engagements: (i) enforce and abide by the

bye-laws restricting destructive use of trees such as charcoal burning; (ii) nurture and manage tree seedlings found growing in their gardens; (iii) deliberately plant and manage trees in their gardens. Despite this knowledge, the data show that most are engaged in nurturing and managing trees found growing in their gardens, but referred to a lack of accessible land to deliberately plant trees.

3.2 | Wetlands in Alebtong

Community members in both Apala and Abia described the state of wetlands in their areas as either *degraded* (when referring to areas near roads and access points), and *highly degraded* (when referring to areas far away from roads). The reason for this contrast is in part due to the fact that inaccessible sections of wetlands away from roads were not monitored by law enforcers. The most dominant uses of wetlands of Alebtong are crop cultivation and livestock grazing. Other activities observed include, water harvesting, sand mining, fishing and wood collection. The perceived wetland degradation by the community was confirmed by NDVI analysis which showed a negative trend in wetland productivity (Table 2).

The status of wetlands as described by community members was validated by the Chairperson Local Council five (LCV) who said

> …in Alebtong district, we cannot talk about our local community minus talking about the environment. On realizing that people have destroyed some of the protected environments like wetlands and some of the trees and the rest, as a District Chairperson, I am happy that with the help of the chief administrative officer, we started by sensitizing the community early last year because we realized that even when you move deep in the village all the wetlands have been destroyed…

Community participants express awareness about the consequences of wetland degradation. The main risks shared include: (i) reduction of water for domestic use by the community; (ii) loss of grazing land for livestock; (iii) reduced rainfall in their areas; (iv) loss of materials for making crafts and building houses; (v) loss of fish obtained from wetlands and (vi) loss of suitable land to cultivate rice.

This awareness of the importance of wetlands was supported by the Local council III Chairperson when he said

> … we know that in the wetland there are some plants and animals that are supposed to live there. But with the digging in the wetland, all the ecosystem that support the plants and animals that live in the wetlands are destroyed….

Despite the awareness of the status and consequences of wetland degradation in the area described by the community, they were still cultivating in them. A 37-year-old father of two children of Otongogiri village in Abia parish who owned a garden in the wetland explained why he continued to cultivate in the wetland despite the consequences:

> …. crops on upland these days are of poor yields. It is only in wetlands that we expect a reasonable harvest for the family to survive until the next season. We have nothing else to survive on….

Wetland use (for utilising residual moisture) as a means of survival was also echoed by the local leadership when the Chairperson LCV replied about why people continue to degrade wetlands:

> …People were thinking that since it was not raining, their only way to survive was to cultivate in the wetland or areas surrounding the wetland. And we have almost remained with nothing in terms of wetlands across the district….

TABLE 1 The nine other tree species apart from shea nut tree in the Alebtong landscape described by the community as either declining or scarce in their landscape.

Tree species		Uses	Perceived status in the Alebtong landscape	Reason for perceived status
Species name	Local name			
Albizia coriaria	Itek	Timber, charcoal, rain making, medicinal	Scarce, hard to find	Commercial timber harvesting
Ximenia Americana	Olemo	Firewood, Timber, Medicine, rain making, fruits	Scarce, hard to find	Commercial timber harvesting, charcoal burning, firing brick kilns
Albizia grandibracteata	Owak	Timber, fire wood, rain making	Declining	Commercial timber harvesting, charcoal burning, firing brick kilns
Mangifera indica	Aeme	Fruit/food, firing brick kilns	Declining	Charcoal burning, firing brick kilns
Afzelia Africana	Beyo	Timber, building, medicine, rain making	Scarce, hard to find	Commercial timber harvesting
Acacia hockii	Okutu	Timber, building, medicine, rain making	Scarce, hard to find	Charcoal, firing brick kilns
Annona senegalensis	Obwolo	Timber sold for cash, charcoal, rain making	Declining	Charcoal, firing brick kilns
Combretum collinum	Odugu	Timber sold for cash, charcoal, rain making	Declining	Charcoal, firing brick kilns
Milicia excelsa	Mvule	Timber sold for cash, charcoal, building, rain making	Scarce, hard to find	Commercial timber harvesting

Note: Apart from *Mangifera indica* which is naturalised, the rest are native tree species.

TABLE 2 Land use/cover complexes of Abia and Apala for the different NDVI clusters and their NDVI trends between 2001 and 2016 (+ and − represent positive and negative trends respectively).

Land use clusters	Colour	Land use complexes	Slope	Period
Class 23, 28, 32		Agriculture	−0.0190, 0.0011	2001–2006, 2006–2016
Class 36		Woodland	0.0031, −0.0020	2001–2006, 2006–2016
Class 31, 35		Wetland	−0.0230, −0.0065, −0.0070	2001–2006, 2006–2012, 2012–2016
Class 29		Sparse vegetation	N/A	2001–2016

According to community participants, there are no measures to halt wetland degradation in their area apart from some attempts to enforce laws that prohibited unsustainable use of wetlands. From all data sources, the community confirmed that they were aware of the law that prohibited certain activities from taking place in the wetlands. This was also detailed by the District Environment Officer when he said:

> …. Yes, here after they are arrested (wetland encroachers) they are charged in courts and given penalties such as imprisonment for six months or community work such as sweeping the market, hospitals….

3.3 | Land productivity in Alebtong

Overall, the community perceived the productivity of their land as low and declining. They described declining harvests per area of land from year to year. The reasons they gave for the declining productivity included: (i) persistent drought over the last 5 years; (ii) soil exhaustion; (iii) unpredictable rains and (iv) new crop pests and diseases that have emerged in their area. As with the other aspects of the natural environment, the community also shared their awareness of the solutions to declining productivity. These include: (i) spraying with insecticides recommended by extension workers (educationalists); (ii) use of fertilisers; (iii) crop diversification including cultivation of non-traditional crops in the area such as ginger and red pepper and (iv) prayer for rains to come on time. Of these solutions, the communities reported relying only on prayer at the time of this study, they said prayer was their solution because it did not cost them.

3.4 | NDVI-based land productivity

We identified four (4) major land cover clusters from NDVI classification; agriculture (52%), wetland (2%), woodland (23%) and sparse vegetation (24%) (Table 2 and Figure 2). The map had an overall accuracy of 81% with a kappa coefficient of 0.84, which implies that the classification result had a good agreement with the ground truth data (Jensen, 1996). There was a general decline in vegetation productivity for all the land cover clusters. The highest decline was observed in wetland areas with a slope of −0.0230, while agriculture had a slope of −0.0190 (Figure 3). There was a slight improvement in productivity for agricultural and wetland areas after 2006; the trend for agriculture became positive (0.0011), while the slope of decline for wetland areas became less steep at −0.007 (Table 2 and Figure 3). On the other hand, the trend of productivity for woodland areas worsened after 2006 with a reversal in trend from positive to negative (Table 2). The declining productivity is consistent with community observations about wetland degradation and scarcity of various tree species, since this would result in reduced biomass in the affected areas. The worsening productivity of woodland areas is most likely due to the increased market for fuel wood as explained by the local communities.

4 | DISCUSSION

'I am because you are' is the common English translation of Ubuntu. This reflects an understanding of complete interdependence. Throughout the qualitative data generated with community members this notion is lived out through their interdependence with trees, land and wetland. They shared how their livelihoods, food security, faith practices and health are all inextricably intertwined with their natural environments. This idea has borne out over millenia of human-environment eco-systems. It is only through the health of the land, wetland and trees that the community of people is healthy, and it is only through the health of the community that the lands, wetland and trees can be healthy.

In response to the ecological question that guided this research, the lands supporting the communities of Abia and Alebtong are quickly declining in health, stability and sustainability. Community health is similarly suffering. Ubuntu, as a culturally appropriate conceptual tool, explains the relationship and alignment between community and environmental well-being, but not the external forces that are effecting that, nor the potential solutions to more sustainable outcomes.

In response to the sociological questions that guided this research, the results show that the local community and governance of northern Uganda were aware of the: (i) importance of environmental resources; (ii) negative impacts of their activities on their resources and, (iii) implications of resource degradation on their livelihoods. Despite this awareness, activities that further degrade these resources persisted. The primary explanation for

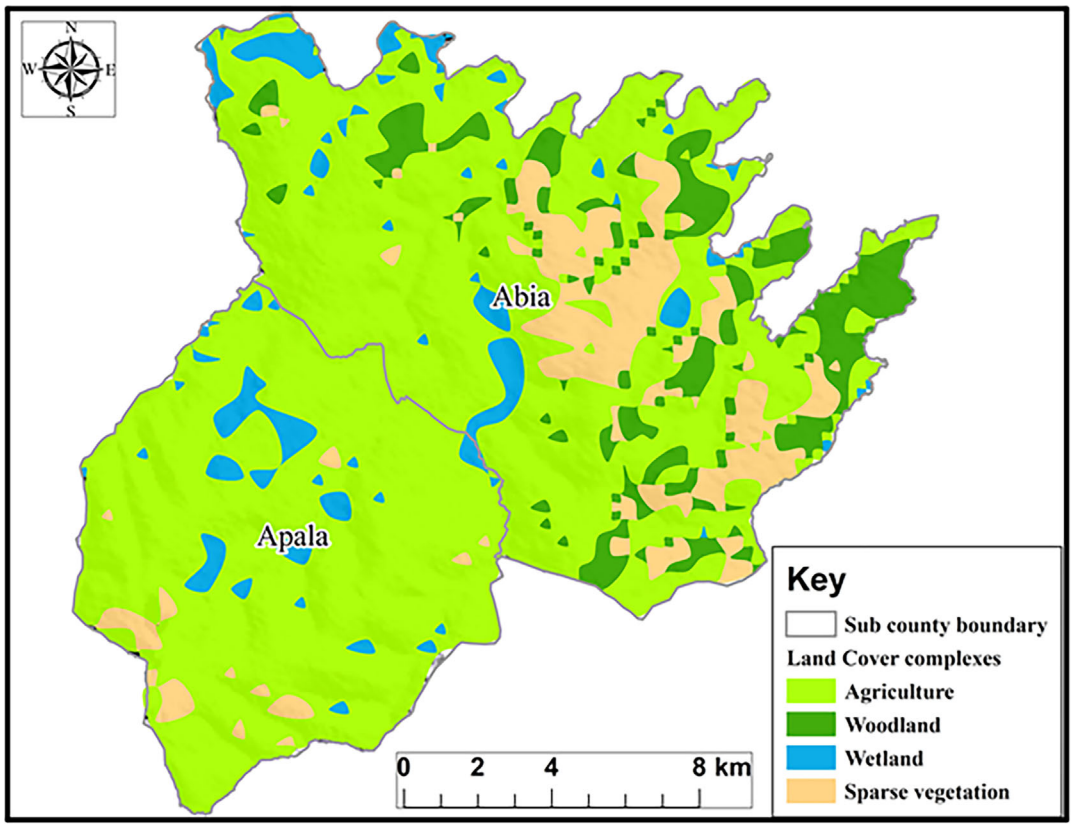

FIGURE 2 NDVI classes for different clusters in Apala and Abia sub-counties of Alebtong district.

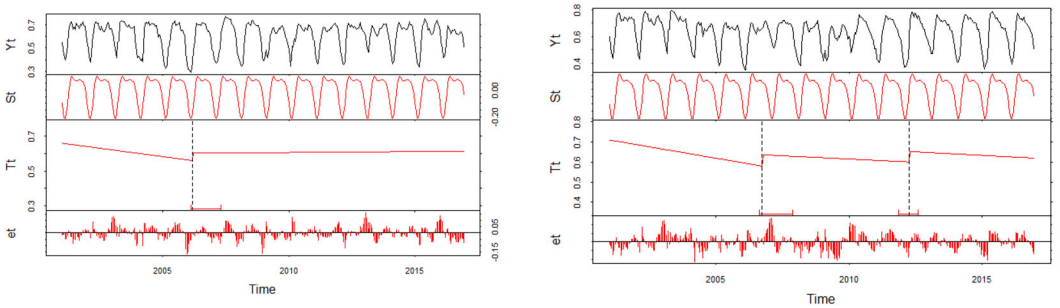

FIGURE 3 NDVI trend for agriculture (left) and wetland areas (right) between 2001 and 2016. Yt, St, Tt and et represent NDVI time series, the seasonal component, the trend component and the residual component respectively.

environmentally unsustainable activities at a community level is always related to immediate survival needs. In other words, land, wetland and trees are used extractively and not sustainably because the quick extraction of resource fulfils a need of food, or money in order to pay for food and basic needs. Community participants demonstrate the difficult trade-off in decision-making about natural resources that they face as they seek to balance the conflicting demands of sustainably managing environmental resources with their immediate needs. This is similar to Pullanikkatil

et al. (2020), who found that in Malawi, unsustainable trade-offs of land use change and provisioning ecosystem services were driven by the need for food production by subsistence communities. Similarly, depletion of natural resources used in basket weaving in Botswana has been reported in literature, the cause being over-utilisation of the Hyphaene palms used in basket and traditional wine making (Babitseng & Teketay, 2013; Cunningham & Milton, 1987). The participants noted that though communities realised the resource degradation over time, any proposals to prohibit harvesting would be rejected outright by the same communities unless an alternative and viable option was found for livelihood generation. This apparent incongruity, where the community knows the detrimental impact of their activities but continue the activities, is consistent with the poverty trap concept (Matsuyama, 2008), a self-perpetuating condition whereby poverty equates to a lack of capital for longer term development, which prevents a person or group from breaking out of further poverty and the basic survival decisions that it necessitates.

Poverty traps have been invoked to explain the increasing loss of biodiversity in poor nations (Barrett et al., 2011; Naughton-Treves et al., 2011), land degradation among smallholder farmers in some parts of Africa (Tittonell & Giller, 2013). This is similar to Botswana, where poverty was one of the major drivers of environmental degradation (Mulale et al., 2014). In Botswana, it was found that land users were aware of the causes of environmental degradation emanating from human activities and made calls for adaptive management of natural resources in their area (Thakadu & Dikobe, 1998).

But poverty is a relative concept, and in relation to the global market economy, local and district governance play an important role in mediating the divide between local and global economies and value systems. Political ecology provides an important lens to the complex dynamics between communities, local and district officials and national and international government and aid programmes. Interviews carried out with political leaders (Local Council Chairpersons), Natural Resource and Production Officers and Sub-County Chiefs were related to community generated data to reveal the distrust and mis-information between stakeholders as investments are made and wasted, and policies exist but are not implemented (see also, Howes et al., 2017).

The trade-offs then, in sustainability practices do not only exist at the community level, although the predicaments made at community level are fundamental, that is survival or starvation. At local, district and national governance levels, politics, trade-offs and often conflicting agendas exacerbate the already critical challenges of environmental protection in rural communities. The Alebtong case study provides sobering evidence of this. The leaders agreed that policies, laws and by-laws were in place but were seldom implemented due to budgetary constraints. The failure to enforce the law by local authorities was attributed to budgetary constraints and resistance from residents. It could also have been deliberate because the effective enforcement of such laws on poor rural households could worsen the situation sending many people into illicit activities (e.g., Aleksic et al., 2011; Saunders, 2014). Furthermore, there seemed to be no coordination between district leadership and local level leaders. For example, while the law requires that Local Environmental Management Committees are established to coordinate natural resource management at local level, these were defunct due to lack of financial resources. In fact, leaders were in agreement that at sub-county level, no human resource was responsible for natural resource management. They depended on district officials who rarely interact with local level leaders due to financial challenges. In addition to a lack of financial resource, weak political will to conserve the environment was a major concern by some of the leaders interviewed. These leaders were concerned that some political leaders compromise conservation activities by protecting encroachers who form part of their vote bank. Efforts to punish law breakers often meet resistance from those in political offices. Howes et al. (2017), in a global review of the causes of policy implementation failures, found similar results being evident through failure to arrest environment degradation. The authors synthesised causes of policy failures into three, being 'structural causes, implementation traps or knowledge/scope issues'. The structural causes corroborate findings from the Alebtong case study in that they include among others the socio-economic, political and legal factors, with these factors are often interacting and dominant.

In addition to local level politics as it relates to sustainability practices, the ecology of politics leads to relationship of the local conditions with national funding for agricultural development and the needs of community lands and farmers. Operation wealth creation (OWC), for example, is a government programme that invests large amounts

of money in the supply of seeds and seedlings to rural communities. However, in many cases, the seeds provided are not indigenous to the land, more susceptible to local pests and disease, and therefore result in failed harvests. In other cases, crops have been delivered in the wrong season and therefore wasted while farmers had to wait for rain to plant. This narrative of mis-allocated resources resonated across our study and explains a waste of precious resources; but also a persisting mis-trust of governance by not only local community members, but also often by the government appointed local officials as well.

Given that the country's economy is highly dependent on environmental resources, these trends in disconnected governance can lead to a spiralling unsustainable trajectory. For instance, wetland degradation not only distorts wetland biodiversity but also decreases their economic value. Turyahabwe et al. (2013) estimated a loss of US$432 per year per person for communities that had originally been dependent on wetlands. Other consequences of wetland degradation include food insecurity, reduced carbon sequestration potential and deteriorating nutrient cycling and water holding capacity (Lolu et al., 2020; Mitsch et al., 2010; Pritchard et al., 2020). Accordingly, the reduction of wetland quality will also negatively impact the local weather patterns, and the lost hydrological wetland services will be reflected in compromised hydrological services (Turyahabwe et al., 2013).

The broad range of stakeholders engaged in this study brought an equally broad range of responses to this situation and to the potential for sustainable solutions. Some were hopeful that their efforts together with input from the central government and non-governmental organisations would continue to engage people at the grass root for positive outcomes. Others were primarily uncertain of their future; of the future of their subjects; and that of future generations, if the status quo does not change. Narratives from this study demonstrate that it is not the absence of the law that has led to the socio-ecological predicament in Alebtong, but rather the combination of issues including but not limited to the absence of commitment from local governance for sustainable solutions, a disconnect between local leadership and the aspirations of people, the urgent need for immediate survival and the wider political economy that, for instance, creates demand for charcoal made from a valuable and legally protected tree species. The overriding finding from an engagement and analysis across physical, and social data is the need to improve natural resources through an integrated approach that places local people and their leaders at the centre stage of environmental management.

Through engagement, a shared understanding of practical approaches to sustainability can be achieved among communities and their leadership. This is feasible with the support of the national government that has already established decentralised institutional arrangements for environmental management in Uganda. Creating a shared understanding of interdependence is a hard task among very different stakeholders and their various attachments to lands. This challenge grows ever harder as the struggles for individual survival can overshadow the longer-term or wider spread benefits of cooperation. However, with ground-level reciprocity, mutual trust between stakeholders and multi-disciplinary expertise that spans community and environmental knowledge, genuine community engagement and consequent collaboration across local, district and national levels is possible.

In Southern Africa, co-management of natural resources has been achieved through community-based natural resources management (CBNRM) projects (Jones, 2004). The CBNRM programmes were initiated on the proposition that people living with the resources are best placed to conserve them. CBNRM was initiated as a bottom-up approach that will facilitate development and conservation at local level (Abrams et al., 2009). CBNRM, as a grassroot initiative, offers potential for incorporation of the people's knowledge, being Indigenous Knowledge Systems or traditional knowledge in natural resources management.

The Alebtong case of supplying seeds for rural farming communities also points to a need for participatory communication approaches when dealing with communities (Thakadu & Tau, 2012), as well as tapping from their indigenous knowledge. The rural communities have lived and interacted with their respective environments over time and experimented and adapted accordingly to their dynamic environment, and thereby have gained knowledge on the most effective ways of improving productivity in the land. The advantage of indigenous knowledge is not only lived experience, but also its inherent transdisciplinarity: knowledge that integrates expertise in agriculture, disease control, natural resources management, land use, medicine and cultural and spiritual practice.

Extensive data, within and beyond this study confirm and characterise the physical degradation taking place in Alebtong and similar contexts across sub-Saharan Africa. Exhaustive studies portray the challenges of community development, livelihoods and health in the same areas. What this case study foregrounds is the intersections of these issues. In doing so, it shines a light on the crisis that is local and scientific knowledge falling through the gaps entrenched between a land-dependent community and their systems of political governance. The solution lies perhaps not in new science, laws, system of governance or more funds; but rather, in methods of co-management, communication and collaboration across ways of knowing and governance systems with common interests in a sustainable future.

AUTHORS CONTRIBUTIONS

Vincent B. Muwanika, **Mia Perry** and Alex Okot conceptualised and designed the study, **Vincent B. Muwanika**, Alex Okot and Gordon Yofesi **Mwesigwa** collected data, Mia Perry, Ellen J Kayendeke, Deepa **Pullanikkatil** and **Olekae Tsompi Thakadu** analysed and interpreted data, **Vincent B. Muwanika**, Mia Perry, **Olekae Tsompi Thakadu** and Deepa **Pullanikkatil** drafted the manuscript, **Olekae Tsompi Thakadu**, Deepa **Pullanikkatil** and **David Mfitumukiza** critically revised the manuscript. All authors read and approved the final manuscript.

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CONFLICT OF INTEREST STATEMENT

All authors certify that they have no affiliations with or involvement in any organisation or entity with any financial interest or non-financial interest in the subject matter or materials discussed in this manuscript.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

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