Exploring links between socio-ecological systems and psychological distress: a case study in rural Uganda

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Abstract Poor mental health is a leading contributor to the global burden of disease but there is poor understanding of how it is influenced by people's interactions with ecological systems. In a theory-generating case study we asked how interactions with ecosystems were perceived to influence stressors associated with psychological distress in a rural setting in Uganda. We conducted and thematically analysed 45 semi-structured interviews with residents of Nyabyeya Parish. Poverty and food insecurity were the primary reported causes of 'thinking too much' and related idioms suggesting psychological distress. Households bordering a conservation area reported that crop losses from wildlife contributed to food insecurity. However, forest resources represented important safety nets for those facing poverty and food insecurity. Commercial agricultural expansion also emerged as a salient theme in the lives of residents, reportedly exacerbating poverty and food insecurity amongst poorer households but contributing incomes to wealthier ones. Our exploratory study suggests how two globally prevalent land uses, nature conservation and commercial agriculture, may influence social determinants of psychological distress in the study area. We highlight co-benefits and trade-offs between global sustainability goals that could be managed to improve mental health.

Keywords Biodiversity conservation, commercial agriculture, mental illness, nature conservation, planetary health, psychological distress, socio-ecological systems, Uganda

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Introduction

Nature ('the nonhuman world, including coproduced features, with particular emphasis on living organisms'; IPBES, 2019, p. 14) underpins diverse aspects of human health and well-being (Whitmee et al., 2015). Mental health is a core aspect of health, described as a state of well-being through which individuals can cope with daily stressors, realize their abilities and function productively (WHO, 2004). A large body of research has explored relationships between natural ecosystems and mental health. However, much of this research focuses on a comparatively limited range of linkages (e.g. the psychological benefits of green space exposure), largely from studies in the Global North. This evidence may not reflect the potentially diverse psychological consequences of interacting with natural ecosystems in the rural Global South, particularly amongst those whose livelihoods are closely coupled to natural systems. Here we aim to identify underexplored ways in which interacting with ecosystems could influence psychological distress, through an exploratory case study in Uganda, located in the Global South. The following summarizes existing literature linking nature and mental health, identifies key evidence gaps and presents our conceptual framework.

One increasingly well-studied linkage relates to the psychological benefits of exposure to green and blue space (Collins et al., 2020). This linkage suggests that people's direct sensory exposure to nature can promote positive psychological states and mental health (Bratman et al., 2015). For example, a study amongst 16,307 respondents in 18 countries found that the frequency of visits to green and blue spaces was positively associated with self-reported mental well-being and negatively associated with psychological distress (White et al., 2021). Other research has examined how green and blue spaces facilitate exercise (Barton et al., 2016), support cultural ecosystem services (Nawrath et al., 2022) and mitigate environmental stressors such as noise and heat (Dzhambov & Dimitrova, 2015), all of which are potentially linked to mental health (Marselle et al., 2021). However, much of this research examines people's non-use interactions with nature. For example, Marselle et al. (2019) reviewed multiple frameworks connecting nature and mental health. These frameworks and their corresponding

evidence overwhelmingly focused on the non-material contributions of nature to mental health. Yet the direct material contributions of nature, such as food, fuel, materials and other products, play crucial roles in people's lives worldwide (IPBES, 2019), particularly in low-income settings. These material aspects of people's lives could be important predictors of mental health (Lund et al., 2010). For example, forests can support food security, a social determinant of mental health (Ickowitz et al., 2014; Jones, 2017).

Furthermore, many studies exploring the psychological benefits of nature exposure come from the Global North, often from urban contexts (Fisher et al., 2021). For example, a systematic map of 276 studies linking nature exposure and mental health found that 83% were conducted in predominantly high-income Europe, North America, Australia and New Zealand, and only 15% in Asia (Collins et al., 2020). Similar patterns can be observed in other reviews linking nature and mental health (Twohig-Bennett & Jones, 2018; Wendelboe-Nelson et al., 2019). But nearly 4 billion people live in lower-middle- and low-income countries, of which nearly 60% live in rural areas (World Bank, 2021).

The geographically biased understanding of how interacting with ecosystems affects mental health is of concern, as many in the rural Global South depend on nature for their basic needs (Fedele et al., 2021), can be highly exposed to its loss (Powers & Jetz, 2019) and have limited access to mental healthcare services (Vigo et al., 2019). A more representative understanding could be useful in several ways. A Global Action Plan for Biodiversity and Health has been proposed to help mainstream biodiversity–health linkages into cross-sectoral and sector-specific planning (CBD SBSTTA, 2021). A better understanding of these links could help decision-makers account for (and thus take adequate action to avert) the full health costs of the global biodiversity crisis. Furthermore, this understanding could identify opportunities to support both conservation and human health. For example, livelihood-focused conservation interventions could simultaneously protect nature whilst directly and indirectly enhancing people's quality of life in ways that could support their mental health (Wright et al., 2016; Pienkowski et al., 2022). Finally, accounting for the role of ecosystems could help explain variation in mental health between groups, such as the observed but unexplained differences between communities in Uganda (Kinyanda et al., 2011, 2013, 2017).

One commonly used marker of mental health is the presence and severity of psychological distress, a state of emotional disturbance that impairs day-to-day activities and social functioning (Drapeau et al., 2012). Although not itself a disorder, severe psychological distress is 'indicative of impaired mental health and might reflect common mental disorders, like depressive and anxiety disorders' (Viertiö et al., 2021, p. 2). Our exploratory case study was conducted amongst nine rural communities in Nyabyeya Parish, western Uganda. This Parish borders Budongo Forest Reserve, a valuable site for nature conservation, but one that has experienced extensive recent land-use change. Therefore, the relationship between ecosystems and people's experiences of psychological distress could be particularly acute. Within the case study, we ask: (1) How do Nyabyeya's residents describe their experiences of distress? (2) What are the perceived stressors causing this distress? (3) How do interactions with ecosystems influence these stressors?

Conceptual framework

We developed a generic conceptual framework describing how interactions between social systems and ecosystems could influence social determinants of psychological distress. This framework was intentionally broad, providing a general structure but allowing themes to emerge from the data. This framework has been described in detail previously (Pienkowski et al., 2022), and so is only briefly presented here (but see Supplementary Material 1). The first component of the framework describes how excessive exposure to stressors could increase the risk of psychological distress (Fig. 1). We explored experiences of distress using locally appropriate idioms of distress (Nichter, 2010). The second component of the framework describes broad categories of stressors faced by populations experiencing poverty, drawing on the Voices of the Poor initiative (Narayan et al., 2000). This initiative identified five categories of stressors: material lack and want; physical ill-being; bad social relations; insecurity and vulnerability; and powerlessness, frustration and anger. These stressors could represent potential social determinants of mental health (Lund et al., 2018). The final component describes how the interaction of social and ecological systems defines the context of people's lives, including the stressors they face. Ostrom provides a multilevel framework for organizing and structuring the many features found in socio-ecological systems, including agro-ecological systems (Ostrom, 2007). This socio-ecological systems framework is often used to examine a specific phenomenon of interest, termed the action situation.

Study site: Nyabyeya Parish and the surrounding areas

The scope of the case study includes Nyabyeya Parish, the nine communities within it and the surrounding area (Fig. 2; Supplementary Material 2). The area has experienced substantial changes in land cover since 1994, with widespread loss of forest outside forest reserves and a shift from subsistence to contract farming (Babweteera et al., 2018). These socio-ecological changes would be expected to affect the livelihoods of residents, many of whom are
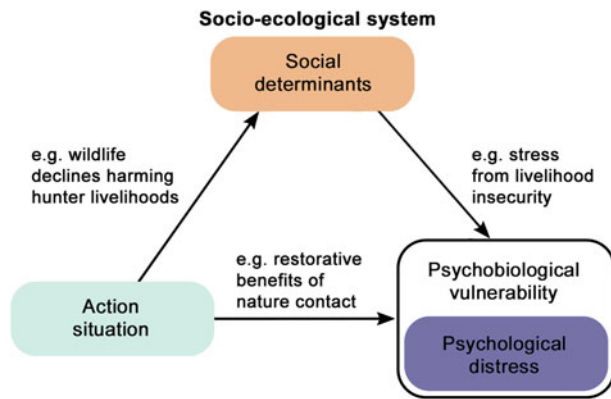
FIG. 1 The direct and indirect ways in which interacting with ecosystems could influence the risk of psychological distress, depending on the psychobiological characteristics of an individual, within a socio-ecological system.

subsistence farmers or make a living through forest resource use. We anticipated that these and other changes could have implications for residents' experience of psychological distress. However, these changes are typical of similar transitions in other parts of Uganda and East Africa (Martiniello, 2021). As such, we expected our findings to be generalizable to similar contexts.

Methods

Study population and sample

The study population includes male and female household heads (the primary decision-makers) over 18 years of age in the nine study communities. We selected household heads for this study because we presumed they would be knowledgeable about household and community conditions. This population included Indigenous Banyoro and immigrants, spanning subsistence and small-scale contract sugarcane farmers, non-farmers and landless commercial agricultural workers.

The a priori target sample included five respondents in each of the nine communities, totalling 45 interviews. We chose this sample size to ensure equal representation across all communities. Data saturation was met within the 45 interviews. We purposively sampled respondents to capture demographic and socio-economic variation by walking through each community (Supplementary Material 3). At the respondent's request, we excluded one interview conducted in Kanyege from the study. We conducted an additional interview in Nyabigoma community as the third interview there was only partially completed (but was informative and so we retained this in the analysis). Accounting for this exclusion in Kanyege and addition in Nyabigoma, we conducted 45 semi-structured interviews, each lasting 118 min on average, in the nine communities during September–November 2019.
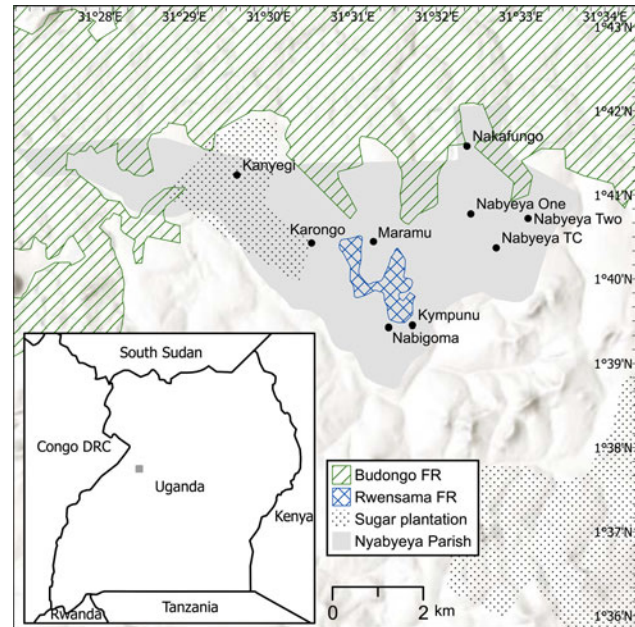

FIG. 2 The study area in Uganda, which includes Nyabyeya Parish and its nine communities, Budongo and Rwensama Forest Reserves, and the large-scale commercial sugarcane estates.

Data collection

We collected data through semi-structured interviews led by TP, following an interview guide (Supplementary Material 4). The interview guide included broad themes from the conceptual framework, in three sections. The first section asked respondents to describe important places, natural resources, livelihood and other activities and governance systems (Ostrom, 2007). The second section asked about the major challenges and problems people experience in their lives (Narayan et al., 2000). Finally, we asked respondents how they felt when experiencing stressors, allowing them to introduce terminology related to distress in their own words. When respondents introduced such terms, we prompted them to provide details on associated symptoms. We covered all themes in all interviews (Supplementary Material 5).

Data analysis

We employed inductive thematic analysis to identify, analyse, organize and report interview themes (following Braun & Clarke, 2006). The thematic analysis proceeded through the following five steps (Supplementary Material 6): (1) Familiarization with data, including re-reading transcripts and postscripts and comparing word clouds between demographic and social groups. (2) Generating codes and systematically applying them to the text over two rounds of coding. (3) Identifying and clustering codes into themes. (4) Reviewing themes, ensuring consistency within (but

discrete differences between) them and counting the instances in which respondents explicitly connected two given themes. (5) Defining and naming themes (see Supplementary Table 2 for definitions of the key themes).

One of the emergent themes related to symptoms of 'thinking too much'. We evaluated the extent to which these symptoms appeared to describe emotional disturbance that impaired day-to-day activities and social functioning (Drapeau et al., 2012). The expected ways in which the positionality of the authors could have influenced the results and the steps taken to account for these are discussed in Supplementary Material 7.

Results

We interviewed 21 men and 24 women with a range of demographic and socioeconomic characteristics (Supplementary Material 3). We discussed a broad range of themes during the interviews, but only those most frequently mentioned and relevant to the research questions are presented here (but see Supplementary Material 8).

How do the residents of Nyabyeya Parish describe their experiences of distress?

Terms used to describe the experience of distress included *kufikiri sana* in Kiswahili and *kuterageza muno* in Runyoro, both of which translate to 'thinking too much' in English. For instance, respondent R05 (lower-income older female) said, 'It brings me so many thoughts, I think too much.' When asked about the experience of 'thinking too much', respondents mentioned a range of experiences or symptoms (Fig. 3). For instance, R29 (lower-income middle-aged male) stated, 'You find yourself growing thinner and thinner. Like the way they say that too many thoughts cause pressure.' Several reported that the experience of 'thinking too much' disrupted daily activities. For example, R09 (middle-income middle-aged male) said, 'You sleep from now [early evening at the time of the interview] up till 10 am, [but] you are supposed to wake up and get your hoe and start digging, so those are all about thoughts.'

Several respondents indicated that the frequency and duration of 'thinking too much' depended on the presence of specific stressors. For instance, when asked how to alleviate 'thinking too much', R38 (middle-income older male) said, 'There is no way you can reduce those thoughts if you are still with those challenges. [Those thoughts only disappear when] those challenges are not there.' However, several others indicated that the experience of 'thinking too much' was more chronic, such as R27 (lower-income middle-aged female), who said, 'You cannot imagine the period that those thoughts can get finished from you.'
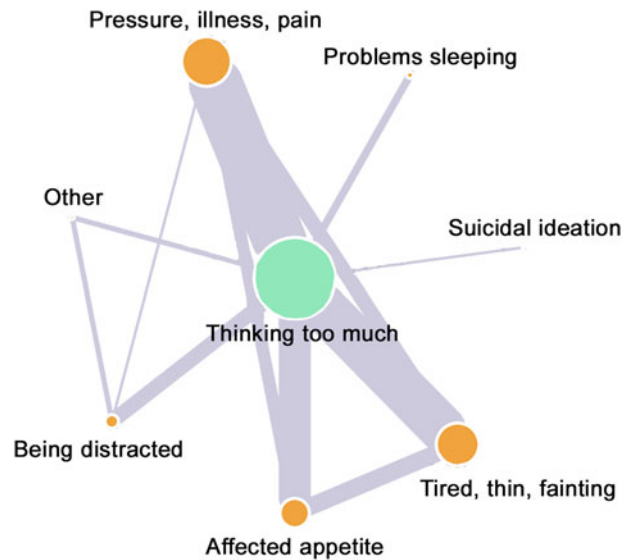

FIG. 3 The reported experiences or symptoms of 'thinking too much' amongst respondents in Nyabyeya Parish, Uganda. The width of the lines illustrates the relative number of interviewees that reported connections between nodes. The node size represents the number of interviewees mentioning the associated theme for that node.

What are the perceived stressors associated with distress amongst residents?

Many respondents reported that poverty, bad health and inadequate food were associated with 'thinking too much' (Fig. 4). For instance, when asked what the term 'overthinking' meant, R20 (middle-income older female) responded, 'No energy for digging, no money, [which] brings famine; it makes you overthink. You start thinking, what will I eat?' Although being poor was an umbrella term for someone's socio-economic condition, it was often associated with insufficient money to meet essential needs. These needs included basic housing, paying for healthcare and school fees and buying food. Therefore, in the following, we use the term 'poverty' to mean inadequate money.

Many respondents used the terms 'famine' and 'hunger' to describe not having enough food. When asked how this affected them, several respondents mentioned reducing the number of meals eaten per day, eating less favoured food or reducing dietary diversity. For instance, when asked about the experience of hunger, R13 (middle-income younger male) stated, 'You cannot eat expensive things, and if you have been eating like four cups of posho (maize flour) now, you end up reducing to two cups.' Although a few respondents indicated that the current experience of hunger was a cause of 'thinking too much', many more said that the prospect of food supplies running out before the next harvest caused them distress.
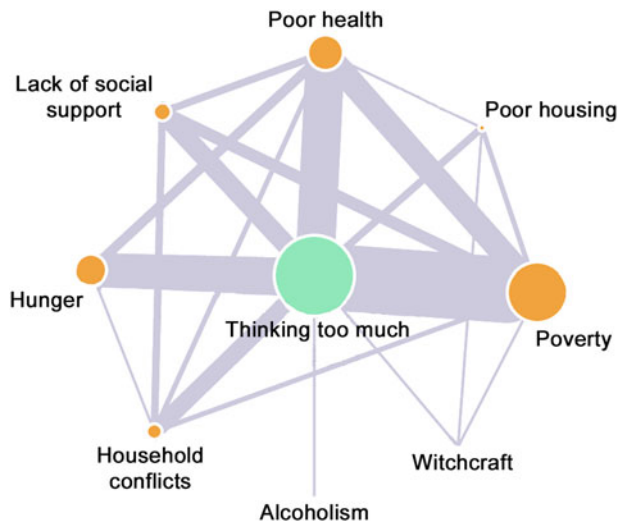
FIG. 4 The reported sources of 'thinking too much' and related idioms of distress amongst respondents in Nyabyeya Parish, Uganda. The width of the lines illustrates the relative number of interviewees that reported connections between nodes. The node size represents the number of interviewees mentioning the associated theme for that node.

What are the perceived roles of socio-ecological processes in these stressors?

We focus on poverty and hunger because they were the most frequently mentioned intermediaries between the broader socio-ecological context of respondents and 'thinking too much'. Further evidence and other pathways of interest are presented in Supplementary Figs 1–3.

Hunger, nature conservation and the sugarcane industry

The main reported drivers of hunger included insufficient land (linked to the sugarcane industry, discussed below), inadequate money to buy food, and crop losses. Many subsistence farmers said unexpected and unseasonal rains during June–July 2019 left crops rotting in their fields. Many also reported that crop foraging by wildlife (baboons *Papio anubis*, chimpanzees *Pan troglodytes* and red river hogs *Potamochoerus porcus*) contributed to crop losses. For instance, R16 (lower-income younger female) stated, 'Wild animals are good at [destroying] most of our food crops.' Whether or not they farmed adjacent to the reserve, interviewees said that crop-eating wildlife most affected farmers at the forest edge.

In response to crop-eating by wildlife, many subsistence farmers reported having to guard their crops, which several respondents said disrupted other income-generating activities and leisure time. Consequently, several subsistence farmers had negative attitudes towards wildlife and a desire to trap or kill wild animals. However, it was unclear whether respondents had acted upon these desires. For instance, R18 (middle-income middle-aged female) stated, '[Wild animals] cannot leave you to eat your food, and you are not allowed to kill them, meaning you just suffer. But if you get time, you can go and wait for them. You chase them.'

Poverty, farm size and the sugarcane industry

The primary reported contributors to poverty were low farm production, poor health and lack of employment. For instance, R29 (lower-income middle-aged male) stated, 'What has caused poverty in this community is lack of enough land. You do not have [enough land] where you can farm; you just have a plot [a small unit of land].' When discussing farm production, many subsistence farmers suggested that there was inadequate or 'squeezed' land. For instance, when asked to describe the history of the community, R25 (medium-income middle-aged male) said, 'Others are getting problems of land because [there is not enough land] where they can do good farming to get good money [...] that's what is making us suffer.' When asked why there was inadequate land, most subsistence farming respondents said that the expansion of contract farming and large-scale commercial estates had displaced small-scale farming. For instance, R02 (middle-income middle-aged male) stated, 'You cannot struggle for a small piece of land since sugarcane has taken most of the land.' Mechanisms of displacement included the voluntary selling or renting of land to meet immediate needs, forced displacement by large-scale commercial estates and increased prices restricting land purchase.

However, both subsistence and small-scale contract farmers said that the sugarcane industry benefitted those able to engage in it. For instance, when describing the drivers of household development, R01 (middle-income middle-aged female) said that some households engage in 'sugarcane growing, and after growing, they sell and get a lot of money'. Nevertheless, many subsistence farmers reported barriers to small-scale contract farming; insufficient land was most commonly mentioned. Consequently, several respondents said that the benefits of the sugarcane industry mainly accrued to wealthier households with large amounts of land.

The importance of the forest during hunger and poverty

As well as the threats posed by crop-eating wildlife, many said that subsistence farmers and landless young men harvested forest resources to cope with hunger or poverty. This forest use included legal (e.g. harvesting wild plants and mushrooms) and illegal activities (e.g. producing charcoal, hunting and timber harvesting). Several respondents said that wealthier households, including those outside the study area, often paid landless young men to illegally harvest timber. Similarly, several respondents said charcoal was typically produced by poorer households and sold to wealthier ones. For instance, R02 (middle-income middle-aged male) said, '[People are struggling to survive] as the sugarcane is the most [common] crop grown on the ground, so [food crop] gardens are few.' R02 then proceeded to say,

'That is why people are entering the forest, just stealing [forest resources], just burning charcoal, collecting firewood in days that are not allowed.'

Hunting and harvesting of forest foods reportedly contributed to diets. Furthermore, income generated from forest product harvesting was used to purchase food and to meet other needs. However, many respondents also mentioned the risks of illegal forest use, including corporal punishment, fines and imprisonment. However, no respondents explicitly associated these risks with 'thinking too much'.

Discussion

Psychological distress in Nyabyeya Parish

Many of the reported symptoms of 'thinking too much' (e.g. sleep disturbance, fatigue, problems concentrating, changes in weight and appetite, suicidal ideation and the sensation of heart palpitations) were consistent with a stage-based model of poor mental health (APA, 2013; Patel et al., 2018). Furthermore, some respondents described the disruption of their daily activities during periods of 'thinking too much', which is consistent with definitions of psychological distress (Drapeau et al., 2012). However, there was apparent variation in the severity and variety of symptoms. For instance, some emphasized loss of appetite and weight loss, whereas others highlighted chest discomfort, and some did not explicitly report disruption of daily activities and social functioning. Therefore, in isolation, our study provides only some evidence that 'thinking too much' is associated with psychological distress.

However, multiple studies in Uganda and East Africa have found both qualitative and statistical associations between 'thinking too much' and psychological distress and common mental disorders (Kaiser et al., 2015). For example, several studies using qualitative approaches have found evidence linking 'thinking too much' to distress and poor mental health amongst Ugandan, Kenyan and Malawian populations (Okello & Ekblad, 2006; Velloza et al., 2020; Harrington et al., 2021; Miller et al., 2021). Pienkowski et al. (2022) found a strong positive statistical association between the reported frequency of experiencing 'thinking too much' and depression symptom severity within the same area as the current study. More generally, in a review of 60 studies in sub-Saharan Africa, Backe et al. (2021, p. 1) stated that 'thinking too much is a useful idiom for understanding rumination and psychiatric distress [...] in clinical settings'. When considering our results in the context of the wider literature, there is good evidence that the term 'thinking too much' is indicative of psychological distress. Furthermore, although psychological distress is not a mental disorder, severe distress is indicative of poor mental health and is experienced across a range of severity of common mental disorders (Drapeau et al.,

2012; Viertiö et al., 2021). Consequently, considered in relation to previous evidence, our results highlight potential risk factors for poor mental health.

Social determinants within a socio-ecological context

Conserved landscapes and 'thinking too much'

Over recent decades large amounts of forest outside the forest reserves in Uganda appear to have been lost, partly attributed to commercial agricultural expansion (Twongyirwe et al., 2017). In this context, Budongo Forest Reserve appears to contribute to the livelihoods of those in the region, particularly those experiencing poverty and food insecurity (Fig. 5).

In general, nature conservation seeks to maintain ecosystems and their essential contributions to human well-being (IPBES, 2019). In doing so, conservation may influence social determinants of mental health for many worldwide. For example, forest products are consumed by many populations globally, sometimes supporting food security (Rasolofoson et al., 2020), which is a well-established determinant of mental health (Kinyanda et al., 2011; Lund et al., 2018; Myers, 2020). Thus, conserving forest habitats could maintain the flow of these benefits, potentially supporting mental health. Yet not all interactions with ecosystems are desirable. Several studies describe how interactions with wildlife can be distressing, potentially contributing to the risk of mental illness (Jadhav & Barua, 2012; Barua et al., 2013; Chowdhury et al., 2016). Our findings suggest that living in proximity to crop-eating wildlife may also be a stressor potentially indirectly linked to experiences of psychological distress. This stressor appeared to vary across the study area, with households bordering forest reserves being most affected by crop-eating wildlife, consistent with findings from previous studies (Tweheyo et al., 2005). As such, the full set of social costs and benefits associated with conservation and how they are distributed between groups should be considered when managing landscapes to protect nature. For instance, the post-2020 Global Biodiversity Framework includes plans to nearly double the current extent of protected areas globally by 2030 (CBD, 2021). However, many have argued that these plans have not been based on a thorough assessment of their social impacts (e.g. ICCA Consortium, 2021), which could include impacts on mental health.

Uganda has adopted the Sustainable Development Goals, which include Goal 3 to 'Ensure healthy lives and promote well-being for all at all ages' and Goal 10 to 'Reduce inequality within and amongst countries' (United Nations, 2015). Perceptions play a central role in people's subjective evaluations of their well-being (Diener, 2009), including their health. Therefore, managing the factors perceived to affect mental health could help promote healthy lives and well-being as subjectively experienced. In the current study
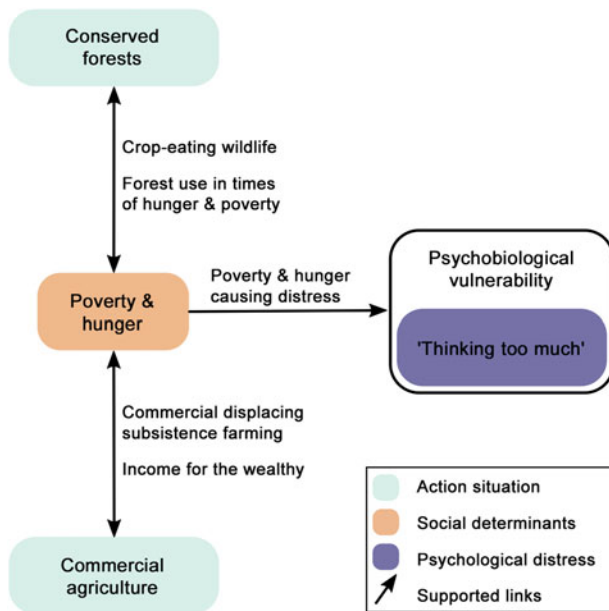
FIG. 5 Hypothesized causal connections between two socio-ecological action situations, social determinants and psychological distress affecting respondents in Nyabyeya Parish, Uganda.

context this could mean acknowledging and acting on people's concerns about landscape management and policy (Bennett, 2016). For example, the Ugandan Government should investigate how rural residents view conservation, and avoid policies that are perceived to worsen inequalities and trigger 'thinking too much'. This process could be facilitated by strengthening the decentralized governance system in Uganda (Mushemeza, 2019), with local councils soliciting the perspectives of residents and raising these perspectives with decision-makers in central government.

Perceptions can also influence attitudes and behaviours and the success of projects that depend on local support (Bennett, 2016). For example, perceptions regarding forests as a source of resources and a home for crop-eating wildlife (both reportedly indirectly linked to 'thinking too much') may influence attitudes towards their protection. Preventing or compensating for human–wildlife conflict has been a persistent issue in the study area and elsewhere in East Africa. However, there are emerging innovations that Ugandan authorities could consider, such as community-operated compensation schemes (Watve et al., 2016). If successful, such interventions might reduce experiences of 'thinking too much' and foster support for local forest conservation, potentially contributing to sustainable development and biodiversity goals.

Agro-ecological systems and 'thinking too much'

The prominence of the sugarcane industry across responses was unexpected, but this theme emerged as important. Our findings indicate that most of those who benefitted from the expansion of contract farming were wealthier families with large amounts of land, many of whom were Indigenous Banyoro. However, this expansion reportedly displaced subsistence farming, potentially exacerbating social determinants of psychological distress amongst poorer households (Fig. 5). The Ugandan government has sought to promote contract farming models as a tool for poverty alleviation (White et al., 2012). However, our results corroborate other studies suggesting that this model could have limitations in terms of delivering pro-poor development (Mwavu et al., 2018; Martiniello, 2021). More broadly, numerous studies across various countries illustrate the diverse impacts of commercial agriculture on smallholder farming systems, sometimes contributing to food insecurity and poverty amongst vulnerable groups (Hall et al., 2017). For example, agriculture commercialization has been linked to global market exposure, indebtedness and uncertain yields, leading to high rates of suicide in some farming communities (Mohanakumar & Sharma, 2006).

Study limitations

This study was primarily focused on the perspectives of respondents. Local and Indigenous knowledge can be a valuable source of information for landscape management and conservation decision-making (Wheeler & Root-Bernstein, 2020). However, these perspectives are also shaped by social and cognitive factors. As such, the current study may not have captured the full breadth of possible linkages between interactions with ecosystems and social determinants of psychological distress. Moreover, residents may have an inaccurate understanding of socio-ecological dynamics or strategically misreported their responses to gain future benefits. Further research could integrate long-term monitoring of socio-ecological dynamics to evaluate the reliability of the perceptions of respondents.

Conclusion

In this exploratory study, we have applied a new framework that situates social determinants of psychological distress in socio-ecological systems. We find that nature conservation and commercial agriculture could influence social determinants of psychological distress. Our case study indicates opportunities to manage perceived co-benefits and trade-offs between the Sustainable Development Goals, thereby potentially improving subjective experiences of mental health, and demonstrates the importance of taking a more holistic and locally nuanced approach to understanding how people's relationships with ecosystems relate to psychological distress and mental health.

Conflicts of interest None.

Ethical standards Ethical approval was granted by the Uganda National Council of Science and Technology (Ref. SS6007) of the Government of Uganda and the Central University Research Ethics Committee (Ref. R63458) of the University of Oxford. Before commencing interviews, we informed respondents of the research purpose, who was conducting it, that participation was voluntary and how their data would be used alongside other information. We sought documented, free, prior and informed consent before individuals could participate. We debriefed respondents after completing the interviews, which included providing the contact details of the research team and the Ethical Review Board. We provided respondents with household essentials (including soap, salt, oil and sugar) as in-kind compensation for their time following the completion of the interviews. This research abided by the *Oryx* guidelines on ethical standards.

Data availability The data contain potentially sensitive information, such the personal details of participants or the disclosure of illegal behaviours, and therefore we are unable to make these data available.

References

APA (2013) *Diagnostic and Statistical Manual of Mental Disorders (DSM-5).* American Psychiatric Publishing, Washington, DC, USA, and London, UK.

Babweteera, F., Christopher, M., Asiimwe, C., Eric, O., Muhanguzi, G., Okimat, J.P. & Robinson, S. (2018) Budongo forest: a paradigm shift in conservation? In *Conservation and Development in Uganda* (eds C. Sandbrook, C.J. Cavanagh & D.M. Tumusiime), pp. 104–122. Routledge, Abingdon, UK.

Backe, E.L., Bosire, E.N., Kim, A.W. & Mendenhall, E. (2021) 'Thinking too much': a systematic review of the idiom of distress in sub-Saharan Africa. *Culture, Medicine, and Psychiatry*, 45, 655–682.

Barton, J., Bragg, R., Wood, C. & Pretty, J. (2016) *Green Exercise: Linking Nature, Health and Well-Being.* Routledge, Abingdon, UK.

Barua, M., Bhagwat, S.A. & Jadhav, S. (2013) The hidden dimensions of human–wildlife conflict: health impacts, opportunity and transaction costs. *Biological Conservation*, 157, 309–316.

Bennett, N.J. (2016) Using perceptions as evidence to improve conservation and environmental management. *Conservation Biology*, 30, 582–592.

Bratman, G.N., Daily, G.C., Levy, B.J. & Gross, J.J. (2015) The benefits of nature experience: improved affect and cognition. *Landscape and Urban Planning*, 138, 41–50.

Braun, V. & Clarke, V. (2006) Using thematic analysis in psychology. *Qualitative Research in Psychology*, 3, 77–101.

CBD (2021) *First Draft of the Post-2020 Global Biodiversity Framework.* Convention on Biological Diversity, Montreal, Canada. cbd.int/doc/c/abb5/591f/2e46096d3f0330b08ce87a45/wg2020-03-03-en.pdf [accessed December 2023].

CBD SBSTTA (2021) *Biodiversity and Health.* Subsidiary Body on Scientific, Technical and Technological Advice, Convention on Biological Diversity, Montreal, Canada. cbd.int/doc/c/76f9/1b75/42e360ab3ae6e53d0762c449/sbstta-24-09-en.pdf [accessed July 2024].

Chowdhury, A.N., Mondal, R., Brahma, A. & Biswas, M.K. (2016) Ecopsychosocial aspects of human–tiger conflict: an ethnographic study of tiger widows of Sundarban delta, India. *Environmental Health Insights*, 10, 1–29.

Collins, R.M., Spake, R., Brown, K.A., Ogutu, B.O., Smith, D. & Eigenbrod, F. (2020) A systematic map of research exploring the effect of greenspace on mental health. *Landscape and Urban Planning*, 201, 103823.

Diener, E. (ed.) (2009) Subjective well-being. In *The Science of Well-Being: The Collected Works of Ed Diener*, pp. 11–58. Springer Netherlands, Dordrecht, The Netherlands.

Drapeau, A., Marchand, A. & Beaulieu-Prvost, D. (2012) Epidemiology of psychological distress. In *Mental Illnesses: Understanding, Prediction and Control* (ed. L. Labate), pp. 105–134. IntechOpen, London, UK.

Dzhambov, A.M. & Dimitrova, D.D. (2015) Green spaces and environmental noise perception. *Urban Forestry & Urban Greening*, 14, 1000–1008.

Fedele, G., Donatti, C.I., Bornacelly, I. & Hole, D.G. (2021) Nature-dependent people: mapping human direct use of nature for basic needs across the tropics. *Global Environmental Change*, 71, 102368.

Fisher, J.C., Bicknell, J.E., Irvine, K.N., Fernandes, D., Mistry, J. & Davies, Z.G. (2021) Exploring how urban nature is associated with human wellbeing in a neotropical city. *Landscape and Urban Planning*, 212, 104119.

Hall, R., Scoones, I. & Tsikata, D. (2017) Plantations, outgrowers and commercial farming in Africa: agricultural commercialisation and implications for agrarian change. *Journal of Peasant Studies*, 44, 515–537.

Harrington, B.J., Klyn, L.L., Ruegsegger, L.M., Thom, A., Jumbe, A.N., Maliwichi, M. et al. (2021) Locally contextualizing understandings of depression, the EPDS, and PHQ-9 among a sample of postpartum women living with HIV in Malawi. *Journal of Affective Disorders*, 281, 958–966.

ICCA Consortium (2021) *Territories of Life: 2021 Report.* ICCA Consortium, Genolier, Switzerland. report.territoriesoflife.org [accessed December 2023].

Ickowitz, A., Powell, B., Salim, M.A. & Sunderland, T.C.H. (2014) Dietary quality and tree cover in Africa. *Global Environmental Change*, 24, 287–294.

IPBES (2019) *Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.* IBPES, Bonn, Germany.

Jadhav, S. & Barua, M. (2012) The elephant vanishes: impact of human–elephant conflict on people's wellbeing. *Health & Place*, 18, 1356–1365.

Jones, A.D. (2017) Food insecurity and mental health status: a global analysis of 149 countries. *American Journal of Preventive Medicine*, 53, 264–273.

Kaiser, B.N., Haroz, E.E., Kohrt, B.A., Bolton, P.A., Bass, J.K. & Hinton, D.E. (2015) Thinking too much: a systematic review of a common idiom of distress. *Social Science and Medicine*, 147, 170–183.

Kinyanda, E., Woodburn, P., Tugumisirize, J., Kagugube, J., Ndyanabangi, S. & Patel, V. (2011) Poverty, life events and the risk for depression in Uganda. *Social Psychiatry and Psychiatric Epidemiology*, 46, 35–44.

Kinyanda, E., Kizza, R., Abbo, C., Ndyanabangi, S. & Levin, J. (2013) Prevalence and risk factors of depression in childhood and

adolescence as seen in four districts of north-eastern Uganda. *BMC International Health and Human Rights*, 13, 19.

Kinyanda, E., Nakasujja, N., Levin, J., Birabwa, H., Mpango, R., Grosskurth, H. et al. (2017) Major depressive disorder and suicidality in early HIV infection and its association with risk factors and negative outcomes as seen in semi-urban and rural Uganda. *Journal of Affective Disorders*, 212, 117–127.

Lund, C., Breen, A., Flisher, A.J., Kakuma, R., Corrigall, J., Joska, J.A. et al. (2010) Poverty and common mental disorders in low and middle income countries: a systematic review. *Social Science & Medicine*, 71, 517–528.

Lund, C., Brooke-Sumner, C., Baingana, F., Baron, E.C., Breuer, E., Chandra, P. et al. (2018) Social determinants of mental disorders and the sustainable development goals: a systematic review of reviews. *The Lancet Psychiatry*, 5, 357–369.

Marselle, M.R., Martens, D., Dallimer, M. & Irvine, K.N. (2019) Review of the mental health and wellbeing benefits of biodiversity. In *Biodiversity and Health in the Face of Climate Change* (eds M.R. Marselle, J. Stadler, H. Korn, K.N. Irvine & A. Bonn), pp. 175–211. Springer, Cham, Switzerland.

Marselle, M.R., Hartig, T., Cox, D.T.C., de Bell, S., Knapp, S., Lindley, S. et al. (2021) Pathways linking biodiversity to human health: a conceptual framework. *Environment International*, 150, 106420.

Martiniello, G. (2021) Bitter sugarification: sugar frontier and contract farming in Uganda. *Globalizations*, 18, 355–371.

Miller, A.P., Ziegel, L., Mugamba, S., Kyasanku, E., Wagman, J.A., Nkwanzi-Lubega, V. et al. (2021) Not enough money and too many thoughts: exploring perceptions of mental health in two Ugandan districts through the mental health literacy framework. *Qualitative Health Research*, 31, 967–982.

Mohanakumar, S. & Sharma, R.K. (2006) Analysis of farmer suicides in Kerala. *Economic and Political Weekly*, 41, 1553–1558.

Mushemeza, E.D. (2019) *Decentralisation in Uganda: Trends, Achievements, Challenges and Proposals for Consolidation*. ACODE, Kampala, Uganda. acode-u.org/uploadedFiles/PRS93.pdf [accessed December 2023].

Mwavu, E.N., Kalema, V.K., Bateganya, F., Byakagaba, P., Waiswa, D., Enuru, T. & Mbogga, M.S. (2018) Expansion of commercial sugarcane cultivation among smallholder farmers in Uganda: implications for household food security. *Land*, 7, 1–15.

Myers, C.A. (2020) Food insecurity and psychological distress: a review of the recent literature. *Current Nutrition Reports*, 9, 107–118.

Narayan, D., Chambers, R., Shah, M.K. & Petesch, P. (2000) *Voices of the Poor: Crying Out for Change*. The World Bank, New York, USA. elibrary.worldbank.org/doi/abs/10.1596/0-1952-1602-4 [accessed December 2023].

Nawrath, M., Elsey, H. & Dallimer, M. (2022) Why cultural ecosystem services matter most: exploring the pathways linking greenspaces and mental health in a low-income country. *Science of the Total Environment*, 806, 150551.

Nichter, M. (2010) Idioms of distress revisited. *Culture, Medicine and Psychiatry*, 34, 401–416.

Okello, E.S. & Ekblad, S. (2006) Lay concepts of depression among the Baganda of Uganda: a pilot study. *Transcultural Psychiatry*, 43, 287–313.

Ostrom, E. (2007) A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences of the United States of America*, 104, 15181–15187.

Patel, V., Saxena, S., Lund, C., Thornicroft, G., Baingana, F., Bolton, P. et al. (2018) The Lancet Commission on global mental health and sustainable development. *The Lancet*, 392, 1553–1598.

Pienkowski, T., Keane, A., Kinyanda, E., Asiimwe, C. & Milner-Gulland, E.J. (2022) Predicting the impacts of land

management for sustainable development on depression risk in a Ugandan case study. *Scientific Reports*, 12, 11607.

Powers, R.P. & Jetz, W. (2019) Global habitat loss and extinction risk of terrestrial vertebrates under future land-use-change scenarios. *Nature Climate Change*, 9, 323–329.

Rasolofoson, R.A., Ricketts, T.H., Jacob, A., Johnson, K.B., Pappinen, A. & Fisher, B. (2020) Forest conservation: a potential nutrition-sensitive intervention in low- and middle-income countries. *Frontiers in Sustainable Food Systems*, 4, 20.

Tweheyo, M., Hill, C.M. & Obua, J. (2005) Patterns of crop raiding by primates around the Budongo Forest Reserve, Uganda. *Wildlife Biology*, 11, 237–247.

Twohig-Bennett, C. & Jones, A. (2018) The health benefits of the great outdoors: a systematic review and meta-analysis of greenspace exposure and health outcomes. *Environmental Research*, 166, 628–637.

Twongyirwe, R., Bithell, M., Richards, K.S. & Rees, W.G. (2017) Do livelihood typologies influence local perceptions of forest cover change? Evidence from a tropical forested and non-forested rural landscape in western Uganda. *Journal of Rural Studies*, 50, 12–29.

United Nations (2015) *Transforming our world: the 2030 Agenda for Sustainable Development*. United Nations, New York, USA. sdgs.un.org/2030agenda [accessed December 2023].

Velloza, J., Njoroge, J., Ngure, K., Thuo, N., Kiptinness, C., Momanyi, R. et al. (2020) Cognitive testing of the PHQ-9 for depression screening among pregnant and postpartum women in Kenya. *BMC Psychiatry*, 20, 31.

Viertiö, S., Kiviruusu, O., Piirtola, M., Kaprio, J., Korhonen, T., Marttunen, M. & Suvisaari, J. (2021) Factors contributing to psychological distress in the working population, with a special reference to gender difference. *BMC Public Health*, 21, 611.

Vigo, D., Kestel, D., Pendakur, K., Thornicroft, G. & Atun, R. (2019) Disease burden and government spending on mental, neurological, and substance use disorders, and self-harm: cross-sectional, ecological study of health system response in the Americas. *The Lancet Public Health*, 4, e89–e96.

Watve, M., Patel, K., Bayani, A. & Patil, P. (2016) A theoretical model of community operated compensation scheme for crop damage by wild herbivores. *Global Ecology and Conservation*, 5, 58–70.

Wendelboe-Nelson, C., Kelly, S., Kennedy, M. & Cherrie, J.W. (2019) A scoping review mapping research on green space and associated mental health benefits. *International Journal of Environmental Research and Public Health*, 16, 2081.

Wheeler, H.C. & Root-Bernstein, M. (2020) Informing decision-making with Indigenous and local knowledge and science. *Journal of Applied Ecology*, 57, 1634–1643.

White, B., Borras, Jr, S.M., Hall, R., Scoones, I. & Wolford, W. (2012) The new enclosures: critical perspectives on corporate land deals. *Journal of Peasant Studies*, 39, 619–647.

White, M.P., Elliott, L.R., Grellier, J., Economou, T., Bell, S., Bratman, G.N. et al. (2021) Associations between green/blue spaces and mental health across 18 countries. *Scientific Reports*, 11, 8903.

Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A.G., de Souza Dias, B.F. et al. (2015) Safeguarding human health in the Anthropocene epoch: report of The Rockefeller Foundation–Lancet Commission on planetary health. *The Lancet*, 386, 1973–2028.

WHO (2004) *Promoting Mental Health: Concepts, Emerging Evidence, Practice. Summary Report*. World Health Organization, Geneva, Switzerland. iris.who.int/bitstream/handle/10665/42940/9241591595.pdf [accessed December 2023].

World Bank (2021) *World Bank Open Data*. data.worldbank.org [accessed December 2021].

Wright, J.H., Hill, N.A., Roe, D., Rowcliffe, J.M., Kumpel, N.F., Day, M. et al. (2016) Reframing the concept of alternative livelihoods. *Conservation Biology*, 30, 7–13.