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Abstract

Background and Aims: The rising global population has increased land demand due to the increased need for agricultural and settlement spaces. Land ownership security tremendously impacts environmental sustainability because it influences ecological decisions. Kenya's land ownership and land use changes nexus has not received sufficient attention. Consequently, we explored this research gap in Mwatate Sub County, Taita County, Kenya. **Methods:** A sample size of 301 households was selected using stratified proportionate and simple random sampling techniques. A cross-sectional survey research design was used, while data was collected using semi-structured questionnaires. The Neo-Malthusian theory was adopted as a theoretical framework. **Results:** Results revealed that most (85.6%) households had insecure land ownership rights. Most (64.1%) households inherited land and had no Title deeds. Accordingly, findings reveal unsustainable land use practices, including deforestation, tree logging, high fuelwood use, bush clearance for human settlement and cultivation, poor farming methods, and overreliance on agriculture for livelihood. Using a 95% confidence level, Chi-square tests revealed a significant relationship between agricultural land use changes and land ownership security. Our findings concluded that insecure land ownership influenced agricultural expansion, deforestation, clearing of land for human settlement, and the type of farming techniques adopted by farmers. **Implications for Conservation:** Taita Taveta is a vital biodiversity hotspot that continues to be degraded by human activities. The correlation between land ownership and land use changes established by our study confirms the impending land degradation and threat to biodiversity loss. This is coupled with the concern that approximately 62% and 11% of the county are under a National Park and sisal estates, respectively, implying a growing threat to biodiversity loss and the need for enhanced conservation efforts in the area. This calls for the need to address the constant land issues in the area to incentivize sustainable land use practices.

Keywords

land use changes, land ownership security, land degradation, agriculture, agricultural land

Introduction

Over the last millennium, anthropogenic forces have significantly changed the Earth's surface (Winkler et al., 2021). These activities contribute to land-use changes that ultimately affect our ecosystem (Gitau & Mutua, 2020). For instance, global population growth contributes to land scarcity, accelerating land use changes (Lambin & Meyfroidt, 2011). Across the globe, this is manifest in various ways, including urbanization, which increases the demand for land for settlement and infrastructural development (Shabu et al., 2021; Mathanraj, 2020).

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Moreover, rapid population growth is often accompanied by the need to guarantee food security, thereby increasing land fragmentation due to agricultural land expansion (Teshome, 2014; Maja & Ayano, 2021). According to Winkler et al., (2021), agricultural expansion is relatively higher in the global south. Nyamwamu, (2016) attributes this expansion to the need to boost livelihood and food security. Eventually, approximately half of the land available on Earth has, over time, undergone use and cover changes (Baig et al., 2022). Therefore, it is safe to conclude that demographic transition, among other factors, is responsible for increased agricultural activities exacerbating land cover and land use changes (Gabathuler et al., 2009). This harms ecosystems and degrades environmental quality (Agarwal et al., 2002).

Land is valuable capital because it regulates, sustains, and provides cultural services (Smith et al., 2014). It represents a society's social, cultural, economic, and political values (Taru, 2004). However, being a finite resource, the unprecedented global population growth strains her carrying capacity and potential for productivity (Neumayer, 2006). This calls for an understanding of the dynamics of land use. Land use is the socioeconomic exploitation of land to modify or preserve it for production (Silva, 2011). It occurs when humans seek to alter the environment for their utility to realize well-being (Msofe et al., 2019). Over time, land use results in land use changes that eventually modify the Earth's surface (Hamza & Iyela, 2012). These land-use changes are manifested through human activities, including cultivation, grazing, ranching, and urbanization (Baig et al., 2022).

Land is a natural and cultural yet scarce resource whose ownership security impacts its use pattern (Murken & Gornott, 2022). Waswa et al. (2002) point out that land tenure is based on access, ownership, use, control, and land transfer. This, in effect, has ecological implications, especially on agricultural land. For instance, Taru (2004) observed that private land tenure affects land use because it encourages the subdivision of land for various uses. On the one hand, Chigbu et al. (2019) portend that land access and ownership rights impact land use changes. On the other hand, Dube and Guveya (2013) point out that land ownership insecurity limits farmers' ability to access agricultural financing and investment in agricultural technology. This may increase land use and fragmentation, leading to poor agricultural development and increased agricultural intensification.

Land use changes are precursors to livelihood security (Kiio & Achola, 2015). This security is threatened by, among other factors, population growth, which increases the need for more land for settlement and agriculture. This situation strains the available resources and increases the demand for land ownership to meet competing human needs (Kavanagh et al., 2021). The result manifests in unsustainable land use patterns, hence land degradation (Maitima et al., 2010). Mainuri et al. (2019) state that unsustainable land-use practices make

planning challenging and often result in harmful land-use changes. Such changes are associated with overgrazing, tree harvesting, harmful agricultural practices, and charcoal burning (Mwagore, 2003).

On this basis, the United Nations Convention to Combat Desertification (UNCCD) (2014) links environmental hazards, degradation of ecosystem services, and loss of agricultural crop diversity to intensive land use changes. Kareri (2018) posits that social and economic determinants influence land use changes. However, in Kenya, land ownership rights and land use changes have been separately studied despite the nexus between these concepts (Mbudzya et al., 2022). This has made it difficult to achieve environmental planning (Mainuri et al., 2019).

Land ownership in Kenya has evolved from social ownership during the colonial era to the current private ownership (Onguny & Gillies, 2019). Private land ownership is associated with ease of access to land and could increase land productivity, even though these benefits remain scantily reported in many developing countries (Grimm & Lesorogol, 2012). This dates back to the colonial era, when Kenyans were stripped of land ownership rights in favor of non-Africans, increasing tenure insecurity (Mbudzya et al., 2023). Even though land ownership patterns in Taita adopt Kenya's general land ownership systems, most households do not have land ownership title deeds. Private land tenure security gives landowners exclusive rights of use and access to land within existing legal frameworks, hence boosting productivity (Lipski, 2015). However, whether such private land ownership security ultimately benefits land productivity and sustainability in Taita Taveta remains in question.

According to Berry (2009), private land ownership rights are associated with unsustainable land use practices that seek short-term gratification. Consequently, secure land tenure significantly leads to deforestation in favor of agricultural expansion (Busch & Ferretti-Gallon, 2017). However, Taru (2004) posits that Kenya has yet to adopt a robust land use policy that could address land use issues. While the general Taita Taveta region preferred a Community Land Trust (CTL), the trend is gradually changing, and many households are now seeking to privatize their land by acquiring title deeds *ibid*.

Agricultural intensification due to population growth has resulted in rapid land cover changes in Taita Taveta (Piironen et al., 2015). This boosts food security, accelerating climate change, ecosystem disturbance, biodiversity loss, and increasing global CO₂ emissions (Bastos et al., 2021). The tenets of Sustainable development require balancing land use and environmental integrity (Gutzler et al., 2015). Monitoring land use dynamics is crucial for environmental sustainability and sound ecosystem functioning (Willkomm et al., 2016). Therefore, understanding land use change dynamics is essential in boosting land use sustainability (Lambin &

Meyfroidt, 2011; Winkler et al., 2021). This paper, therefore, examines how land ownership rights affect changes in land use.

Research Gap

Taita Taveta County is a known global biodiversity hotspot (Abera et al., 2022). Over the years, the region has experienced harmful land use and cover changes, resulting in land degradation and deforestation (Kung'u et al., 2023; Habel et al., 2023). Eventually, this has resulted in intensive agriculture, deforestation, and tree logging, further contributing to environmental degradation (Pellikka et al., 2013). This is a threat to biodiversity and sustainable environmental sanity. Given this trend, the sustainability of productivity of the available land in the region is in great jeopardy. Taita Taveta has grappled with land issues, including land ownership rights. While there is a demonstrable nexus between land tenure security and land use changes, little research has been done on this effect in Taita Taveta. This is despite the region having experienced increased land use changes and land tenure insecurity. Therefore, this means there is an urgent need to establish the contribution of land ownership rights on land use changes in Taita Taveta County.

Methods

Site of the Study

This study was conducted in Kenya's Mwatate sub-county, Taita Taveta County. Taita-Taveta County is a known biodiversity hotspot that has recently recorded increased population growth. This has largely contributed to the rise in agricultural and anthropogenic activities. This study targeted households practicing subsistence farming. While the findings indicate that the average household size was five people, the majority (92%) of the households predominantly reported agriculture as their primary source of livelihood.

Research Design

Our study used a cross-sectional survey research design to understand the variables under scrutiny. This research design was preferred because it allows for the simultaneous study of a predetermined population subset. Moreover, a cross-sectional survey is very relevant to social science research as it can be used with statistical techniques. The study was interested in observing its subjects only at a specific time, so this research design was suitable for such a study.

This study targeted households involved in farming, irrespective of the farming level. A sample of 301 households was selected proportionately from the five wards used as the study strata. Data was collected using semi-structured questionnaires on household heads. The data collected was

entered and analyzed using Statistical Package for Social Scientists (SPSS) version 23.0. Univariate analysis using frequencies was presented to show the general trends in the results. Chi-square analysis was used to test the relationship between land use rights and land use changes.

Theoretical Framework

The hypothesized nexus between land tenure and land use changes gave this paper the scientific space to investigate the impact of land ownership rights on agricultural land use changes in Mwatate sub-county. The study adopted the Neo-Malthusian theory, founded on Robert Malthus' original theory as an analytical framework. Egger et al. (2020) posit that this theory explores the impact of anthropogenic activities on land use changes, which resonates with the scope of this paper. Malthus pointed out that population growth often outstrips land's ability to provide adequate human food. This increased human population contributes to increased conflicts and anthropogenic influence on land use (Gausset, 2005; Mellos 1988). As the human population grows, pressure is exerted on agricultural land to expand to meet the rising food demand. Moreover, population growth increases the need to create spaces for settlement and infrastructural development.

Accordingly, the Neo-Malthusian theory posits that population growth results in decreased land ownership per head and consequently contributes to degradation (Chowdhury & Hossain, 2019). Notably, land tenure insecurity rises as the land per head decreases, given that land supply is limited. Whereas secure land tenure positively correlates with environmental health and sustainable agriculture, tenure insecurity promotes unsustainable agricultural practices (Murken & Gornott, 2022). Generally, the Neo-Malthusians contend that scarcity of resources results in degradation (Kahl, 2005). Therefore, it is clear that population pressure intended to boost food security results in land use changes. These changes are manifested through overgrazing, deforestation, and loss of soil fertility, which can result in biodiversity decline and land degradation.

Taita Taveta County is a global biodiversity hotspot associated with forest plantations, agroforestry, and croplands that has seen significant land use changes (Abera et al., 2022). Over the past decades, the area has experienced intensified agriculture, resulting in forest shrinkage favoring farmlands and human habitation, biodiversity loss, and general land degradation (Pellikka et al., 2004).

The Neo-Malthusian theory further acknowledges that a community's culture and traditions influence land ownership, management, and land-use techniques that, in the long run, affect land-use changes (Egger et al., 2020). Therefore, this theory was valuable for this study, as it became the basis for investigating the influence of land use rights amid population growth on land use changes witnessed at the study site.

Ethical Considerations

Ethical considerations were strictly adhered to, where ethical approval from the Ethical Review Board and a research permit were obtained before the commencement of this study. The research's ethical principles of professionalism, voluntary participation, confidentiality, anonymity of the respondents, respect, and informed consent were sought from the participants before the research tools were administered.

Results

The following section provides a univariate presentation of the frequency of occurrence of various indicators related to land ownership and land use.

Univariate Results

Household Livelihood Strategies. To understand land use patterns in the study site, the researcher sought to establish the selected households' primary livelihood source. The findings revealed that nearly half (49.5%) of the households surveyed depended on subsistence crop farming, 4.7% practiced animal husbandry, and 37.5% practiced mixed farming. Moreover, 0.4% of households reported mining as a source of livelihood, with a further 3.5% engaging in small-scale businesses. Results also showed that over half (53.3%) of households adopted intercropping as their primary farming method.

This study also revealed that more than two-fifths (44.6%) of the studied households practiced multiple agriculture associated with planting multiple crops in the same year. Shifting and sedentary agriculture were reported to be the least common types of agriculture, reported among 0.4% of the households interviewed. In general, it is evident that a more significant proportion (over 91%) of the households engaged in agriculture. Consequently, it became essential to establish the ease with which the households surveyed had access to land and the form of such access.

Land Access and Ownership Security. Land is a critical factor in agricultural production. Accordingly, an interesting observation in this study is that the majority (91.2%) of the households surveyed reported having easy access to land, with land ownership per household averaging about 2.6 acres. When probing was done by the researcher, most (85.6%) of the households interviewed reported gaining access to their parcel(s) of land through inheritance but had no land ownership documentation or title deed. On the other hand, 10.2% of respondents reported having mixed land access rights, including rented and leased land.

Taita Taveta has struggled with land ownership issues for a long time. This dates back to the colonial era when the colonial Government influenced land tenure to the disadvantage of the local community. A significant proportion of land in

Taita Taveta County is covered by Tsavo National Park, with a paltry 11% left for human settlement (Anyona & Rop, 2015). It was revealed in this study that most of the respondents hold private land ownership rights, which are mainly acquired through inheritance. While there is an established nexus between land use and ownership security, it is further observable that land ownership security profoundly affects land use decisions. Accordingly, the findings of this study revealed that 64.1% of the households reported feeling secure with their land ownership status. In comparison, 17.6% reported feeling vulnerable with their land ownership security status.

Drivers of Land Use Changes. The increase in human population continues to exert pressure on the carrying capacity of our environment. The results of this study reveal that the average household size was five people. This was slightly above Kenya's national average of 3.8 persons per household. Population growth increases demand for land, especially for human settlement and agricultural purposes. This, in essence, heavily impacts existing forests and bushes as people search for more space. Additionally, land fertility is thrown in great jeopardy, drawing the need to adopt sustainable farming techniques to optimize productivity.

Due to population growth, Taita Taveta has been prone to land cover degradation over the past few years. The findings revealed that most (70.6%) of the households interviewed agreed that deforestation is a significant driver of land use changes in the Mwatate sub-county. Furthermore, clearing bushes to make room for agriculture, infrastructure development, and human settlement were mentioned as some of the land use patterns experienced being reported by 15% of the households.

The pressure exerted on the environment by the current global demographic transition manifests itself in many folds, including the adoption of various unsustainable forms of energy. As the population grows, the existing resources are easily outnumbered, creating room for adopting any available means. Accordingly, we established that over three-fifths (67.1%) of the households interviewed relied on firewood as a source of cooking energy. In comparison, only 5.4% of the selected households reported using charcoal as a source of cooking energy, 2% reported using biogas, and 25.5% reported using a combination of firewood, charcoal, and biogas. Furthermore, the findings show that more than half (53%) of the studied households agreed that tree logging was a problem in the study area. This finding is particularly poignant given that most (72.5%) of the selected households reported relying on charcoal and firewood for cooking energy.

Taita forests are categorized as Government lands that have been protected. Given the proximity and ease of access to these forests, it was observed that many locals resorted to harvesting trees from these forests. Continued harvesting of these energy sources without renewal mechanisms accounts for increased changes in land cover and probably calls for

land use changes as a coping mechanism. We further probed to establish whether the community was aware of the impact of various land use patterns on the quality of the environment. Figure 1 summarizes the findings.

It is observed that most households know that various anthropogenic activities significantly impact the quality of our environment. Overgrazing of fields contributes to increased degradation of agricultural land, according to 70.8% of the sample, and intensive agriculture contributes to increased degradation of agricultural land, according to 75.3%. Further, 69.6% and 75.9% of the households reported that they were aware that clearing more land for human settlement and agriculture, respectively, interferes with biodiversity and thus affects environmental quality.

From the analysis, 72.8% and 64.5% of the households involved in the survey reported that soil erosion and pollution from agricultural chemicals were issues on their farms, respectively. It was also discovered that most (75.5%) households reported that soil fertility was a significant issue affecting farm productivity. An interesting observation, however, is that despite acknowledging the existence of harmful land use patterns, only slightly over half (51%) of the respondents saw real value in the need to conserve Taita forests, a valuable biodiversity spot in the county and country.

The researcher further determined some of the mechanisms the community considered useful in limiting some of the land degradation activities in the study site. It was encouraging to note some of the suggestions put forth. It was noted, for example, that most respondents were willing to adopt sustainable practices, as depicted in Figure 2.

The study results in Figure 2 revealed that over three-fifths (67.7%) of the households surveyed agreed on the importance of maintaining buffer zones between agricultural and non-agricultural land areas, particularly forests. It is also clear that

while a majority (93.2%) and (91.4%) of the selected households were willing to replant trees or reduce tree cutting, respectively, only over three-fifths (65.5%) saw the need to reduce charcoal burning. Other observations were made by 85.9% and 78.7%, who said they were willing to reduce tree harvesting and that livestock farmers should embrace zero grazing to reduce the impact of livestock on land use changes, respectively.

Chi-Square Analysis of the Nexus Between Land Ownership and Land Use Changes

Chi-square analysis, a statistical technique that helps determine the existence and significance of relationships among categorical variables, was employed in this study. While the univariate analysis presented percentages of variables considered, the Chi-square analysis was helpful in this study in establishing the influence of private land ownership rights on changes in land use. This study established land use changes, including deforestation, land clearing for agriculture, human settlement, and agricultural expansion. A significance level of 5% was used to test for a significant relationship between the independent and dependent variables. A variable was considered significant if its P-value was less than 0.05.

In this study, land tenure security was determined based on possession of a land title deed. Thus, a household was deemed to have tenure security when it had formal land ownership documents such as a title deed. The absence of such formal land ownership documentation was regarded as land tenure insecurity. The variation in land tenure status among the studied households was then correlated with the various land use changes under scrutiny. Table 1 presents Chi-square statistics for variables that were found to have a significant

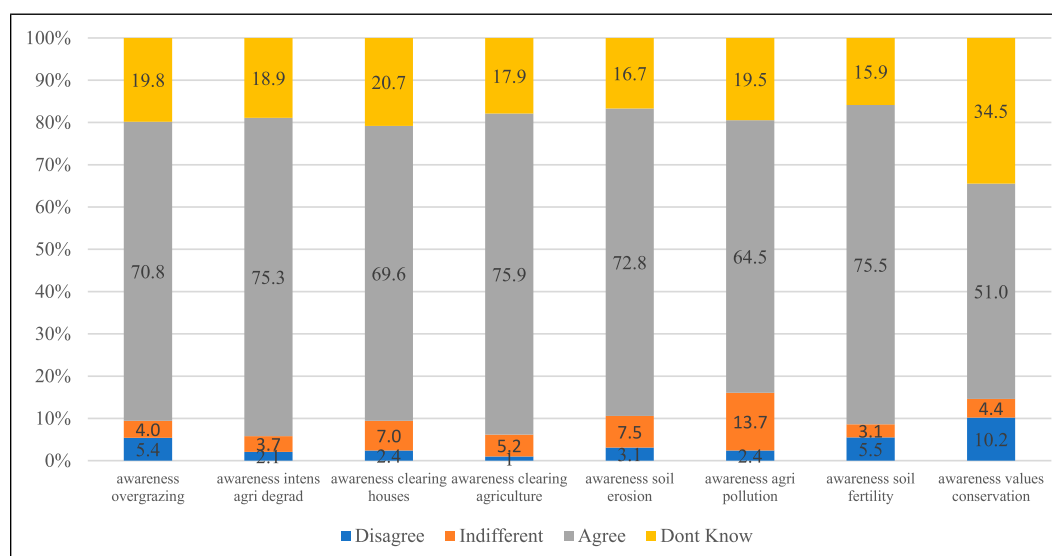


Figure 1. Level of awareness of unsustainable land use activities.

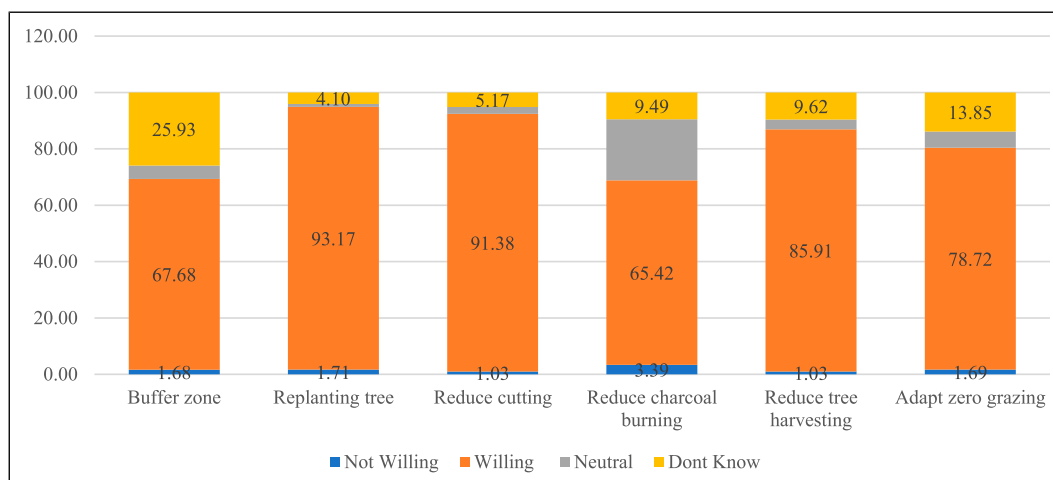


Figure 2. Willingness to adopt better land use.

Table 1. Chi-square Test Results Table.

	Chi- square value	P-Value
Farming technique	566.845	0.001*
Agricultural expansion	262.684	0.001*
Deforestation	31.002	0.03*
Clearing human settlement	40.135	0.02*

*P < .05.

relationship. Results reveal a significant relationship (Chi-square value of 31.0002; P value of 0.03) between private land ownership status and land use changes indicated by deforestation.

Second, we established that clearing bushes for agricultural expansion is significantly associated with land tenure, with a P value of 0.02 and a Chi-square value of 40.135. Third, the expansion of agricultural activities was primarily influenced by land tenure insecurity, revealing a P value of 0.01 and a Chi-square value of 262.684. Finally, test results show that land ownership status influenced the choice of farming techniques, with a P value of 0.001, meaning the relationship was significant at 0.05 and 0.01 and a Chi-square value of 566.845.

Discussion

Land is a crucial part of a people's identity, and its ownership has deep cultural connotations (Onguny & Gillies, 2019). Thus, many communities see land ownership as a symbol of wealth and security. However, even though land tenure is critical in attaining improved agricultural productivity, land tenure insecurity is rampant in sub-Saharan Africa (Mbudzya et al., 2023). This is because, on the one hand, sub-Saharan Africa's traditional land tenure system complicates the land ownership matrix, where tenure security cannot be achieved

through title deed land ownership (Kang'ethe, 2012). Secondly, during the colonial period, most land tenure systems were designed for the benefit of white settlers and were further complicated by the departure of the white settlers at independence (Mbudzya et al., 2023). As a result, most African countries were forced to adopt hybrid, colonial, and traditional land tenure systems.

However, despite the land reforms emphasizing the titling of land as a form of formal ownership, our study results established that most respondents in Taita Taveta County had acquired their land through inheritance. Land issues, especially land ownership, are thorny in the region and date back to the colonial period. It is, therefore, not surprising that with the insecurity of land ownership in the study site, these forms of land use patterns were widespread. An interesting observation emerging from the findings of this study is that while ownership of land was through inheritance, most of the households felt secure about it. This is because land inheritance provided a sense of belonging and an ancestral connection.

The land tenure insecurity challenge is also experienced in Kenya. First, land ownership in Kenya is highly political, with two predominant land tenure systems categorizing land ownership as public, communal, or private (Waswa et al., 2002). The political nature of land ownership in Kenya is a product of land reforms that mainly advocated for land tenure security through legal land titling (Mbudzya et al., 2023). This, in essence, is a loophole in favor of land grabbers who take advantage of most lands held under customary land systems in the country. Moreover, the increase in population coupled with the need to privatize land has had immense influence on land subdivision and fragmentation, increasing tenure insecurity (Mbudzya et al., 2023). Subdivision of land reduces agricultural land into small land units that are not agriculturally viable.

However, despite recognizing land ownership through the ancestry route, the Government of Kenya encourages

legalized private land ownership through titling (Cacciarru, 2013). This presents a precarious dichotomy where, even though the claim to land was based on solid ancestry ties, the formal land ownership in the region is still a challenge. Current land reforms in Kenya require formalized land ownership through title deeds. This creates a legal loophole for land grabbers who eventually prey on households with inherited land. Taita Taveta County has a historical challenge with land ownership. There are reported cases of land grabbing and large corporations that own vast land estates for Sisal farming. Moreover, this problem is compounded by the county's proximity to the Tsavo National Park, where human-wildlife conflict is also rife.

Land ownership is an incentive for sustainable land use patterns. Therefore, tenure insecurity associated with inherited land often leads to either land overuse or degradation (Washim et al., 2014). The lack of land tenure security creates uncertainty around future access to such land, leading to the need for instant gratification at the expense of the future. Notably, even though respondents reported secure land ownership, the lack of formal land ownership documentation occasioned by land inheritance has a negative impact on tenure insecurity. This is because Taita Taveta is prone to many land issues associated with mining, large corporation land ownership, sisal estates, and human-wildlife conflicts. All these, combined with the slow and complex land adjudication processes, have inherently contributed to insecure land tenure, affecting sustainable land use patterns (Waswa et al., 2002). This finding is profound for this study, as it clarifies the nexus between land ownership and land use changes.

Agriculture is a source of livelihood for most households in many developing countries (Mountford et al., 2018). We established that the households surveyed were engaged mainly in subsistence farming. In Kenya, the agricultural sector employs more than 80% of the population (Mwagore, 2003). However, Paneque-Gálvez et al. (2013) posit that insecure land ownership rights increase tendencies for agricultural expansion. The global increase in food insecurity has paved the way for agricultural expansion and intensification (Gutzler et al., 2015). However, this has been worsened by insecure land tenure, where the intensive increase of agricultural land use harms the soil quality, thereby reducing food production.

Moreover, the increase in global population not only increases demand for food but also leads to agricultural intensification. Our study reveals that respondents reported having cleared bushes to increase agricultural spaces. Additionally, Chi-square statistics from our results reveal a significant correlation between land ownership, the expansion of agricultural spaces, and the clearing of bushes for human settlement. Agricultural activities account for a more significant proportion of agricultural land use changes observed in developing countries, altering their biodiversity profiles (Hettig, 2016). All these results are witnessed

through the unsustainable use of agricultural land that accelerates land use changes.

Land degradation due to poor farming practices derails food insecurity intervention mechanisms (IPCC, 2019). These include unsustainable farming practices such as heavy reliance on machinery, intensive cropping, short crop rotations, and overgrazing (Kanianska, 2016). It is noted, for example, that continuous cropping reduces the quality and productivity of agricultural land (Maitima et al., 2010). This is why (Kundu et al., 2021) advocate using conservation agriculture to reduce disturbance on agricultural landscapes. Agriculture should ensure increased land productivity and improve environmental quality (OECD, 2001). Since it was established that most households had insecure land tenure, this result correctly predicts the association between land ownership and land use changes.

Moreover, while crop rotation helps in soil regeneration, a short cycle crop rotation leads to soil compaction. Our study results establish that most households used short-term crop rotation farming techniques. Whereas this can directly be linked to insecure land ownership and alienation, this farming technique does not incentivize sustainable farming techniques. Unsustainable agricultural systems contribute to environmental degradation by promoting soil erosion, a significant component of land use changes (Borrelli et al., 2020). Additionally, households reported deforestation, particularly those living adjacent to forests. This is interpreted as an outcome of human-wildlife conflict and a general lack of environmental stewardship due to insecure land tenure. This aligns with the observations made by Faingerch et al. (2021), who found that insecure land tenure contributes directly to deforestation. Furthermore, commercial, private, fuelwood, and charcoal burning were reported even as (Mwagore, 2003) notes that wood is the primary fuel source in many Kenyan households.

Therefore, secure land tenure is associated with environmental conservation, whereas insecure land ownership is associated with clearing forests in favor of agricultural land (Mwagore, 2003). Our findings reveal that encroachment by deforestation on forests adjacent to homesteads had occurred on a large scale. Furthermore, we further noted in the study's findings that there was widespread tree logging and charcoal burning, with the primary forms of cooking energy being fuelwood. Taita Taveta has been synonymous with deforestation and tree logging for charcoal and fuel wood (Pellikka et al., 2013). In this case, it is safe to conclude that land ownership directly affects the conservation of forests, a significant global land cover source.

Limitations of the study

Some limitations were observed in our study. Firstly, this study was conducted at the height of the COVID-19 pandemic, which had restrictions regarding direct human interaction. As a result of the social distance required, some

households were unwilling to participate in the survey. Nevertheless, we observed the WHO health guidelines and got a representative sample.

Secondly, current studies have criticized the Malthusian claim that population growth strains the environment and that technology is instrumental in increasing food production without compromising environmental integrity (Bergthaller & González, 2018; De Jong and collaborators, 2021; Unat, 2020). However, the Neo-Malthusian theory acknowledges a correlation between land ownership and land use changes (Gleditsch, 2021). The theory further observes that this association could depend on household consumption patterns (Collins, 2002; Ivanova and collaborators, 2016; Unat, 2020). However, our study did not directly delve deep into understanding household consumption patterns. We consider this to be a potential limitation of our findings. Therefore, it is notable that other than land ownership security, consumption patterns could also explain land use changes.

Thirdly, we note that Taita Taveta County is categorized as one with a relatively high poverty prevalence (Wakesho and collaborators, 2022). Globally, a correlation between poverty and land use intensity has been considered. Our study did not directly consider the effects of poverty on land use changes, even though we remain cognizant of this association. However, we note that the low-income levels witnessed among households could also explain land use changes.

Lastly, land management in Kenya is highly centralized, so planning for land management for emerging and region-specific issues is challenging (Ogutu, 2019). Taita Taveta is facing many land issues, including land adjudication, which are affected by local contexts, including mining, large sisal estates, and land grabbing. This is coupled with Tsavo National Park occupying a more significant part of Taita Taveta County, leaving little space for human settlement and agricultural activities. This has caused an increase in human-wildlife conflicts. As such, no specific government programs are responsive to these issues. We acknowledge that these issues, alongside administrative bureaucracies and a weak land use policy, could explain the existing land use changes in Taita Taveta County.

Implications to Conservation

Anthropogenic forces have a profound impact on land use changes. Our results confirm that these changes can be accelerated by land tenure insecurity. Notably, various forms of land degradation due to unsustainable land use patterns have been reported in Taita Taveta. These include deforestation, tree logging, agricultural expansion, overgrazing, and soil erosion. Existing evidence denotes that Taita Taveta County, a vital biodiversity spot, has experienced alarming degradation rates.

There is an existing nexus between land ownership security and land use changes. This is because secure land ownership rights incentivize sustainable land use patterns,

whereby tenure security continuously increases the guarantee to draw benefits from such land. Our research findings reveal that most households had insecure land ownership rights, mainly acquired through inheritance. The existing land reforms in Kenya put a premium on title deeds as proof of land ownership. Whereas land inheritance is acceptable in law, these land reforms have created room for land grabbers who can obtain title deeds for inherited land, creating land tenure insecurity. Even though customary land inheritance is recognized in Kenya, it generally does not directly confer the legal right of ownership and, as such, lacks security of tenure. The lack of land tenure security is a disincentive to environmental management, resulting in land degradation.

Therefore, our survey results show that land tenure insecurity could partly explain the existing land degradation issues in Taita Taveta. Most households were found to be subsistence farmers. Amid the rising population, there is increased demand for human energy, settlement, and agriculture. It is not surprising that deforestation, bush clearing, increased agricultural activities, and tree logging were also observed, especially in Taita Taveta forests. Given the land ownership insecurity that characterizes most households in the study site, we call on the need to streamline the land tenure system in Kenya. Specifically, Kenya's Government and relevant land departments must take bold steps to encourage and ease the land registration and titling process. This could be achieved in multiple layers, starting from the household, societal, and government levels. Agricultural extension education promoting sustainable agricultural practices and farming techniques must be improved. These techniques should be responsive not only to productivity but also to land degradation.

Furthermore, because Taita Taveta is a biodiversity hotspot, this study highlights the need to increase environmental awareness and education among the locals in the study site about the importance of conserving natural resources, particularly forests. This would mitigate climate change's effects on agriculture and sustainably achieve environmental resource use. This can be accomplished by encouraging tree planting, zero grazing, reducing charcoal burning, and logging trees.

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