

## REVIEW ARTICLE OPEN ACCESS

# Impacts of Land Tenure Security on the Conversion of Agricultural Land to Urban Use

Saghi Movahhed Moghaddam<sup>1</sup>  | Hossein Azadi<sup>2</sup>  | Petr Sklenička<sup>1,3</sup> | Kristina Janečková<sup>1</sup>

<sup>1</sup>Faculty of Environmental Sciences, Czech University of Life Sciences Prague, Prague, Czech Republic | <sup>2</sup>Department of Economics and Rural Development, Gembloux Agro-Bio Tech, University of Liège, Gembloux, Belgium | <sup>3</sup>Institute of Environmental Studies Karlovy Vary, Czech University of Life Sciences Prague, Prague, Czech Republic

**Correspondence:** Saghi Movahhed Moghaddam ([movahhed\\_moghaddam@fzp.czu.cz](mailto:movahhed_moghaddam@fzp.czu.cz))

**Received:** 15 April 2024 | **Revised:** 15 January 2025 | **Accepted:** 13 February 2025

**Funding:** This study was supported by the Internal Grant Agency of the Faculty of Environmental Sciences, Czech University of Life Sciences Prague, No. 2024B0006, and the Operational Programme Just Transition, No. CZ.10.01.01/00/22\_001/0000287 "Smart Landscape 2030+.

**Keywords:** cadastral assignment | legal status | meta-regression | ownership | tenure type

## ABSTRACT

Land tenure security influences several processes relevant to the long-term sustainability of farmland management, including agricultural land conversion to urban use (ALCU). This phenomenon has been illustrated by several studies, mainly on the scale of individual countries. However, there is a noticeable lack of global-scale analyses examining how different aspects of land tenure affect ALCU. To address this gap, we have conducted a meta-analysis of 62 studies that provide quantitative insights into the effects of land tenure variables on ALCU. We used Comprehensive Meta-Analysis (CMA) software to extract data from original articles, including land tenure type (expressed as land farmed by its owner and land farmed by a tenant), legal status (titled land and untitled land), cadastral assignment (designated and not-designated agricultural land), and land ownership (private land and communal land). We have found significant effects of all these aspects of land tenure on ALCU. Land farmed by its owner was the most substantial factor protecting agricultural land from urbanization, with a 3.42% decrease in ALCU. We also observed a 2.97% decrease in ALCU on titled land, a 2.62% decrease on designated agricultural land, and a 1.85% decrease on land that was privately owned. The application of findings and implications for policymakers are substantial: (i) efforts to secure land tenure, especially in underinvested areas, can minimize the degradation of land resources and facilitate better farmland preservation, (ii) the support of owner-operated farming, land titles, private ownership of land, and designated agricultural land is conducive to sustainable farmland management, and (iii) the synergic effect of promoting land tenure security should be utilized to protect agricultural land from conversion to urban uses.

## 1 | Introduction

Land conversion is defined as a process of change in the character and use of land that is often irreversible (Busko and Szafranska 2018; Ustaoglu and Williams 2017). In most reported cases, land is converted from agricultural to urban use (Soriano et al. 2019), resulting in a global phenomenon that is on a steep rise due to accelerated economic development and population growth (Ma et al. 2020; Kirschner et al. 2022).

Given the limited and non-renewable nature of land supply, intense competition arises between agricultural and non-agricultural sectors for land use. Consequently, agricultural land conversion becomes prevalent, markedly diminishing agricultural land availability and threatening food security (Loehr 2012). Ironically, in many countries, especially those where agriculture is the main source of income, agricultural land conversion for urbanization is the prevailing type of land use change (Alphan 2003; Azadi, Barati, Nazari Nooghabi,

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2025 The Author(s). *Land Degradation & Development* published by John Wiley & Sons Ltd.

et al. 2022; Das et al. 2022). As local governments or investors in developing countries have realized that urban development is much more affordable on agricultural land than on old urban residential land, there is a greater demand for agricultural land conversion for urbanization (ALCU) (Azadi et al. 2011). In recent years, ALCU has significantly varied by region, but global rates are concerning. According to estimates, between 2000 and 2020, ~4%–7% of agricultural land was converted to urban areas. Asia has one of the highest rates of ALCU, ranging from 6% to 8%, because of rapid urban expansion in countries like China and India. Despite rapid urbanization, Africa has a lower overall percentage of ALCU, because of its considerable rural population and inadequate infrastructure, with conversion rates of 3%–5% for agricultural land. More robust urban planning and land-use laws have resulted in lower conversion rates in Europe, which are about 2%. In North America, ~11 million acres of agricultural land were converted to urban or other non-agricultural uses between 2001 and 2016, making up 2% of all agricultural land on average (Spangler et al. 2020). South America (or Latin America) has mixed rates. In some countries (e.g., Brazil), logging and mining are the primary drivers of agricultural land conversion, but the overall rate of urbanization is about 3% (Cabernard et al. 2024; Ritchie and Roser 2024).

Uncontrolled ALCU, driven by high population density and rapid economic growth (Ho and Lin 2004; Munroe and Müller 2007), has serious consequences for agricultural production, farmers' livelihoods, and the availability of ecosystem goods and services generated by agricultural lands. Rondhi et al. (2018) argued that ALCU is an incentive-driven process used to convert agricultural land, decreasing agricultural production and threatening food security. According to Suu (2009), the disruption of farmers' traditional livelihoods is another significant effect of ALCU. Land conversion has resulted in growing disparity in access to land use rights among farmer households, and especially in the loss of traditional livelihoods, as the majority of the taken land is agricultural land in the densely populated lowland areas near metropolitan centers. At the same time, land tenure security has been recognized in this context as a vital factor in promoting social equality, eradicating poverty, developing sustainable agriculture, and preserving natural resources (Azadi, Barati, Nazari Nooghabi, et al. 2022; Azadi, Burkart, Movahhed Moghaddam, et al. 2022; Nhamo et al. 2022).

Land tenure security is determined by characteristics of land use and ownership, such as private/communal land, land farmed by owner/tenant, titled/untitled land, and designated/non-designated land. In this study, "private land" refers to land owned by an entity or individual, while "communal land" refers to land that is collectively owned or managed by a community or group of people (Gottlieb and Grobovšek 2019; Lipski 2015). It should be noted that there is a third type of land ownership, "public (or state-owned)" land, which is owned and managed by a government or public authority on behalf of the state (Wily 2011).

However, as none of the relevant studies were concerned with state-owned land, this type of ownership does not occur in our study. Land can be either farmed by its owner (in our study, this

owner can be either private or communal), or by a tenant based on a lease contract of variable duration. "Titled land" refers to land with legally recognized ownership documentation, while "untitled land" lacks formal legal titles. The term "designated agricultural land" refers to land that has been formally recognized or assigned for agricultural purposes by land-use planning policies, while "non-designated land" lacks this formal recognition (Dadashpoor and Ahani 2019; Payne 2001, 2004).

A high level of land tenure security stimulates incentives that boost investment and effective use of resources, promoting better access to land (Deininger and Jin 2006; Bennett et al. 2012), and provides official recognition that prevents the illegal conversion of agricultural land for urban purposes (Katusiime and Schütt 2020; Wang et al. 2022). Tenure security also defines the conditions of access to and the use of land resources, including the rights to use, control, and transfer (Deininger and Jin 2006). Land property rights contribute to marginalized groups by increasing food security, economic growth, natural resource management, and agricultural productivity while reducing socio-economic inequalities (Lawry et al. 2017; Tong et al. 2018; Zhu et al. 2020). Secured land tenure has, therefore, been shown to provide support for profitable agriculture that is less environmentally destructive and more economically viable (Bahn et al. 2021; Mishenin et al. 2021).

Several studies (Aguiar et al. 2022; Azadi 2020; Paltasingh et al. 2022; Searchinger et al. 2018; Verburg et al. 2019) have examined the relationship between tenurial arrangements and farm investment and farm efficiency. They have suggested that in this context, tenure security in terms of the formalization of land rights, tenancy arrangements, and transparent ownership status can enhance farm investments. For example, the results of Paltasingh et al. (2022) showed that determining tenancy arrangements will lead to enhanced farm investments. Their results also showed that efficiency is favorably influenced by ownership status in landholding as a whole, demonstrating that owner-operators are more effective than partly tenants and tenants. According to Suchá et al. (2020), land tenure security is essential for facilitating investments in urban agriculture, especially in regions rapidly becoming more urbanized in Soweto, South Africa. Secure land tenure contributes to promoting long-term productivity and food security in urban areas and to increasing farmers' willingness to invest in sustainable agricultural practices. Conversely, insecure land tenure discourages investment, reducing urban agriculture's ability to support livelihoods and environmental sustainability. These results highlight how important it is to incorporate tenure security into urban land-use policies to balance agricultural sustainability and urban growth. Other studies such as Deininger and Ali (2008); Abdulai et al. (2011); Ali et al. (2012), and recent studies such as Byamugisha and Dubosse (2023) in Sub-Saharan Africa and Vu and Goto (2020) in Vietnam have also confirmed the beneficial influence of secure land tenure on farm-level investment decisions. However, infrastructural factors such as inappropriate or fragmented farm size and labor shortages can undermine profitability (Olumba et al. 2021; Sánchez et al. 2022; Stringer et al. 2020).

Evidence shows that land tenure security can promote farm investment. This is achieved by enhancing access to capital,

as secure land tenure allows farmers to leverage their land as collateral in the credit acquisition process (collateralizable effect), enhancing the claim for land investment return (assurance effect), turning the land trade around from inefficient to efficient (transferability effect), and providing more opportunities for innovation (Bambio and Bouayad Agha 2018). Regarding economic and social benefits, Byamugisha and Dubosse (2023) performed a cost–benefit analysis of land tenure security to examine its transformative potential for agricultural development and poverty alleviation in sub-Saharan Africa. According to their study, secure land tenure encourages long-term investments in sustainable practices and land improvements, which have significant positive social and economic effects.

Overall, the literature emphasizes the beneficial impact of secure land tenure on investment and socio-economic potential (Fenske 2011; Lawry et al. 2017). Investment in land can increase tenure security, but tenure security itself might be strengthened by land investment, especially for informal land rights (Fabusoro et al. 2008; Chigbu et al. 2019; Alemu and Tolossa 2022; Ulukan et al. 2022). Multiple studies (Moor 1996; Fenske 2011) have shown that investment in land benefits from secured land tenure. Other findings underline the fact that wealth impacts, pre-existing tenure institutions, and complementary, holistic institutions all play a role in how land tenure affects land investment (Perera et al. 2018; Gounaridis et al. 2019; Malek and Verburg 2020).

Suu (2009) described a scenario where the land tenure system has yet to recognize an adequate level of private property in relation to land, and where ALCU has consequently become a contentious issue and has frequently disrupted farmers' traditional livelihoods, forcing them to face insecure livelihood prospects. Land-related issues in developing countries are economically, socially, ecologically, technically, culturally, and politically multiplex. Thus, multidisciplinary interventions are necessary (Mdege et al. 2022; Totin et al. 2021) to enhance farm investment. To sum up, land tenure security is firmly rooted in cultural and socio-economic aspects, and dealing with it may necessitate long-term and inclusive approaches.

As shown in Table 1, several review studies have investigated land tenure security in different aspects, with varying levels of focus on its relationship to land conversion. For example, Payne (2001) focused on urban land tenure issues and policy options by analyzing different types of land tenure (e.g., customary, private, public, religious) and property rights. In a similar study, Payne (2004) paid more attention to selected tenure systems such as registered/unregistered and documented/undocumented land and placed them in the global context of land and housing markets. Robinson et al. (2014) performed a meta-analysis to discover the relationship between tropical deforestation and land tenure. To better understand the broad linkages between the form of tenure, security, and forest change, they selected literature that links land tenure and forest outcomes. In a few recent review studies, researchers have investigated various aspects of land tenure security, such as the impact of urbanization expansion on agricultural land (Ayele and Tarekegn 2020), registration and administration of land rights (Valkonen 2021), the human development approach to land tenure security (Abdillah et al. 2022), and the nexus of land tenure, food security, gender,

and urbanization (Nchanji et al. 2023). However, there is a research gap in understanding the impacts of land tenure security variables on ALCU at the global level. Furthermore, the effect of converting land use from agriculture to urbanization has been thoroughly studied, but most of the existing literature consists of case studies with different definitions and approaches that concentrate on single countries or regions. Despite their value, these studies have limited generalizability concerning the global factors influencing ALCU. Moreover, until now, there has been little investigation into the synthesis of findings through meta-analyses, which are often restricted to specific forms of tenure security or geographical contexts. Therefore, to the best of our knowledge, no study has yet systematically examined the quantitative impacts of various facets of land tenure security (such as ownership type, land titles, and cadastral designation) on ALCU globally, using a meta-regression approach. This study's methodological approach is novel, as it uses meta-regression to aggregate quantitative data from multiple studies and determine the specific impacts of various land tenure aspects on ALCU. In addition to offering a global perspective, the study offers policy-relevant insights that could direct regulatory frameworks and land use planning efforts to protect agricultural land and minimize the negative social and environmental effects of ALCU.

Therefore, to address the research gap and to derive a better understanding of the links between land tenure security and agricultural land conversion, this study aimed to (i) make a critical review of articles that have examined land tenure security affecting ALCU, (ii) explore the patterns of land tenure security linked to ALCU, and (iii) provide recommendations for strengthening global land tenure security in the future.

## 2 | Methodology

Our study has used a meta-analysis (Vesco et al. 2020; Woodcock et al. 2014) to synthesize the impacts of land tenure variables on ALCU on a global scale. Quantitative results are synthesized to examine the validity of the effects obtained in the original articles on a larger scale. The effects were estimated through a meta-regression in which multiple variables interact (Röver and Friede 2023). Table 2 summarizes the land tenure security variables used in this meta-regression. Each of the studied land tenure security variables, that is, Land ownership, Legal status, Tenure type, and Cadastral assignment, assumed values that reflect the dichotomic categories used in the original studies.

### 2.1 | Data Collection and Inclusion and Exclusion Criteria

During an initial search (Pigott and Polanin 2020), several databases including Web of Science, ScienceDirect, Springer, Oxford University Press, ProQuest, and SID were thoroughly investigated to identify original studies. The time scope for the studies was between the years 2000 and 2023. The main keywords used to obtain data were “land tenure,” “land tenure security,” “private land,” “communal land,” “titled land,” “untitled land,” “land farmed by owner,” “land farmed by tenant,” “designated agricultural land,” and “agricultural land conversion.” Overall, 4236 original articles were found in the initial search.

**TABLE 1** | Several examples of review studies conducted by researchers worldwide.

Study	Variables										Case study
	Ownership		Legal status		Tenure type		Cadastral assignment				
	Private land	Communal land	Titled land	Untitled land	Land farmed by owner	Land farmed by tenant	Designated agricultural land	Not-designated agricultural land	ALCU		
Payne (2001)	X	X									Global
Payne (2004)		X	X	X							Global
Robinson et al. (2014)	X	X	X								Continental
Robinson et al. (2018)	X	X	X								Global
Kenfack Essoungong and Tegua (2019)	X	X						X	X	X	Regional
Alban Singirankabo and Willem Ertsen (2020)			X	X	X	X	X	X	X		Global
Ayele and Tarekegn (2020)		X			X		X			X	National
Valkonen (2021)	X	X	X	X							Global
Abdillah et al. (2022)			X	X							Regional
Nchanji et al. (2023)	X	X	X							X	Regional

**TABLE 2** | Definition of the main land tenure security variables.

Variables	Values	Definition
Ownership	Private land	Land owned by individuals, families, corporations, or other private entities
	Communal land	Land owned or managed collectively by a community or group
Legal status	Titled land	Land registered in the real estate register
	Untitled land	Land not registered in the real estate register
Tenure type	Land farmed by owner	Land farmed by individuals, families, corporations, or other private entities who own this land
	Land farmed by tenant	Land farmed by individuals, families, corporations, or other private entities who rent this land from other subjects
Cadastral assignment	Designated agricultural land	Land designated in the cadastral system for agricultural purposes
	Not-designated agricultural land	Land not designated in the cadastral system but used for agricultural purposes

The second step was to select articles focusing on the impact of land tenure security on ALCU in their titles and abstracts, which resulted in 1252 articles. In the third step, we selected papers written in English that contained quantitative data on the land tenure security impacts and its variables (as defined in Table 2) on ALCU. This step resulted in the selection of 93 journal articles. In the fourth step, the effect sizes were considered among different aspects of land tenure security on ALCU in the original articles, to exclude papers that failed to provide the necessary data to calculate percentage differences. We calculated the percentage differences between land tenure security variables for all outcome values to obtain uniform effect sizes, as we go into further detail in the following section. Overall, in this step, the total number of original articles was narrowed down to 62. In November 2023, the literature search was completed.

## 2.2 | Data Processing, Extraction, and Combination

In this study, ALCU was the dependent variable, and the independent variables were land ownership, legal status, tenure type, and cadastral assignment. This meta-analysis focused on the effect of land tenure security and its variables on ALCU.

Individual studies measured outcome variables in different units (e.g., yields are measured in tons or kg per acre or ha; income can be measured in local currency, US dollars, or percentage increase). Therefore, to have uniform effect sizes and to prevent the problem of heterogeneity, which frequently occurs in meta-analysis studies (Meemken 2020), the percentage differences between variables were considered as the unit. Percentage differences have a unique benefit over other standardized effect size measures in that they can be calculated without considering variance. This feature is particularly useful when dealing with studies where variance information is frequently omitted. Furthermore, percentage differences are favored in this context due to their simplicity and ease of comprehension (Klümper and Qaim 2014). Weights are assigned to individual results based on the sample size of their respective studies, while cluster corrections are also applied for observations from shared datasets.

This approach allows us to derive the average mean and median effect sizes. In this study, the median effects are estimated using quantile regressions.

The variability in the methodologies of the analyzed articles, which is a significant challenge of meta-analysis studies (Vesco et al. 2020), was factored into the analysis via several additional variables such as time, space, type of article, and methodology applied. Then, the variables were categorized as continuous (i.e., time) or dummy (i.e., space, type of article, and methodology applied). To perform the analysis, a dummy variable was assigned a value of 1 if it showed the defined variable (e.g., study area); otherwise, it was assigned a value of 0.

The coefficient of determination, or  $R^2$ , is a statistical criterion for determining data accuracy, since it reflects the percentage of variance in the dependent variable based on the independent variables defined in the regression model. Using Comprehensive Meta-Analysis (CMA) software, we extracted the data from original articles that analyzed the quantitative impact of land tenure security on ALCU. Overall, the results presented in the original articles were summarized using a meta-analysis of statistical methods, and the mean effects of land tenure security on ALCU were estimated by integrating the effect sizes from the output of the collected articles.

## 3 | Results

### 3.1 | Descriptive Statistics

The original articles capture different aspects of land tenure, including ownership, legal status, tenure type, and cadastral assignment (Table 3). Among the selected articles, most of the studies focused on land ownership (24 articles). The other classes of legal status, tenure type, and cadastral assignment were studied in 16, 14, and 8 articles, respectively.

Figure 1 displays the spatial distribution of the 62 original studies. Research for the articles was done across 17 different countries on the continents of Africa, South America, North America, Asia,



Europe, and Oceania. The largest proportion of the studies—20 articles, or 32.2%—were performed in Asia; the most widely represented country was China (10 articles, or 16.1%). Four original articles studied several countries at once, while the rest of the original articles focused on only one country.

Figure 2 illustrates the temporal trend of the studies. There is an increasing trend in numbers from old studies to more recent studies. Between 2000 and 2003, only 2 studies were performed, and between 2004 and 2007, the number was 8. The largest number of studies (17 articles; 27.4%) was conducted between 2016

and 2019. As shown in Figure 2, the number of studies on the impact of land tenure security on ALCU has increased considerably since 2015, highlighting the increasing focus on this topic.

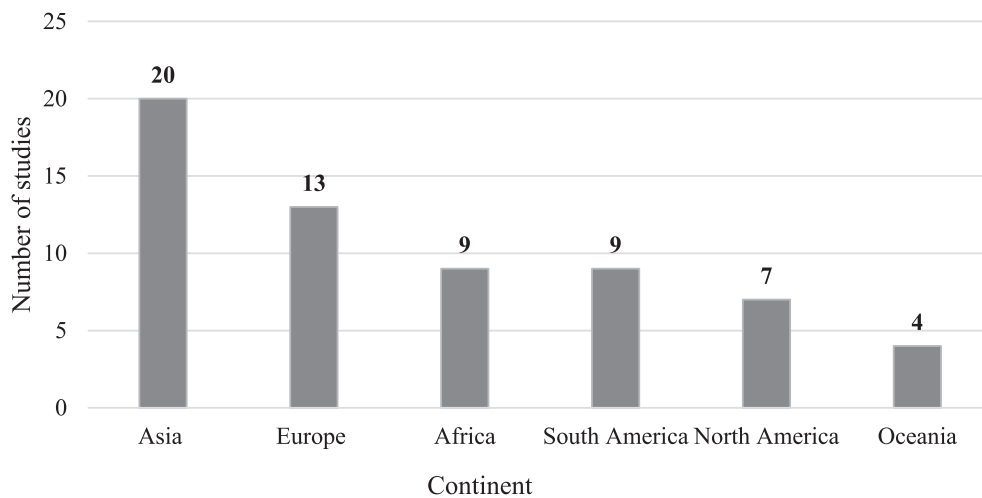
### 3.2 | Meta-Regressions

Results of meta-regression in CMA are listed in Table 4 and Figure 3. The results show that ALCU has been affected by all studied land tenure variables: land ownership, legal status, tenure type, and cadastral assignment. More specifically, ALCU has been found to occur significantly less on private land (mean effect:  $-1.86$ ,  $p \leq 0.01$ ), on titled land (mean effect:  $-2.97$ ,  $p \leq 0.01$ ), on land farmed by its owner (mean effect:  $-3.42$ ,  $p \leq 0.01$ ), and on designated agricultural land (mean effect:  $-2.62$ ,  $p \leq 0.01$ ). The opposite parts of land tenure security variable dichotomies, as mentioned in the original articles, did not have a significant effect on ALCU. The variables included communal land (mean effect: 1.92), untitled land (mean effect: 7.96), land farmed by tenants (mean effect: 2.64), and not-designated agricultural land (mean effect: 4.47). The highly significant impacts of land tenure variables on ALCU, illustrated in Figure 3, are the most relevant results of this study.

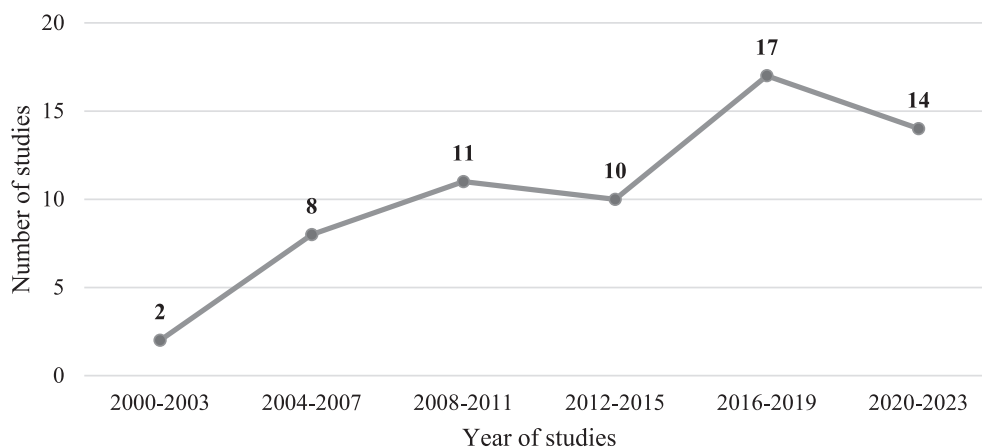
**TABLE 3** | Overview of the original articles focusing on land tenure features.

Land tenure	Number of original articles
Ownership	24
Legal status	16
Tenure type	14
Cadastral assignment	8

Source: Study findings.



**FIGURE 1** | The spatial distribution in different continents Source: Study findings.



**FIGURE 2** | The temporal trend of the studies Source: Study findings.

**TABLE 4** | Results of meta-regression in CMA.

Variable	Values	Land use impacts		
		ALCU		
		Mean effect	Median effect	Standard error
Ownership	Private land	−1.86***	−1.96***	0.25
	Communal land	1.92	2.05	1.62
Legal status	Titled land	−2.97***	−3.20***	4.92
	Untitled land	7.96	7.10	0.40
Tenure type	Land farmed by owner	−3.42**	−3.22**	1.83
	Land farmed by tenant	2.64	2.27	1.89
Cadastral assignment	Designated agricultural land	−2.62***	−2.66***	0.52
	Not-designated agricultural land	4.47	3.20	3.20
Time	Year of data collection	0.35	0.20	0.76
Space	Africa	−1.39	−0.14	1.41
	South America	4.16**	3.14**	1.94
	North America	3.25	2.11	2.01
	Asia	1.46	0.32	1.09
	Europe	−0.80	−0.21	1.42
	Oceania	−0.71	−0.06	2.06

Note: \*\* and \*\*\* indicate  $p \leq 0.05$  and  $p \leq 0.01$ , respectively. The results of CMA evaluated the following results for other additional variables: article type: 0.89% — Methods to cope with heterogeneity: −2.24%.  $R^2$  is 72%, which shows the ratio of the variance of the impacts that were explained by including additional variables in meta-regressions.

Source: Study findings.

Considering the temporal patterns, with a 1-year increase in data collection time, the conversion of agricultural land to urban use increased by ~0.3%. Focusing on different continents, the levels of ALCU were significantly higher in studies conducted in South America (mean: 4.2,  $p \leq 0.05$ ). In North America and Asia, the ALCU levels tended to be above average (mean effect: 3.25 and 1.46, respectively, not significant), while in Africa, Europe, and Oceania, ALCU occurred less frequently (mean effect: −1.39, −0.80, and −0.71, respectively, not significant).

## 4 | Discussion

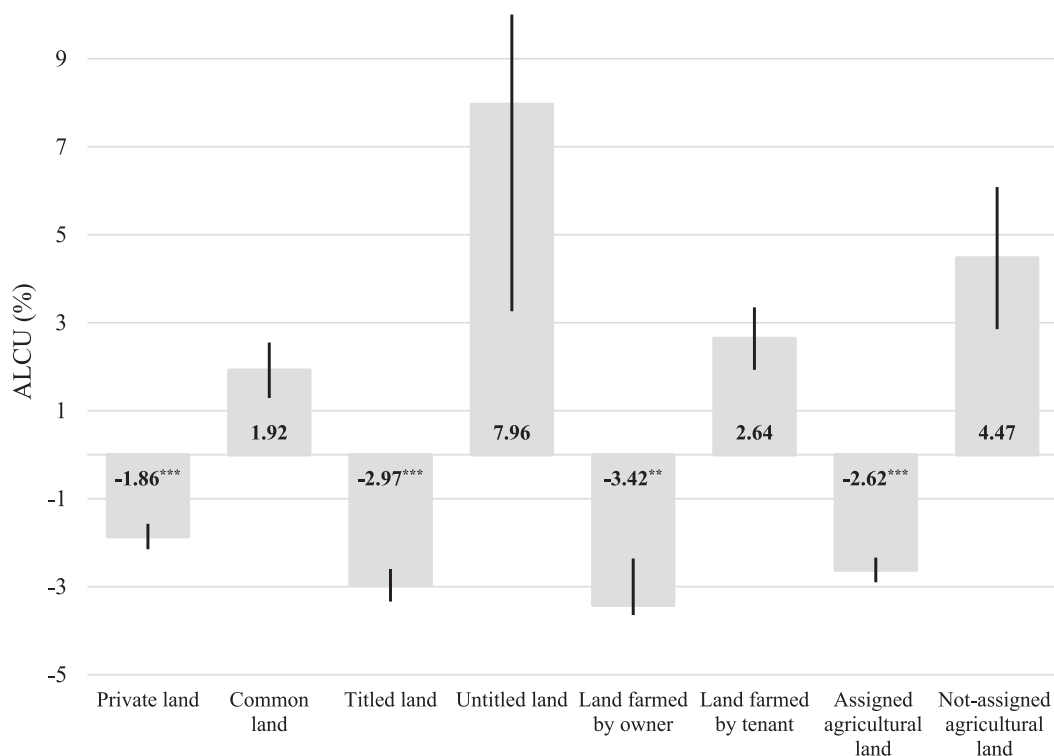
To assess the impacts of land tenure and its variables on ALCU, the present study applied a meta-analysis of 62 studies published between 2000 and 2023. The study aimed to fill a research gap in the understanding of the principles underlying the effect of land tenure variables on ALCU, particularly at the global level.

### 4.1 | The Effect of Land Tenure Security Variables on ALCU

The findings of our study show that all studied land tenure security variables, that is, Land ownership, Legal status, Tenure type, and cadastral assignment, have significant effects on

ALCU. Specifically, mean ALCU decreased by 3.42% on land farmed by its owner, by 2.97% on titled land, by 2.62% on designated agricultural land, and by 1.86% on private land, compared with the overall sample. While this is the first study to make a comprehensive assessment of the effects of multiple land tenure security variables on ALCU, its results are in line with studies focusing on the impact of these variables on the sustainability of farming and land management. Where farming systems lack environmental, social, or economic sustainability, the likelihood of farmland abandonment and its conversion to other uses increases (Movahedi et al. 2021). A systematic review by Higgins et al. (2018) on rural land tenure security showed its significant impacts on environmental conservation, agricultural productivity, and socio-economic outcomes. Similar to our findings, their results demonstrated that increased tenure security encourages owner-operated farming to invest in long-term improvements. However, their review also emphasized how differences in policy implementation and sociopolitical contexts lead to disparities in benefits.

Several studies have confirmed the benefits of land being farmed by its owners (also referred to as owner-operated farming), as opposed to land being farmed by tenants. For example, Sklenicka et al. (2015) found that farming owners adopted soil conservation measures to a significantly higher degree than farming tenants. Potthoff and Dramstad (2023) note that renting farmland can lead to less sustainable decisions, and they recommend land reallocation. The benefits of owner-operated farming



**FIGURE 3** | The impacts of land tenure variables on ALCU in the mean with standard deviations. Source: Study findings. \*\* and \*\*\* indicate  $p \leq 0.05$  and  $p \leq 0.01$ , respectively.

to sustainable land management are consistently confirmed by studies from different countries with various natural conditions and legal and political environments (Hu 1997; Praneevatukul et al. 2001). In this respect, our study has contributed to a body of literature supporting the introduction of policy and fiscal measures to promote owner-operated farming to facilitate the sustainable management of land and other vital resources.

Similarly, farming on titled land has been illustrated to lead to more sustainable land use than farming on untitled land (Mutangadura 2007; Tatsvarei et al. 2018). Charoenratana and Shinohara (2018) demonstrate that farmers' livelihoods and, therefore, the social and economic sustainability of farming depend on whether and how their farmland is titled. Their results showed that plots, where farmers have formal land titles, are cultivated more intensively and have higher productivity than plots without titles. Wannasai and Shrestha's (2008) findings revealed that the reduction in the likelihood of land conversion to non-agricultural uses is linked to households with titled land being more likely to invest in sustainable land management practices in the Prasae Watershed, Thailand. To achieve sustainable land use outcomes, the study highlighted the importance of tailored land policies that address both tenure security and household dynamics. Improving farmers' access to land, better recognition of customary land rights, and more effective protection of land without recognized claims could be helpful to policy responses. Byamugisha and Dubosse (2023) demonstrate the institutional and financial difficulties in putting tenure security reforms into practice, especially in areas with fragmented governance systems. These results imply that improving tenure security is crucial for tackling broader development issues and promoting economic resilience.

As confirmed by several studies (Besley et al. 2016; Szuma 2016), due to market dynamics, regulatory protections, land use policies, and community engagement aimed at preserving agricultural resources and landscapes, designated agricultural land generally experiences lower conversion rates to urban uses than non-designated agricultural land.

Discussing the lower susceptibility of private agricultural land to conversion to urban areas, given the fact that private land is typically owned and managed by individuals or organizations with the power to decide how it will be used and developed, Lipski (2015) stated that private agricultural land can satisfy farmers' demand for land plots and interest in investing in their farms. In this sense, Nguyen et al. (2016) indicated that in countries with private agricultural land ownership, land conversion occurs through agreements between local governments and investors, or it takes place voluntarily, aligned with landowners' preferences. However, in such land ownership regimes, development permits and land use planning policies can play a significant role in determining the possibility of converting private farmland to urban areas.

The case studies indicate that most of the studied spatiotemporal variables did not have a significant effect on ALCU, apart from the higher occurrence of ALCU in South America (4.16%). According to Silva and Vergara-Perucich (2021) economic, socio-demographic, cultural, and political forces define the primary causes of ALCU in Latin America. In the case of Santiago de Chile, the determinants are context-based, such as enhancements in regional connectivity, deficiencies in agricultural land use planning and regulations, and uncertainties regarding the consequences of urban development. Pauchard



and Barbosa (2013) illustrate the abandonment of poor soils, low levels of governance, and limited information on urban development strategies as the main contributors to ALCU in South America.

## 4.2 | Methods and Challenges in Increasing Land Tenure Security

There are two main approaches that can be utilized in efforts to increase land tenure security and thereby limit ALCU. First, efficient land use and planning policies can greatly contribute to a higher level of land tenure security. For example, land consolidation plans, which aim to reallocate farmland within a cadastre or similar land-management unit, can often contribute to an increase in owner-operated farming in the area, as they create plots of land that are more viable for this type of farming (Zhang and Ye 2024). However, it is important to note that while in many parts of the world, land consolidation efficiently combats land tenure insecurity and land degradation (Jürgenson 2016; Li et al. 2015) land consolidation methods employed in other countries can contribute to deterioration in livelihoods and environmental conditions (Asiama et al. 2017; Wang and Li 2019). Similarly, efficient cadastre systems are key to providing and preserving safe titles to farmland (Fisher and Whittal 2020). However, in some cases, especially in developing economies, cadastral systems have been recorded to facilitate higher inequality in the distribution of land resources (Kapstein 2018). Analogically, spatial planning has been noted to be an effective method for securing farmland designation (Chen et al. 2021) and a method facilitating faster conversion of farmland to non-agricultural uses (Xu et al. 2015). To be effective in increasing land tenure security and preventing ALCU, planning policies have to be informed by high-quality research, and, equally importantly, they need to be inclusive and based on democratic planning principles, as defined, for example, by Bruns and Hennecke (2022).

Second, while the long-term benefits of increasing land tenure security and preventing ALCU are often well understood, short-term economic interests may prevail (e.g., Fraser 2004). Therefore, a well-balanced system of economic incentives, both positive and negative, can significantly contribute to the long-term sustainability of land-use systems by supporting owner-operated farming, land titles, private ownership of land, and agricultural land designation.

## 5 | Conclusion

The results of this study show that land tenure security can be effective in preventing undesirable changes in land use in all parts of the world and the associated harmful impacts on farming communities and the environment. Land tenure security should, therefore, be preserved and promoted by land use and planning policies, as well as by economic incentives. Regulatory protection should include accessible land titling programs, simplified land registration procedures, and frameworks legally prioritizing agricultural use in specific regions. However, as mentioned earlier, fragmented regulatory frameworks and limited institutional capacity may compromise efforts to secure

land tenure. To address this, there should be a central coordinating body to simplify communications and capacity-building efforts to enforce tenure regulations.

The main implications of our results for land use policymaking and other regulatory activities can be summed up in the following three points:

1. Land tenure security plays a significant role in preserving agricultural land and its functions. Therefore, ensuring this security in present and future land use systems is one of the most critical tasks of land use policy. Especially in underinvested areas, preserving and enhancing land tenure security is vital in reducing the degradation of land resources. Therefore, directly involving local communities in land governance is necessary in such areas to promote tenure security through community engagement. Also, to ensure policies consistent with local practices and requirements, it is necessary to include community-led resource management programs, participatory land mapping, and regular consultations in land use policy programs. However, in underinvested areas, financial limitations usually make it impossible to implement and enforce land tenure security policies. To tackle this, there is a need for resource allocation and external financial support in maintaining effective land tenure measures.
2. Each of the four land tenure security variables examined in this study has the potential to reduce the level of ALCU significantly. Land use policies need to focus on promoting owner-operated farming, land titles, private ownership of land, and agricultural land designation as practices conducive to the preservation of agricultural land and the prevention of detrimental social and environmental effects associated with ALCU. Our results also emphasize the prominent role of owner-operated farming as the most substantial factor preventing ALCU.
3. The findings of this study add a new aspect to the body of literature discussing the role of land tenure security and its various forms in ensuring the economic, social, and environmental sustainability of farmland management. In accordance with the results of our study, owner-operated farming, land titles, private ownership of land, and designated agricultural land have been found to significantly promote the sustainability of farming systems.

Overall, our study contributes to the understanding of the impacts of land tenure security on ALCU at the global level by applying a robust literature review and meta-regression method. However, better knowledge of land tenure security variables and their impacts may not lead to better protection of agricultural land from conversion to urban uses due to barriers such as a lack of institutional support and limited financial resources. We therefore suggest that future research should look into the extent and the consequences of land degradation resulting from agricultural land conversion, and also into ways of mitigating land degradation using land tenure security strategies. Future research should also investigate the allocation and utilization of financial resources in this field, and the effectiveness of existing institutional frameworks and policies addressing land tenure security.

## Author Contributions

**Saghi Movahhed Moghaddam:** conceptualization, formal analysis, data curation, writing original, writing review and editing. **Hossein Azadi:** formal analysis, validation, writing review and editing. **Petr Sklenička:** funding acquisition, project administration, writing review and editing. **Kristina Janečková:** funding acquisition, project administration, supervision, writing review and editing.

## Acknowledgements

This study was supported by the Internal Grant Agency of the Faculty of Environmental Sciences, Czech University of Life Sciences Prague, No. 2024B0006, and the Operational Programme Just Transition, No. CZ.10.01.01/00/22\_001/0000287 "Smart Landscape 2030+. The authors owe special thanks to Robin Healey for his useful advice. Open access publishing facilitated by Ceska Zemedelska Univerzita v Praze, as part of the Wiley - CzechELib agreement.

## Conflicts of Interest

The authors declare no conflicts of interest.

## Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## References

- Abdillah, K. K., A. Abdul Manaf, and A. H. Awang. 2022. "Land Tenure Security for Low-Income Residents' Urban Livelihoods: A Human Development Approach Review of Temporary Occupation License." *Land Use Policy* 119: 106223. <https://doi.org/10.1016/j.landusepol.2022.106223>.
- Abdulai, A., V. Owusu, and R. Goetz. 2011. "Land Tenure Differences and Investment in Land Improvement Measures: Theoretical and Empirical Analyses." *Journal of Development Economics* 96, no. 1: 66–78. <https://doi.org/10.1016/j.jdeveco.2010.08.002>.
- Aguiar, S., M. E. Mastrángelo, M. Texeira, P. Meyfroidt, J. N. Volante, and J. M. Paruelo. 2022. "Roads and Land Tenure Mediate the Effects of Precipitation on Forest Cover Change in the Argentine Dry Chaco." *Land Use Policy* 112: 105806. <https://doi.org/10.1016/j.landusepol.2021.105806>.
- Alban Singirankabo, U., and M. Willem Ertsen. 2020. "Relations Between Land Tenure Security and Agricultural Productivity: Exploring the Effect of Land Registration." *Landscape* 9, no. 5: 138. <https://doi.org/10.3390/land9050138>.
- Alemu, Y., and D. Tolossa. 2022. "Livelihood Impacts of Large-Scale Agricultural Investments Using Empirical Evidence From Shashamane Rural District of Oromia Region, Ethiopia." *Sustainability* 14, no. 15: 9082. <https://doi.org/10.3390/su14159082>.
- Ali, A., A. Abdulai, and R. Goetz. 2012. "Impacts of Tenancy Arrangements on Investment and Efficiency: Evidence From Pakistan." *Agricultural Economics* 43, no. s1: 85–97. <https://doi.org/10.1111/j.1574-0862.2012.00622.x>.
- Alphan, H. 2003. "Land-Use Change and Urbanization of Adana, Turkey." *Land Degradation and Development* 14, no. 6: 575–586. <https://doi.org/10.1002/ldr.581>.
- Asiama, K. O., R. M. Bennett, and J. A. Zevenbergen. 2017. "Land Consolidation on Ghana's Rural Customary Lands: Drawing From the Dutch, Lithuanian and Rwandan Experiences." *Journal of Rural Studies* 56: 87–99. <https://doi.org/10.1016/j.jrurstud.2017.09.007>.
- Ayele, A., and K. Tarekegn. 2020. "The Impact of Urbanization Expansion on Agricultural Land in Ethiopia: A Review." *Environmental and Socio-Economic Studies* 8, no. 4: 73–80. <https://doi.org/10.2478/environ-2020-0024>.
- Azadi, H. 2020. "Monitoring Land Governance: Understanding Roots and Shoots." *Land Use Policy* 94: 104530. <https://doi.org/10.1016/j.landusepol.2020.104530>.
- Azadi, H., A. A. Barati, S. Nazari Nooghabi, and J. Scheffran. 2022. "Climate-Related Disasters and Agricultural Land Conversion: Towards Prevention Policies." *Climate and Development* 14, no. 9: 814–828. <https://doi.org/10.1080/17565529.2021.2008291>.
- Azadi, H., S. Burkart, S. Movahhed Moghaddam, et al. 2022. "Famine in the Horn of Africa: Understanding Institutional Arrangements in Land Tenure Systems." *Food Reviews International* 38, no. suppl: 829–845. <https://doi.org/10.1080/87559129.2021.1888974>.
- Azadi, H., P. Ho, and L. Hasfiati. 2011. "Agricultural Land Conversion Drivers: A Comparison Between Less Developed, Developing and Developed Countries." *Land Degradation and Development* 22, no. 6: 596–604. <https://doi.org/10.1002/ldr.1037>.
- Bahn, R. A., A. A. K. Yehya, and R. Zurayk. 2021. "Digitalization for Sustainable Agri-Food Systems: Potential, Status, and Risks for the MENA Region." *Sustainability* 13, no. 6: 3223. <https://doi.org/10.3390/su13063223>.
- Bambio, Y., and S. Bouayad Agha. 2018. "Land Tenure Security and Investment: Does Strength of Land Right Really Matter in Rural Burkina Faso?" *World Development* 111: 130–147. <https://doi.org/10.1016/j.worlddev.2018.06.026>.
- Bennett, J. E., A. R. Palmer, and M. A. Blackett. 2012. "Range Degradation and Land Tenure Change: Insights From a 'Released' Communal Area of Eastern Cape Province, South Africa." *Land Degradation and Development* 23, no. 6: 557–568. <https://doi.org/10.1002/ldr.2178>.
- Besley, T., J. Leight, R. Pande, and V. Rao. 2016. "Long-Run Impacts of Land Regulation: Evidence From Tenancy Reform in India." *Journal of Development Economics* 118: 72–87. <https://doi.org/10.1016/j.jdeveco.2015.08.001>.
- Bruns, D., and S. Hennecke, eds. 2022. *The Routledge Handbook of Landscape Architecture Education*. Routledge. <https://doi.org/10.4324/9781003212645>.
- Busko, M., and B. Szafranska. 2018. "Analysis of Changes in Land Use Patterns Pursuant to the Conversion of Agricultural Land to Non-Agricultural Use in the Context of the Sustainable Development of the Malopolska Region." *Sustainability* 10, no. 1: 136. <https://doi.org/10.3390/su10010136>.
- Byamugisha, F. F. K., and N. Dubosse. 2023. "The Investment Case for Land Tenure Security in Sub-Saharan Africa: A Cost-Benefit Analysis." *Journal of Benefit-Cost Analysis* 14, no. S1: 272–300. <https://doi.org/10.1017/bca.2023.14>.
- Cabernard, L., S. Pfister, and S. Hellweg. 2024. "Biodiversity Impacts of Recent Land-Use Change Driven by Increases in Agri-Food Imports." *Nature Sustainability* 7, no. 11: 1–13. <https://doi.org/10.1038/s41893-024-01433-4>.
- Charoenratana, S., and C. Shinohara. 2018. "Rural Farmers in an Unequal World: Land Rights and Food Security for Sustainable Well-Being." *Land Use Policy* 78: 185–194. <https://doi.org/10.1016/j.landusepol.2018.06.042>.
- Chen, Y., M. Yao, Q. Zhao, et al. 2021. "Delineation of a Basic Farmland Protection Zone Based on Spatial Connectivity and Comprehensive Quality Evaluation: A Case Study of Changsha City, China." *Land Use Policy* 101: 105145. <https://doi.org/10.1016/j.landusepol.2020.105145>.
- Chigbu, U. E., P. D. Ntuhinyurwa, W. T. de Vries, and E. I. Ngenzi. 2019. "Why Tenure Responsive Land-Use Planning Matters: Insights for Land Use Consolidation for Food Security in Rwanda." *International Journal of Environmental Research and Public Health* 16, no. 8: 1354. <https://doi.org/10.3390/ijerph16081354>.

- Dadashpoor, H., and S. Ahani. 2019. "Land Tenure-Related Conflicts in Peri-Urban Areas: A Review." *Land Use Policy* 85: 218–229. <https://doi.org/10.1016/j.landusepol.2019.03.051>.
- Das, P., P. Bhunia, and R. Maiti. 2022. "Assessment of Land Use and Land Cover Change in the Purulia District, India Using LANDSAT Data." In *Applied Geomorphology and Contemporary Issues*, edited by S. Mandal, R. Maiti, M. Nones, and H. R. Beckedahl, 329–350. Springer International Publishing. [https://doi.org/10.1007/978-3-031-04532-5\\_17](https://doi.org/10.1007/978-3-031-04532-5_17).
- Deininger, K., and D. A. Ali. 2008. "Do Overlapping Land Rights Reduce Agricultural Investment? Evidence From Uganda." *American Journal of Agricultural Economics* 90, no. 4: 869–882. <https://doi.org/10.1111/j.1467-8276.2008.01171.x>.
- Deininger, K., and S. Jin. 2006. "Tenure Security and Land-Related Investment: Evidence From Ethiopia." *European Economic Review* 50, no. 5: 1245–1277. <https://doi.org/10.1016/j.euroecorev.2005.02.001>.
- Fabusoro, E., T. Matsumoto, and M. Taeb. 2008. "Land Rights Regimes in Southwest Nigeria: Implications for Land Access and Livelihoods Security of Settled Fulani Agropastoralists." *Land Degradation and Development* 19, no. 1: 91–103. <https://doi.org/10.1002/ldr.816>.
- Fenske, J. 2011. "Land Tenure and Investment Incentives: Evidence From West Africa." *Journal of Development Economics* 95, no. 2: 137–156. <https://doi.org/10.1016/j.jdeveco.2010.05.001>.
- Fisher, R., and J. F. Whittal. 2020. *Cadastre—Principles and Practice*. South African Geomatics Institute SAGI. <https://www.sagi.co.za/product/cadastre-principles-and-practice/>.
- Fraser, E. D. G. 2004. "Land Tenure and Agricultural Management: Soil Conservation on Rented and Owned Fields in Southwest British Columbia." *Agriculture and Human Values* 21, no. 1: 73–79. <https://doi.org/10.1023/b:ahum.0000014020.96820.a1>.
- Gottlieb, C., and J. Grobovšek. 2019. "Communal Land and Agricultural Productivity." *Journal of Development Economics* 138: 135–152. <https://doi.org/10.1016/j.jdeveco.2018.11.001>.
- Gounaridis, D., I. Chorianopoulos, E. Symeonakis, and S. Koukoulas. 2019. "A Random Forest-Cellular Automata Modelling Approach to Explore Future Land Use/Cover Change in Attica (Greece), Under Different Socio-Economic Realities and Scales." *Science of the Total Environment* 646: 320–335. <https://doi.org/10.1016/j.scitotenv.2018.07.302>.
- Higgins, D., T. Balint, H. Liversage, and P. Winters. 2018. "Investigating the Impacts of Increased Rural Land Tenure Security: A Systematic Review of the Evidence." *Journal of Rural Studies* 61: 34–62. <https://doi.org/10.1016/j.jrurstud.2018.05.001>.
- Ho, S. P. S., and G. C. S. Lin. 2004. "Converting Land to Nonagricultural Use in China's Coastal Provinces: Evidence From Jiangsu." *Modern China* 30, no. 1: 81–112.
- Hu, W. 1997. "Household Land Tenure Reform in China: Its Impact on Farming Land Use and Agro-Environment." *Land Use Policy* 14, no. 3: 175–186. [https://doi.org/10.1016/S0264-8377\(97\)00010-0](https://doi.org/10.1016/S0264-8377(97)00010-0).
- Jürgenson, E. 2016. "Land Reform, Land Fragmentation and Perspectives for Future Land Consolidation in Estonia." *Land Use Policy* 57: 34–43. <https://doi.org/10.1016/j.landusepol.2016.04.030>.
- Kapstein, E. B. 2018. "Governing the Global Land Grab." *Global Policy* 9, no. 2: 173–183. <https://doi.org/10.1111/1758-5899.12543>.
- Katusiime, J., and B. Schütt. 2020. "Linking Land Tenure and Integrated Watershed Management—A Review." *Sustainability* 12, no. 4: 1667. <https://doi.org/10.3390/su12041667>.
- Kenfack Essougong, U. P., and S. J. M. Teguia. 2019. "How Secure Are Land Rights in Cameroon? A Review of the Evolution of Land Tenure System and Its Implications on Tenure Security and Rural Livelihoods." *GeoJournal* 84, no. 6: 1645–1656. <https://doi.org/10.1007/s10708-018-9935-7>.
- Kirschner, V., D. Franke, V. Řezáčová, and T. Peltan. 2022. "Poorer Regions Consume More Undeveloped but Less High-Quality Land Than Wealthier Regions—A Case Study." *Landscape* 12, no. 1: 113. <https://doi.org/10.3390/land12010113>.
- Klümper, W., and M. Qaim. 2014. "A Meta-Analysis of the Impacts of Genetically Modified Crops." *PLoS One* 9, no. 11: e111629. <https://doi.org/10.1371/journal.pone.0111629>.
- Lawry, S., C. Samii, R. Hall, A. Leopold, D. Hornby, and F. Mtero. 2017. "The Impact of Land Property Rights Interventions on Investment and Agricultural Productivity in Developing Countries: A Systematic Review." *Journal of Development Effectiveness* 9, no. 1: 61–81. <https://doi.org/10.1080/19439342.2016.1160947>.
- Li, X., H. Wang, J. Wang, and Z. Gao. 2015. "Land Degradation Dynamic in the First Decade of Twenty-First Century in the Beijing–Tianjin Dust and Sandstorm Source Region." *Environmental Earth Sciences* 74, no. 5: 4317–4325. <https://doi.org/10.1007/s12665-015-4507-3>.
- Lipski, S. A. 2015. "Private Ownership for Agricultural Lands: Advantages and Disadvantages (Experience of Two Decades)." *Studies on Russian Economic Development* 26, no. 1: 63–66. <https://doi.org/10.1134/S1075700715010074>.
- Loehr, D. 2012. "Capitalization by Formalization?—Challenging the Current Paradigm of Land Reforms." *Land Use Policy* 29, no. 4: 837–845. <https://doi.org/10.1016/j.landusepol.2012.01.001>.
- Ma, W., G. Jiang, Y. Chen, Y. Qu, T. Zhou, and W. Li. 2020. "How Feasible Is Regional Integration for Reconciling Land Use Conflicts Across the Urban–Rural Interface? Evidence From Beijing–Tianjin–Hebei Metropolitan Region in China." *Land Use Policy* 92: 104433. <https://doi.org/10.1016/j.landusepol.2019.104433>.
- Malek, Ž., and P. H. Verburg. 2020. "Mapping Global Patterns of Land Use Decision-Making." *Global Environmental Change* 65: 102170. <https://doi.org/10.1016/j.gloenvcha.2020.102170>.
- Mdege, N., S. Mayanja, and N. N. Mudege. 2022. "Youth Engagement in Sweetpotato Production and Agribusiness: The Case of Northern Uganda." *Third World Quarterly* 43, no. 10: 2430–2449. <https://doi.org/10.1080/01436597.2022.2094236>.
- Meemken, E.-M. 2020. "Do Smallholder Farmers Benefit From Sustainability Standards? A Systematic Review and Meta-Analysis." *Global Food Security* 26: 100373. <https://doi.org/10.1016/j.gfs.2020.100373>.
- Mishenin, Y., I. Yarova, and I. Koblianska. 2021. "Ecologically Harmonized Agricultural Management for Global Food Security." In *Ecological Intensification of Natural Resources for Sustainable Agriculture*, edited by M. K. Jhariya, R. S. Meena, and A. Banerjee, 29–76. Springer. [https://doi.org/10.1007/978-981-33-4203-3\\_2](https://doi.org/10.1007/978-981-33-4203-3_2).
- Moor, G. M. 1996. "Tenure Security and Productivity in the Zimbabwean Small Farm Sector: Implications for South Africa." <https://researchspace.ukzn.ac.za/handle/10413/11866>.
- Movahedi, R., S. Jawanmardi, H. Azadi, I. Goli, A.-H. Viira, and F. Witlox. 2021. "Why Do Farmers Abandon Agricultural Lands? The Case of Western Iran." *Land Use Policy* 108: 105588. <https://doi.org/10.1016/j.landusepol.2021.105588>.
- Munroe, D. K., and D. Müller. 2007. "Issues in Spatially Explicit Statistical Land-Use/Cover Change (LUCC) Models: Examples From Western Honduras and the Central Highlands of Vietnam." *Land Use Policy* 24, no. 3: 521–530. <https://doi.org/10.1016/j.landusepol.2005.09.007>.
- Mutangadura, G. 2007. "The Incidence of Land Tenure Insecurity in Southern Africa: Policy Implications for Sustainable Development." *Natural Resources Forum* 31, no. 3: 176–187. <https://doi.org/10.1111/j.1477-8947.2007.00148.x>.
- Nchanji, E. B., T. Chagomoka, I. Bellwood-Howard, A. Drescher, N. Schareika, and J. Schlesinger. 2023. "Land Tenure, Food Security,



- Gender and Urbanization in Northern Ghana." *Land Use Policy* 132: 106834. <https://doi.org/10.1016/j.landusepol.2023.106834>.
- Nguyen, T. H. T., V. T. Tran, Q. T. Bui, Q. H. Man, and T. D. V. Walter. 2016. "Socio-Economic Effects of Agricultural Land Conversion for Urban Development: Case Study of Hanoi, Vietnam." *Land Use Policy* 54: 583–592. <https://doi.org/10.1016/j.landusepol.2016.02.032>.
- Nhamo, L., S. Mpendeli, S. Liphadzi, and T. Mabhaudhi. 2022. "Securing Land and Water for Food Production Through Sustainable Land Reform: A Nexus Planning Perspective." *Landscape* 11, no. 7: 974. <https://doi.org/10.3390/land11070974>.
- Olumba, C. C., C. N. Olumba, and J. O. Alimba. 2021. "Constraints to Urban Agriculture in Southeast Nigeria." *Humanities and Social Sciences Communications* 8, no. 1: 1. <https://doi.org/10.1057/s41599-021-01007-1>.
- Paltasingh, K. R., A. K. Basantaray, and P. K. Jena. 2022. "Land Tenure Security and Farm Efficiency in Indian Agriculture: Revisiting an Old Debate." *Land Use Policy* 114: 105955. <https://doi.org/10.1016/j.landusepol.2021.105955>.
- Pauchard, A., and O. Barbosa. 2013. "Regional Assessment of Latin America: Rapid Urban Development and Social Economic Inequity Threaten Biodiversity Hotspots." In *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities: A Global Assessment*, edited by T. Elmqvist, M. Fragkias, J. Goodness, et al., 589–608. Springer Netherlands. [https://doi.org/10.1007/978-94-007-7088-1\\_28](https://doi.org/10.1007/978-94-007-7088-1_28).
- Payne, G. 2001. "Urban Land Tenure Policy Options: Titles or Rights?" *Habitat International* 25, no. 3: 415–429. [https://doi.org/10.1016/S0197-3975\(01\)00014-5](https://doi.org/10.1016/S0197-3975(01)00014-5).
- Payne, G. 2004. "Land Tenure and Property Rights: An Introduction." *Habitat International* 28, no. 2: 167–179. [https://doi.org/10.1016/S0197-3975\(03\)00066-3](https://doi.org/10.1016/S0197-3975(03)00066-3).
- Perera, E. N. C., D. T. Jayawardana, P. Jayasinghe, R. M. S. Bandara, and N. Alahakoon. 2018. "Direct Impacts of Landslides on Socio-Economic Systems: A Case Study From Aranayake, Sri Lanka." *Geoenvironmental Disasters* 5, no. 1: 11. <https://doi.org/10.1186/s40677-018-0104-6>.
- Pigott, T. D., and J. R. Polanin. 2020. "Methodological Guidance Paper: High-Quality Meta-Analysis in a Systematic Review." *Review of Educational Research* 90, no. 1: 24–46. <https://doi.org/10.3102/0034654319877153>.
- Potthoff, K., and W. E. Dramstad. 2023. "Management of Rented Farmland in Norway: Factors Impacting on Tenants' Decisions to Make Investments." *Land Use Policy* 135: 106941. <https://doi.org/10.1016/j.landusepol.2023.106941>.
- Praneetvatakul, S., P. Janekarnkij, C. Potchanasin, and K. Prayoonwong. 2001. "Assessing the Sustainability of Agriculture: A Case of Mae Chaem Catchment, Northern Thailand." *Environment International* 27, no. 2–3: 103–109. [https://doi.org/10.1016/s0160-4120\(01\)00068-x](https://doi.org/10.1016/s0160-4120(01)00068-x).
- Ritchie, H., and M. Roser. 2024. "Half of the World's Habitable Land is Used for Agriculture. Our World in Data." <https://ourworldindata.org/global-land-for-agriculture>.
- Robinson, B. E., M. B. Holland, and L. Naughton-Treves. 2014. "Does Secure Land Tenure Save Forests? A Meta-Analysis of the Relationship Between Land Tenure and Tropical Deforestation." *Global Environmental Change* 29: 281–293. <https://doi.org/10.1016/j.gloenvcha.2013.05.012>.
- Robinson, B. E., Y. J. Masuda, A. Kelly, et al. 2018. "Incorporating Land Tenure Security Into Conservation: Conservation and Land Tenure Security." *Conservation Letters* 11, no. 2: e12383. <https://doi.org/10.1111/conl.12383>.
- Rondhi, M., P. A. Pratiwi, V. T. Handini, A. F. Sunartomo, and S. A. Budiman. 2018. "Agricultural Land Conversion, Land Economic Value, and Sustainable Agriculture: A Case Study in East Java, Indonesia." *Landscape* 7, no. 4: 148. <https://doi.org/10.3390/land7040148>.
- Röver, C., and T. Friede. 2023. "Using the Bayesmeta R Package for Bayesian Random-Effects Meta-Regression." *Computer Methods and Programs in Biomedicine* 229: 107303. <https://doi.org/10.1016/j.cmpb.2022.107303>.
- Sánchez, A. C., H. N. Kamau, F. Grazioli, and S. K. Jones. 2022. "Financial Profitability of Diversified Farming Systems: A Global Meta-Analysis." *Ecological Economics* 201: 107595. <https://doi.org/10.1016/j.ecolecon.2022.107595>.
- Searchinger, T. D., S. Wiersenius, T. Beringer, and P. Dumas. 2018. "Assessing the Efficiency of Changes in Land Use for Mitigating Climate Change." *Nature* 564, no. 7735: 249–253. <https://doi.org/10.1038/s41586-018-0757-z>.
- Silva, C., and F. Vergara-Perucich. 2021. "Determinants of Urban Sprawl in Latin America: Evidence From Santiago de Chile." *SN Social Sciences* 1, no. 8: 202. <https://doi.org/10.1007/s43545-021-00197-4>.
- Sklenicka, P., K. J. Molnarova, M. Salek, et al. 2015. "Owner or Tenant: Who Adopts Better Soil Conservation Practices?" *Land Use Policy* 47: 253–261. <https://doi.org/10.1016/j.landusepol.2015.04.017>.
- Soriano, M., N. Hilvano, R. Garcia, A. J. Hao, A. Alegre, and J. Tiburan. 2019. "Land Use/Land Cover Change Detection and Urban Sprawl Analysis in the Mount Makiling Forest Reserve Watersheds and Buffer Zone, Philippines." *Environments* 6, no. 2: 9. <https://doi.org/10.3390/environments6020009>.
- Spangler, K., E. K. Burchfield, and B. Schumacher. 2020. "Past and Current Dynamics of U.S. Agricultural Land Use and Policy." *Frontiers in Sustainable Food Systems* 4: 98. <https://doi.org/10.3389/fsufs.2020.00098>.
- Stringer, L. C., E. D. G. Fraser, D. Harris, et al. 2020. "Adaptation and Development Pathways for Different Types of Farmers." *Environmental Science and Policy* 104: 174–189. <https://doi.org/10.1016/j.envsci.2019.10.007>.
- Suchá, L., M. Schlossarek, L. Dušková, N. Malan, and B. Šarapatka. 2020. "Land Tenure Security and Its Implications for Investments to Urban Agriculture in Soweto, South Africa." *Land Use Policy* 97: 104739. <https://doi.org/10.1016/j.landusepol.2020.104739>.
- Suu, N. V. 2009. "Agricultural Land Conversion and Its Effects on Farmers in Contemporary Vietnam." *Focaal* 2009, no. 54: 106–113. <https://doi.org/10.3167/fcl.2009.540109>.
- Szuma, K. 2016. "Assigning Agricultural Land Which Constitutes Agricultural Areas of Class I to III for Non-Agricultural and Non-Forest Purposes in the Light of the Act of 10 July 2015 Amending the Act on the Protection of Agricultural Land and Woodland." *Polish Yearbook of Environmental Law* 6, no. 6: 81. <https://doi.org/10.12775/PYEL.2016.005>.
- Tatsvarei, S., A. Mushunje, S. Matsvai, and S. Ngarava. 2018. "Farmer Perceptions in Mashonaland East Province on Zimbabwe's Agricultural Land Rental Policy." *Land Use Policy* 75: 468–477. <https://doi.org/10.1016/j.landusepol.2018.04.015>.
- Tong, S., F. Zhiming, Y. Yanzhao, L. Yumei, and W. Yanjuan. 2018. "Research on Land Resource Carrying Capacity: Progress and Prospects." *Journal of Resources and Ecology* 9, no. 4: 331–340. <https://doi.org/10.5814/j.issn.1674-764x.2018.04.001>.
- Totin, E., A. Segnon, C. Roncoli, M. Thompson-Hall, A. Sidibé, and E. R. Carr. 2021. "Property Rights and Wrongs: Land Reforms for Sustainable Food Production in Rural Mali." *Land Use Policy* 109: 105610. <https://doi.org/10.1016/j.landusepol.2021.105610>.
- Ulukan, D., G. Bergkvist, M. Lana, et al. 2022. "Combining Sustainable Livelihood and Farm Sustainability Approaches to Identify Relevant Intensification Options: Implications for Households With Crop-Based and Gathering-Based Livelihoods in Tanzania." *Ecological Indicators* 144: 109518. <https://doi.org/10.1016/j.ecolind.2022.109518>.
- Ustaoglu, E., and B. Williams. 2017. "Determinants of Urban Expansion and Agricultural Land Conversion in 25 EU Countries." *Environmental*

*Management* 60, no. 4: 717–746. <https://doi.org/10.1007/s00267-017-0908-2>.

Valkonen, A. 2021. “Examining Sources of Land Tenure (In)Security. A Focus on Authority Relations, State Politics, Social Dynamics and Belonging.” *Land Use Policy* 101: 105191. <https://doi.org/10.1016/j.landusepol.2020.105191>.

Verburg, P. H., P. Alexander, T. Evans, et al. 2019. “Beyond Land Cover Change: Towards a New Generation of Land Use Models.” *Current Opinion in Environmental Sustainability* 38: 77–85. <https://doi.org/10.1016/j.cosust.2019.05.002>.

Vesco, P., S. Dasgupta, E. De Cian, and C. Carraro. 2020. “Natural Resources and Conflict: A Meta-Analysis of the Empirical Literature.” *Ecological Economics* 172: 106633. <https://doi.org/10.1016/j.ecolecon.2020.106633>.

Vu, H. T., and D. Goto. 2020. “Does Awareness About Land Tenure Security (LTS) Increase Investments in Agriculture? Evidence From Rural Households in Vietnam.” *Land Use Policy* 97: 104721. <https://doi.org/10.1016/j.landusepol.2020.104721>.

Wang, Y., and Y. Li. 2019. “Promotion of Degraded Land Consolidation to Rural Poverty Alleviation in the Agro-Pastoral Transition Zone of Northern China.” *Land Use Policy* 88: 104114. <https://doi.org/10.1016/j.landusepol.2019.104114>.

Wang, Y., A. Sarkar, M. Li, et al. 2022. “Evaluating the Impact of Forest Tenure Reform on Farmers’ Investment in Public Welfare Forest Areas: A Case Study of Gansu Province, China.” *Landscape* 11, no. 5: 708. <https://doi.org/10.3390/land11050708>.

Wannasai, N., and R. P. Shrestha. 2008. “Role of Land Tenure Security and Farm Household Characteristics on Land Use Change in the Prasae Watershed, Thailand.” *Land Use Policy* 25, no. 2: 214–224. <https://doi.org/10.1016/j.landusepol.2007.07.003>.

Wily, A. L. 2011. *The Tragedy of Public Lands: The Fate of the Commons Under Global Commercial Pressure*. Alden Wily Contribution to ILC Collaborative Research Project on Commercial Pressures on Land. <https://landportal.org/pt/library/resources/mokoro5837/tragedy-public-lands-fate-commons-under-global-commercial-pressure>.

Woodcock, P., A. S. Pullin, and M. J. Kaiser. 2014. “Evaluating and Improving the Reliability of Evidence Syntheses in Conservation and Environmental Science: A Methodology.” *Biological Conservation* 176: 54–62. <https://doi.org/10.1016/j.biocon.2014.04.020>.

Xu, Y., E. H. W. Chan, and E. H. K. Yung. 2015. “Overwhelming Farmland Conversion for Urban Development in Transitional China: Case Study of Shanghai.” *Journal of Urban Planning and Development* 141, no. 2: 05014013. [https://doi.org/10.1061/\(ASCE\)UP.1943-5444.0000215](https://doi.org/10.1061/(ASCE)UP.1943-5444.0000215).

Zhang, X., and Y. Ye. 2024. “Advances in Land Consolidation and Land Ecology.” *Landscape* 13, no. 11: 1897. <https://doi.org/10.3390/land13111897>.

Zhu, S., X. Kong, and P. Jiang. 2020. “Identification of the Human-Land Relationship Involved in the Urbanization of Rural Settlements in Wuhan City Circle, China.” *Journal of Rural Studies* 77: 75–83. <https://doi.org/10.1016/j.jrurstud.2020.05.004>.