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Review

Driving Forces behind Land Use and Land Cover Change: A Systematic and Bibliometric Review

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Abstract: This paper is based on reviewing the literature in the past 10 years on the drivers of land use and land cover change (LULCC) in urban areas. It combines quantitative and qualitative keyword analysis of papers drawn out from the Scopus database. The analysis is primarily based on the number of mentions of keywords in the titles and abstracts of the papers, in addition to the number of keywords appearing in the papers. On the basis of content analysis, a three-level structural categorization of the driving factors was developed. These are presented in a schematic diagram, where the contextual factors are shown as influencing economic and financial factors and policy and regulation, which in turn influences transportation investments and availability, and industrial and residential location choices. Transportation availability was seen as the most frequent factor identified in the literature. This research contends that LULCC is mostly determined by interactions among these four themes in a three-level structure, and on this basis, a model is presented that illustrates LULCC drivers based on local circumstances across the globe.

Keywords: urban growth; land use change; land cover change; driving forces

Citation: Allan, A.; Soltani, A.; Abdi, M.H.; Zarei, M. Driving Forces behind Land Use and Land Cover Change: A Systematic and Bibliometric Review. *Land* **2022**, *11*, 1222. https://doi.org/10.3390/land11081222

Academic Editor: Giusppe Pulighe

Received: 4 July 2022
Accepted: 25 July 2022
Published: 2 August 2022

1. Introduction

Land Use and Land Cover Change (LULCC) is the most prevalent and dynamic landscape phenomena on the surface of the planet, and it plays a key role in reflecting regional and global environmental changes. Urban regions, in particular, have seen the most extreme alterations and transitions between urban vegetation, built land, water bodies, and other forms of land [1]. Hence, urbanized places reflect the most dramatic changes in LULCC [2]. When the aim is to optimize land use patterns for urban development, it is critical to properly understand the factors that drive urban expansion. Because urban expansion is a complex spatiotemporal activity, it is influenced by a variety of factors including society, economy, geography, and policy [3]. Some researchers have considered demographic factors such as population increase [4–7], population density [8–10] and migration from rural to urban areas to be key drivers in LULCC [11–13].

Other researchers have identified economic factors as critically important in the expansion of urban areas such as increase of income [6,14–16], gross domestic product per capita [10,17–19] and foreign direct investment [20–23]. Literature has also focused on geographical factors such as slope [24–27], elevation [1,10,28,29], and distance from water bodies [16,18,30–34] as key drivers. In this regard, the impacts of geomorphological landscape [35], environmental and natural risks such as volcanoes [36], flood, subsidence, unstable soils and rockfalls [37–39] were considered. On the policy side, many scholars have placed emphasis on the fact that institutional factors such as local government policy [10,21,40,41], rules and regulations [7,22,42,43] and land ownership change [11,44–48] have impacts on urban growth processes.

Although many empirical studies show that urban growth is evolving under the influence of varied and diverse factors [1,49–52] less research has been conducted on the systematic classification and explanation of motivating factors affecting LULCC of urban areas [16,53]. Hence, related work of albeit of secondary interest in related journals, scholars' specialties (including their theoretical, methodological and temporal dimension) have tended to be overlooked.

The goal of this article is to offer the foundation for a comprehensive examination and systematic analysis of chosen studies in order to determine the drivers of LUCC. To do this, the primary issue is, what are the driving factors influencing land use change and land cover during the urban development process? In this context, notable publications published over the past decade (i.e., from 2012 to 2022) were investigated. The selected publications evaluated in this study were both quantitative and qualitative. The study focuses on three key indicators at the quantitative level: study timeline, primary concepts and methods/tools, and journal characteristics. It is subsequently followed by two qualitative analyses: the identification and classification of methodological structure, as well as the identification and classification of factors affecting LUCC.

2. Materials and Methods

This article is a bibliometric and systematic review, with the aim of identifying the drivers LULCC from 2012 to 2022. The systematic review process was conducted in four steps: collecting, assessing, extracting, and explaining the data (thematic synthesis).

In the first step (collecting the data), attention was paid to academic papers published in English from 2012 to 2022 selected from the prominent scientific Scopus database which contain a significant number of contributions in the fields of urban development, urbanization, urban growth, land use and land cover change. In order to ensure homogeneity and consistency, conference papers, book chapters and dissertations and grey literature were excluded from this process. To address the major research question and find peer-reviewed articles published in Scopus, several keywords were then queried using the following components of search formula in the title, abstract or keywords sections (Table 1).

Table 1. Components of search formula.

Item	Sub-Item	Details
Keywords	Main keywords	Land Use Change, Land Cover Change, Land Use and Land Cover Change, Land Use/Land Cover Change, Land Use/Land Cover, Land Use, Land Cover
	Supplemented Key-Words	Urban Growth, Urbanization, Urban Development, Urban Area, Urban Planning, Urban Sprawl, Urban Expansion, Expansion, Land Use Planning, Planning
Operators		"OR", "AND"
Time period		2012–2022
Language		English
Document type		Journal paper

Following the collection of papers, the second phase (document assessment) was followed by five steps (Figure 1). The initial collection of 1541 studies based on the searched database was reduced to 1,121 after duplications were removed. By eliminating ambiguous or irrelevant titles, the data set was reduced to 883 records. Subsequently, 432 records were excluded through abstract screening yielding 451 pre-final records. These records were centered on LULCC, providing the basis for an additional bibliometric study. The principal eligibility criterion (encompassing the driving reasons for LULCC) was used to generate

the final data set list of research encompassing 110 articles for a full-text content analysis in order to develop the study's synthesizing themes and conceptual model. The data was last updated on 20 June 2022.

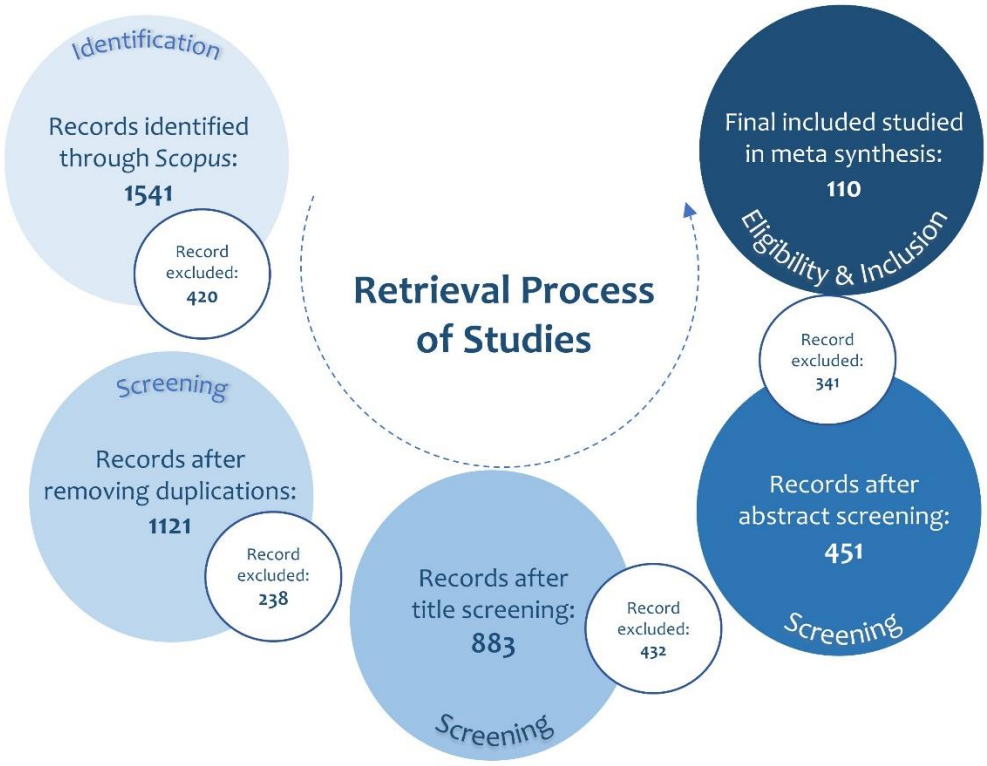

Figure 1. Flowchart for retrieval of studies.

To review all of the selected publications, both quantitative and qualitative methodologies were used. In the case of the former, the following analyses were carried out using the VOSviewer (version 1.6.15), developed by Leiden University, The Netherlands, 2022:

1. Study timeline: number of papers
2. The co-occurrence of fundamental concepts and methodological rules.
3. Journal specialisation and distribution: publications, citations, average citation/publication

In terms of content analysis, the full-texts contained were fed into MAXQDA (version 12.3.3), by VERBI GmbH, Berlin, Germany 2022. Using this method, the codes were taken from the text of the studies (first-order coding) and then re-coded, resulting in the formulation of the ideas (second-order coding). Finally, during the third-order coding procedure, the concepts were synthesised and categories (i.e., theme and sub-theme) were formed. As a result, the evaluation includes the following two key analyses:

1. Methodological approach: Type of methods, data collection, data analysis, and analytical software.
2. Theme of studies: Thematic framework, dimensions and frequency.

3. Results

Several approaches, such as citation analysis and publication count by authors, institutions, universities, or nations, are commonly employed to do this [54]. In this study, a larger sample of articles (n = 451) was assessed using VOSviewer for the number of papers published each year, occurrences of main codes (concepts), methodological codes, and source journals.

3.1. Timeline of Studies

The number of papers published annually varied from 2012 to 2022, but it witnessed a rise as of 2016 with 48 articles, and reached a peak in 2019 with 60 published articles. Figure 2 depicts the annual trends in publications on this topic based on a sample of 451 articles gathered on 25 June 2022.

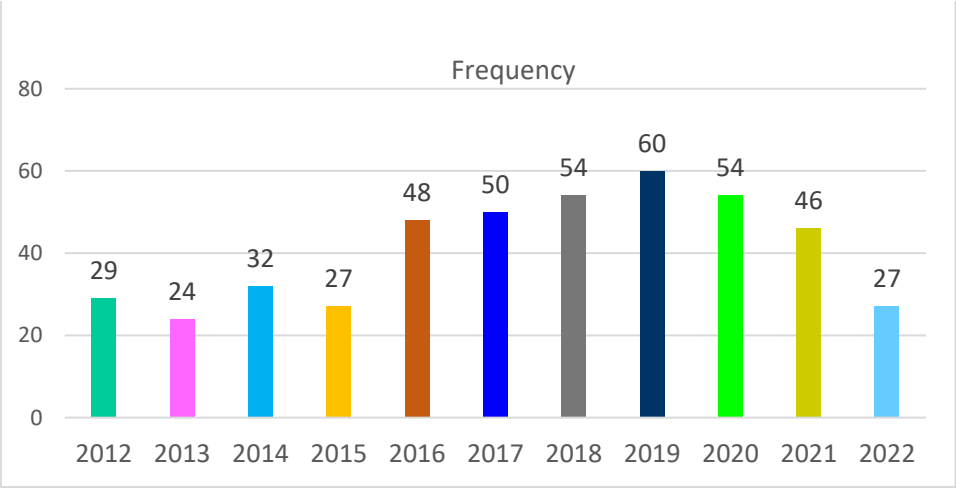

Figure 2. Publication by year (2012–2022).

3.2. Primary Concept and Methodological Codes

The studies selected by abstract screening included primary codes, as illustrated in the Figure 3 below. According to this, "urban growth", "urbanization", "urban expansions", "management", "region", "land", "environment" were among major codes, in other words, primary driving factors behind LULCC. They were thematically synthesized in the next stage, qualitative meta synthesis, resulting in the study themes and sub-themes.

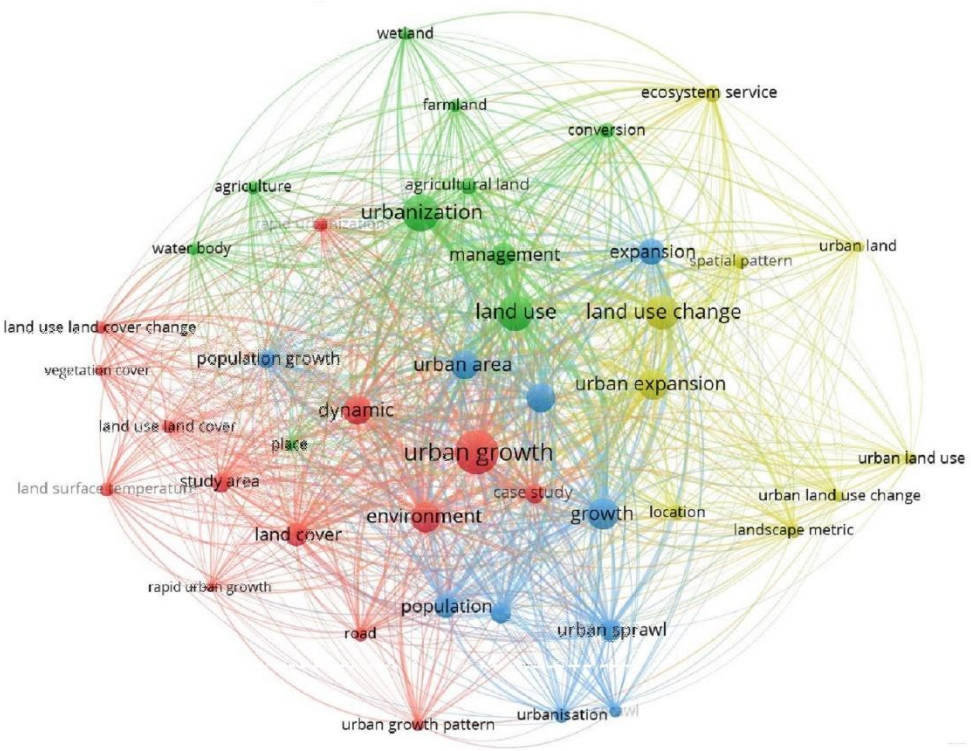

Figure 3. Primary codes (factors driving LULCC) found in the 451 selected records by abstract.

Finding the methodological codes given in the titles and abstracts of the papers was another source of analysis. Figure 4 depicts this, indicating that modelling, scenario building, modeling, mapping, and so on are among the most important methodologies and tools. They cannot, however, represent the methodological approach and instruments utilized in the focused research on variables causing LULCC, which were subsequently produced in the first part of the meta synthesis section.

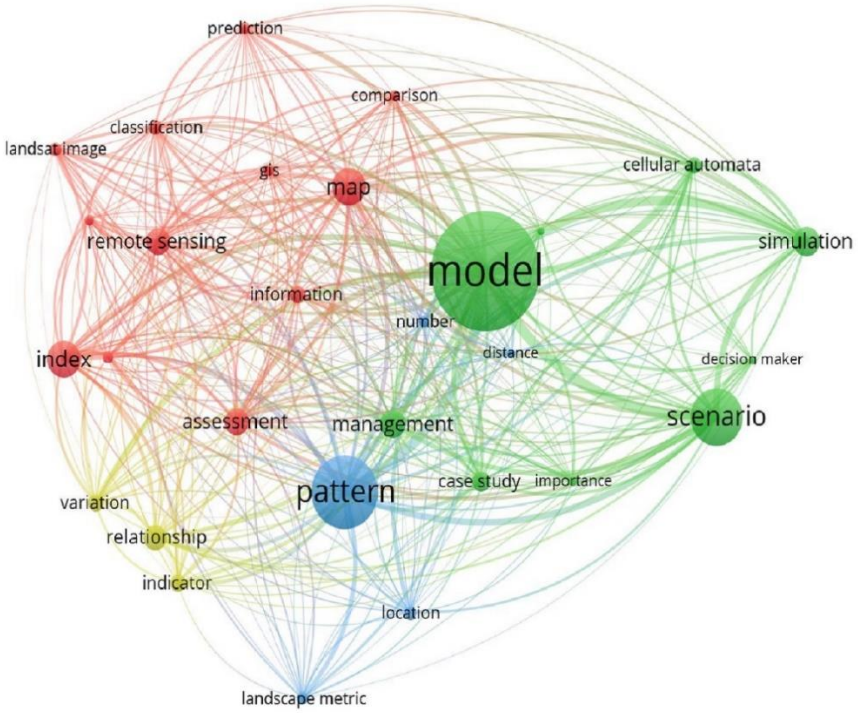

Figure 4. Major methodological codes found in the LULCC studies.

3.3. Leading Journals

According to Dzikowski [55], a journal will have more impact if a greater number of papers are published in it and the more the number of citations it possesses. On this, the number of publications and citations as well as average citation per publication of all journals were used to analyze the source journals. The results of top-ranked journals portrayed that the journals of *Computers, Environment and Urban Systems*, *Ecological Indicators*, *Environmental Monitoring and Assessment* and *Land Use Policy* were among the top-three journal with the highest record of publications in the field of study (Table 2).

Table 2. Top-eight source journals, their number of publications and citations.

Journal Title	Number of Papers	Number of Citations	Citation per Paper
Computers, Environment and Urban Systems	34	381	11.21
Ecological Indicators	22	458	20.82
Environmental Monitoring and Assessment	22	227	10.32
Land Use Policy	22	621	28.23
Landscape and Urban Planning	19	745	39.21
Remote Sensing	17	241	14.18
Science of the Total Environment	14	992	70.86
Sustainability	12	593	49.42

3.4. Methodological Approach

Another source of analysis was locating the methodological codes listed in the titles and abstracts of the studies. Figure 4 demonstrates this, revealing that among the most essential approaches and tools are modelling, scenario building, modelling, mapping, and so on. They cannot, however, represent the methodological approach and instruments

utilized in the focused research on factors that cause LULCC, which was created later in the first part of the meta synthesis section.

According to the findings, 68 studies (62 percent) of the total number of selected papers were done quantitatively, 7 studies (6 percent) qualitatively, and 35 studies (32 percent) utilising the combined method. In relation to data collection, the majority of research (80 studies, 73 percent of total chosen papers) utilized primary data, 29 studies (26 percent) relied on secondary data sources, and just one study applied mixed data collecting. In terms of data analysis, their approach was based on an analytical technique consistent with the study techniques used. The majority of the time, statistical analysis, geographical analysis, descriptive analysis, and qualitative content analysis were used. The qualitative methods mostly include: focus group; interview; policy review; case study research and content analysis. Table 3 outlines the analytical tools used in the chosen LULCC-centered papers.

Table 3. Methodological Analysis of Selected Articles in LULCC.

Research Approach	Number and Percentage of Papers	Data Collection Method	Data Analysis Method	Analytical Tools/Software (Some Examples)
Quantitative	68 (62%)	Primary data	Spatial analysis; Spatiotemporal analysis & Simulation	-Cellular automata, SLUETH: [34] -Imperviousness Change Analysis Tool (I-CAT) and MCE: [28] -Satellite Image analysis: [40,56,57]
			Statistical analysis	-Descriptive comparison: [13,58] - Regression analysis: [20,46,59,60]
			Mixed (Spatial analysis, Statistical analysis & Descriptive analysis)	-Spatial auto-correlation: [61] -Scenario-building: [62] -IDRISI image analyser: [63] -MCE (ANP): [64] -Cellular automata [65,66]
Qualitative	7 (6%)	Primary or	Descriptive analysis	-Narrative: [67]
		Secondary data		-Case study research: [48]
		Mixed (Primary and secondary data)	Qualitative content analysis	-Focus group discussion (FGD), Questionnaire survey and Interview: [47,68] -Systematic review: [16]
Mixed	35 (32%)	Primary or secondary data	Spatial analysis and Statistical analysis	-Satellite image analysis and Regression analysis: Policy review [10,69]
			Spatial analysis, Statistical analysis & Descriptive analysis	-Policy-analysis: [70] -Mixed method [71]
		Mixed (Primary and secondary data)	Spatial analysis	-Principal component analysis (PCA): Policy review [5]
			Mixed (Spatial analysis, Statistical analysis & Descriptive analysis)	-Cross-tabulation: [72] -Spatial Statistics and Logit Regression: Policy review [73]

3.5. The Study Themes: Driving Factors of LULCC

Table 4 displays the core result of the systematic review including the factors driving LULCC, categorized into themes, sub-themes, codes (factors), and the share of repeating the codes within the papers investigated. A total of 64 final factors, 11 sub-themes and four main themes titled *Urban growth Factors*, *Policy and Regulation Factors*, *Economic and Financial Factors*, and *Contextual Factors* were acquired hierarchically (Figure 5).

Table 4. Factors driving land use and land cover change process.

Theme	Sub-Theme	Code (Factor)	Sample Studies	Frequency	Share
Urban growth factors	Transport infrastructure	Airport	Kamh et al. (2012); Banzhaf et al. (2013); Nassar et al. (2014); Chen et al. (2018); Essien & Cyrus (2019)	5	4.55
		Bridge	Geymen (2013); Cao et al. (2021); Chu et al. (2021); Jawarneh et al. (2015); Han & Jia (2017)	5	4.55
		High-speed rail	Zhang et al. (2020)	1	0.91
		Highway	Feng & Wang (2021); Hanlon et al. (2012); Sandhya Kiran & Joshi (2013); Geymen (2013); Nassar et al. (2014); Jawarneh et al. (2015); Kong et al. (2017); Chen et al. (2018); Wang & Zhou (2018); Colsaet et al. (2018); Nadafianshahamabadi et al. (2021); Meyer & Früh-Müller (2020); Chu et al. (2021); Pratama et al. (2022); Schumacher et al. (2019); Inouye et al. (2015); Wu et al. (2021)	17	15.47
		Light rail transit	Hurst, et al. (2014); Wang, et al. (2020); Wu, et al. (2021); Moghadam et al. (2018)	3	3.64
		Railway	Feng & Wang (2021); Chu et al. (2021); Wang & Zhou, (2018); Chen et al. (2018); Kong et al. (2017); Jawameh et al. (2015); Zhang & Xu (2015); Li et al. (2014); Zhao & Shen (2019)	9	8.19
		Road network	Nassar et al. (2014); Chen et al. (2018); Colsaet et al. (2018); McGarigal et al. (2018); Nadafianshahamabadi et al. (2021); Islam et al. (2021); Liu et al. (2020); Kasraian et al. (2020); Tavares et al. (2019); Sunde et al. (2014); Kontgis et al. (2014) Li et al. (2014); Fitawok et al. (2020); Bajracharya et al. (2020); Shafizadeh Moghadam & Helbich (2013); Xu et al. (2013); Jawarneh et al. (2015); Gallardo & Martinezvega (2016); de la Luz Hernández-Flores et al. (2017); Fen (2017); Kong et al. (2017); Essien & Cyrus (2019); Schumacher et al. (2019); Daunt et al. (2021); Deslatte et al. (2022); Lal et al. (2017); Inouye et al. (2015); Gerten et al. (2019); Ma, (2020); Leyk et al. (2020)	30	27.30
		Subway and Subway station	Nassar et al. (2014); Feng & wang, (2021); Ahmad et al. (2016); Wu et al. (2021)	4	3.64
		Traffic service	Wenner & Thierstein (2021); Wu et al. (2021); Wang & Zhou (2018); Deng & Srinivasan (2016)	4	3.64
		Wharf	Cao et al. (2021); Nassar et al. (2014); Daunt et al. (2021); Inouye et al. (2015)	4	3.64
		Train	Meyer & Früh-Müller (2020); Wu et al. (2021)	2	1.82
	Industry	Technological progress and industrial transformation	Din & Mak (2021); Cao et al. (2021); Dong et al. (2020); Liu et al. (2019); Dai et al. (2018); Li et al. (2017); Kontgis et al. (2014); Nassar et al. (2014), Xu et al. (2013); Hasan et al. (2019); Wang et al. (2018); Li et al. (2014); Jawarneh et al. (2015); Leyk et al. (2020); Chu et al. (2021); Dou & Han (2021); Feng & Wang (2021); Tavares et al. (2019); Sandhya Kiran & Joshi (2013); Kleemann et al. (2017); de la Luz Hernández-Flores et al. (2017); Inouye et al. (2015)	22	20.02
		Industrial parks/sites	Cheng (2021), Kang et al. (2019), Zambon et al. (2019), Shin & Chae (2018), Han & Jia (2017), Zhang & Xu (2015)	6	5.45
		Factories	Wu et al. (2021); Shin & Chae (2018); UI Din & Mak (2021)	3	2.73
	Accessibility	Proximity to the city/county/megacity centre	Han & Jia (2017); Deng & Srinivasan (2016); Li et al. (2014); Lal et al. (2017); Wang & Zhou (2018); Fitawok et al. (2020); Nguyen et al. (2018)	7	6.36
		Commercial /leisure centre/park	Gallardo & Martinezvega (2016); Chen et al. (2018); Kong et al. (2017); Bajracharya et al. (2020); Han & Jia (2017); Wu et al. (2021)	6	5.45
		Education and research	Wu et al. (2021); Liu et al. (2020); Cao et al. (2021); Li et al. (2015); de la Luz Hernández-Flores et al. (2017); Zhang & Xu, (2015)	6	5.45
		Hotel	Chen et al. (2018); Essien & Cyrus, (2019); Wu et al. (2021)	3	2.73
		Neighbouring effect	Luo et al. (2018)	1	0.91
		Distance from built-up areas	Shafizadeh Moghadam & Helbich (2013); Xu et al. (2013)	2	1.82
		Medical care	de la Luz Hernández-Flores et al. (2017);	1	0/91
		Accessibility to public facilities	Han & Jia (2017); Kong et al. (2017)	2	1.82
	Residence	Constructing residential settlements	Meyer & Früh-Müller, (2020); Ponstingel (2020); Baj Racharya et al. (2020); Sandhya Kiran & Joshi (2013)	4	3.64
Policy and regulation factors	Urban/land use policies	Administrative division adjustment	Feng & Wang (2021); Feng & Wang (2022)	2	1.82
		Urban administrative hierarchy	Dong et al. (2020); Li et al. (2015)	2	1.82
		Local government policy	Xu et al. (2013); Nassar et al. (2014); Kontgis et al. (2014); Xu et al. (2015); Luo et al. (2018); Cheng, (2021); Meyer & Früh-Müller (2020); Ponstingel (2020); Wang et al. (2018); Wadduwage (2018); Deslatte et al. (2022); Dou & Han (2021); Dai et al. (2018); Yue et al. (2014); Cao et al. (2021); Kuang, (2020); Essien & Cyrus (2019); Gerten et al. (2019); Chen et al. (2018); Kong et al. (2012); Kleemann et al. (2017); Li et al. (2015)	22	20.02
		Private enterprise	Hamnett (2020); Soria et al. (2020)	2	1.82
		User (property owner, developers, real estate companies)	Deslatte et al. (2022); Fitawok et al. (2020); Soria et al. (2020); Colsaet et al. (2018); Zhang et al. (2015); Nassar et al. (2014)	6	5.45
		Changing land ownership	Kleemann et al. (2017); Schumacher et al. (2019); Whiteside (2020); De Tong et al. (2018); Adam (2019); Zhang et al. (2015)	6	5.45
		Zoning	Colsaet et al. (2018); McGarigal et al. (2018)	2	1.82
		Land use policies	Daunt et al. (2021); Deslatte et al. (2022)	2	1.82
		Developable land	Deslatte et al. (2022); Deng & Srinivasan (2016)	2	1.82
	Regulations	Impact property tax	Bimonte & Stabile (2015); Deslatte et al. (2022); Colsaet et al. (2018); Kontgis et al. (2014)	4	3.64
		Municipalities regulation	Deslatte et al. (2022)	1	0.91
		Urban planning regulation	Feng & Wang (2022); Fitawok et al. (2020); Dai et al. (2018); Yue et al. (2014); Banzhaf et al. (2013); Kong et al. (2012); Kong et al. (2017)	7	6.36
		Regulation of residential Land use	Tiitu (2018); Daunt et al. (2021); Colsaet et al. (2018)	3	2.73

Table 4. *Cont.*

Theme	Sub-Theme	Code (Factor)	Sample Studies	Frequency	Share
Economic and Financial factors	Investment	Foreign direct investment	Li et al. (2015); Kontgis et al. (2014); Dai et al. (2018); Asabere et al. (2020); Dou & Han (2021)	5	4.55
		Investment attraction	Dou & Han (2021); Deslatte et al. (2022); Kuang (2020); Chen et al. (2018); Admaus (2015)	5	4.55
	Urban Economy	Market power/incentives	Hamnett (2020); Chen et al. (2018);	2	1.82
		Land market	Simwanda et al. (2020); Yue et al. (2014)	2	1.82
		Land price	Magliocca et al. (2015); Hasan et al. (2019)	2	1.82
		Land price distribution	Hu et al. (2012); Hanlon et al. (2012)	2	1.82
		Housing price	Magliocca et al. (2015); Daunt et al. (2021)	2	1.82
		Tourism development	Kamh et al. (2012); Sang et al. (2019); Colsaet et al. (2018); Nassar et al. (2014); Chu et al. (2021); Daunt et al. (2021)	6	5.46
		Economic opportunities (trade, industrial)	Simwanda et al. (2020); Tavares et al. (2019); Sandhya Kiran & Joshi (2013); Nguyen et al. (2018)	4	3.64
Contextual factors	Demographic	Rural population migration	Kleemann et al. (2017); Ul Din & Mak (2021); Cao et al. (2021); Islam et al. (2021); Asabere et al. (2020); Xu et al. (2020); Gerten et al. (2019); Essien & Cyrus (2019); Simwanda et al. (2020); Fitawok et al. (2020)	10	9.1
		Labor migration	Shin & Chae, (2018); Essien & Cyrus (2019); Kleemann et al. (2017); Dai et al. (2018); Simwanda et al. (2020); Nassar et al. (2014); Sang et al. (2019); Azhdari et al. (2019)	7	6.36
		Internal migration	Colsaet et al. (2018); Kang et al. (2019); Liu et al. (2019); Jawarneh. et al. (2015); Skog & Steinnes (2016); Kamh et al. (2012), Abulibdeh et al. (2019).	6	5.45
		Increase in urban population	Li et al. (2022); Dou & Han (2022); Daunt et al. (2021); Din & Mak (2021); Cao et al. (2021); Leyk et al. (2020); Xu et al. (2020); Bajracharya et al. (2020); Fitawok et al. (2020); Gerten et al. (2019); Tavares et al. (2019); Luo et al. (2018); Kleemann et al. (2017); Skog & Steinnes (2016); Sandhya Kiran & Joshi (2013); Banzhaf et al. (2013); Li et al. (2014); Nassar et al. (2014); Sunde et al. (2014); Zhang & Xu (2015); Lal et al. (2017); de la Luz Hernández-Flores et al. (2017); Essien & Cyrus (2019); Essien & Cyrus (2018); Tiitu (2018); Jawarneh et al. (2015); Kamh et al. (2012); Colsaet et al. (2018)	28	25.48
		Population density	Banzhaf et al. (2013); Lal et al. (2017); de la Luz Hernández-Flores et al. (2017); Xu et al. (2013); Liu et al. (2020); Meyer & Früh-Müller (2020)	6	5.45
	Socio-economic features	Lifestyle	Kleemann et al. (2017)	1	0.91
		Gross Domestic Production (GDP)	Xu et al. (2013); Jiang et al. (2013); Li et al. (2014); Gong et al. (2014); Luo et al. (2018); Colsaet et al. (2018); Liu et al. (2019); Hasan et al. (2019); Dong et al. (2020); Kuang, (2020); Cao et al. (2021); Liu et al. (2020); Chu et al. (2021); Dou & Han (2021); Ul Din & Mak (2021)	15	13.65
		Increased income	Hasan et al. (2019); Ponstingel (2020); Colsaet et al. (2018)	3	2.73
		Economic down-turn/unemployment rate	Meyer & Früh-Müller (2020); Tomao et al. (2021); Salvati (2019); Kang et al. (2019)	4	3.64
	Environment and natural resources	Slope	Kamh et al. (2012); Shafizadeh Moghadam & Helbich (2013); Xu et al. (2013); Sunde et al. (2014); Han & Jia (2017); Kong et al. (2017); Wadduwage (2018); Wang & Zhou (2018); Colsaet et al. (2018); Liu et al. (2020); Fitawok et al. (2020); de la Luz Hernández-Flores et al. (2017); Wu et al. (2021); Gerten et al. (2019); Jawarneh et al. (2015)	15	13.65
		Elevation	Xu et al. (2013); Sunde et al. (2014); Han & Jia (2017); Wang & Zhou (2018); Liu et al. (2020); Wu et al. (2021); Gerten et al. (2019); Jawarneh et al. (2015)	8	7.27
		Climate	Yan et al. (2013); Colsaet et al. (2018); Wang et al. (2018); Admaus (2015)	4	3.64
		Geographical location	Hasan et al. (2019); Dai et al. (2018); Ul Din & Mak (2021); Kamh et al. (2012); Nguyen et al (2018)	5	4.55
		Flood prone areas	Jawarneh et al. (2015)	2	0.91
		Sea shoreline	Kamh et al. (2012); Leyk et al. (2020)	2	1.82
		Distance from water	Han & Jia (2017); Feng (2017); Li et al. (2014); Shafizadeh Moghadam & Helbich (2013); Kong et al. (2017); Sunde et al. (2014); Colsaet et al. (2018); Deslatte et al. (2022); Leyk et al. (2020); Bajracharya et al. (2020)	10	9.09
		Resource	Ma, (2020)	1	0.91
		Oil resource	Li et al. (2014); Nassar et al. (2014); Daunt et al. (2021); Essien & Cyrus, (2019)	4	3.64
		Mine	Lal et al. (2017); de la Luz Hernández-Flores et al. (2017); Wu et al. (2021)	3	2.73
		Ecosystem services	Pan et al. (2021); Peng et al. (2021)	2	1.82

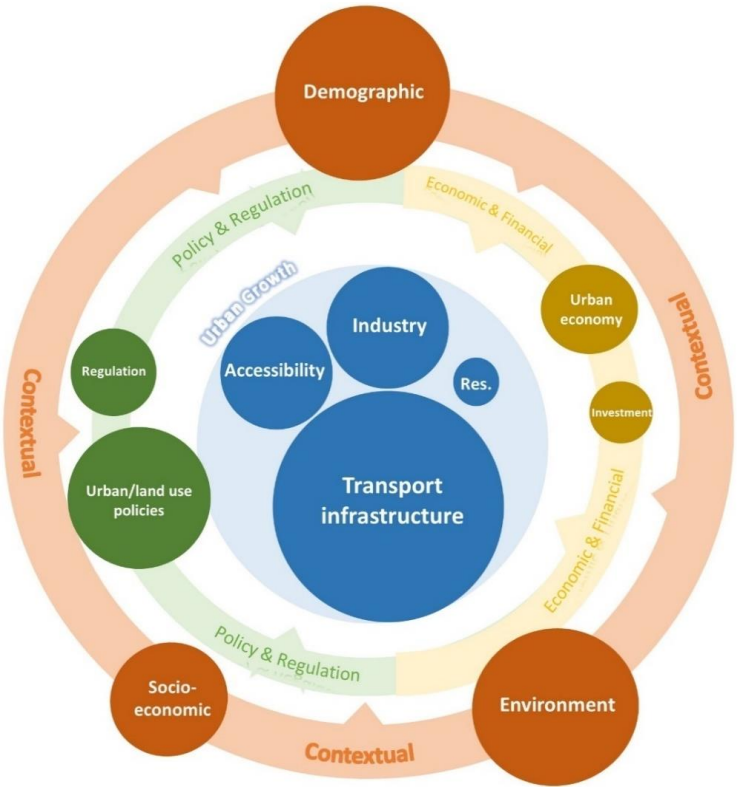

Figure 5. Driving forces causing LULCC, their frequency and interrelations.

4. Discussion

4.1. The Interacting Model

Apart from the driving factors identified above, the consequences determined the frequency of factors among the selected studies. In total, they referred to different terms 373 times. Accordingly, *urban growth factors*- with about 40% of the total references—account for more than double the number of references to *policy and regulation factors* and a little more than *contextual factors*. With regard to the sub-theme level, the most frequently cited items are *transport infrastructure* (an urban growth factors), by a considerable margin, and then *demographic* (a *contextual factor*) with about 23% and 15% of the total references, respectively. *Accessibility* and *industry* subthemes in the urban growth theme are similar with *socio-economic* (a *contextual factor*), in terms of the number of references. This is also the case for *environment* subtheme (a *contextual factor*) and *urban/land use policies*, as the most frequent cited subtheme in *policy and regulation factors.* Figure 5 schematically portrays the extent to which themes and sub-themes are frequent by proportionally sized squares.

Beyond theme synthesis and frequency computation, the results expanded on the relationships between driving elements. This helps in understanding inter-factor processes and side effects, which are highly interdependent. Using placement, level grouping, and arrows, the picture above reveals complicated links between analytical categories (i.e., themes and sub-themes). They may be studied in a three-level interaction on this basis. In the center, direct, place-based urban development initiatives (i.e., building transportation infrastructure, industries, housing, and services) create LULCC in urban areas. The second tier drives urban processes through the creation of policies, regulations, and financing of urban development projects, which is facilitated via various agents, entities and operational processes. Finally, the outer tier, *contextual*, is perceived as a set of effective factors (i.e., demographic, socio-economic, environment) through which the process of LULCC of an urban area is developed. In other words, these factors drive urban growth through decisions on urban policies and other operations (i.e., the second level or immediate inner circle in Figure 5). The theme and sub-themes, and factors (codes) are shown on Figure 6A (top), and B (bottom) respectively.

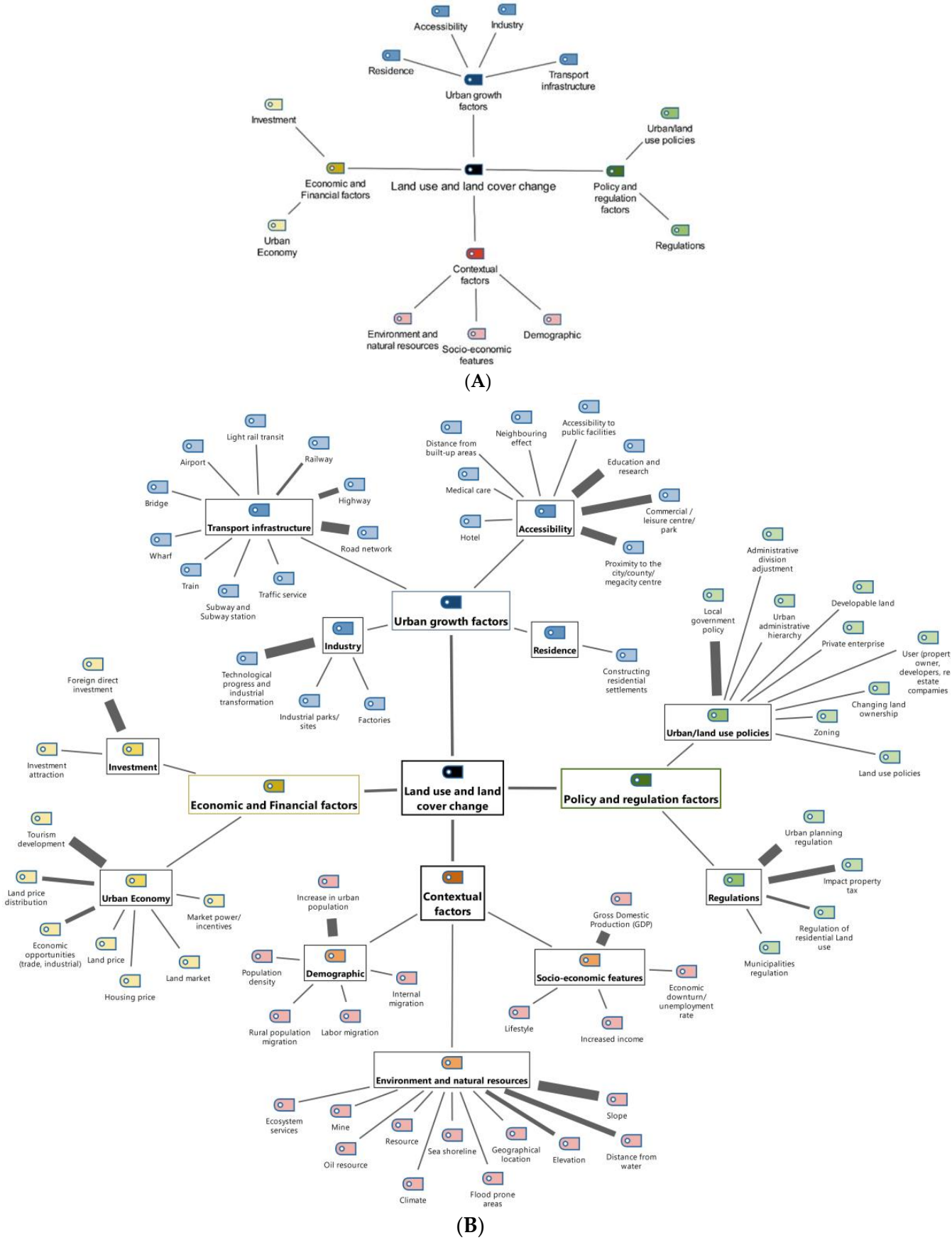

Figure 6. Components of the driving forces system causing LULCC: (**A**) themes and sub-themes (top); (**B**) theme, sub-themes, and factors (codes) (bottom).

4.2. Urban Growth Factors

These factors explore the driving forces of urban growth that contribute to changing the spatial structure and LULC of urban areas. This theme includes physical factors and growth of transportation infrastructure, industry, accessibility to services, and residential development.

4.2.1. Transport Infrastructure

Transport infrastructure is the most frequently cited factor in LULCC, which refers to the large effect of transportation development on a city spatial structure. In this way, transportation networks such as subways [1,3,40,74], can provide a new access model for the city and upset existing spatial equilibrium. Besides development potentials associated with the operation of a subway system [74], the potential for development in the areas around stations are affected by the presence of developable/vacant lands, plot size, urban fabric and pedestrian access.

Another factor is the development potential of rapid bus transit (BRT), light-rail transit [1,75–77], highspeed rail and stations, in value capturing and added value to adjacent properties and spaces. This is related to the dual functions of transit stations, facilitating accessibility to mass transit and multi-modal connections (i.e., as a transit node) [72], but also characterized by mixed-use development, a diversity of architecture and planned open spaces (i.e., transit place). These functional characteristics of transit stations are the key reasons that they are able to be catalysts for increased urban development potential within a larger urban system resulting in higher development intensity and providing structure to urban form [73,78]. Accordingly, a railway station is not an ordinary station, rather, it is a place where various activities take place [79,80] and can completely affect the surrounding space and change the type and composition of established uses. Such modifications can have a significant influence; for example, urban planning regulations and codes allow some activities to take place in residential settings, transferring these activities to these locations, freeing residential areas from everyday traffic disruptions. In general, transportation networks not only facilitate the flow of commodities and passengers, but they also have an impact on urban growth at different scales.

The review confirms that the quality of transit systems such as fast and low-cost rail transportation networks can also play a role in driving urban growth [1,3,18,27,32,56,79,81,82] which can change the growth of the city from a nuclear, centralized form to a multi-centre city through with multiple (employment) centres. Improving the quality, type and speed of access to various urban areas in a metropolitan characterized by distance between areas, is a major driver determining the rate of urban growth over time.

The effect of access networks on urban/regional development is markedly different for road networks, and ring roads when compared to mass transit networks [5,9,10,12,13,16,18,21,24,26–29,31–33,44,57,63,66,83–92], or highway [1,3,16,24,27,32,40,44,57,66,69,79–81,84,93–95]. Road networks are catalysts for residential, office, and commercial development, by facilitating development opportunities through ubiquitous transport connections and accessibility, being particularly suited to Road based transport modes such as motor vehicles, cycling and walking.

Additional factors were identified in the transport infrastructure sub-theme, which were also linked to physical-spatial change in urban areas. Wharfs, ferries, harbors, and ports characterized with special functions and coordinates can increase the speed of urban expansion in coastal cities [40,66,71,88]. Similarly, airports in convenient location contribute to the growth of urban and complementary transport infrastructure, and occasionally, when located near the core of a city can encourage substantial urban growth, that subsequently affects urban form and structure across a metropolitan area [1,8,13,24,25,40,57]. In the case of large-scale transport infrastructure projects, this can lead to the expansion of socio-economic factors such as GDP, industries, increasing investments in real estate, and the development of other complementary transport assets [27,30,71,81,94].

4.2.2. Accessibility

This factor originally refers to the index of distance from other regions/destinations, which has an impact on the development of urban areas. Proximity to the city centre [18,30,73,79,88,90,96] and distance from built-up areas [10,94], accessibility to public facilities such as public transport stations [30,32], access to education and research centres (such as colleges, universities, school, etc.) [1,9,20,56,85], commercial/leisure centre/park [1,30,56,68,96–98], hotel [1,13,57], neighboring effects [16,99], medical care e.g., hospital [1,9] are all considered to be crucial in driving urban growth. This factor refers not only to the physical distance of one region/destination from another, but also to the functional distance or distance to access a region/destination. Indeed, it relates to the tendency and potential of a population to live, work, recreate and invest, which are determinants in attracting development to a particular location. As in Burgess's model of a centralized nuclear city, lower-income households move from the centre to the suburbs as their financial capacity increases and they seek larger dwellings. Apart from the "location" factor, new transportation networks and systems affect the distribution of residential development by providing access to potential job opportunities. However, as the city grows, transportation costs increase, either due to the expansion of the city, the increasing complexity of new transport technologies, demands for increasing transport sophistication or due to the costs of congestion. The role of transport in shaping urban form in the future is however uncertain as the relevance of current forms of transport modes and infrastructure are challenged with increasing uptake of digital technologies incorporating innovative mobility solutions such as shared mobility, micro mobility, electric motor vehicles and autonomous vehicles (including land based and aerial drones).

4.2.3. Industrial Development

The second most frequent factor in urban growth factors is industry. Accordingly, industrial parks or sites [1,30,56,68,97,99], technological progress and industrial transformation [2,3,5,9–11,14,17–19,21,22,24,27,33,40,41,66,71,81,93,99–102], and factories [1,68,100], were cited as influencing factors on changing the spatial structure and LULC of urban areas.

Indeed, this component has played a critical role in the development of under developed areas, because the factors of production in the industrial sector, as opposed to agriculture, have higher potential for change with regard to environmental, regional, and national circumstances. As a result, development centres are industry-based, particularly in the global south and in places with limited agricultural development potential. Thus, urban growth is a direct outcome of the Industrial Revolution and the establishment of the capitalist economy, which occurred first in the developed world and later in the developing world. Many new industrial cities in nineteenth-century England, for example, such as Manchester and Birmingham, grew from a hamlet or a small town into a major metropolis. Similarly, with industrialization, French cities increased rapidly in the second half of the nineteenth century, a phenomenon mirrored in German cities.

4.2.4. Residential Development

The last effective factor of LULCC, relates to developing newly developed areas on the urban periphery [15,34,80,93], subsequently resulting in a decentralized spatial structure characterized by the formation of new sub-centres outside of the main urban core. This factor relates to the functional complementarity among the various sub-centres of urban areas and the main core and sub-centres, made possible by population migration from the urban core to the outer suburbs and facilitated by investment in both road transport and mass transit infrastructures, complemented by large investments in denser, higher value urban development in these sub-centres [53].

4.3. Policy and Regulation Factors

These factors refer to a series of policies, rules, regulation and operational efforts on general urban issues (such as land use) and processes by which urban growth requirements

are facilitated. In this way, the physical and spatial structure of cities including land use/land cover is formulated.

4.3.1. Urban/land Use Policies

On the policy side, land use policies [88,89], include a wide range of activities by which governments seek to influence land use and controlling land ownership [11,45–48], zoning [16,44,83]. The varying role of local government policies on urban growth [2,10,11,13,15,17,20–22,29,40,41,43,57,61,62,70,71,80,89,99,103,104], is influenced by the state/provincial, national and global context. Developing countries, in particular, are increasingly dominated by government-led policies and measures, and consequently, their urbanization depends on how the government acts, predominantly within these communities. Hence, this can be regarded as one of the significant stimuli for the formation and/or change of spatial structure and LULCC. This factor also contains the availability of developable lands [73,89], private enterprise [67,105], participation and the role of property owners, developers and real estate agencies which contribute to the long-term development of the city through land supply, financing, investment, design and construction of large-scale projects and infrastructures [16,40,86,88,89,103].

Additionally, according to some other studies conducted in the context of Chinese cities, administrative division adjustments (ADA) as city country mergers [3,42] and urban administrative hierarchy-spatial system of allocating urban resources [20,101], resulted an enormous transformation in the spatial structure of cities by stimulating industrial development, infrastructure development, and accelerating urban renewal and the equitable distribution of public services.

4.3.2. Regulations

Although less significant than the previous sub-theme, the secondary dimension of regulations, includes centralized rules imposed through official plans and/or directly by governmental entities. For example, effective regulation factors in the growth of urban areas include municipal regulations [89], that impose various types of land purchase and property impact taxes [16,21,61,89], land use regulations [7,16,88] and urban planning regulations [3,8,22,32,42,43,104,106].

4.4. Economic and Financial Factors

Along with *policy and regulation factors*, these factors drive urban growth through rendering developmental projects feasible. On this basis, it is important to study the economic structure of cities as well as financial system.

4.4.1. Urban Economy

As shown in Table 4, Economic Factors investigate market power/market incentives, land market, land price, land price distribution, housing prices, tourism development and economic opportunities (trade, industrial). According to the studies selected, market power or market incentives [57,67] were identified as effective forces in the changing spatial structure of urban areas. In fact, the market plays an important role in housing development, housing density and development time. However, a recession can curb urban growth or redirect it to different locations or types of investment through imposing restrictions on housing development, in addition to increasing rents and housing prices [107]. In recent decades, the demand for urban land has increased sharply in many cities with the supply of land in order to keep up with demand, precipitating inflation of land values [14,43,64,108] and housing prices [88,108]. Land and housing prices are subject to different factors and conditions, so that it varies at different times and places [93,109]. Moreover, this inflation of development costs reduces the ease of access of government and public institutions, as well as low- and even middle-income people to the land market over time, undermining the viability of marginal businesses, which reinforces the importance of the land market in urban growth processes [43,64]. It can also promote the ability to influence other strategic

axes, highlighting land management as amongst the most effective urban management tool. Despite these controls in setting the price of urban land, the price of land can be volatile in responses to speculative behaviors in markets.

Another cited factor was development of the tourism industry [16,25,40,81,88,110] as one of the effective factors in the development of relations between regions and/or nations, which is associated with creating job opportunities in the economic sector [5,64,93] and in improving socio-cultural interactions.

4.4.2. Investment

Although this factor has been less referenced in the selected papers, the role of financing and investment is crucial. This factor includes two main components: investment attraction and foreign direct investment. As the factors of urban expansion in the development of service infrastructure and urban projects [2,57,89,111] these have direct impacts on the location of the settlements and activities.

4.5. Contextual Factors

Finally, how does urban context affect LULCC; what are core contextual dimensions influencing physical-spatial structure of cities? These factors point to several external driving forces through which policies and process are directly, and urban growth are indirectly shaped.

4.5.1. Demographic

Increasing urban population is the major demographic factor that many articles take into account as the effective factors in the formation and changes of land use and land cover [2,4,5,7,9,11,13,16–18,25,27–29,33,34,56,59,61,71,88,90,93,99–101,111–113] and population density [8–10,16,19,80,85,90]. Demographic changes are the result of the improvement in the state of health and well-being of families and individuals, housing affordability, and the growth of communication technology in many regions. As a result, there has been an increasing trend of an intensification of population density in some cities and the emergence of mega cities (*i.e., 10 million or more people*) in recent years.

Another frequently-cited issue related to LUCLCC is the migration of rural populations to the city as the consequence of agricultural land transformation [11–13,23,24,29,59,64,71,88,100]. Other migration concepts such as internal migration within metropolitan regions [16,19,25,27,97,112]; and labor migration [11,13,22,40,64,68,110], were also attributed to the changes in built environment and consequently the change in spatial distribution of job oppurtunities or urban amentities resulted in improving the attractiveness of an area to absorb migrants. Another reason for internal migration includes the disparity in wages and working conditions in different locations, which creates a labour market duality. The influx of immigrants, on the other hand, raises the demand for housing and the expense of living, leading to marginalization. Changes in family structure and lifestyle necessitate changes in housing demands, which encourages bigger households to relocate from core districts to the periphery, affecting the land market and affecting the motive for suburban land usage.

4.5.2. Socio-Economic Features

As the least referenced sub-theme, the socio-economic features include gross domestic product per capita (GDP) [2,10,14,16–19,61,71,80,85,99–101,114–116], and increased income [14–16] which have increased the demand for a luxurious consumer oriented lifestyle [11]. Often this implies status conscious, spacious, comfortable houses accessible to convenient high quality transportation in master-planned estates, thereby increasing the demand for urban land [106]. IN addition, another socio-economic dimension is the phenomenon of second homes and second houses on the urban periphery to provide a retreat or for investment purposes to increase personal capital. Economic downturns/unemployment rate is another factor [80,97,116,117] influencing urban growth that can lead to the loss of

population from an urban core or declining suburbs and result in urban decay. Hence, economic recessions can have a powerful role in shaping urban spatial development.

4.5.3. Environment and Natural Resources

In conjunction with the previous contextual dimensions, environment and natural resources have the capability to change urban land use and land cover patterns. They include geographical location [14,22,25,27,96,101], flood prone areas [118,119], climate quality [16,41,111,120–122], sea shoreline [25,33], distance from water bodies such as rivers, lakes, wetlands, ponds [16,18,26,28,30–34,89,95], all of which are fundamentally important determinants of the extent, spatial distribution, and spatial expansion of urban lands. Furthermore, it can relate to the efficiency of terrestrial resources such as forestry and ecological resources [91], oil resources [13,18,40,88], minerals [1,9] and ecosystem services [65,123]. Slope [1,9,10,16,24–30,32,62,79,85,87,95] and elevation [1,10,27–30,79,85] also determines the location of physical developments within a city since the developers generally prioritise development in flatter areas.

5. Conclusions

With the global urban population rapidly increasing, further physical growth and associated land use and land cover changes are unavoidable. Hence, a critically important strategic priority in the urban planning agenda is in identifying, analysing and modelling the effective drivers underlying land use and land cover change. The work in this paper was a bibliometric and systematic review of LULCC, with the goal of identifying the drivers of land use and land cover change (2012 to 2022), as well as contributing to an analysis of the most significant concepts, methdological rules, and journals in LULCC research.

The main finding from this study is that the LULCC process is impacted by a variety of interconnected elements, ranging from transportation development to legislation, as well as contextual demographic, socioeconomic, and environmental aspects. Although they were arranged in groups and three levels of interactions, and their significance was only explored using the number of occurrences in the literature, it is worth noting that the factors are highly context-sensitive, so that their relationships and significance can change depending on factors such as time, geography, scale, and decision-making agents. It was found that transportation availability was the most frequent factor identified in the literature, although this can be detailed to include multiple dimensions of transport avilability such as provosion of mobility systems, fuel price and vehicle ownesrship area [124]. A caveat is that the frequency of topic mentions in the literature does not necessarily indicate that a factor is stronger in influencing urban growth, since the context of discussion can be supportive or critical of the role of a particular factor and the relative magnitude of a factor is often not easily ascertained from mapping the frequency of a term. Moreover, there may be a bias resulting from funding factors, or other factors that influenced the direction of research. Hence, various elements ambiguously examined in the existing body of literature in this field introduce a degree of uncertainty and have the potential to influence urban growth at various local, municipal, regional/state/provincial, national and globally levels. In terms of scale, for example, the spatial scale at which the studies were conducted has an impact on the results in such a way that human and artificial factors have the greatest impact at the micro level, and as the scale becomes larger (i.e., at the regional scale), the role of environment and natural factors becomes more pronounced, as is the case in the Beijing metropolitan area [125], in relation to altitude, distance from the river, and urbanisation rate.

This is also in line with the fact that the notion of urban growth is highly dynamic with a high level of complexity and uncertainty. Urban growth can be an unstable and discontinuous process that expands metropolitan boundaries and imposes drastic changes in land use that overwhelms social and environmental capacities and the capacity of existing plans and regulations to cope. As a result, governments and urban management systems are confronted with complex challenges, particularly in relation to the stresses to ecologies and human constructed environments arising from climate change.

Additional study is recommended to investigate the usefulness of the model of driving variables (Figure 5) in relation to its unique emphasis and local circumstances. This may include thoroughly examining the impact of particular components (such as transportation infrastructure) or drawing on aspects within each level (such as outer contextual factors). Furthermore, in light of the vast diversity of publishing landscapes globally, further review studies evaluating driving variables depending on country categories (such as global south) with a particular refrence to the social context [126,127] and city size (such as aggolormationa nd scale effects) would expand the scope of this work. Reviews of additional databases (e.g., Web of Science, Google Scholar) would also be beneficial in refining a model to determine LULCC that not only identified key drivers of change but which has predictive capabilities in response to key stressors in natural and human environments.

Author Contributions: Conceptualization, A.A.; methodology, A.A., A.S. and M.H.A.; software, M.Z.; validation, A.A. and A.S.; formal analysis, M.H.A. and M.Z.; investigation, A.S. and M.Z.; resources, A.A.; data curation, M.Z.; writing—original draft preparation, A.S., M.H.A. and M.Z.; writing—review and editing, A.A.; visualization, M.H.A. and M.Z.; supervision, A.A.; project administration, A.A.; funding acquisition, A.A. All authors have read and agreed to the published version of the manuscript.

Funding: This research received funding support from IVE: Australian Research Centre for Interactive and Virtual Environments, and UniSA Creative, University of South Australia, 2021.

Data Availability Statement: Data are available from the second author on request.

Acknowledgments: The authors wish to acknowledge IVE Centre of the University of South Australia and UniSA Creative for their support and resources.

Conflicts of Interest: The authors declare that there is no conflict of interest.

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