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Exploring Spatio-Temporal Pattern of Gentrification Processes in Intracity Slums in the Lagos Megacity

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Abstract: There have been increasing calls in gentrification studies to examine the geography of gentrification in slums, as little is known about the patterns and processes of slum gentrification, especially in sub-Saharan African cities where slums house over 50% of the urban population. This study explored the spatiotemporal changes in slums in Lagos, Nigeria, between 1984 and 20 on the pattern and drivers of gentrification. Data were collected from 42 slums in Lagos through remote sensing (1984–2020) and a field survey (2020–2021). The study integrated geospatial analysis with quantitative and qualitative analysis to investigate the patterns and drivers of gentrification in Lagos slums. The findings show that between 1984 and 2020, all the sampled slums had undergone gentrification processes, apart from those that were completely cleared. However, many slums continue to have deprived areas as they continue to gentrify. Almost all the slum communities have experienced slum clearance in the past. Additionally, the current and new housing developments in the study have favored middle- to high-income groups, which has led to the displacement of previous slum residents. The study identified slum clearance, fires and floodings, the presence of palaces in the community, the proportion of deprived areas in 1984, government interest in the slum, and the size of the church as drivers of slum gentrification processes in Lagos. Finally, the findings show that the vulnerability of slum dwellers increases with slum gentrification. Therefore, this study recommended developing policies and programs, such as sustainable relocation and low-cost housing, to mitigate the negative consequences of slum gentrification, especially in cities with significant shares of low-income groups.

Keywords: slum gentrification; deprivation; Lagos

1. Introduction

In 2003, the UN-Habitat described slums as a "*physical and spatial manifestation of urban poverty and intracity inequality*" [1] (p. xxvi). This definition shows already why the topic is so important in international discourses. Slums constitute a societal and governance challenge, especially in sub-Saharan Africa, where more than 55% of the urban population resides in slums [2]. Furthermore, Africa will contribute approximately 50% of the projected two billion world population increase expected in 2050 [3], and if the status quo were to persist, this would likely lead to slum proliferation in the region as urban population growth and slum growth are on par in African cities [4,5].

The need to differentiate between slum and deprived areas is important, especially when slum is defined based on household. This is because deprived areas "*reflect the social, environmental and ecological risk factor to health and wellbeing above and beyond household and*

individual characteristics while slum household reflects household poverty risk factors to individual health and wellbeing" [6] (p. 3). Generally, slums are characterized by deprivation [7–9]; however, it is noteworthy that not all deprived areas are in slums and that non-deprived areas can also be found in slums [6,10]. Therefore, investigating the pattern and proportion of the deprived areas in slums can give further insight into the dynamics within slums and support the development of tailored slum management programs for different slums.

Past and current slum management programs can be loosely categorized into two classes: slum upgrading and slum clearance. In slum upgrading programs, basic services are provided for slum dwellers, and some go further to introduce security of tenure [11]. Conversely, slum clearance, which could either be total or partial, involves clearing slum communities following the forceful eviction of residents [12]. Slum upgrading is preferable because it is cheaper and promotes residents' participation [13,14]. However, irrespective of the approaches employed, they both lead to gentrification in slums in the long run [15].

Gentrification processes have some positive effects, such as improving the quality of the physical environment, increased prospects of tax generation for the government due to the higher incomes of the new residents [16], and a reduction in poverty and crime, which can improve the overall image of an urban area [17]. However, it does have negative consequences; for instance, at the individual level, it leads to displacement and loss of affordable housing, especially for low-income earners within cities, and at the city level, it causes destabilization and loss of social diversity in neighborhoods [18]. It also eliminates non-private forms of tenure [19], thereby promoting segregation around land accessibility in cities. These negative consequences create major challenges, especially in sub-Saharan Africa, where almost all cities are dominated by low-income residents and the popular tenure system is customary [16,20]. Customary tenure entails a framework of regulations and traditional practices dictating the allocation, utilization, accessibility, and transfer of land and natural resources within a community, i.e., community norms and rules, rather than statutory, prevail on land use decisions in communities [21]. While social equity demands the provision of resettlement plans for displaced low-income residents [22], experience has shown that neither the city officials nor the new occupants make contributions to the plight of displaced low-income residents [23].

This study focuses on Lagos, Nigeria, which has developed from a "*small fishing village in the fifteenth century*" [24] (p. 8) to one of the fastest-growing cities in the world [24]. Lagos currently has more than 100 slums, and over 65% of Lagos residents reside there [25,26]. Prior to 1999, the laissez-faire attitude of the Lagos state government to the slum situation contributed to slum proliferation in the city; however, the change in government in 1999 and the neoliberal approach adopted to transform Lagos into "Africa's model city" promoted slum clearances and new styles of urban development [27,28]. Nevertheless, little is known about the process of urban transformation through slum gentrification in Lagos. Therefore, this study aims to explore the spatio-temporal pattern of gentrification processes in intracity slums in Lagos by addressing three specific questions: (i) What were the spatial patterns and proportions of deprived and gentrified areas in the slums of Lagos from 1984 to 2020? (ii) What characteristics are revealed by the gentrification processes in the slums? and (iii) What drives gentrification processes in intracity slums in Lagos, Nigeria?

2. Slum Gentrification

The term gentrification was coined by Ruth Glass [29] when she observed the replacement of working-class low-income residents with middle-income earners in residential communities in London. In this classic example of gentrification, high-income earners purchase individual residential units from property owners within inner cities, refurbish them, and rent them out at a higher price. Over time, this neighborhood undergoes physical, socio-economic, and demographic transformation [16,30,31]. This process mostly occurs in places where prior disinvestment in urban infrastructure can lead to profitable redevelopment for business owners and elites vis-à-vis any concern for the initial residents of the area [32].

Gentrification can be described as contextually unique because not all gentrification processes follow the same trends as described by [29]. For instance, ref. [33] observed in their household survey of gentrified neighborhoods in America that gentrification does not always involve the displacement of low-income residents. Furthermore, not all gentrification processes lead to neighborhood upgrades, such as conversions of cleared slums into open spaces in Delhi [34]. Thus, various types of gentrification processes can be distinguished based on their specific processes, for example, slum gentrification [15,35], studentification [36], infrastructure-induced gentrification [37], commercial gentrification [16,38], hybrid gentrification [39], green gentrification [40,41], etc.

In this study, slum gentrification is understood as the process by which new (or renewed) interest in a slum leads to investment of capital or material in the area, resulting in changes in the built environment and the partial or total substitution of prior residents from the site of investment [15]. The slum gentrification processes follow four phases: (i) the interest in the slum (socio-cultural and economic) at the local or global level; (ii) the influx of capital investment (human or economic); (iii) transformation of the built environment (through slum upgrade, clearance, and renewal) and (iv) removal of previous residents (displacement) [15]. The dynamics of these processes are very complex since "different phases and types of gentrifications are emerging in different places at different and indeed the same times" [42] (p. 158). This makes comparison between different places difficult as the complex social science theories on the gentrification process cannot explain such temporality [43]. Since slums, like other urban elements, have distinct spatial characteristics [44,45], regularly updated remote sensing data can be used to investigate the temporality of gentrification processes in different places. However, it is important to note some of the limitations, such as cloud coverage (especially in coastal areas), pre-existing knowledge of the study area, limited availability of very high-resolution data, similarity in textural characteristics of complex urban landscapes, etc. [46–48], that can affect the use of remote sensing data in mapping slum gentrification. Yet, there are limited studies that have utilized this method [49–52], and to the best of the researcher's knowledge, no study has utilized this approach to study the slum gentrification process in African cities.

Gentrification processes are generally regarded as driven mainly by economic and political factors [53–56]. One key driving factor is the interest in the slum as it drives the direction and rate of the gentrification process. For instance, a slum with local or global interest as a celebrity/tourist area will likely experience a gradual gentrification process through upgrades rather than total clearance, for example, Kibera in Nairobi and Ma-koko in Lagos [15,57]. In the same vein, slums regarded as vote banks by politicians (Slums as vote banks refers to the political strategy where politicians or political parties target slum areas as a significant source of votes during elections) are allowed to persist, and rather than being cleared, facilities, albeit limited, are provided as upgrading mechanisms [58,59]. Slums perceived as a nuisance to city planning or located on prime land may undergo a fast-paced gentrification process through total or partial clearance, for example, Maroko in Lagos and Vila Autodromo in Rio [60,61]. In addition, existing literature has shown that the location and socio-economic characteristics of slums, security of tenure and social capital in slums can indirectly influence and determine the spatial transformation of slums [15,19,61,62]. For instance, ref. [63] argued that slums located within central Lagos are likely to undergo faster clearance and gentrification processes compared to those at the fringes of the city. Using India as a case study, ref. [58] also showed how slum residents employed their social capital to influence the state of their respective slums.

There is significant work on gentrification processes internationally, but only limited studies have focused on gentrification processes in the Global South. This has resulted in a major research gap because gentrification processes in the Global South do not necessarily follow the same trends as those observed in the Global North [19,42,64]. Thus, theories and concepts of gentrification processes developed in the Global North cannot be fully adopted in the Global South, especially in African cities where the process of urban development differs from the other regions [65]. Furthermore, most of the limited studies on gentrification

studies in African cities provide an overview of the entire cities [39,66–68], with others focusing specifically on inner city areas [16,69–71]. Although African city centers are worthy of interest because of relatively higher deterioration and transformation rates compared to other parts of the city [71–73], many African cities have grown beyond their city centers and experienced significant gentrification processes, for example, Lagos (Nigeria), Nairobi (Kenya), Maputo (Mozambique), etc. Furthermore, it is easier for gentrification processes to proceed unnoticed for some time in non-central city locations because of the gradual nature of the process, for instance, Parkhurst in Johannesburg [74].

3. Methodology

3.1. Study Area

Lagos, a megacity situated in Southwestern Nigeria, lies between longitude 2°42′ E and 3°42′ E and latitude 6°22′ N to 6°52′ N, encompassing a land area of approximately 3577 km^2 (see Figure 1). The city's terrain is predominantly low-lying, characterized by elevations ranging from 13 m below sea level to 95 m above sea level. Geopolitically, Lagos shares borders with the Republic of Benin to the west and Ogun state to the north and east, extending along the Guinea coast of the Bight of Benin for over 180 km, opening to the Atlantic Ocean. Its strategic location on the western African coast has historically facilitated extensive trade both within its hinterland and with neighboring countries [75]. Notably, even during the colonial epoch, Lagos served as a pivotal hub for the transatlantic slave trade [76]. The population of the city was estimated at 27,281,339 in 2020, with an annual population growth rate of 3.2% [77]. The average population density within the built-up area is estimated to be over 20,000 persons per km^2 [76].
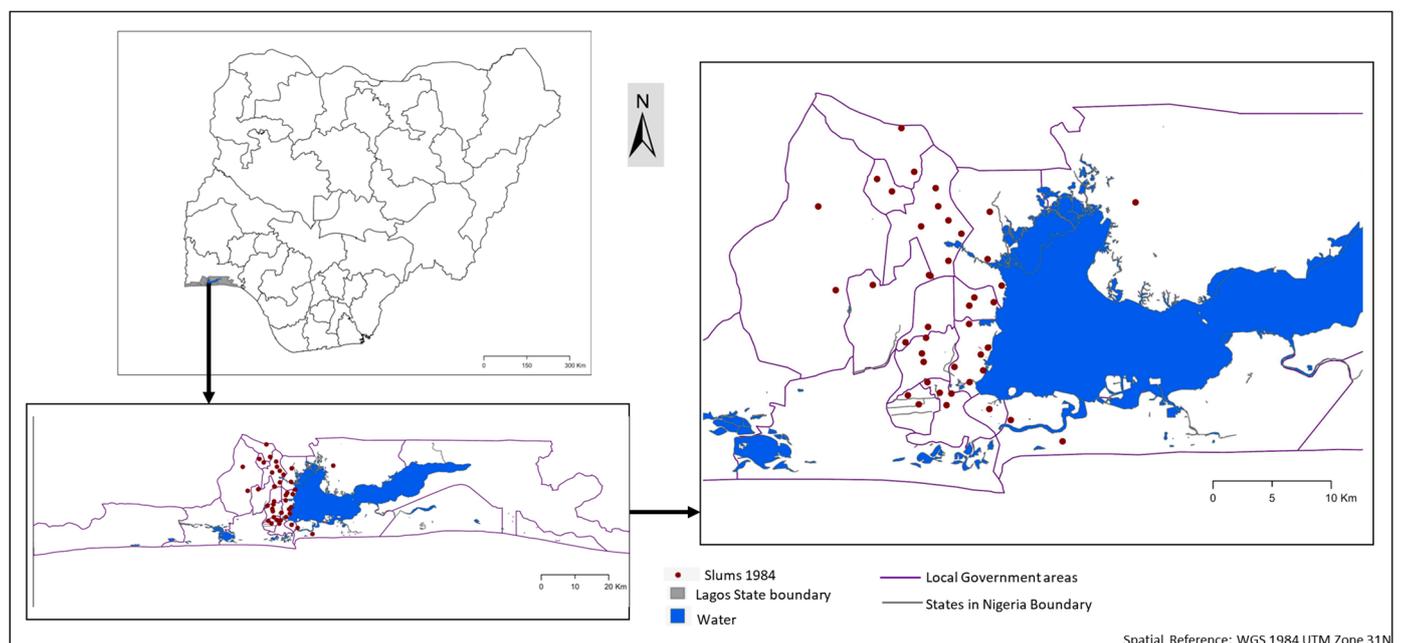

Figure 1. Overview map of the study area of Lagos, Nigeria.

This study was carried out in the 42 slums identified in 1984 in Lagos [78] because they were the earliest officially recognized slums by the Lagos state government in 1984 (see Table 1). A key criterion in the identification of these slums in 1984 was the deterioration of the sites [78]. Based on the high rate of urbanization in Lagos [24], it is expected that these slums have undergone significant changes since then, thereby making them suitable choices for the analysis. Additionally, they exhibit different manifestations of slums in Lagos. These communities can be differentiated according to their legal status into legal communities that were built based on old urban planning standards and zoning but over time, became dilapidated and overcrowded and into illegal communities without legal

status and where residents are frequently referred to as squatters [79,80]. Currently, the Lagos state government employs a similar upgrading strategy in all the communities, irrespective of the legal status. For example, during the implementation of the Lagos Metropolitan Development and Governance, basic urban services such as roads, water, and electrification were provided in nine of the largest slums [81]. The slums vary in size between five and 475 ha, with an average size of 82 ha. The estimated population density of the slums in 2021 ranged from 7631 to 358,474 per ha, with an average of 60,805 per ha. The slums are either located on land or both swamp and land. In 1984, the UNDP ranked the slums according to the level of deterioration between 1 and 42, with 1 being the most deteriorated.

Table 1. Characteristics of the study area.

S/N	Sampled Communities	Tenancy (1984)	Area (ha)	* Projected Population/ha (2021)	Location	Ranked by UNDP, 1984 ***
1	Abule Ijesa	Slum	108	26,541	Land	9
2	Agege	Slum	74	91,576	Land	12
3	Agidingbi	Slum	22	7631	Land	13
4	Aiyetoro	Slum	17	16,127	Land	20
5	Ajegunle	Squatter	244	358,474	Swamp and Land	11
6	Alausa village	Slum	26	29,822	Land	18
7	Alli oromoko	Slum	5	8330	Land	21
8	Amukoko	Squatter	117	67,175	Land	15
9	Badia	Squatter	169	324,005	Swamp and Land	4
10	Bariga	Slum	64	100,446	Land	27
11	Egbe Bolorunpelu	Slum	80	41,493	Land	38
12	Ejigbo	Slum	62	38,318	Land	33
13	Ijeshatedo/Itire	Slum	57	95,981	Land	25
14	Ijora Oloye	Squatter	19	15,263	Land	6
15	Iju	Slum	65	51,531	Land	34
16	Ikorodu	Slum	69	92,362	Land	32
17	Ilaje	Squatter	82	69,971	Water and Land	5
18	Ipaja	Slum	475	58,941	Land	40
19	Ipodo Ikeja	Slum	17	14,994	Land	7
20	Iwaya	Squatter	116	133,279	Water and Land	8
21	Lagos Island	Slum	461	72,384	Land	22
22	Lawanson-Ikate	Slum	27	47,050	Land	36
23	Makoko	Squatter	77	149,095	Water and Land	3
24	Marine beach	Slum	17	24,128	Land	42
25	** Maroko	Squatter	312	0	Land	1
26	Mile 12 market	Slum	11	47,514	Land	31
27	Mushin-Idiaraba	Slum	44	71,143	Land	16

Table 1. *Cont.*

S/N	Sampled Communities	Tenancy (1984)	Area (ha)	* Projected Population/ha (2021)	Location	Ranked by UNDP, 1984 ***
28	Obalende	Slum	62	27,134	Land	41
29	Ogba west	Slum	36	13,213	Land	23
30	Ogudu	Squatter	45	13,195	Land	39
31	Okobaba	Squatter	35	32,221	Water and Land	19
32	Olaleye-Iponri	Slum	42	59,355	Land	2
33	Olusosun village	Slum	9	11,729	Land	30
34	Onigbongbo	Slum	50	37,943	Land	37
35	Oregun	Slum	67	71,584	Land	24
36	Orile-Agege	Slum	13	18,613	Land	29
37	Oshodi market	Slum	16	24,128	Land	35
38	Otto	Slum	17	25,438	Swamp and Land	10
39	Oworonshoki	Slum	49	41,822	Land	28
40	Sari-Iganmu	Squatter	100	36,362	Land	14
41	Shogunle	Slum	31	65,511	Land	17
42	Shomolu	Slum	39	21,991	Land	26

* The projected population/ha is based on a 3.2% population growth rate for Lagos; ** Maroko was demolished in 1991, so the pop/ha is not given. *** The ranking is based on the level of deterioration of each slum ranked by UNDP in 1984. Source: [82,83].

3.2. Data Collection

This study combined various data sets to explore the spatiotemporal patterns of gentrification processes in intracity slums in Lagos: remote sensing data with quantitative and qualitative data through a survey (Figure 2).
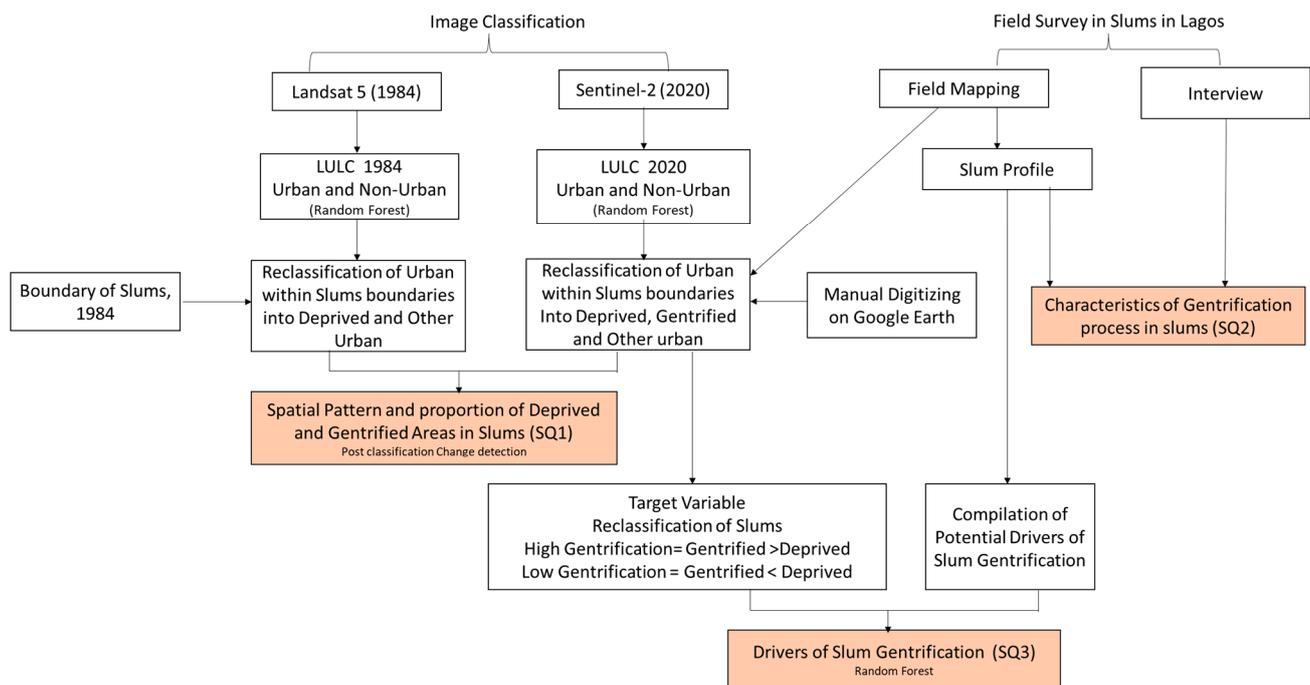

Figure 2. Work flow.

The satellite data utilized in this study were Landsat imagery (Landsat 5; Level 1; 30 m resolution) acquired 18 December 1984, Sentinel-2 (Level 2, 10 m resolution) acquired 26 December 2020, and Google Earth images (January 2021). We generated land use/land cover maps for the data sets and time steps. The two observations were picked because they corresponded to the available in situ data. Thus, the 1984 Landsat imagery corresponded to the mapping of the slums by the Lagos state government in 1984, while the Sentinel-2 and Google Earth images corresponded to the time the fieldwork was carried out in the communities. The data set of the boundaries of the slums (in 1984) was obtained from the Lagos State Ministry of Physical Planning and Urban Development. During the field survey, we observed that the extent of the slums had changed; therefore, the new extent of each slum community in 2020 was digitized from Google Earth images based on the field survey.

Field mapping (2020–2021) was conducted in each slum to develop a slum profile for each of the 42 sampled slums in Lagos. The purpose of the slum profile was to assess the ongoing processes of gentrification and identify its driving factors. Informed by earlier studies, e.g., [15,84–87], we, therefore, collected data about the physical characteristics, available facilities, land prices and rents, housing types, location characteristics (e.g., closeness to open markets, industrial land use, different income residential areas, roads, government buildings, etc.), clearance history, transformation process, etc. in each slum. A buffer of 200 m was created around the boundaries of the 42 slums to identify some of the aforementioned locational characteristics. A buffer of 200 m was selected because it falls within the range of what is considered a walking distance in transportation and proximity studies [88,89].

In-depth interviews were conducted in each community with one stakeholder who is a member of the community groups to obtain a deeper understanding of the observed changes and drivers of slum gentrification. During the field mapping, information about the community groups was obtained from residents of the communities, which aided in the selection of the stakeholders to be interviewed. The aim of the interview was to complement the data obtained from the slum profiles. The interview questions were semi-structured and included questions on how the slums have evolved over time, government/ community group activities in the slums, and the impact of facilities such as roads, new building development, religious centers, etc, on the overall gentrification process in each community.

Saturation is when new data fails to spark fresh theoretical insights or reveal additional properties of core categories [90]. We, therefore, ended the interviews after we obtained results from 10 (out of the total of 42) communities (The communities are Iwaya, Itire/Ijeshatedo, Makoko, Ikorodu, Ajegunle, Otto/Ilogbo, Badia-East, Oshodi, Shomolu and Agindingbin). The study employs pseudonyms for all individuals mentioned, adhering strictly to ethical protocols concerning confidentiality and informed consent.

3.3. Data Analysis

The methodology comprised three steps: (i) image classification and change detection of the remotely sensed images; (ii) an analysis of survey data to investigate the gentrification process in the study area; and (iii) a combination of remotely sensed data and survey data to identify drivers of gentrification processes in slums in Lagos.

3.3.1. Image Classification and Change Detection

The mapping of slums from remote sensing data combined the three approaches of manual digitization, automated classification, or/and combined with field surveys [48,91–93]. The Landsat and Sentinel-2 images, downloaded from the Sentinel Hub, were already geometrically and radiometrically calibrated. Bands 1, 2, 3, 4, 5, and 7 of the Landsat images were used for the classification procedure. Similarly, bands 2, 3, 4, and 8 (because they have a 10 m spatial resolution) of the Sentinel-2 images were used for the classification procedure. The derived land use map from the Sentinel-2 was resampled to 30 m for easier comparability with the land use map derived from the Landsat images. Five hundred

sample points were randomly selected from Google historical images (December 1984 and December 2020) to generate training (80%) and reference (20%) data for the Landsat and Sentinel-2 images, respectively. The random forest classifier [94] was used to classify the images into built-up (impervious) and non-built-up (i.e., water, vegetation, open space).

The performance of the classification was evaluated using cross-validation, overall accuracy and the F1 score [95,96]. Cross-validation allows the model to be more robust as it computes accuracy from the number of folds and iterations [96]. Similarly, the F1 score manages the weakness of user and producer accuracy as it calculates the harmonic mean between them [97] (Table 2).

Table 2. Accuracy of land use and land cover classification.

	Land Use and Land Cover	1984		2020	
		F1	Accuracy	F1	Accuracy
1	Built-up (impervious surface)	0.93	0.96	0.85	0.83
2	Non-Built-up	0.97	0.96	0.80	0.83

Due to the lower resolution of the Landsat and Sentinel-2 images, the slum area, as well as the deprived and gentrified areas, could not be automatically identified. To identify the slum areas, we classified the built-up area within the boundaries of the slums in 1984 as deprived areas since these data were assessed in situ by the government in 1984.

We then manually digitized the current deprived areas within the extent of each slum using Google Earth data from 2021. The delineation was based on expert opinion and the spatial characteristics of slums. For example, areas with haphazard building styles, no/irregular road connections, compacted buildings, and proximity to dumpsites and water bodies were delineated as deprived areas within each slum [98]. The digitizing was run concurrently with the fieldwork, which was used to validate the digitized map. Mapping was, therefore, a back-and-forth process that allowed direct modification of the digitized deprived area within the current extent of slums based on the fieldwork. The digitized map was overlayed on the land cover map developed from the Sentinel-2 image to reclassify the built-up area within each slum extent into gentrified, persistent deprived areas, newly deprived areas, and other urban areas in 2020 (Table 3). A post-classification change analysis was conducted to identify and calculate the changes in the persistent deprived and gentrified areas in each slum between 1984 and 2020.

Table 3. Land Use areas within the study area in 2020.

Classes (2020)	Description
Gentrified areas	Deprived areas in 1984 that transformed into non-deprived areas
Persistent deprived areas	Deprived areas in 1984 that continue to be deprived
Newly deprived areas	Non-built-up areas in 1984 that transformed into deprived areas in 2020
Other urban areas	Non-built-up areas that transformed into a non-deprived urban area in 2020

3.3.2. General Characteristics and Processes of Slum Gentrification in Lagos

The data obtained from the slum profiling were analyzed using descriptive statistics to summarize the slum clearance and housing developments in the study area. Furthermore, the stakeholders' interviews were analyzed using narrative analysis [99] to obtain slum residents' insights on their narration of changes in the slums and the gentrification process.

3.3.3. Drivers of the Slum Gentrification Process

Potential drivers of slum gentrification were selected based on previous studies, such as tenancy in slums, proximity to major roads, high and median income, presence of

social capital, community group activities, size of slum, etc. The categorical variables were derived based on the presence/absence of the facilities (markets, industries, slums, etc.) within a buffer of 200 m (see Table 4).

Table 4. Drivers of slum development used in this study.

Type	Variable Description	Data Type	Justification	Data Source
Target variable	Level of gentrification	Categorical (high/low)		Landsat (1984), Sentinel 2 (2020), GE (2021)
General slum characteristics	Tenancy of community (1984) Legal community, squatter community	Categorical (legal, illegal)	The security of tenure drives slum evictions in Lagos [100]. This allows easier access to rebranding an area into a high/medium-income residential area	[82]
	Dominant land use type	Categorical (residential, industrial and commercial)	There is a cyclical pattern of land use conversion during the gentrification process [86,101]	Survey
	Proportion of the deprived area in each slum in 1984	Continuous (range from 0–1)	Smaller slum settlements are more vulnerable to transformation than bigger ones [85]	Landsat image 1984
Location	Closeness to open markets	Categorical (Yes, No)	Slums develop close to the informal economy and job opportunities [84,102]; residents may resist gentrification due to job opportunities in the open market and industrial area	Survey
	Closeness to industrial land use	Categorical (Yes, No)		
	Closeness to high residential area	Categorical (Yes, No)	Slums close to high and medium residential areas tend to undergo gentrification [87,103]	
	Closeness to medium residential area	Categorical (Yes, No)		
	Closeness to other slum communities	Categorical (Yes, No)	Closeness to other slums may allow residents to move to other slums	
	Closeness to major roads	Categorical (Yes, No)	Roads as an infrastructure facility promote the gentrification process [16]	
	Closeness to government buildings	Categorical (Yes, No)	Nearness to government buildings allow easier access to slums [12], which, in Lagos, may influence the gentrification process in slums	

Table 4. *Cont.*

Type	Variable Description	Data Type	Justification	Data Source
Socio-economic	General income level of residents	Categorical (high, middle, and low-income)	The gentrification process involves the replacement of low-income with middle/high-income residents [15].	Survey/interview
	Influence of social groups: presence of community group association and non-governmental organization	Categorical (Yes, No)	Social capital influences resilience in slums. Non-governmental Organization, community development groups, worship centers, traditional palaces, town halls and other communal places can strengthen social networks, which can influence the gentrification process in slums [60,104,105]	Survey
	Presence worship centers (church and mosque)	Categorical (Yes, No)		
	Presence of palace in slum	Categorical (Yes, No)		
	Presence of communal place (Communal place includes town hall, sport area developed by the community)	Categorical (Yes, No)		
Political /Government influence	Presence of government influence projects in area	Categorical (Yes, No)	Government drives gentrification based on their vision for the city [69]. This can be assessed using their activities and government-led projects	Survey
	Slum clearances	Categorical (Yes, No)	Slum clearances pave the way for the gentrification process in Lagos. Slums cleared in Lagos have been converted to high/medium-income residential areas [28]	
	Type of slum clearance **	Categorical (limited, significant)	Clearance of certain areas in slums create vacant plots for new developers/investors to capitalize on thereby initiating gentrification processes [106].	Survey Landsat image 1984 Sentinel-2 2020
Facilities *	Availability of public water	Categorical (Yes, No)	Provision of infrastructure and facilities supports the rebranding of an area [37].	Survey
	Availability of schools	Categorical (Yes, No)		
Recorded hazards	History of fire outbreak	Categorical (Yes, No)	Fire outbreak and flooding have been used as driving forces for slum clearance and gentrification processes in Lagos [60,87]	Survey
	History of flooding	Categorical (Yes, No)		

* Electricity was excluded from the drivers because all the communities sampled had access to electricity via the presence of electric poles in the area. ** Limited means less than 50% of the deprived area cleared, while significant here means more than 50%.

3.3.4. Random Forest and Variable of Importance

The study applied the random forest classifier [94] to determine the drivers of the slum gentrification process in Lagos. "*Random forest models are an ensemble method of decision tree*" [107] (p. 83). Random forest models operate by training numerous decision trees on random subsets of the dataset and subsequently averaging the results of these decision trees to generate a final prediction [107]. Through this, the random forest can lead to high predictive accuracy without overfitting the data [107,108]. It can also manage multicollinearity, handle variables of different scales, and have high dimensionality in the data sets [107,108]. Another advantage of random forests is the possibility of assessing the importance of variables (A variable of importance is a score that indicates how important a feature (in this case, drivers) is to the model) and their contribution to overall model performance [107]. These advantages made it suitable for the study. However, it is important to note that the result of a random forest is sometimes difficult to interpret [94]. Nevertheless, for this study, the extracted result from the variable of importance provides an indication of the drivers of gentrification in the study area, which was the focus of this section of the study.

For our analysis, our target variable was a binary variable comprising of low gentrification (0) and high gentrification (1). While our predictor variables (continuous and categorical) were the drivers described in the previous section. We want to point out that one unit of sample in this study is a slum, thus our total samples were the 42 slum communities.

To develop the target variables, we compared the land area that was transformed from deprived areas in 1984 to gentrified areas in 2020, as well as deprived areas that persisted until 2020. The proportion of gentrified areas was then compared to that of deprived areas within the boundary of the sampled slum. Thus, if a sampled slum had a larger gentrified area compared to its deprived area, the slum was classified as highly gentrified (1); if the deprived area was larger, then the sampled slum was classified as low gentrified (0).

After the reclassification of the target variable, based on the comparison between the deprived and gentrified area within each slum (see Section 3.3.3), 14 of the slums were reclassified as low-gentrification areas and 28 as high-gentrification areas, leading to unbalanced classes. Thus, we specified the class weight as representing balance in the random forest algorithm in the Scikit-learn Library in Python, which was used to fit the data set. Hyperparameter tuning was performed using the grid search method [96] to obtain the best hyperparameters to fit the data sets and was evaluated using the cross-validation method and overall accuracy score (0.73). Finally, the important drivers of slum gentrification were computed, based on the variable of importance, after fitting the data sets using the best combination of hyperparameters.

4. Results

4.1. What Were the Spatio-Temporal Patterns and Proportions of Deprived and Gentrified Areas in the Slums of Lagos from 1984 to 2021?

We identified and characterized the development of the slums in Lagos between 1984 and 2020, as shown in Figure 3. The figure depicts the areas where slums have been gentrified, that is, which areas have changed from deprived to non-deprived, which ones were newly deprived, and those in which no changes could be observed. Maroko, Oshodi, and Lagos Island showed increasing gentrification processes, while deprived areas increased in slums such as Iwaya. All 42 slums examined have experienced area changes within the time interval studied, which is expected of a fast-developing city such as Lagos, with a neoliberal approach to urban management and negative perceptions of slums [27,28]. However, the policies have not eradicated deprived areas in the slums.
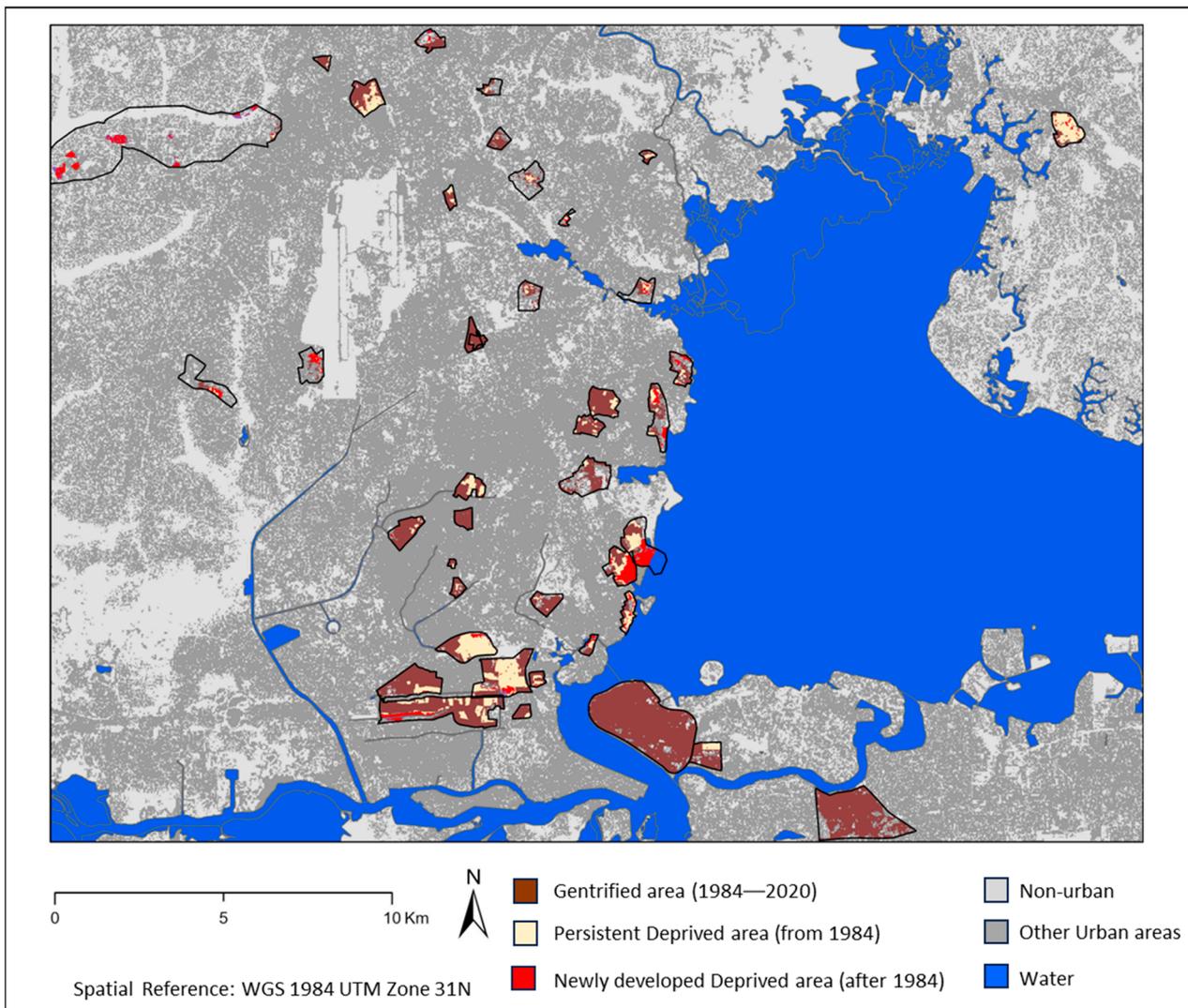
Figure 3. Gentrification processes in the slums of Lagos (1984–2020). Source: Landsat image (Land use map, 1984), Sentinel-2 (Land use map, 2020), Google Earth image (2021).

While the existing slums are undergoing gentrification, newly deprived areas can be seen springing up around the slums, especially those close to waterbodies, for example, Iwaya and Makoko. This is because of the higher rent of the newly built houses, which are expensive for the previous residents, and due to the slum residents' attachment (i.e., socio-cultural) to these slums [44], they look for alternative shelters closer to their previous homes. This has led to a simultaneous process of gentrification and deprivation in the sampled slums. Corroborating this displacement is a previous resident of Iwaya, who presently resides by the lagoon close to Iwaya:

I was living close to the University of Lagos before; then I had to move with my family because I could not afford the new rents my landlord wanted me to pay. (Ayo, Iwaya, January, 2021)

As the administrative and economic hub of Nigeria and neighboring countries, Lagos has experienced population growth, especially in the inner city, since 1984. This has contributed to a high proportion of built-up densification in inner city slums such as Ajegunle, Lagos Island, Marine Beach, and Maroko compared to other slums such as Ipaja, Ejigbo, and Iju located on the fringes of Lagos. However, the Ikorodu slum (also located on the fringes of Lagos) was an exception because the Ikorodu enclave had an economic relationship with the Lagos metropolis through the provision of agrarian produce for

the people residing in Lagos [109]. The implication was that while the other slums in inner Lagos grew due to the economic pull into Lagos, Ikorodu already had economic opportunities for its people to grow. This could be the reason why the old slum in Ikorodu persists without so much gentrification within the old boundary of the Ikorodu slum (see Figures 3 and 4).
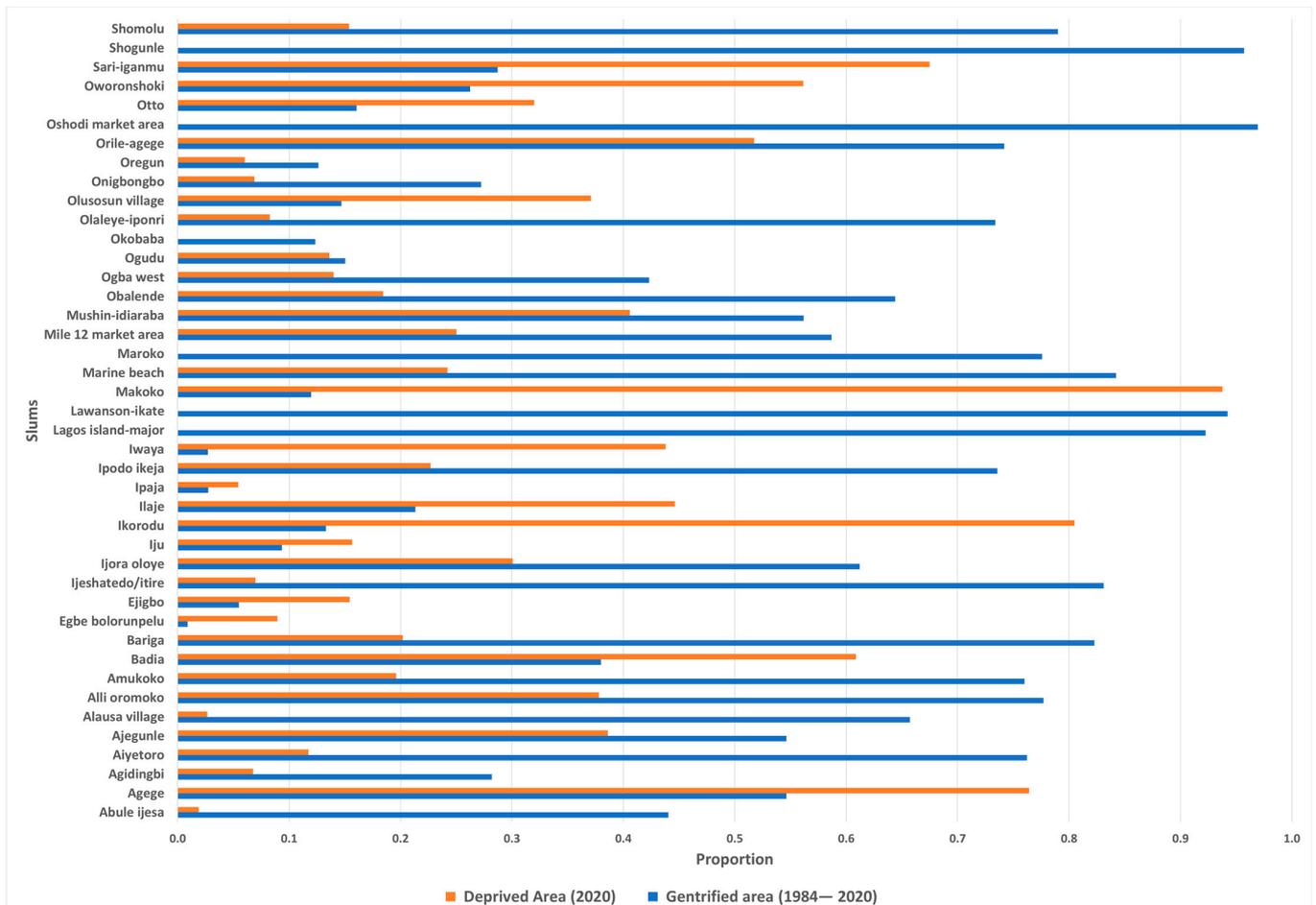

Figure 4. Proportion of deprived and gentrified areas in the study area.

Lagos Central, where the inner slums are located, has a higher economic value; therefore, there is a high demand for land in this area [62]. Thus, a more intense process of gentrification has been observed in the inner-city slums compared to the outer-city slums, such as Ikorodu slums. Slums such as Maroko, Oshodi, and Lagos Island, with a deprived area of over 85% in 1984, have completely gentrified into high-income residential areas and commercial hubs after undergoing slum clearances. Therefore, it is not farfetched to assume that slum clearances were the reasons for these complete changes as one phase in the slum gentrification process (Figure 4).

4.2. Which Characteristics Are Revealed by the Gentrification Process in Slums?

Two dominant types of gentrification processes are observed in the slums: residential gentrification and commercial gentrification. In residential gentrification, the slums have primarily transformed into high/middle-income residential areas; for instance, the Oniru Private Housing Estate, a high-income residential area, is in the present-day Maroko slum. New housing estates are currently being developed in parts of the Badia slum. Commercial gentrification, which entails the conversion of the land area of slums into commercial use, can be observed in Lagos Island and Oshodi. The commercial gentrification of some slums can be attributed to their location in prime spots and along major road corridors in Lagos.

In these locations, the demand for commercial accommodation outpaces that for residential buildings [16].

Housing delivery in Lagos is dominated by the private sector [110], with house owners/private developers building houses for maximum profit [111]. The current housing styles in the sampled slums are predominantly more expensive (i.e., blocks of flats and duplexes) because they are privately owned (Table 5). The implication is that the initial residents of the slums cannot afford the new rents and, therefore, have become displaced after redevelopment. A resident of Ijeshatedo/Itire remarked as follows:

Table 5. Dominant residential housing developments in the study area.

	Response	Frequency (%)
Design of new residential houses	Block of flats	73.8
	One single family houses	11.9
	Face-to-face	9.5
	Others	4.8
Dominant ownership of new housing development	Privately	95.2
	Government owned	2.4
	Mixed	2.4

Source: Author's survey 2020/2021.

After the government built this road, many landlords leased their land to developers to rebuild and then rent it out at a higher price. Many people have moved out because they could not afford the new rents. (Shola, Interview, Ijeshatedo/Itire, February, 2021)

An important phase in the slum gentrification process is slum clearance. We found that 39 out of the 42 sampled slums have experienced slum clearance in the past. Additionally, out of the 39 slums that have experienced slum clearance, 21 of them have had more than half of their land area cleared between 1984 and 2021. This shows the government's influence on these communities, as a massive scale of slum clearance cannot occur without government knowledge [28], even if driven by other stakeholders in Lagos [60]. In addition, selective demolition has been a common occurrence in the study area, especially in the slums considered to be legal, as new buildings can be seen sandwiched between deteriorating buildings and vice versa. This is because most of the selective demolitions were orchestrated by landowners or through partnerships between the government and landowners (e.g., the Isale Gangan housing scheme).

4.3. What Drives the Process of Gentrification

We identified the following key drivers and their importance to slum gentrification in Lagos based on the random forest model: the proportion of deprived areas, closeness to high-income residential areas, presence of government projects, type of slum clearance, Palace in the slum, Average level of income residents, fire and flooding incidence, size of church, closeness to major roads and closeness to the Government buildings. The x-axis gives the variable of importance, which shows how important the drivers are to slum gentrification in Lagos (Figure 5).

The proportion of deprived area in each of the slums in 1984 gives the size of the exact built-up area of the slum in relation to the total land area of the slum community. Slums with smaller deprived areas is assumed to have a smaller population compared to those with a larger deprived area. This size can deter slum removal as smaller deprived areas are more vulnerable to changes than bigger ones [85]. Additionally, the scale of operation required to transform a larger deprived area is higher compared to smaller deprived areas.
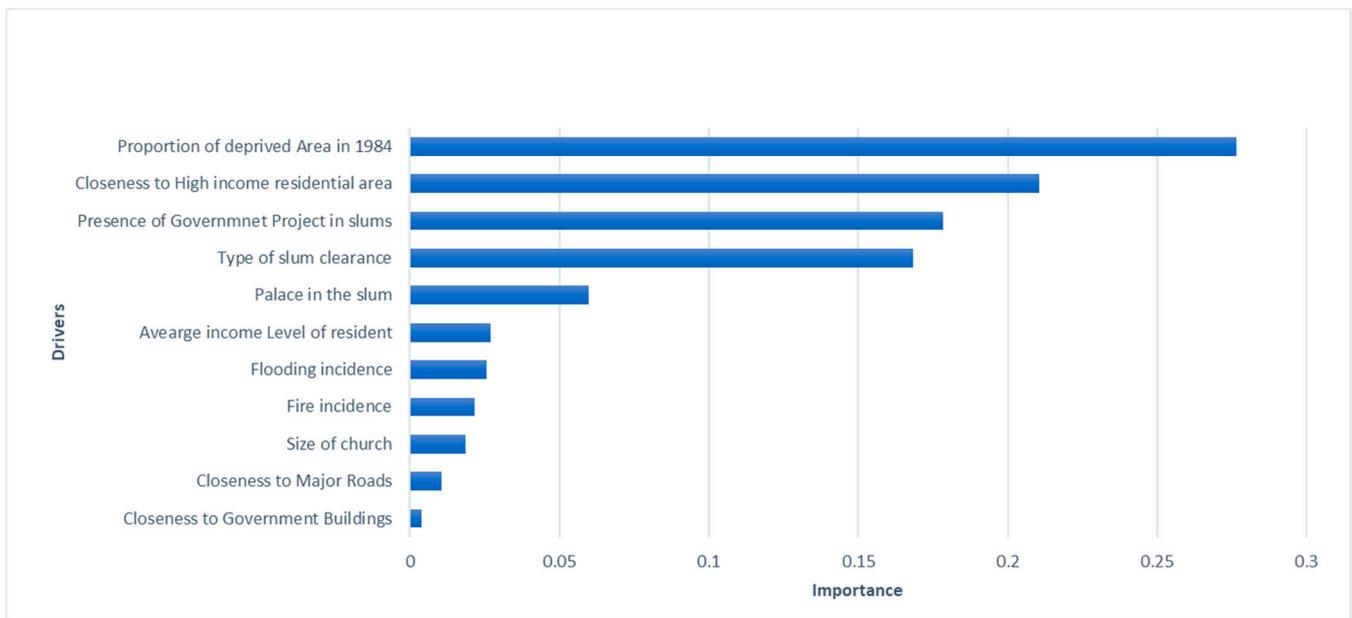
Figure 5. Drivers of slum gentrification in Lagos.

Residents in slums close to high-income residential areas have a high chance of being evicted to make room for new high-income residential areas, corporate buildings, or shopping malls [103]. This is because the high-income residential areas drive the property value in the neighboring slums, which attracts upscale businesses, thus changing the overall physical development in the slums [112].

Government investments such as the establishment of schools and the construction of roads and residential houses in slums symbolize the government's recognition of slums. The facilities provided by the government enable the transition of slums, thereby driving new residential houses in these slums. For instance, according to a resident in Itire-Ijeshatedo, the roads constructed by the government contributed to renewed interest from private developers in Itire-Ijeshatedo slums as well as rent increases.

The type of slum clearance has hastened the slum gentrification process in Lagos as it has made slum land readily available for redevelopment and replaced previous residents with middle- to high-income residents. An example is the Maroko slum, which was cleared in 1990 and is now a high-income residential area. This community is regarded as having been fully gentrified as the slum no longer had a deprived area in 2020 (Table 2). Additionally, Badia East has been experiencing similar clearances and is currently undergoing a higher rate of slum gentrification [60].

The customary land tenure system in Nigeria allows traditional heads to claim ownership of land [60,113]. As traditional heads have built their palaces on their land and in communities where the palaces are located, a gradual form of gentrification has been observed. This is because residents living in proximity to the palace tend to have security of tenure and cannot be forced out without compelling reasons. However, to secure profits, many house owners lease their lands to private developers to rebuild, thereby leading to a change in the environment and displacement of prior residents due to higher rents. This also leads to leapfrog developments during the gentrification process as the need to redevelop is determined by landlords/landowners. This type of development is seen in the Ijesahtedo/Itire community and was corroborated by one of the landlords.

When our father died, we didn't want to sell the land, and we do not have money to rebuild. So, we leased it to the developers, who built this new house; they gave us this floor that we are living in, and they rented the other floors out to tenants. (Kola, interview, Itire, January, 2021)

Gentrification occurs mostly in low-income residential neighborhoods [114], and during the process, previous residents are replaced because they can no longer afford the new rents in the newly gentrified neighborhood. As observed in Table 5, the dominant new housing development styles in the sampled slum communities are more expensive and beyond the reach of the previous residents, who have had to move to low-income shelters.

Flooding and fire incidence are also influential factors behind slum removals in Lagos as they pave the way for slum gentrification. Among the reasons given by the Lagos state government for slum resident evictions are environmental reasons, such as flooding, which, after the evictions, clears the slums and makes the land vacant [87]. These vacant lands are then converted into high-income residential areas. Additionally, fire incidences in slums allow land to become readily available for redevelopment as old buildings are removed and land becomes vacant for other uses. For instance, fire incidences have been reported during slum clearances in Lagos [115]. A resident of Otto-Ilogbo corroborated this:

> *Someone set our houses on fire so we could be forced out and then sold our land to people that would pay more.* (Bidemi, Otto-Ilogbo Residents, March 2021)

Churches have grown to be one of the biggest organizations in Nigeria [116]. Their headquarters/camps can be seen as communities in themselves, as they function like communities, as well as a form of growth pole, for example, The Redeemed Christian Church of God and Mountain of Fire ministries camp/headquarters [117]. The bigger the size, the more functions they are assumed to perform. Furthermore, many churches tend to buy neighboring houses to accommodate their activities. The bigger the church, the more properties they require, and the more redevelopment is assumed to take place in the environment where they are located. This trickles down to changes in the slum's general built environment as new buildings spring up around the church facility. An example is the Mountain of Fire International headquarters in Iwaya slum, which, according to an older resident, had led to increases in new housing redevelopments, rents, and property prices in Iwaya.

5. Discussion

Urbanization has led to slum proliferation as well as an increase in slum gentrification in many cities in the Global South. In this study, all the sampled slums have experienced gentrification processes, which is likely to continue, given the status quo in Lagos. Furthermore, while slum gentrification is ongoing, deprivation is also increasing; therefore, gentrification and deprivation are arguably integral to the slum transformation process. Though they are usually studied separately [6,28,42,118], they are both interrelated and can occur simultaneously within a slum, such as in the case of Iwaya. Additionally, it is noteworthy that the existence of a deprived area in a community does not necessarily make the community a slum. As observed in this study, almost all the sampled communities continue to have deprived areas, yet not all of them are still classified as slums. Ref. [6] observed a similar situation in cities in India and Bangladesh, where deprived areas were found to occur more in non-slum than in identified slum communities.

With the application of remote sensing data, the study showed that the current state and patterns of slum gentrification differed among the slum communities. Some of these differences may be difficult to explain, especially in terms of the selective demolition of buildings, as decisions are sometimes based on individualism (i.e., for landlords with the security of tenure), thereby exemplifying the uniqueness and complexity of the slums within the city.

The major consensus is that residential gentrification is often accompanied by commercial gentrification [38,119]. However, in the case of slum gentrification, what is observed is either primarily dominated by residential gentrification (e.g., Maroko) or commercial gentrification (e.g., Oshodi). It is also important to note that the dominant form of slum gentrification depends on the location of the slum. This buttresses the importance of locational characteristics in slum transformation and diversity, as discussed in previous studies [16,61].

While there is ongoing debate about distinguishing between slum clearance and gentrification [34,54], this study showed that it is not farfetched to include slum clearance as part of the gentrification process. This is because slum clearance occurs within the gentrification process and creates avenues for capital reinvestment into the slum community, changes to the built environment, and the replacement of prior residents, for example, the Maroko and Badia slums. Similar cases have been observed in Indian cities [42], where slum clearance has driven the gentrification process. Therefore, slum clearance could be seen as propelling slum gentrification, especially in the Global South.

The assumption that improving basic services in slums can increase the security of tenure of slum residents [120] is not supported by the evidence in the case of Lagos. The government's provision of amenities, such as roads, schools, better drainage systems, etc., in slums drives up the value of land and rent in slums, which indirectly leads to slum gentrification and the displacement of slum residents [121]. Considering that a significant proportion of slum residents in Lagos are tenants [44], they are at the mercy of landlords who prefer to replace them with relatively better middle-class residents offering to pay higher rents or sell their lands to private developers. Ref. [122] observed a similar case in Rio, where the introduction of amenities to favelas led to increased rents and the stimulation of gentrification, which induced the displacement of previous favela residents.

The neoliberal system of government has led to urban transformations that primarily cater to middle- and high-income groups [44,121]. This trickles down to slum communities where newer developments mainly favor middle- to high-income groups and low-income groups are excluded or displaced. This has also been observed in other countries in the Global South, such as India, China [123], and South Africa [39]. The implication is that slum gentrification may likely increase poverty and vulnerability in African cities if not adequately managed. This is because slum dwellers are already in a precarious position due to their social, spatial, and economic status [2,87,124]. Combining this position with displacement from their homes aggravates their challenges, thereby increasing their deprivation.

6. Conclusions

This article contributes to the body of knowledge on slum gentrification in cities in that it answers the call for more research on the geography of gentrification, it considers temporality, and it expands the borders of global gentrification to areas yet unexplored. It specifically combined different methods to investigate slum gentrification in 42 slums in Lagos, Nigeria, which, to the best knowledge of the authors, has not yet been done. The study investigated the changes in deprived/gentrified areas between 1984 and 2020 and the process and drivers of gentrification in slums in Lagos.

The study showed that between 1984 and 2020, slums in Lagos underwent gentrification processes, though many of them still have significant deprived areas. Additionally, while gentrification was taking place, deprivation was also increasing in some of the sampled communities. Almost all the slum communities have experienced slum clearance in the past. Additionally, the current and new housing developments examined in the study favored middle- to high-income groups, which has led to the displacement of previous slum residents. Finally, the important drivers of slum gentrification in Lagos include the type of slum clearance, residents' income level, fire outbreaks, presence of palaces in communities, the proportion of deprived areas in 1984, and church size.

Cities such as Lagos will continue to experience slum gentrification because of high urbanization rates and limited land availability. However, it is important to manage its consequences, especially for low-income groups, as it increases their vulnerability via displacement. Additionally, the fact that all slum management approaches directly or indirectly lead to slum gentrification shows the need to fashion policies and programs (e.g., sustainable relocation and low-cost housing) that can mitigate the negative consequences of slum gentrification, especially in African cities with a prevalence of low-income groups.

Additionally, while this study has shown the applicability of remote sensing data to investigate spatiotemporal changes in slum gentrification in African cities, there is room

for improvement. The remote-sensing data utilized in this study was for two periods with a 36-year time interval. We might not have been able to capture short-term fluctuations and rapid changes in slum development over the years. More so, we only investigated the earliest forty-two known slums, leading to the exemption of other slums that developed after 1984. Therefore, future studies that could cover short-term fluctuations and rapid changes, as well as the exempted slums, are needed to give further insight into slum gentrification in Lagos, Nigeria. Lastly, despite the merits of in-depth interviews as utilized in this study, they are generally viewed as one-way conversations between the interviewers and the participants, who are just getting to know themselves. This is devoid of the social interactions and trust needed for the participants to pour out their minds, which might affect the reliability of the social data. Future research on the spatio-ethnographic analysis of the gentrification of slums in Lagos could be conducted to close this gap.

Data Availability Statement: The original contributions presented in the study are included in the article, further inquiries can be directed to the corresponding authors.

Conflicts of Interest: The authors declare no conflicts of interest.

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