International Journal of Human Capital in Urban Management
(IJHCUM)

Homepage: http://www.ijhcum.net/

ORIGINAL RESEARCH PAPER

Planning implication of universities growth on land use: Confirmatory evidence from GIS spatial analysis

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ARTICLE INFO

Article History:
Received 18 October 2021
Revised 11 January 2022
Accepted 12 February 2022

Keywords:
Development control
Kisii Municipality
Land use change
Planning standards
Universities

ABSTRACT

BACKGROUND AND OBJECTIVES: Universities have customarily been seen as agents of development in the regions they serve owing to their roles of teaching, research, innovation and community extension. There is however a dearth of knowledge on how they influence land use change with a specific reference to compliance with planning standards. This paper therefore through a case study investigates the impacts that the growth of Kisii University has on land use change in Nyamage, a neighbourhood where it is situated within Kisii Municipality, Kenya. It subsequently links the observed change to compliance with planning standards.
METHODS: Guided by the theory of regulatory compliance, the study adopted a case study research design with a sample size of 226 drawn from 577 developments in Nyamage. Spatial data on land use change was collected using satellite images from Google Earth covering three epochs of 2005, 2014 and 2021. Analysis was undertaken using GIS. Data investigating compliance with planning standards were conversely collected using an observation checklist, land survey maps and analyzed using a one-sample t-test and paired t-test.
FINDINGS: The study established that in 2005, forest, short vegetation, transitional and built-up areas respectively covered 17%, 39%, 34% and 11%. These by 2021 correspondingly changed by 46%,-10%,-29% and 57% for the forest, short vegetation, transitional and built-up areas. The latter recorded the highest land use change, a condition mainly credited to the hostels built by private developers in an attempt to meet a demand created by students who could not find accommodation within the university. Research findings further disclosed that developments around the university were not complying with the planning standards used in regulating plot sizes, building coverage ratio and road reserves, leading to land use conflicts.
CONCLUSION: The establishment and growth of Kisii University have remarkably influenced land use change, which in the absence of development control contributes to the disregard of planning standards. This is because the government mainly sees universities as an avenue for spurring regional economic growth with less attention on their spatial implications. These findings may enlighten policy-making institutions with critical information for effective planning and development control around universities. The study also fills a gap that hitherto existed on the nexus between land use change and compliance with planning standards as relates to the growth of universities. It additionally enlightens the international audience on how the impacts of universities growth on land use may be evaluated through a triangulation of spatial and statistical approaches.

DOI: 10.22034/IJHCUM.2022.02.04

NUMBER OF REFERENCES	NUMBER OF FIGURES	NUMBER OF TABLES
68	9	10

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Note: Discussion period for this manuscript open until July 1, 2022 on IJHCUM website at the “Show Article.

INTRODUCTION

Although investment in human capital attracted less attention before the nineteenth century, the perception considerably changed in the twentieth century when the acquisition of skills and competencies emerged as a precursor for development. This is because education was gradually being used to influence productivity and creativity in addition to promoting entrepreneurship and advances in technology, and in so doing, playing a central role in economic and social progress (Owen *et al.,* 2017). Central to this proposition is the theory of human capital which underpins that investment in education enhances workers' productivity thus resulting in an increased economic return along with increased macroeconomic growth (Laura and Jeff, 2017). Increased investment in education has further been linked to benefits such as reduction in poverty and income inequality, a decline in population growth, low crime rates, national unity and political stability. These have made countries heavily invest in the sector (Psacharopoulos and Patrinos, 2018), a fact corroborating that education is not only key to sustainable development but similarly a requisite for promoting inclusive participation in the societies and economies which are constantly affected by the rapid globalization (UNESCO, 2014). A country cannot, therefore, realize meaningful development if it overlooks investment in the education sector (Karolyn, 2021; Patrinos and Psacharopoulos, 2020). Attention is drawn to the establishment of universities and suggests why many countries are leveraging the sector to accelerate their economic prospects. The aim is to promote the intellectual, cultural, and economic betterment of their populace (Bayuo *et al*., 2020; Odhiambo, 2018; Mapuranga, 2016). Appraising the benefits of knowledge, skills and competencies that accrues from universities, therefore, remains paramount (Pee and Vululleh, 2020) owing to the role they play in advancing society by teaching, learning, research, outreach and innovation (Al-Youbi *et al*., 2021; Kimathi, 2020). This is attained by disseminating new skills, knowledge and moral responsibilities that meet the future job market needs along with promoting gainful participation in the global economy (Chan, 2016). Regionally, Agenda 2063, Africa's tactic for a prosperous continent vouched for the development of the African Virtual and E-University as a policy for promoting academic programmes that enhance the accessibility of continuing and tertiary education. The agenda further envisions an Open, Distance and eLearning (ODeL) of high quality and that students can easily access in any location and anytime (The African Union Commission, 2014). Locally, the Government of Kenya (GOK) in 2008 launched its popular economic blueprint christened "Vision 2030" to transition the country into a middle-income country that is globally competitive. To achieve this, the need to invest in the training of qualified manpower was singled out as a priority. Universities were consequently tasked to play this pivotal role. For a progressive implementation, a 100% increase in the number of accredited universities by the year 2030 was set as a target in the Vision's Sector Performance Standard (SPS) (The Republic of Kenya, 2010). This study, therefore, operationalized two objectives. First, by investigating the impacts that the growth of Kisii University has had on land use in Nyamage, Kisii Municipality, Kenya. Second, it determined the link between the observed change and compliance with planning standards. It was undertaken between February 2021 and August 2021 to contribute further knowledge on land use development control by addressing the limitations of previous studies. It attained this by addressing the existing research gaps consequently linking theoretical and practical approaches to spatial planning and development control. The study specifically enlightens the international audience by demonstrating how the impacts of universities growth on land use may be analyzed through a triangulation of spatial and statistical approaches. It also apprises key policy formulating bodies in Kenya such as the GOK, Commission for University Education (CUE), County Government of Kisii (CGOK) and other county governments in Kenya with factual evidence that could inform policy framework on spatial planning. From the foregoing, section 26 of the Universities Act, 2012 (The Republic of Kenya, 2012) requires the CUE to ensure the establishment of universities in each of the 47 counties of Kenya by giving priority to those without universities. A policy question arising at this point is whether the GOK, CUE and CGOK undertake risk-based spatial planning to ensure that proposed universities do not have a negative impact on land use. To further put this question into context, the next subsection gives a background understanding of university education in Kenya.

Background to university education in Kenya

University education was formally introduced in Kenya when the Royal College, Nairobi, was elevated to a university college in 1961. The college entered into a memorandum with the University of London to enable students to receive degrees. Later in 1963 when the University of East Africa (UEA) was established, a period when Kenya also ceased to be a colony of Britain, the college was elevated to the University College, Nairobi (UCN), making it one of the constituent colleges of the UEA (others being Makerere, Uganda, and Dar es Salam, Tanzania). The UEA wound up in 1970 resulting in the establishment of the University of Nairobi as the first university in Kenya (Makerere and Dar es Salam universities were also established during this time) (Kimathi, 2020). Upon attaining independence in 1963, the GOK developed a policy titled, "African Socialism and its Application to Planning in Kenya," commonly known as "Sessional Paper Number 10 of 1965," to initiate the country's economic transformation agenda. It recommended that economic growth needed human resource that is adequately skilled, trained and experienced (The Republic of Kenya, 1965). From this background, the GOK came up with further policies that would enhance access to education resulting in rapid growth at all levels including the university sector. Since the mid-1980s, a response to higher demand for university education has led to a remarkable expansion of public universities (Mutula, 2002). For instance, while in 2013 there were seven public universities, the tally exponentially increased to 31 (343%) by 2021, a move prompted by the GOK's intention to ensure that each county has a university. While this growth has contributed to regional economic benefits, a debate is now ensuing that public universities are too many and not financially viable. This has attracted controversies across the political and academic fronts. For instance, in 2019, the National Treasury announced the intention to merge public varsities (Mutua, 2021; Nganga, 2019; Nyaundi, 2020; Tubei, 2019; Kenya News Agency, 2019). The plan was however set aside in favour of comprehensive policy reforms only for the debate to re-emerge when the World Bank, as a condition for advancing financial assistance to Kenya, recommended the merging of the public universities due to duplication of courses and the need to cut spending (Otiato, 2021). However, the University Academic Staff Union (UASU) through a court petition successfully stopped the proposal on the contention that it was not aligned with any national educational policy in addition to not being participatory as required by the constitution of Kenya (Wanzala, 2021). The GOK's recent approach to the establishment of public universities has so far been driven by two interrelated agendas. First is the legal requirement for having a university in each county. The second is the target set in Vision 2030 of increasing the number of universities by 100% (The Republic of Kenya, 2012; The Republic of Kenya, 2007). While the noble intent is to promote access to higher education, a policy limitation is that no prior planning is usually undertaken to mitigate the potential implications that universities would have on land use, a gap the current study filled. The World Bank and GOK's recent policy articulation on merging public universities is therefore seen as a one-sided affair since it does not take cognizance of their spatial implications on land use and development.

Literature review

A growing body of empirical evidence confirms the important roles played by universities in promoting development and in so doing linking knowledge creators with the industry through incubations, entrepreneurship and community development (Al-Youbi *et al.,* 2021; Marozau *et al.,* 2021; Arocena *et al.,* 2021; Mei and Symaco, 2021; Pee and Vululleh, 2020; Filho *et al*., 2019; Purcell *et al*., 2019; Brennan, *et al.,* 2018; Kimathi, 2020; Odhiambo, 2018; Michaela *et al*., 2015; Filho *et al.,* 2017; Harrison and Turok, 2017; Chan, 2016; Mapuranga, 2016). Their scope is however limited to the impact of universities on socio-economic development and not land use. A further body of literature hence attempts to address this gap by examining the impact that universities have on land use and the consequential spatial implications. As a starting point, through the application of the Normalized Difference Vegetation Index (NDVI) technique covering 10 to 13 years, Cetin *et al.,* (2021) recently established that the newly established 13 universities in the eastern and south-eastern regions of Turkey changed the boundaries of urban centres by 4.49%, consequently contributing to land use change. A related study by Ruoppila and Zhao (2017) also confirmed that universities were influencing land use development in Shanghai town. From a theoretical viewpoint, the results of this study are suggesting that research focusing on China's urban development should not be overlooking the spatial implication of universities. This corroborates a previous insight by Owoeye and Ogunleye (2015) that the establishment and subsequent growth of universities influence the spatial heterogeneity of urban land use. Comparable observations in Indonesia (Rahadianto *et al.,* (2021) found out that although in 2015 the vegetation around Universitas Padjadjaran covered 64.99% of the total land use, it declined to 52.28% in 2017 due to new neighbourhood developments. In Malaysia, Yigitcanlar and Sarimin (2011) upheld that although universities promoted a knowledge-based economy through rapid spatial transformations, they still required regulation to foster economic development. A previous study around the Catholic University of Brasilia and the University of Brasilia by Martins and Sarimin (2007) also established that most commercial activities were near the campuses because of the demand created by their population. Proximity to the universities also influenced land prices, that is, parcels closer to the campuses were more expensive than those that were far. In this way, the campuses acted as magnets that attracted developers. Failure by policy and legislation to effectively address the spatial implication of establishing universities has also been acknowledged. This fact is supported by Odhiambo (2014) who argues that the Urban Areas and Cities Act of 2011, and the Universities Act of 2012, overlooked the possibility of having university towns in Kenya resulting in unplanned small urban centres around universities, a situation heightened by a lack of effective coordination framework among relevant government agencies. A study by Kinoti and Nyaga (2018) around Karatina University, Kenya, as well established that lack of coordination among different government institutions led by the CUE contributed to uncontrolled land use change resulting in the loss of biodiversity and environmental degradation. Their findings relate to that of Ngochi (2011) in Meru, Kenya, which investigated the influence that Kenya Methodist University had on its neighbouring land use. Results demonstrated that before the establishment of the university, agriculture was the dominant land use. The situation however rapidly changed after the university was established with residential buildings being the dominant land use. Built-up areas increased by 13% in contrast to vegetation cover that declined by 16%. Property values as a result increased by 19% (1-kilometre radius from the university) and 16% (2 kilometres radius from the university). Rapid land use around the university contributed to land use conflicts because of inadequate development control and the lack of a neighbourhood spatial plan. A comparable study by Mabonga (2016) in Kakamega, Narok and Juja towns between 1989 and 2014 revealed that before the establishment of Masinde Muliro University of Science and Technology (MMUST), Jomoo Kenyatta University of Agriculture and Technology(JKUAT) and Masai Mara University (MMU), the towns' annual growth rate was 0.13%. However, after their establishment, the rate gradually increased to 0.53%. This led to uncontrolled developments characterised by inadequate infrastructural services such as water, roads and sanitation. From the reviewed studies, while most of them link the location of universities with socioeconomic development, some associate them with land use change. There is therefore a gap in knowledge on how a neighbourhood land use change that has been elicited by the establishment of universities contribute to non-compliance with planning standards. As alluded to before, the current study was undertaken in Nyamage within Kisii Municipality, Kenya, between February 2021 and August 2021. It was steered by two objectives. First, to investigate the impacts that the growth of Kisii University has had on land use in Nyamage, Kisii Municipality, Kenya. Second, to determine the link between the observed change and compliance with planning standards

MATERIALS AND METHODS

Study area, growth of Kisii University and scope of the study

Nyamage is located in the Bobaracho sublocation, approximately 2 kilometres from the Kisii Municipality's central business district. It is the neighbourhood where Kisii University has been established. The Municipality is situated in the western part of Kenya, 316 km from Nairobi, Kenya's capital city (Fig. 1). As the administrative and commercial capital of Kisii County, the Municipality strategically sits at the centre of the western Kenya tourist circuit that includes the renowned Maasai Mara Game Reserve. The town's population was 121,115 in 2021 and projected to be 250,000 by 2030. Spatially, although

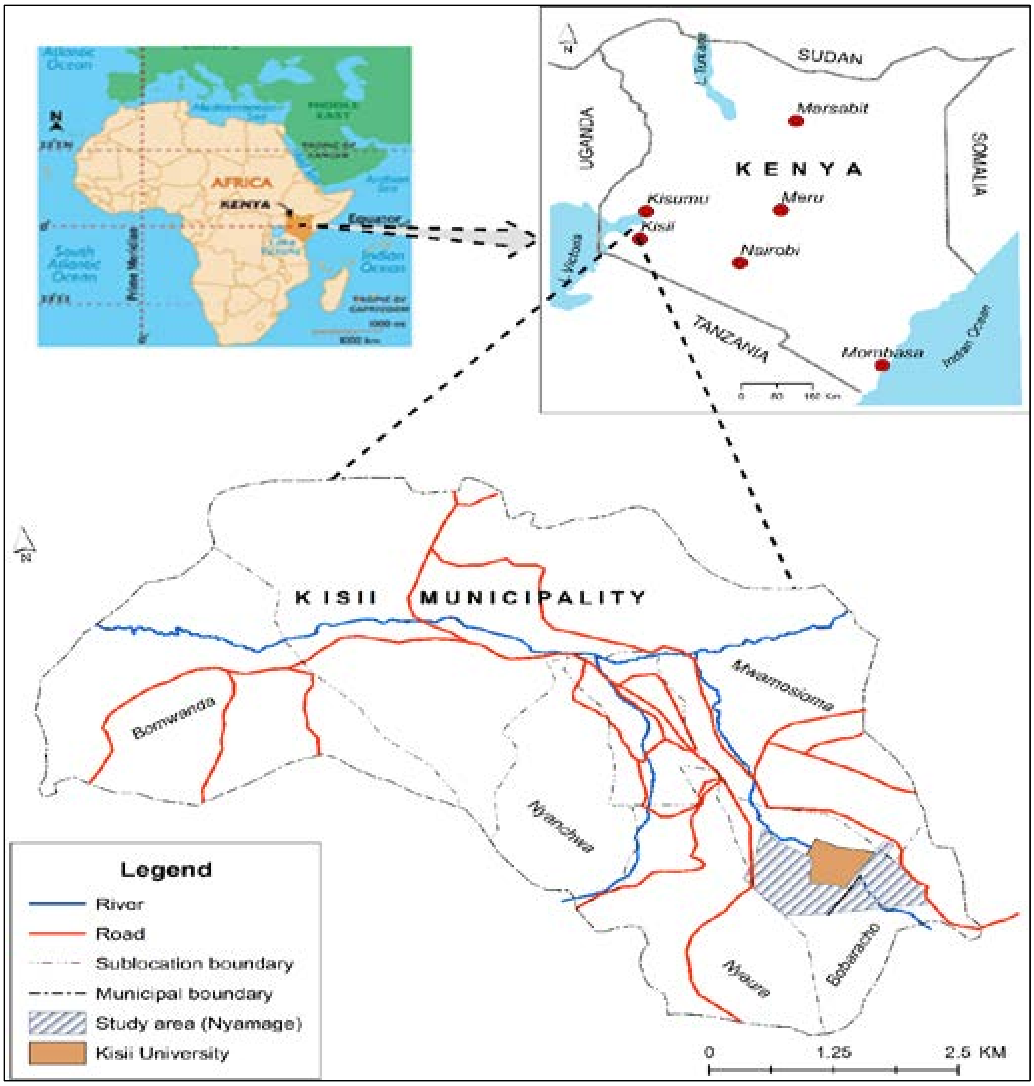

Fig. 1: Location of the study area in the national and regional context

the town covers 34 km^2 only 4% is planned implying that much of the development is taking place without any spatial planning intervention framework (Omollo, 2021; Omollo, 2020). This includes Nyamage where Kisii University is situated. The institution was first established in 1965 as a primary teachers' training college and then elevated to a secondary teachers' training college in 1983, and thereafter established as a campus of Egerton University to host the faculty of commerce. The status changed in 2007 when the campus was gazetted through a legal notice as one of the constituent colleges of Egerton University. Finally, the college was in 2013 awarded charter making it a public university. Since then, the university has expanded rapidly in terms of academic programs, student enrolment and staff establishment. It currently has over 15,000 students spread across eight schools: Arts and Social Sciences, Education and Human Resource Development; Business and Economics, Agriculture and Natural Resources Management, Law, Health Sciences, and Information Science and Technology (Kisii University, 2019). In the recent admission of government-sponsored students to the 63 universities by the Kenya Universities and Colleges Placement Service, Kisii University received the sixth-highest share of 4,600 (Nyaundi, 2021). A progressive increase in students' population coupled with inadequate hostels within the university has led to uncontrolled developments in Nyamage as investors rush to make the most of rental income. As a way forward, the university delinked accommodation from admission making most students seek alternative accommodation outside the university. This shift in policy contributed to a proliferation of unregulated private hostels and other developments around the university, consequently contributing to a significant change in land use. With a student's population of more than 15,000, the university technically and legally meets the population threshold of establishing a town as recommended by the Urban Areas and Cities (Amendment) Act (The Republic of Kenya, 2019b). This demonstrates the stature that it has towards land use change which currently remains unregulated. While the study area covered 1.05km^2 around the university (Fig. 1), spatial analysis was based on the epochs covering the years 2005, 2014 and 2021. Guided by the distance decay theory which avers that demand for a commodity increase as the distance to the market decreases and then significantly declines as distance increases, the study area was spatially delineated based on students' hostels which were assumed to determine the spatial influence the university had on the neighbourhood land use. The planning standards investigated were limited to the building coverage ratio (BCR), plot size and widths of road reserves.

Theoretical setting and research design

This study was steered by the theory of regulatory compliance (TRC) to justify the importance of complying with planning standards. Historically, TRC dates back to the 1970s when the correlation between compliance with rules was likened to good practice values (Fiene, 2019). Full compliance was therefore envisaged to promote positive outcomes. Economic activities, hence, need regulation through monitoring, surveillance and enforcement to ensure full compliance (Besselink and Yesilkagit, 2020). In the current study, TRC underpins why developments around universities should comply with the recommended spatial planning standards effected through development control. The GOK, CGOK and CUE have therefore a responsibility of ensuring that developments around universities are planned and controlled to promote sustainable spatial development as construed under the United Nation's Sustainable Development Goals (SDGs). This study adopts a case study research design which permits detailed and intensive examination of multifaceted subjects in their real-life environment (Pacho, 2015; Tetnowski, 2015; Crowe *et al.,* 2011). Applied in the current study, this approach entailed a deep contextualization of the spatial implications of establishing Kisii University in Nyamage neighbourhood, Kisii Municipality. The research findings may therefore be applied to other regions where universities have equally contributed to unregulated land use change.

Study population, sample and sample design

The study population were 577 developments in Nyamage, a neighbourhood covering 1.3 km^2 to the southern, eastern and western parts of Kisii University (Fig. 1). This area was segregated through a ground-truthing exercise which delimited where private students' hostels were located in relation to the university, consequently determining the span of influence that the university had on land use change. Owing to the lack of a sampling frame, developments were spatially identified using a cropped and georeferenced Google Earth image dated June 2021. The buildings were thereafter digitized using ArcGIS version 10.5 software resulting in an attribute table that was used as the sampling frame. Sample size determination relied on the table provided by Krejcie and Morgan (1972). Accordingly, if the population is between 550 and 600, the sample should be 226. With this information, a random number table was employed to draw the required samples.

Data collection and analysis

Google Earth provides high spatial resolution free images that can be used in land use mapping, particularly for the regions where landscapes are heterogeneous (Malarvizhi *et al.,* 2016; Wibowo *et al.,* 2016: Hu *et al.,* 2013). On the account of this insight, Google Earth satellite images covering three epochs (2005, 2014 and 2021) were used in the current study to determine the impacts that Kisii University had on the surrounding land use change. The images were saved in *jpeg* format, georeferenced using ArcGIS 10.5 software and spatial analysis was undertaken as hereunder:

i) Clipping the three epochs (each 1.3 km^2) covered by Kisii University that also includes Nyamage, the neighborhood whose land use has been spatially transformed by the university.

ii) Running *iso cluster* unsupervised image classification to automatically divide the spatial data into groups of similar items.

iii) Ground truthing and accuracy assessment (using 500 points) of 2005, 2014 and 2021 classifications to a certain their validity.

iv) Preparing land use maps for 2005, 2014 and 2021 classifications.

v) Computing land use change between 2005, 2014 and 2021 from the spatial attribute tables.

A structured observation checklist was used in collecting quantitative data on whether developments in Nyamage complied with the CGOK's permitted planning standards of BCR (75%), widths of access roads (9-18 meters) and minimum plot sizes (0.05 hectares – ha.). BCR refers to the ratio of the area covered with buildings (ground floor) divided by the area of the land covered by the building, where building area is a building's floor space when observed from the sky/above. The checklists had four columns: type of planning standard, the value of the recommended planning standard, observed/measured compliance and deviation from the recommended standard. Data from checklists were analyzed using a one-sample t-test and dependent sample t-test in SPSS version 21 software. Paired sample t-test was used to establish if the mean difference between the observed widths of access roads and their recommended planning standards were zero. It was preferred because the study area had different road widths (ranging from 9-18 m). One sample t-test on the other hand examined whether the mean of observed minimum plot sizes and BCR were statistically different from the known hypothetical values/planning standards, that is, 0.05 ha. and 75% respectively. The presence of a statistically significant difference between the recommended planning standards and observed/measured values for each planning standard was determined using a dependent sample t-test. To assure truthful observations, the recommended widths of road reserves were obtained from the survey/Registry Index Maps procured from the county survey office, scanned, georeferenced and vectorized to roads and land parcels thereafter overplayed with the 2021 satellite image. This enabled computation on the extent to which the buildings complied with the three planning standards. A two-week ground-truthing exercise was undertaken to validate the measured compliance. Before commencing data collection, permission was sought from each sampled property owner. In cases where a sampled property was occupied by a tenant, details of the landlord were obtained from them and the landlord contacted for an interview at an agreed date that was within the data collection work plan. An assurance was given that the study was for academic purposes only and that any sensitive information will not be disclosed.

RESULTS AND DISCUSSIONS

This paper through a case study of the Nyamage neighbourhood in Kisii Municipality, Kenya, investigated the impacts that the growth of Kisii University has had on land use change. It further sought to link the observed change to compliance with three planning standards: BCR, plot size and access roads. This section therefore presents and discusses the research findings. It does this under two interrelated subsections. While the first section examines the implications of land use change, the second determines compliance with the three planning standards. The two sections ultimately culminate into a conclusion and recommendations based on the research objectives and findings.

Spatial implications of Kisii University on land use change

There is no common standard for classifying land use and land cover, and it is less likely that an accepted standard might be soon developed. Classifications are therefore developed to address the objective of what the user intends to achieve. Nevertheless, when planning to come up with a land use classification in remote sensing that will meet the expectations of most users or readers, some evaluation criteria guidelines should first be determined (Anderson *et al.,* 1976). Based on earlier knowledge of Nyamage along with a ground-truthing that was undertaken, a scheme for land use classification guided by Anderson *et al.,* 1976 was developed in Table 1.

Table 1: Land use classification for Nyamage

Type of land use	Description
Built-up areas	Areas with features such as road networks and buildings that are man-made/unnatural.
Forest	Densely growing trees that forms closed canopies. Also, encompass forests planted along the rivers.
Short vegetation	Land covered by grass and land that is used for cultivating crops, for example, maize or tea bushes.
Transitional areas	Areas that are intermittently converting or changing from one land use to another. Occurs when any category of land use stops to occur as its area become provisionally without any land use cover/development.

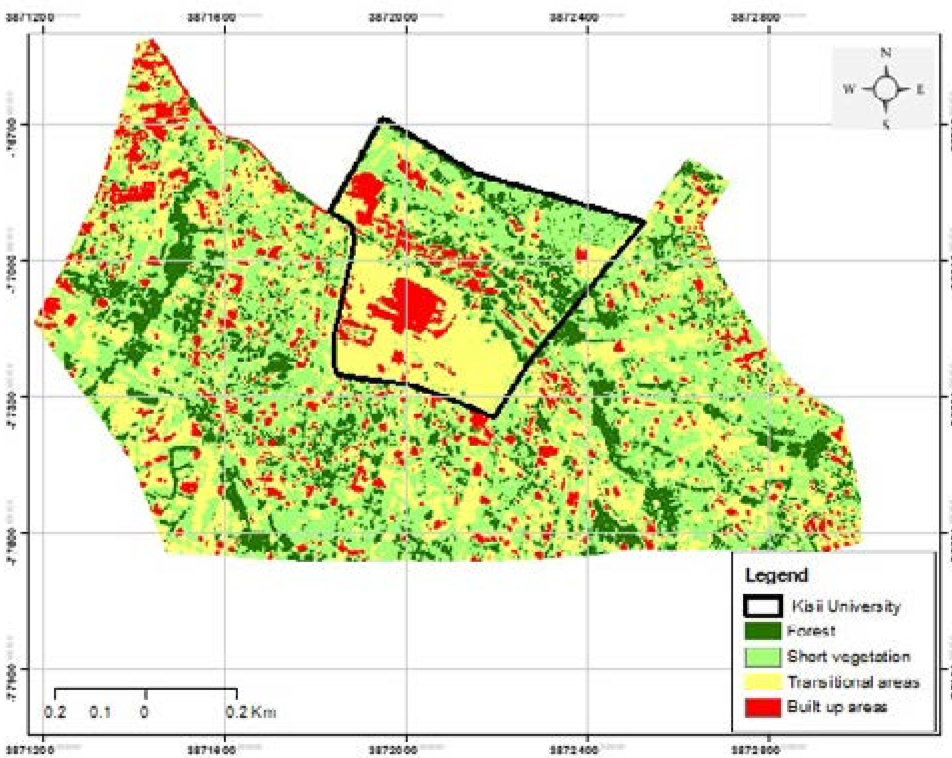

Fig. 2: Land use in 2005

Land use in 2005

The year 2005 was chosen as the base for establishing the status of land use in the study area before the establishment of the university, consequently providing a comparative insight into how land use around the university was likely to change in future. In 2005, the university was a campus of Egerton University hosting one faculty with less than 500 students. Further, the devolved governments (including Kisii County) had not been established since Kenya was still operating under the 1969 constitution. During this period, short vegetation accounted for the highest land use (39%/52 ha.) followed by transitional areas (34%/45 ha.) and forest (17%/22 ha). Built-up areas had the lowest coverage (11%/14 ha.). The proportional land use is spatially illustrated in Fig 2. The cell size used in this land use classification (X, Y) was 1.649 m by 1.649 m.

A thematic map resulting from a land use

Table 2 Confusion matrix for 2005 classification

Land use	Forest	Short vegetation	Transitional areas	Built-up areas	Total	User Accuracy	Kappa
Forest	**78**	3	1	0	82	0.950617	
Short vegetation	0	**196**	0	0	196	1	
Transitional areas	0	0	**169**	1	170	0.994118	
Built-up areas	0	0	0	**52**	52	1	
Total	78	199	170	53	**500**		
Producer Accuracy	1	0.984925	0.994118	0.981132		0.98998	
Kappa							0.985544

Table 3: Land use in 2014

Land use	Area (Ha)	Proportional %	Change (%) from 2005
Forest	30	23	+5
Short vegetation	54	41	+1
Transitional areas	35	26	-8
Built-up areas	14	11	0

classification is considered valid only if it impartially or accurately represents the land cover of the region it is attempting to spatially depict. Fundamentally, classification accuracy is construed to imply the degree to which the resultant satellite image classification concurs with reality or conforms to the 'truth' on the ground (Stehman and Foody, 2019). Two important issues concerning accuracy are whether each land use category classified is present at the points indicated on a map, and if the boundaries separating each category is validly located (Lyons *et al.,* 2018). Table 2, therefore, attempts to address these interrogations by undertaking an accuracy assessment for the 2005 classification in the form of a confusion matrix.

User accuracy accounts for the number of pixels correctly classified in each land use class/category divided by the total number of pixels (row total) classified for all the land use categories of the classified image. It aims at representing the likelihood that a pixel classified into a particular category characterizes that category on the ground (Salah, 2014). It consequently computes the commission error by signifying the likelihood of the extent to which the classified sample accurately represents what is on the ground (the truth). The overall accuracy for the 2005 land use classification was 0.98998 (99%). Table 2 also indicates that in 2005, the maximum user accuracy was 100% for built-up areas and short vegetation. On the other hand, the highest producer accuracies (omission error) were for transitional areas (99.4%) and built-up areas (98.1%). The overall accuracy for the entire classification was however 98.6%. A more detailed method for conducting classification accuracy is the use of the Kappa coefficient which likens the sum of pixels per cell of the confusion matrix with the likelihood to allot pixels as an arbitrary variable. It was used to measure each classification's accuracy since it considers all the elements in the confusion matrix instead of the diagonal elements. This resulted in 0.986, an almost perfect agreement, consequently giving additional credence and validation that the classification could be used to inform spatial policy on planning.

Land use in 2014

Further analysis is undertaken (Table 3 and Fig. 4) to compare land use change in 2014, a year after the university had been awarded charter to become a public university, against land use in 2005 before awarding of the charter in 2017. The cell size for the classification (X, Y) was 1.644 m by 1.644 m.

Compared to 2005, land use under forest in 2014 increased by 5% to 30 ha. This was the highest recipient of the 2005-2014 land use transition period. A similar increase in coverage occasioned for short vegetation that witnessed an increase of 1% translating to 54 ha. Land use under transitional areas, however, reported the highest decline (8%). This may be explained by

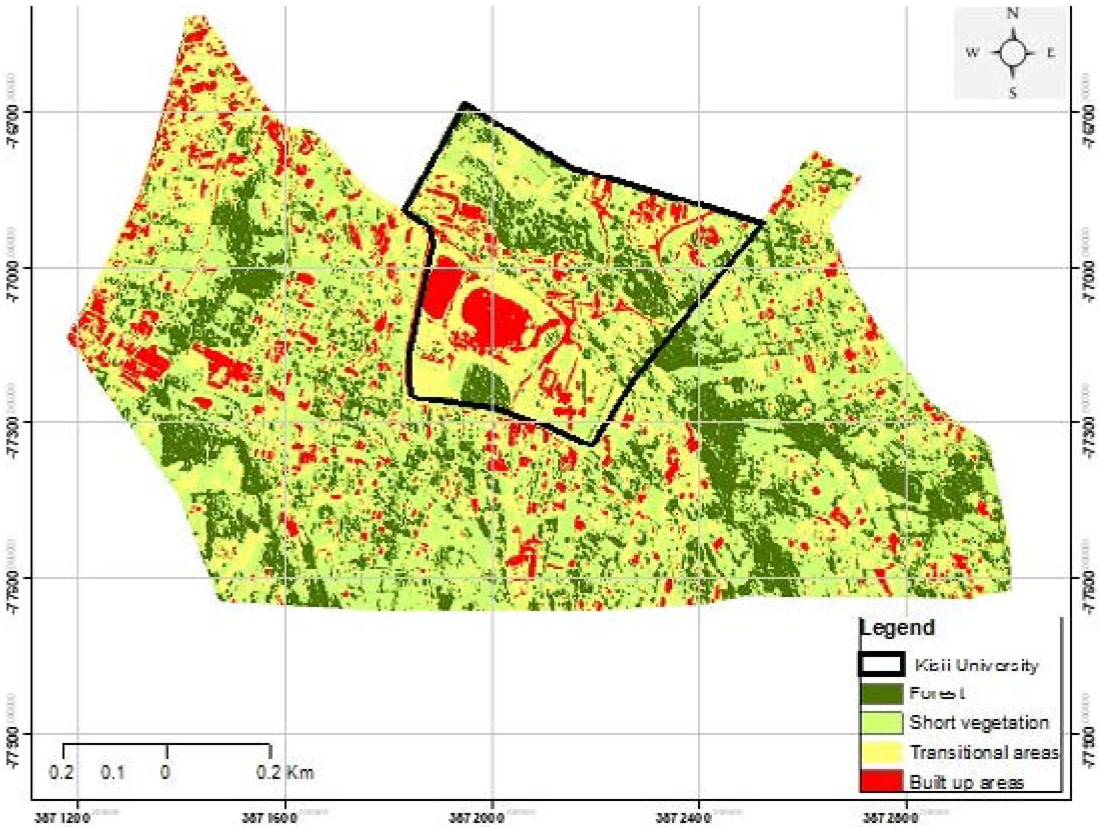

Fig. 3: Land use in 2014

Table 4: Confusion matrix for 2014 classification

Land use	Forest	Short vegetation	Transitional areas	Built-up areas	Total	User Accuracy	Kappa
Forest	**114**	0	0	0	114	1	
Short vegetation	0	**159**	28	16	203	0.783251	
Transitional areas	0	0	**6**	125	131	0.045802	
Built-up areas	0	0	0	**52**	52	1	
Total	114	159	34	193	**500**		
Producer Accuracy	1	1	0.176471	0.26943		0.662	
Kappa							0.555817

the fact that much of it could have changed to other uses. Noticeably, there was no change under land covered by the built-up areas. This suggests that the demand for developments around the university's neighbourhood had not started picking up. To determine the efficacy of the 2014 classification, an accuracy assessment in form of a confusion matrix was computed in Table 4.

The overall accuracy assessment for the classification was 66.2%. Further, the Kappa coefficient was 0.556 (55.6%) which is interpreted as moderate agreement. As the case of the user's accuracy, the producer's accuracy also determines how good a particular area has been classified on a

Table 5: Land use in 2021 and comparative land use change

Land use	Area (Ha) 2021	Proportional %	% change, 2005 - 2014	% change, change, 2005 - 2021
Forest	32	24	+7	+46
Short vegetation	47	35	-13	-10
Transitional areas	32	24	-9	-29
Built-up areas	22	17	+57	+57

map. It however focuses on the omission error, that is, the percentage of observed ground features that the map has not classified. The higher the errors of omission, the lesser the producer's accuracy in the map. As indicated in Table 4, transitional areas and built-up areas had the lowest producer accuracies of 0.176 (18%) and 0.269 (27%) respectively for the 2014 classification. Transitional areas were largely misclassified due to comparable spectral properties with short vegetation, regarding built-up areas. A similar misclassification also occurred due to similar spectral similarities with transitional areas. This may be explained by the fact that most of the rusted roofing sheets appeared similar to areas under transition such as open grounds or murram roads. While transitional areas registered the lowest user accuracy of 0.05%, built-up areas and forests had the highest user accuracies of 100%.

Land use in 2021

The year 2021 marked eight years since the university was awarded a charter. By this time, unlike in 2014, short vegetation was dominant (35%) followed by transition and forest areas respectively (24%). Built-up areas covered was the least. Comparatively, between 2005 and 2014, forested land increased by 7%. This was due to an increase in the number of trees planted along the riparian reserves of River Nyakomisaro that also traverses the university. Short vegetation on the other hand declined by 10% with transitional areas also declining by 9%. Particular attention is however drawn to the built-up areas that significantly expanded by 57%, further revealing the impact that the university has on the neighbourhood's spatial transformation (Table 5 and Fig. 4). The study, therefore, sought to determine the differences in land use change between 2005, the base year used for undertaking spatial analysis and 2021. Results demonstrated that built-up area was the highest recipient (57%), followed by forests (46%). The highest losers during the period were short vegetation (13%) and transitional areas (29%). This summary is presented in Table 5.

A comparison between 2005 and 2014 conversely confirms that the built-up areas expanded more (57%) followed by forests (7%) (Fig. 4). Short vegetation equally experienced the highest decline (13%). Land use under forest went through the highest expansion owing to the concerted efforts by the university to complement the GOK's initiatives of attaining a minimum forest cover of 10% in Kenya. This initiative is evident by a visible greenbelt of forest cover that traverses the university along River Nyakomisaro. The trend is also evident in the southeastern part of the university where the neighbouring community has planted eucalyptus trees along the river. This initiative is however not environmentally friendly since the trees are known to drain water resources.

As alluded to in the land use classification scheme for the study area (Table 1), short vegetation was construed as grasses and cultivated land. Its decline may therefore be explained by the fact that much of it could have been changed to built-up areas (buildings development). Alternatively, vegetation such as maize whose production is predictably seasonal could have been harvested by the time the image was taken by the Google Earth satellite. Despite the interplay between various land uses, the most outstanding so far remains built-up areas whose unregulated expansion contributed to spatial conflicts through the disregard of planning standards elicited by the growth of Kisii University in Nyamage. The accuracy assessment for this classification is presented in Table 6.

While the resulting Kappa coefficient for the 2021 land use classification was 0.7356 (74%), thus rated as a substantial agreement, overall accuracy, on the other hand, was 80% (rated as very good). The commission errors were 0.00834 (forest), 0.25424 (short vegetation), and 0.44629 (transitional areas). There was no commission error for the built-up areas, denoting that no other land use was erroneously included as part of the built environment. Conversely,

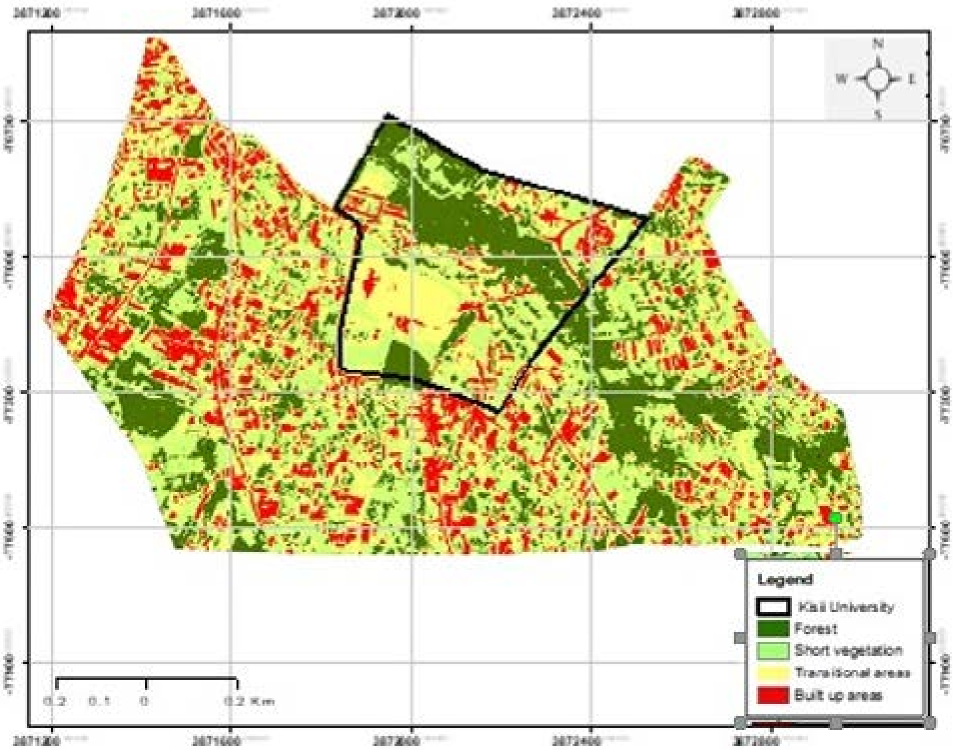

Fig. 4: Land use in 2021

Table 6. Confusion matrix for 2021 classification

Land use	Forest	Short vegetation	Transitional areas	Built-up areas	Total	User Accuracy	Kappa
Forest	**119**	1	0	0	120	0.99166	
Short vegetation	1	**132**	2	42	177	0.74576	
Transitional areas	0	0	**67**	54	121	0.55371	
Built-up areas	0	0	0	**82**	82	1	
Total	120	133	69	178	**500**	0	
Producer Accuracy	0.991	0.99248	0.97101	0.460		0.8	
Kappa							0.7356

the omission errors were 0.009 (forests), 0.00752 (short vegetation), 0.02899 (transitional areas) and 0.54 (built-up areas). The producer accuracy for the built-up land was low because some cells (transitional areas and vegetation) which should have been included as part of the built-up areas was erroneously excluded. A summary of land use change between the 2005 and 2021 periods is finally presented in Fig. 5.

The Table confirms that short vegetation and transitional areas underwent a noticeable decline between 2005 and 2021. Forests and built-up areas appear as the key beneficiaries of this decline since their spatial coverage noticeably increased during the period. In all cases, forests and built-up areas recorded the highest increase in land use change. Particular attention is however drawn to the rapid expansion of built-up areas which, in absence of adequate development control by the CGOK, has contributed to unsustainable spatial development in Nyamage.

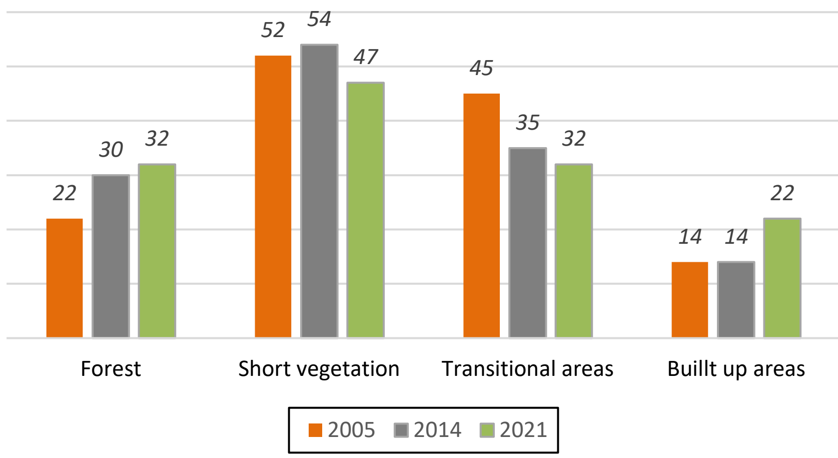

Fig. 5: Summary of land use change, 2005-2017

Implications of Kisii University on land use – A development control perspective

Having examined land use change around the university, this subsection now delves into the planning implications of this observed change. Under it, compliance with three planning standards that included land subdivisions, BCR and widths of access roads are examined.

Land subdivisions

When a parcel of land is divided or partitioned into two or more new parcels of land, the large or the original piece is deemed to have been subdivided (Strack, 2019). Land subdivision is consequently a continuous process that involves the regulation of private and public land ownership through development control. Land subdivision planning standards, therefore, serves to promote the development control principles of safety, convenience and accessibility (CMDHCD, 2009). Their effectiveness is enforced through planning standards which forms part of development control instruments. Subdivision planning standards also intends to regulate uneconomic land subdivisions along with controlling plot congestion. Their enforcement improves the provision of activities within a plot for instance parking and sufficient space for supporting linked infrastructural services. In this way, subdivision planning standards are closely related to the floor area index and BCR. Given that the recommended minimum planning standard for plots in Nyamage was 0.05 ha, the current study determined if developments complied with it. An initial interpretation of the data using the one-sample statistics showed that mean compliance ($M=0.154$, $SD = 0.240$) was within the recommended 0.05 ha. (the recommended planning standard). This prompted a further investigation to confirm whether the observations were statistically significant. The outcome is presented in Table 7.

The one-sample test (Table 7) reveals the outcome of the significance test where the top row gives the population mean or the known/hypothesized value (recommended planning standard of 0.05 ha.). In this case, the extent of compliance was significantly higher than the recommended planning standard, $t\ (182) = 5.866$, $p = .000$, signifying compliance. With this insight, through a case by case descriptive statistics, the study determined if compliance with this planning standard was observed by each sampled development. The descriptive outcome is presented in Table 8.

The Table reveals that although compliance was significantly higher by a mean difference of 0.104 ha, cumulatively, 65% of developers (a majority) overlooked the recommended planning standard on minimum plot size, further demonstrating inadequate development control. To further explore the magnitude of the problem, a spatial analysis was undertaken to single out the subdivisions that were

Table 7: Test for significance on compliance with land subdivision planning standard

One-sample test	Test value = 0.05 ha.					
	t	df	Sig. (2-tailed)	Mean Difference	95% confidence interval of the difference	
					Lower	Upper
Recommended *vs* observed plot size	5.866	182	.000	.104030	.06904	.13902

Table 8: Case by case grouping of observed compliance with subdivisions

Observed Plot size (ha)	Frequency	Proportional %	Cumulative %
0.006	6	3.3	3.3
0.010	1	0.5	3.8
0.030	6	3.3	7.1
0.030	6	3.3	10.4
0.037	7	3.8	14.2
0.039	18	9.8	24.0
0.040	27	14.8	38.8
0.041	6	3.3	42.1
0.042	6	3.3	45.4
0.043	6	3.3	48.6
0.044	6	3.3	51.9
0.045	18	9.8	61.7
0.046	6	3.3	65.0
0.050	18	9.8	74.9
0.059	5	2.7	77.6
0.330	6	3.3	80.9
0.340	6	3.3	84.2
0.380	6	3.3	87.4
0.390	6	3.3	90.7
0.650	6	3.3	94.0
0.900	11	6.0	100.0
Total	183	100.0	

not complying with the standard of 0.05 ha. This was undertaken by examining the parcels of land that were located on the western part of the university. Two registry index maps (2005 and 2020) were used for comparison. Results presented in Figs. 6 and 7 submits that in 2005, shortly before the university was established as a college, noncomplying plots were not following any predetermined spatial pattern. The situation, however, changed in 2020 with much of the noncomplying subdivisions now evidently forming a linear pattern near the university.

Building Coverage Ratio

As alluded to before, BCR refers to the total area covered with buildings (ground floors) divided by the area of the land covered by the buildings, where building area is construed as a building's floor space when observed from the sky/above, usually indicated as a percentage. The approved BCR for Nyamage, the neighborhood where Kisii University is located, was 75%. Its enforcing as a planning standard is envisaged to result in the following benefits:

i) Controlling the intensity and density of land use development. Thus, within the same plot, a higher BCR value correspondingly contributes to a higher floor area/coverage, therefore increasing pressure and demand on land use and infrastructural facilities.

ii) Provision of space for supporting essential services, for example on plot parking and septic tanks.

iii) Presents planners with design opportunities

Fig. 6: Noncomplying land subdivisions in 2005

for increasing the amount of habitable and open spaces that could be available within a plot, therefore improving the principles of development control that includes safety, conservation, access and convenience.

The study, therefore, sought to establish if the standard was being observed by the sampled developments in Nyamage. The initial one-sample descriptive statistics showed that mean compliance (M = 82.022, SD = 15.950) exceeded 75%. A further analysis was undertaken to establish if the observations could have been statistically significant. The test returned a significant increase in BCR among the developments that were sampled, t (182) = -5.955, p = .000, consequently depicting inadequate development control by the CGOK. The maximum BCR was 100% while the lowest was 25%. The modal frequency on the other hand was 85%. Table 9 further gives a comparative analysis on a case-by-case descriptive review of each of the sampled developments in the neighbourhood.

The table authenticates that cumulatively, only 17% of the sampled development complied with the recommended minimum planning standard of 75% that regulates BCR. This further depicts inadequate development control by the CGOK. This problem is bound to escalate soon as the university continues expanding through an increased student population and community engagement through extension.

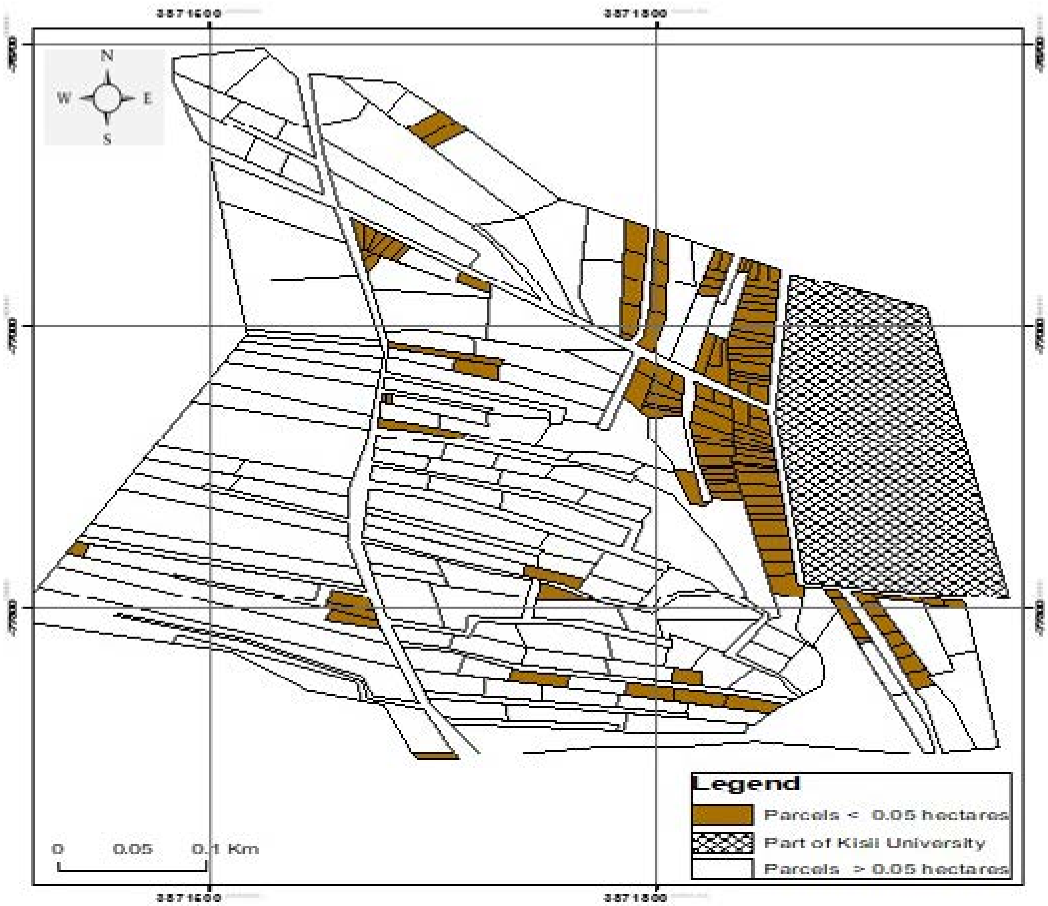

Fig. 7: Noncomplying land subdivisions in 2020

Table 9: Case by case grouping of observed compliance with BCR

Observed BCR (%)	Frequency	Proportional %	Cumulative %
25.00	6	3.3	3.3
50.00	12	6.6	9.8
65.00	7	3.8	13.7
70.00	6	3.3	16.9
80.00	30	16.4	33.3
85.00	54	29.5	62.8
90.00	31	16.9	79.8
95.00	19	10.4	90.2
100.00	18	9.8	100.0
Total	183	100.0	

Minimum road reserves

Roads open up isolated areas by stimulating socio-economic development. As such, they are considered the most important public assets (Mostafa, 2018). The current study, therefore, investigated the level to which the planning standard on the minimum widths of road reserves in the study area was complied with by the sampled developments. The results of the descriptive paired sample statistics showed that the observed mean for road reserves (M = 5.093, SD =

Table 10: Test for significance on minimum road reserve

Paired samples	Paired Differences					t	df	Sig. (2-tailed)
	Mean	Std. Deviation	Std. Error Mean	95% confidence interval of the difference				
				Lower	Upper			
Observed widths of the road vs Recommended width of roads	-3.957	1.189	.087	-4.129	-3.782	-44.98	182	.000

Fig. 8: Illegal developments (left and right) fronting the university's main gate (center)

1.166) was lower than the planning standard (M = 9.049, SD = 382). To further explore if this increase was statistically significant, analysis of paired sample t-test was computed in Table 10. The outcome indicates that the observed minimum plot sizes (M = -3.956, SD = 1.190) were statistically significant, t (182) = - 44.981, P = 0.00 therefore suggesting why most roads in the study area are narrow. This disregards the development control principles of accessibility, conformity, safety and convenience which should be promoted by the CGOK.

The problem is also depicted pictorially (Fig. 8 and Fig. 9) where illegal developments are sited Infront of the university's main gate and behind the tuition block. The developments are located on the stormwater drains and pedestrian footpaths, further undermining the principles of development control such as safety, access and compatibility, a situation that validates insufficient planning and development control by the CGOK. In Fig. 9, uncontrolled developments are not only built along the university's fence but also blocks the fronting 9-meter road reserve in Nyamage..

The findings of the current study agree with that of Dindi (2013) who established that the growth of Jomoo Kenyatta University of Science and Technology contributed to a decrease in vegetation, bare ground and tremendous growth in built-up areas in Juja. The increase in built-up areas was due to the construction boom of hostels around the university in an attempt to meet a demand created by students who could not be housed on campus. This expansion was without proportionate to investment in physical infrastructure leading to an unsustainable environment. Research findings from the current study similarly corroborate that of Mabonga (2016) who through spatial analysis demonstrated a significant change in land use and

Fig. 9: Illegal developments behind the university's newly constructed tuition block

land cover as a result of establishing JKUAT, MMUST and MMU. The study recorded the considerable transformation of farmlands and forests into built-up environments leading to uncontrolled settlements around the universities. The current study however examines the planning implications of such land use change by focusing on compliance with the recommended planning standards and in so doing filling a gap in the literature that hitherto existed in urban land use planning and development control as a legislative and policy requirement.

CONCLUSION

This study investigated the impacts that the growth of Kisii University has had on land use change through a case study of the Nyamage neighbourhood in Kisii Municipality, Kenya. It also sought to link the observed change to compliance with the recommended planning standards that included BCR, plot size and access roads. Research findings revealed that the establishment and growth of Kisii University have in the past 14 years contributed to significant land use change within the surrounding neighbourhood of Nyamage with built-up areas accounting for the greatest transformation. This rapid change further contributed to noncompliance with key planning standards such as the minimum plot size, BCR and minimum plot size, resulting in land use conflicts and pressure on the limited infrastructure such as water and sewer reticulation, consequently contributing to unsustainable spatial development. The problem keeps recurring even though the CGOK has been mandated by part IV of the Physical and Land Use Planning Act (The Republic of Kenya, 2019a) to among others, ensure that land use development is orderly; ensuring that approved plans are implemented; conservation and protection of the environment; promoting public health and safety; control land subdivision; approve and issue development permits. It, therefore, appears that the GOK's main focus of establishing universities was to meet the target set in Kenya Vision 2030 of having at least 100 universities alongside the recommendation of the Universities Act of 2012 which advocates for university in each of the 47 counties, without paying attention to their implications on land use change.

Recommendations

The study makes two policy pronunciations. First, at the moment, the CUE through the Universities Standards and Guidelines, 2014 (The Commission for University Education, 2014) require universities that are proposing to be chartered to only possess master plans that show the physical infrastructure that is existing and the proposed developments. The guidelines also condition universities to have strategic plans that cover general development in areas such as learning and administrative facilities, enrolment of the student, staff establishment and development, research, academic programs on offer, information communication and technology, and community extension. Given this observed limitation, it is recommended that regulation number INST/STD/07 on planning should be revised to make it mandatory that any proposed university, besides the physical master plan and strategic plan, should also in collaboration with the concerned county governments, ensure that the neighbourhood where it is proposed is first planned. Second, as provided under section 52 of the Physical and Land Use Planning Act, the CGOK should at the earliest opportunity declare the entire study area as a "special planning area" to provide a legal basis and resource allocation for preparing a comprehensive physical and land use development plan which will be used as a tool for undertaking development control. Although the current study has linked the growth of universities to urban land use, its scope in terms of spatial planning was limited to only three planning standards. Future research may therefore be undertaken to explore the impacts that universities have had on other related physical planning standards such as floor area ratio, car parking, and provision of pedestrian footpaths.

ACKNOWLEDGEMENT

The author thanks the Subchief for Nyamage sublocation who assisted in delineating the study area during the field survey. Special appreciation also goes to the Kisii County Survey office for providing the registry index maps/survey maps that were used to determine the extent of conformity with the approved subdivision regulations.

CONFLICT OF INTEREST

The author declares no potential conflict of interest regarding the publication of this work. In addition, the ethical issues including plagiarism, informed consent, misconduct, data fabrication and, or falsification, double publication and, or submission, and redundancy have been completely witnessed by the author.

Publisher's note

Tehran Urban Planning and Research Center remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.

ABBREVIATIONS

BCR	Bulling Coverage Ratio
CGOK	County Government of Kisii
CUE	Commission for University Education
Fig.	Figure
GIS	Geographic Information Systems
GOK	Government of Kenya
ha.	hectares
JKUAT	Jomoo Kenyatta University of Science and Technology
Km	Kilometers
Km^2	Kilometer square
m.	Meters
MMU	Masai Mara University
MMUST	Masinde Muliro University of Science and Technology
NDVI	Normalized Difference Vegetation Index
SDGs	Sustainable Development Goals
SPS	Sector Performance Standards
TRC	Theory of Regulatory Compliance
UASU	Union of Academic Staff Union
UCN	University College Nairobi

UEA	University of Eastern Africa
%	Percentage

REFERENCES

Anderson, A., (1976). Land use and land cover classification system. Geological Survey Professional Paper 964, Washington DC. (**34 pages**).

African Union Commission, (2014). Agenda 2063, the Africa we want - first ten-year implementation plan 2013-2023. (**130 pages**).

Al-Youbi, A.O.; Zahed, A.H.M.; Nahas, A.M.; Hegazy, A.A., (2021). The leading world's most innovative universities. Springer Nature Switzerland AG. Cham, Switzerland (**115 pages**).

Arocena, R.; Sutz, J., (2021). Universities and social innovation for global sustainable development as seen from the south. Technol. Forecast Soc. Change, 162(2021): 2-10 **(10 pages).**

Bayuo, B.B.; Chaminade, C.; Goransson, B., (2020). Unpacking the role of universities in the emergence, development and impact of social innovations - A systematic review of the literature. Technol. Forecast Soc. Change, 155(2020): 1-11 **(11 pages).**

Besselink, T.; Yesilkagit, K., (2020). Market regulation between economic and ecological values: Regulatory authorities and dilemmas of responsiveness. Public Policy Adm., 1-9 (**9 pages**).

Brennan, J.; Cochrane A.; Lebeau Y.; Williams R., (2018). Universities, economic development and regeneration. In: the University in its place. Springer, Dordrecht (**14 pages**).

Cetin, M.; Talha, A.; Saye, N.C.; Muzeyyen, A.S.K.; Alper, C., (2021). Employing remote sensing technique to monitor the influence of newly established universities in creating an urban development process on the respective cities, Land Use Policy, 109 **(11 pages).**

Chan, R.Y., (2016). Understanding the purpose of higher education: An analysis of the economic and social benefits for completing a college degree. JEPPA., 6(5): 1-40 **(40 pages).**

CMDHCD, (2009). An overview of the subdivision control law (**61 pages**).

Crowe, S.; Cresswell, K.; Robertson, A.; Huby, G.; Avery, A.; Sheikh, A., (2011). The case study approach. BMC Med. Res. Methodol., 11(1): 1-9 **(11 pages)**.

Dindi, A., (2013). The impact of the rapid expansion of universities on their neighbourhood development: A case study of JKUAT Juja Campus: A paper presented in the proceedings of SABS conference on promoting sustainable built environments: Architecture, environment, technology and society in the Global South, 10-12 October at JKUAT, AICAD Juja, Kenya. (**15 pages**).

Fiene, R.J., (2019). A treatise on the theory of regulatory compliance. J. Regul. sci., 7(2019): 1-3 **(3 pages).**

Filho, L.; Shiel, C.; Paço, A.; Mifsud, M; Ávila, L.V.; Brandli, L.L.; Molthan-Hill, P.; Pace, P.; Azeiteiro, U.M.; Vargas, V.R.; Caeiro, S., (2019). Sustainable development goals and sustainability teaching at universities: Falling behind or getting ahead of the pack?. J. Clean. Prod., 232(2019): 285-294 (**10 pages**).

Filho,L.; Wu,W.; Yen-Chun, J.; Londero, B.L.; Veiga,A.L.; Miranda, A.U.; Caeiro, S.; da Rosa Gama, L.M.R., (2017). Identifying and overcoming obstacles to the implementation of sustainable development at universities. J. Integr. Environ. Sci., 14(1): 93-108 **(16 pages).**

Harrison, J.; Turok, I., (2017). Universities, knowledge and regional development. Reg. Stud., 51(7): 977-981 (**15 pages**).

Hu, Q.; Wu, W.; Xia, T.; Yu, Q.; Yang, P.; Li, Z.; Song, Q., (2013). Exploring the use of Google Earth imagery and object-based methods in land use/cover mapping. Remote Sens., 5(11): 6026-6042 (**17 pages**).

Karoly, L.A., (2021). Investing in the future: Reducing poverty through human capital investments. Understanding poverty, edited by Sheldon Danziger and Robert H. Haveman, Cambridge, MA and London, England: Harvard University Press, 2021. 314-356 **(43 pages).**

Kenya News Agency, (2019). Approach merger of universities with caution, says Chancellor (**1 page).**

Kimathi, I., (2020). The growth of universities in Kenya and their role in economic development (**5 pages**).

Kinoti, K.; Nyaga, N.P., (2018). Understanding universities land policy and their implementation strategies in Kenya: The case of Karatina University main campus, Kenya. Int. J. landsc. plann. Architect., 4(1): 1-8 (**8 pages**).

Kisii University, (2019). Strategic Plan, 2019-2024 (**90 pages**).

Krejcie, R.V.; Morgan, D.W., (1970). Determining sample size for research. Activities. Educ. Psychol. Meas., 30: 607-610 (**4 pages**).

Laura, H.; Jeff, B., (2017).The introduction of human capital theory into education policy in the United States. Hist. Political Econ., 49 (4): 537-574 **(38 pages).**

Lyons, M. B.; Keith, D. A.; Phinn, S. R.; Mason, T. J.; Elith, J., (2018). A comparison of resampling methods for remote sensing classification and accuracy assessment. Remote Sens. Environ., 208(2018): 145-**153 (9 pages).**

Mabonga, J. S., (2016). University establishment and its role in urban sprawl in Kenya. Int. J. Innov. Res. Dev., 5(9):134-153 (**20 pages**).

Malarvizhi, K.; Kumar, S.V.; Porchelvan, P., (2016). Use of high-resolution Google Earth satellite imagery in landuse map preparation for urban related applications. Procedia IUTAM., 24: 1835-1842 **(9 pages).**

Mapuranga, B., (2016.) The role of universities in economic development. J. Econ. Sustain. dev., 7(6): 1-23 **(23 pages).**

Marozau, R.; Guerrero, M.; Urbano, D., (2021). Impacts of universities in different stages of economic development. J. Knowl. Econ., 12: 1-21. (21 pages).

Mei, W.; Symaco, L., (2021). Higher education for development: The role of university towns in China. SAGE Open, 2021, 1-14 (**14 pages).**

Michaela, T.; Tanja, S.; Smith, H.L., (2015). The role of universities in regional development: conceptual models and policy institutions in the UK, Sweden and Austria. Eur. Plan. Stud., 23(9): 1722-1740 (**19 pages).**

Mostafa, H.M., (2018). Road maintenance in Africa: Approaches and perspectives. E3S Web Conf. 38: EDP Sciences (**6 pages**).

Mutua, J., (2021). Parliament revives push for merger of public varsities. Bus. Daily (**1 page**).

Mutula, S.M., (2002) University education in Kenya: current developments and future outlook. Int. J. Educ. Manage., 16 (3): 109-119 (**11 pages**).

Nganga, G., (2019). University world news. Court blocks university merger plan, calls for consultation (**1 page**).

Ngochi, B.M., (2011). Impacts of university location on rural neighborhood land use a case of Kenya Methodist University main campus in Meru County. Unpublished masters of Arts thesis, University of Nairobi (**100 pages**).

Nyaundi, L., (2020). Legal hitches stalling varsity merger plans, says Magoha. Star (**1 page**).

Nyaundi, L., (2021). KU, Maseno, JKUAT win big in 2021 University placement. Star (**1 page**).

Odhiambo, G., (2018). The role of Kenyan universities in national development. FIRE, 4 (3): 191-209 **(19 pages**).

Odhiambo, H.V.O., (2014). Institutions of higher learning as drivers of urban development: A case study of University of Eastern Africa, Baraton Nandi County-Kenya. Unpublished master's thesis, Kenyatta University **(117 pages)**.

Owoeye, J.O.; Ogunleye, O.S., (2015). Urban development and land use changes around the Ekiti State University (EKSU), Ado-Ekiti Nigeria. J. Geogr. Reg. plann., 8(4): 111-119 **(9 pages).**

Omollo, W. O., (2020). Compliance with planning standards related to the setbacks around domestic buildings: Empirical evidence from Kenya. JCUA., 4(2): 95-108 (**13 pages)**.

Omollo, W.O., (2021). Development control on urban road reserves in Kenya: A case study on compliance with planning standards. Int. J. Architect. Eng. Urban Plan., 31(1): 1-15 (**15 pages**).

Otiato, G., (2021). Cash-strapped Kenyan varsities face closure in World Bank loan deal. East African (**1 page**).

Owen, S.; Palekahelu, D.; Sumakul, T.; Sekiyono, E.; White, G., (2017). Systematic educational change and teacher skill-building in developed and developing countries: the importance of teacher peer learning groups. Teach. Dev., 2(4): 447-463 (**17 pages**).

Pacho, T.O., (2015). Exploring participants' experiences using case study. Int. J. Human. Soc., 5 (4): 53-60 (**10 pages)**.

Patrinos, H.A.; Psacharopoulos, G., (2020). The economics of education: returns to education in developing countries, 53-64.

Pee, S.; Vululleh, N., (2020). Role of Universities in Transforming Society: Challenges and Practices. In International Perspectives on Policies, Practices & Pedagogies for Promoting Social Responsibility in Higher Education. Emerald Publishing Limited.32: 67-79 (**13 pages**).

Psacharopoulos, G.; Patrinos, H. A., (2018). Returns to investment in education: a decennial review of the global literature. Educ. Econ., 26(5): 445-458 **(15 pages).**

Purcell, W.M.; Henriksen, H.; Spengler, J.D., (2019). Universities as the engine of transformational sustainability toward delivering the sustainable development goals: Living labs for sustainability, Int. J. Sustain, 20(8): 1343-1357 **(15 pages).**

Rahadianto, M.A.E.; Henry, E.; Endyana, C.; Aufaristama, M., (2021). Application of high-resolution remote-sensing data for land use land cover mapping of university campus. Sci. World J., 2021 **(17 pages).**

Ruoppila, S.; Zhao, F., (2017). The role of universities in developing China's university towns: The case of Songjiang university town in Shanghai, Cities, 69 (2017): 56-63 **(8 pages).**

Salah, M., (2014). Combining pixel-based and object-oriented support vector machines using bayesian probability theory. ISPRS Ann. Photogramm. Remote Sens. Spat. Inf. Sci., 2(7): (**9 pages**).

Stehman, S. V.; Foody, G. M., (2019). Key issues in rigorous accuracy assessment of land cover products. Remote Sens. Environ., 231(2019): 1-23 **(23 pages**).

Strack, M., (2019). Reconfiguring land and property: What is a subdivision? New Zealand Surveyor, 305 (**29 pages**).

Tetnowski, J., (2015). Qualitative case study research design. Perspectives, 25 (1): 39-45 (**7 pages**).

The Commission for University Education, (2014). Universities Standards and Guidelines (**134 pages**).

The Republic of Kenya, (2012). Universities Act (**41 pages**).

The Republic of Kenya, (2019a). Physical and Land Use Planning Act (**67 pages**).

The Republic of Kenya, (2019b). The Urban Areas and Cities (Amendment) Act, 2019 (**21 pages**).

The Republic of Kenya, (2010). Sector performance standards (SPS) (**261 pages**).

The Republic of Kenya, (2007). Kenya Vision 2030: The popular version (**32 pages**).

The Republic of Kenya, (1965). African socialism and its application to planning in Kenya (**61 pages**).

Tubei, G., (2019). Pulse. Kenya halts plans to merge public universities that would have resulted in 9,000 lecturers becoming unemployed (**1 page**).

UNESCO, (2014). UNESCO education strategy, 2014-2021 **(63 pages).**

Wanzala, O., (2019). Nairobi news. UASU goes to court to stop planned merger of public universities (**1 page)**.

Wibowo, A.; Sallah, K.O.; Sitanala, F.; Jarot, S.M., (2016). Spatial temporal land use change detection using Google Earth data. 2nd International Conference of Indonesian Society for Remote Sensing (**12 pages**).

Yigitcanlar, T; Sarimin, M., (2011). The role of universities in building prosperous knowledge cities: The Malaysian experience. Built Environ., 37(3): 260-280 **(21 pages).**

HOW TO CITE THIS ARTICLE

Omollo, W.O., (2022). Planning implication of universities growth on land use: Confirmatory evidence from GIS spatial analysis. Int. J. Hum. Capital Urban Manage., 7(2): 183-204.

DOI: 10.22034/IJHCUM.2022.02.04

url: http://www.ijhcum.net/article_249399.html