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Article

Geospatial Assessment of Land Use and Land Cover Dynamics and Perceptions of Farmers in Gaya Local Government, Kano State, Nigeria

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Abstract

Land use and land cover (LULC) changes have been one of the most immense and perceptible transformations of the earth's surface. Evaluating land use/land cover change at varied spatial scales is imperative in wide range of perspectives such as environmental conservation, resource management, land use planning and sustainable development. This study looked at the use of GIS tools and the perception of registered farmers for the assessment of land use and land cover changes between 1986 and 2019 with a view to facilitate effective planning in Gaya Local Government Area of Kano State and environ. Supervised classification method with maximum likelihood classifier was adopted for the study. Results revealed that there had been substantial changes in the land use and land cover during the period. The results revealed that built up area increased with only 80.83 hectares, Agricultural land had increased with 2,275 hectares, Dense vegetation has decreased with 1,315.53 hectares, open field had decreased with 1,049.31 hectares. However, the perception of farmers showed results from spatial and farmers' view analyses confirmed a general increase in agricultural lands from 1986 to 2002 (1936.09ha) and 2002 to 2019 (338.51ha) as was confirmed by the respondents. More participants showed little intentions of changing their farming status owing to gains and family supports derived from farming in the study area.

Keywords: Land use, Land Cover, Remote Sensing and Geospatial

1. Introduction

Land use and land cover dynamics are widespread, accelerating, and significant processes majorly encouraged by human actions and at the same time resulting to changes that impact human livelihood. Land use/land cover is the conversion of different land use types and is the result of complex interactions between humans and the physical environment. Land and its resources have been used to meet the material, social, cultural and other needs of human beings.

Land use and land cover change is often used interchangeably but the two have different meanings. Land cover describes the natural and anthropogenic features that can be observed on the Earth's surface. Examples include deciduous forests, wetlands, developed/built areas, grasslands, water, etc. Land use, by contrast, describes activities that take place on the land and represent the current use of property. Examples include residential homes, shopping centers, tree nurseries, state parks, reservoirs, etc. as seen in the work of Fonji and Taff [1].

According to Lillesand, Kiefer and Chipman [2] distinction was made between Land cover and land use by referring to Land cover as relates to the type of feature present on the surface of the

earth which can include but not limited to cornfields, lakes, maple trees, and concrete highways while the term land use relates to the human activity or economic function associated with a specific piece of land which examples can include a tract of land on the fringe of an urban area used for singlefamily housing. They explained further that depending on the level of mapping detail, its land use could be described as urban use, residential use, or single-family residential use; thus, a knowledge of both land use and land cover can be important for land planning and land management activities.

Globally, most of the land cover has lost their natural state, as most of the landscapes have been altered by anthropogenic activities. The Earth surface is being significantly altered in some manner by man's presence on the Earth and his activities have created a profound effect on the natural environment thus resulting into an accelerated growth in settlements expansion, (Riebsame, Meyer and Tunner [3]. In addition, land use change through the conversion of the world's forest land to other uses continues on an increasing scale due to the unprecedented growth of the human population which increases the demand for food and land [4].

Viewing the Earth from space is now very crucial to the understanding of the influence of man's activities on the earth over time. In situations of rapid and often unrecorded growth in settlement, observations of the earth from space provide objective information of human utilization of the landscape [5]. Over the past years, data from Earth sensing satellites has become vital in mapping the Earth's features and infrastructures, managing natural resources and studying environmental change. Land is becoming a scarce resource due to immense agricultural, city growth (settlements expansion) and demographic pressure on land. The information on land use and land cover changes and possibilities for their optimal use is essential for research, planning and implementation of land use schemes to meet the increasing demands for basic human needs, welfare and sustainable development.

Loveland, Acevedo and Sayler [6] submitted that Land use/land cover change studies attempt to explain where change is occurring, what land cover types are changing, the types of transformation occurring, the rates or amounts of land change, and finally, the driving forces and proximate causes of change. What would be the future change patterns of the land use and land cover, mostly derived through simulation modelling according to Brown *et al*. [7] is also an imperative dimension of such investigations. In order to understand when, where, and why Land use and land cover changes occur, the models usually involve empirically fitting the evaluation system to some historical pattern of change, then extending those patterns into the future for projection [7]. Remote sensing is currently most reliable tool for monitoring varied spectrally sensitive changes of the earth. The information obtained through the technology is also crucial for modelling other natural and cultural processes [8].

Farming provides food for the populace and also contributes to land-based livelihoods of rural households by improving self-provisioning capacity, providing non-food goods, monetary and non-monetary services, buffer from shocks, livelihood diversification, a sense of place, identity and wellbeing, and security from the knowledge of having land and a home on that land. Thus, there are many reasons to support small-scale farmers to promote reductions in food insecurity, poverty and household vulnerability, whilst simultaneously promoting regional or national food production, economies, and sustainable land use. Sub-Saharan Africa also has enormous potential to improve smallholder farming yields as most agricultural land has under realized potential productivity and smallholder productivity would need to double by 2030 to realize the United Nations Sustainable Development goals on poverty, food security and environmental sustainability [9].

Despite the clear need for increased agricultural engagement and productivity, abandonment of agricultural land is increasing both globally and within sub-Saharan Africa. Definitions of agricultural land abandonment vary according to the approach (e.g., social, administrative), or whether qualitative (e.g., land condition) or quantitative (e.g., number of years abandoned) data are used. Bryceson's [10] 'deagrarianization' describes a holistic process that constitutes changes in

occupation, redirection of income-earning, social identification, and spatial relocation of rural inhabitants away from strictly agriculture-based livelihoods. The difficulties in defining cropland abandonment speak to the multiscale, interconnectedness of the natural, economic and social aspects of agricultural activities.

Essentially, agricultural land abandonment is the cessation of agricultural activities, but it is a complex process that may occur simultaneously with farmland clearing, or with interrupted and short periods of crop farming [11]. Cropland abandonment occurs at varying intensities and is often a non-linear process with possible multiple alternative trajectories, reflecting the emergent properties of complex local and global feedbacks in social-ecological systems [12]. Crop land abandonment as a component of deagrarianization should not be confused with rotational systems of crop land resting implemented to restore soil fertility or temporary withdrawal from agricultural production due to adverse conditions such a drought or transient lack of labor or inputs. Here, we define 'cropland abandonment' as land that is no longer farmed for economic, social or other reasons. Professional farmers in the study area have a lot to lose or gain from the sustainability of land use and cover in the study area. Gaya witnessed drastic land use and land cover changes mainly as a result of increase in population size, economic growth, changes in agriculture practices, and execution of different development projects particularly from 1986 to date.

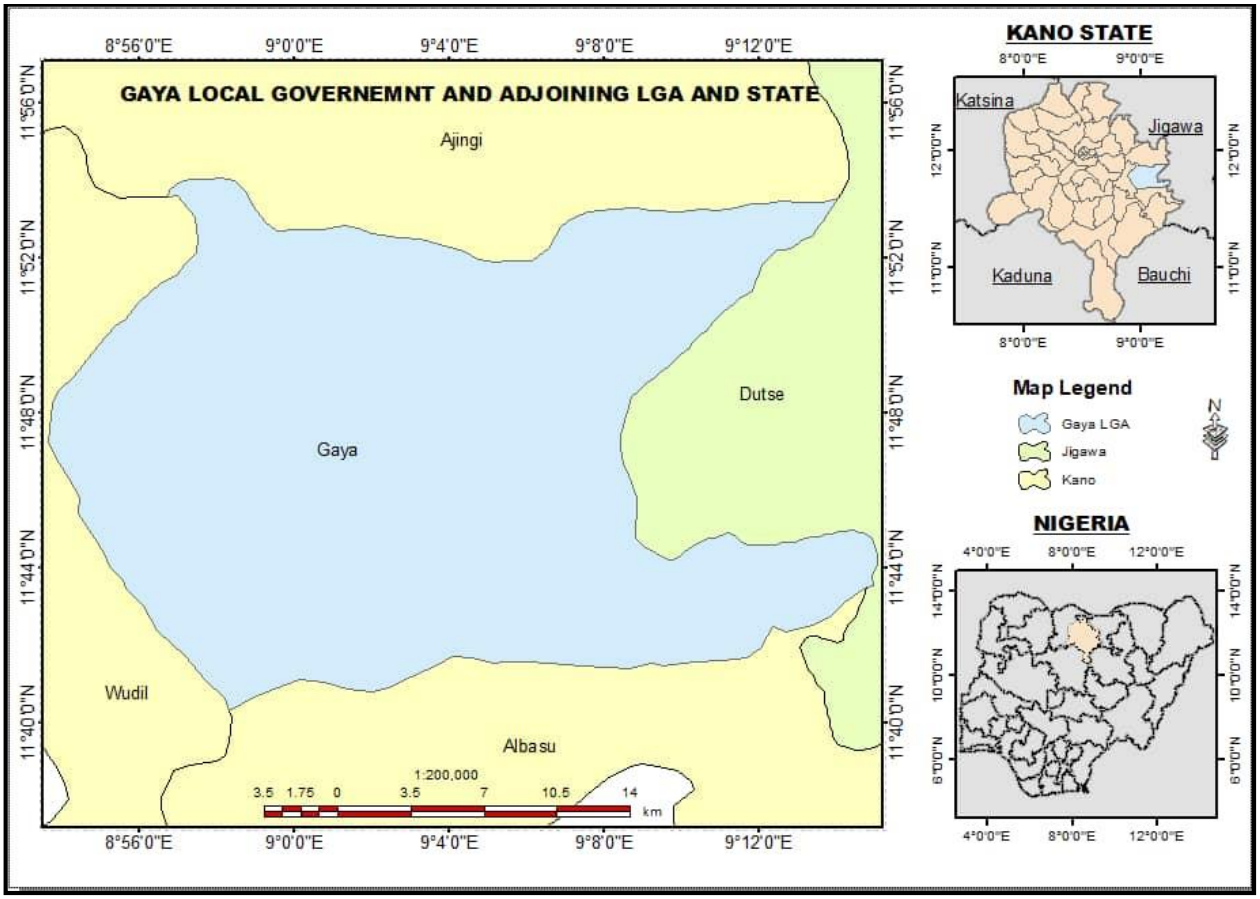

Figure 1: Map of the Study Area

Gaya Local Government is among the oldest local governments in Kano state (Figure 1). With the headquarter in Gaya, southern part of Kano state, 64km from Kano City. It is located between Latitudes 11°52′5″N and 11°55′30″N and Longitudes 8°55′30″E and 9°15′30″E. It has total land area of 613 km² and comprises of ten wards, Gaya Local Government is bounded by Ajingi Local Government to the north, Wudil to the West, Albasu to the South and Dutse Local Government in Jigawa state to the East. As at 1991 the total population of Gaya was 105,199 (1991 census) and in 2006 census Gaya had a total of 201,016. However, the Land use and land cover changes are not

being monitored in a systematic way and estimation of the magnitude of the changes is rarely being done; hence, knowledge of the Land use and land cover dynamics in the region is scarce. In the present study, attempt is made to map and quantify the Land use and land cover changes, using multi-temporal remote sensing satellite data.

2. Materials and Methods

2.1 Data

This study made use of two types of data. They are the primary and secondary data sets. The primary data were obtained from field survey which were the structured questionnaires designed to answer questions that provided clues to the problems of land use/land cover changes. On the other hand, the secondary data (Table 1) was collected from reliable and relevant websites. The datasets used in this study were geometrically referenced to the WGS1984, UTM Zone 32 projection system.

Table 1: Sources of Data

Data Type	Date / Resolution	Purpose	Source
Landsat 5 TM	1986-10-16 / 30m	LULC Analysis	USGS official Website
Landsat 7 ETM	2002-02-22 / 30m	LULC Analysis	USGS official Website
Landsat 8 OLI/TIRS	2019-01-12 / 30m	LULC Analysis	USGS official Website
Nigerian Shapefile	2020-08-20	Map of study area	Cartography & GIS Department of Federal School of Surveying, Oyo
Gaya Local Government Population data	2020-08-20	Population change analysis	National Bureau of statistics website
Farmers population	2020-11-30	Farmer's perception	KNARDA Gaya L.G. office
Questionnaire	2020-12-03	Farmer's perception	Field survey

Sources: Field work and various websites

2.2 Methods

The study employed the use of geospatial technology methods and structured questionnaires to assess the land use and land cover dynamics in Gaya Local Government of Kano State. The methodology flowchart is shown in Figure 2. The Landsat 5, 7 and 8 with spatial resolutions of 30m each were downloaded from the USGS official websites for the periods of 1986, 2002 and 2019 respectively that covered two epochs. Image enhancements were performed on the imageries to remove noise using specialized tools in ArcGIS software used. The study area was also extracted to avoid working beyond the boundary of the study area. Sample sets were created and the classification done using supervised classification method and the results were subjected to accuracy assessment. The data from the questionnaires (Table 2) were subjected to descriptive analysis also and prediction for the year 2035 was made through the analyses carried out. The results were produced with the 1986, 2002, 2019 and 2035 maps.

3. Results and Discussion

The results shown in this section were based on the principles of GIS and Remote Sensing using Supervised Classification in ArcGIS software and also the perceptions of the farmers on Land Use and land Cover Dynamics using structured questionnaires distributed to the farmers within the study area.

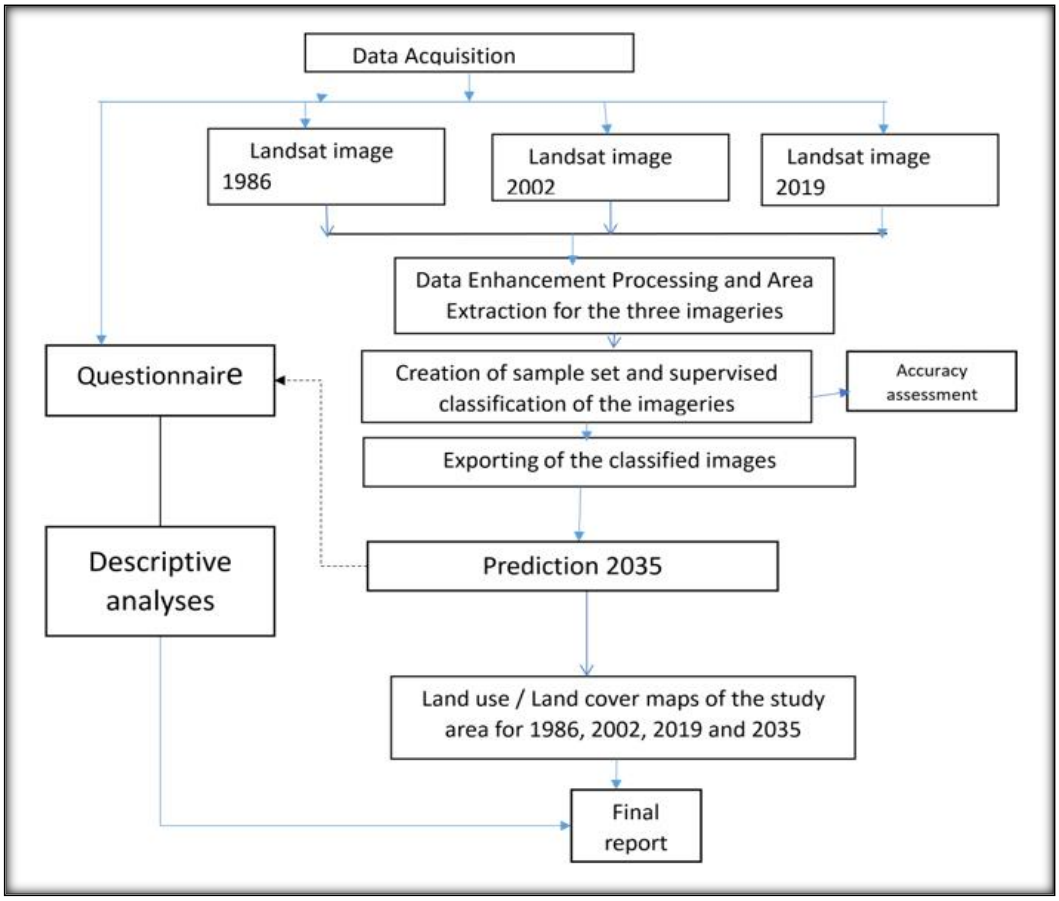

Figure 2: Flow Chart of Methodology for the research work

3.1 Assessment of land use/land cover changes in the study area

This section looked at the use of GIS and Remote Sensing approaches to look at the assessment of land use/land cover changes in the study area. The study area was divided into built up area, agricultural land, dense vegetation and open field for the purpose of carrying out the classification of the area using supervised classification. The statistics for the land use/land cover changes in the study area are presented in Table 3. The findings showed that Built up area has increased from 274.31 hectares (3.25%) in 1986 to 313.06 hectares (3.70%) in the year 2002 and the area increased to 355.14 hectares (4.20%) in 2019 (Table 3).

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Agricultural land has increased from 4,580.83 hectares (54.17%) in 1986 to 6.516.93 hectares (77.07%) in 2002 and increased to 6855.84 hectares (81.08%) as at 2019; while dense vegetation has decreased from 1.954.49 hectares (23.10%) in 1986 to 960.82 hectares (11.36%) in 2002 and rose to 638.97 hectares (7.56%) in 2019. The open field area in the study area has decreased from 1,647.27 hectares (19.48%) in 1986 to 665.09 hectares (7.87%) in 2002 and increased to 605.96 hectares (7.17%) in 2019 (Table 3).

Table 3. Land use /land cover distribution (1986, 2002, & 2019)

Land Cover	1986		2002		2019	
	Area (ha)	Area (%)	Area (ha)	Area (%)	Area (ha)	Area (%)
Built up	274.31	3.25	313.06	3.70	355.14	4.20
Agricultural land	4,580.83	54.17	6,516.93	77.07	6,855.84	81.08
Dense vegetation	1,953.49	23.10	960.82	11.36	638.97	7.56
Open field	1,647.27	19.48	665.09	7.87	605.96	7.17
Total	8,455.90	100.00	8,455.90	100.00	8,455.90	100.00

It was noted from the analysis carried out that agricultural land has the highest percentage of coverage which increased during the periods in review. The increase was as a result of population growth and agricultural practices expansion in the study area where as dense vegetation is always decreasing due to settlement growth and expansion of agricultural land which involves felling of trees to allow farming at large scale as it was seen in the study area. Table 4 showed the summary of the rate of land use and land cover changes between the two epochs considered for the study which were 1986 - 2002 and 2002 – 2019.

Table 4: Rate of land use/land cover changes per annum between: 1986 - 2002 and 2002 - 2019

Land Cover	1986 – 2002			2002 – 2019		
	Area (ha) change	% of change	% per annum	Area (ha) change	% of change	% per annum
Built up	38.76	1.2	0.08	42.07	0.50	0.03
Agricultural land	1,936.09	22.90	1.43	338.51	4.00	0.24
Dense vegetation	-992.67	-11.74	-0.73	-321.85	-3.81	-0.22
Open field	-982.18	-11.61	-0.73	-59.13	-0.70	-0.04

3.2 Perceptions of Farmers on Land Use/land Cover Dynamics

Perceptions of farmers on land use/land cover dynamics were gathered with the aid of the questionnaires distributed to farmers with the view of getting relevant information to perform this analysis. Responses from the farmers showed that majority of the farmers were males; 128 out of 143 representing 89.5% of the respondents were males while only 15 respondents representing 10.5% of the farmers that responded to the questionnaires were females. The age brackets of the farmers are as shown in Table 5 with 27.97% of the respondents were within the age brackets 30-40 years, 51.05% were within 40-50 years and 20.98% were above 50 years.

Table 5: Age brackets of respondents

S/N	Age bracket	Frequency	Percentage of Total
1	30 – 40	40	27.97
2	40 – 50	73	51.05
3	Above 50	30	20.98
	Total	**143**	**100**

If the educational attainment of the farmers was anything to go by, majority had no formal education (81) while some had up to Post-Secondary education (8) as shown in Table 6. The table showed that 20.28%, 14.69%, 5.59% and 59.44% represent those with primary, secondary, post-secondary and no formal education respectively in the study area.

Table 6: Respondents' educational qualifications

S/N	Qualification	Frequency	Percentage
1	Primary	29	20.28
2	Secondary	21	14.69
3	Post-secondary	8	5.59
4	No formal education	81	59.44
	Total	**143**	**100**

Table 7 shows the percentage of respondents' type of farming. The results revealed that 19.58% practiced mixed farming, 41.96% practiced subsistence farming while 38.46% were practicing commercial farming.

Table 7: Respondents' type of farming

S/ N	Type of farming	Frequency	Percentage
1	Mixed farming	28	19.58
2	Subsistence farming	60	41.96
3	Commercial farming	55	38.46
	Total	**143**	**100**

Table 8 shows the percentage of farmers that plan to change their farming systems in the future as a result of land use and land cover changes. The result shows that 11.89% respondents strongly agree to change their farming system, 26.57% agree to change, while 3.50% neither agree nor disagree, 37.76% do not agree and 20.28% strongly disagree to change their farming system.

Table 8: Farmers that plan to change their farming system

S/N	Responses	Frequency	Percentage
1	Strongly agree	17	11.89
2	Agree	38	26.57
3	Neither	53	3.50
4	Disagree	54	37.76
5	Strongly disagree	29	20.28
	Total	**143**	**100**

The percentage of land lost to farming between 2002 and 2019 is presented in Table 9. The result shows that 6.29% strongly agree they lost 70% of their land, 4.9% agreed they lost 70% of their land, 4.9% agreed they lost 50% of their land, 11.89% agreed they lost 30% of their land, 3.5% strongly agreed they lost less than 30% of their land, while 7% agreed they lost less than 30% of their land while 40.56% disagreed and 21% strongly disagreed they lost any part of their land during the period in review.

Table 9: Lost land by farmers between 2002 – 2019

	Land loss percentage	SA	%	A	%	N	%	D	%	SD	%	Total
2002-2020	0	**0**	0	**0**	0	**0**	0	**58**	40.56	**30**	21.00	**88**
	70	**9**	6.29	**7**	4.9	**0**	0	**0**	0	**0**	0	**16**
	50	**0**	0	**7**	4.9	**0**	0	**0**	0	**0**	0	**7**
	30	**0**	0	**17**	11.89	**0**	0	**0**	0	**0**	0	**17**
	< 30	**5**	3.5	**10**	7	**0**	0	**0**	0	**0**	0	**15**
	Total	**14**	9.79	**41**	28.69	**0**	0	**58**	40.56	**30**	21.00	**143**

4. Conclusions and Recommendations

The study showed that within the 34 years period (1986-20019) in the study area, the built-up area increased with only 80.83 hectares; agricultural land increased with 2,275 hectares; dense vegetation lost 1,315.53 hectares; open field decreased with 1,049.31 hectares due to conversion to other useful purposes. Whereas literature shows that the diversity of stakeholders' sometimes - contradictory perceptions generate resentment towards planning processes and may impede consensus building [13]. This work revealed a somewhat unanimity of interest in protecting the existence of farmlands.

Moreover, among items that interest farmers, this work revealed that more farmers disagreed with change of land use as may be influenced by the Government or Farmers owing to accrued gains enjoyed by professional farmers in the study area and which in turn enable them to support their family needs - subsistence and commercial agro-economic returns. There is need to also as a matter of urgency to essentially consider among other things, the interests of the association of farmers in any serious farmland planning or related land use development processes, so as not to destabilize food security in Gaya and beyond Kano State - and for all other States in Nigeria to also take cue from the experience in Gaya Local Government.

However, to prevent any avoidable mishaps in future as concerns policy implementation, the researcher supports the notion that scholars need to expose value conflicts and issues of fairness regarding farmland cum land use planning issues in Gaya, especially addressing participatory and collaborative approaches.

Finally, Remote Sensing and GIS were proved to be helpful in estimating the reality of urban expansion and its effect on existing Land use and land cover dynamics study as shown in the study area. Satellite images from open source can be used further for detection, measurement and analysis of change in Land use and land cover.

Having concluded the research and findings made, the following recommendations are therefore proffer for a Decision Support System. Future studies are recommended to focus on a relevant statistical test of farmers' perception, which will enable drawing of more useful statistical inferences. A more refined and detailed work that will use higher resolution images is necessary, which will support definition of individual farmlands and procurement of diversified attributes such as crop yield monitoring among others. The future study can evolve a more robust study that will be able to relate other dimensions involving parameters such as house hold experiences, actual gains from farming, and spatial defection on converted farm land among others. Further study on the land use/land cover changes should be conducted to check the effects on the water bodies in the study area which can be done to cover the same period.

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