

The Dual Pathways in the Process of Urban Development and their influence on Flood Damage in Kisumu City, Kenya

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Abstract- Urban flooding is becoming an increasingly severe and more frequent problem in African cities. The floods result into loss of lives and damages to properties in these urban places. Vulnerability to flood damages has been explained to be related to the manner in which urban settlements develop. Particular processes of urban development, especially in developing countries, where plans follow rapid urban growth, rather than direct it, have been blamed for the increased vulnerability to flood damage. Potential impacts of climate changes are expected to exacerbate this urban flood menace. This therefore necessitated a study of this nature so as to explore the dichotomous pathways in urban development process and how they contribute to the rise in flood damage. This would in turn enable us confront such processes through appropriate urban development planning framework.

Index Terms- Dual pathways; Flood damages; Urban development; Spatial patterns.

I. INTRODUCTION

Urban flooding is becoming an increasingly severe and more frequent problem in African cities. Many of these cities have experienced extreme flooding since 1995 (Douglas, *et al*, 2008). The floods result into loss of lives and damages to properties in these urban places (Sanderson, 2000). Increased flood damages in urban areas in Africa have been evident over the last five decades (Munich Re, 2011 cited in IPCC, 2012). This therefore means that where urban areas were once seen as place of safety, they are now the hub of modern flood risks (Wilby & Keenan, 2012). The reasons for the increased flood damages are several and correlated. Potential climate changes are expected to cause a rise in the frequency and intensity of rainfall thereby exacerbating the urban flood menace (IPCC, 2012). Although there is an expectation that climate change will increase the magnitude and frequency of flood events, the damages by flooding depend on a host of site-specific factors (Wilby & Keenan, 2012). Authors like Brody, *et al* (2007) and Douglas, *et al* (2008) point out that the rising flood-related damages in urban areas is not just related to increases in annual mean precipitation, rather, it is also related to the manner in which urban settlements develop.

Through processes of growth and expansion, urban areas transform their environments and their surrounding hinterlands and may generate and create new hazard patterns (UNDP, 2004; IPCC, 2102). These processes of urban development do not explain vulnerability to flood damage per se. It is particular processes of urban development that increase vulnerability to flood damage. These processes vary considerably from context to context and yield different patterns of settlement (UNDP, 2004). In developing countries where plans follow rapid urban growth rather than direct it, unplanned urban development is common (Jha, *et al*, 2013). This poorly planned and managed urbanization play a major role in increasing flood damages in these countries over the last few decades (IPCC, 2012).

Generally, two paths in the process of urban development exist in Kenya. On one hand, we have the formal urban development process that begets conventional urban patterns and layouts. While on the other, there is the informal urban development process that creates irregular and disorganized patterns. The question that can be asked is: How do these two pathways in urban development process emerge and how do they shape flood damages? Although a number of authors have researched on the different urban development pathways in Kenya (Anyamba, 2006; Anyumba, 1995; Ayonga, 2008; Esho, 2009; Majale, 1998), rarely have they ventured into their contribution in configuring flood damages. This study therefore attempts to fill this hiatus by exploring the dual pathways in the process of urban development and examine their influence in shaping flood damages in Kisumu city.

II. AREA OF STUDY

Kisumu city is located on the western part of Kenya in Kisumu County. The city is situated between longitudes 00^o 06' south of the Equator and latitudes 34^o 35' and 34^o 55' east of Greenwich (Anyumba, 1995; Mireri, *et al*, 2007). It is sited at the eastern extremities of Lake Victoria referred to as Winam Gulf and it is bordered to the north by the Nandi escarpment which rises to over 2000 metres above sea level; Lake Victoria to the southwest with an elevation of about 1140 metres above sea level; and Kano plains to the east (Anyumba, 1995; Mireri, *et al*, 2007). It receives mean annual rainfall of 1245 mm occurring in two seasons; the long and the short rainy seasons, occurring

during March-June and October-November periods respectively (Mireri, *et al*, 2007).



Fig. 1 Map of Kenya showing location of Kisumu city
Source: Maoulidi, (2011)

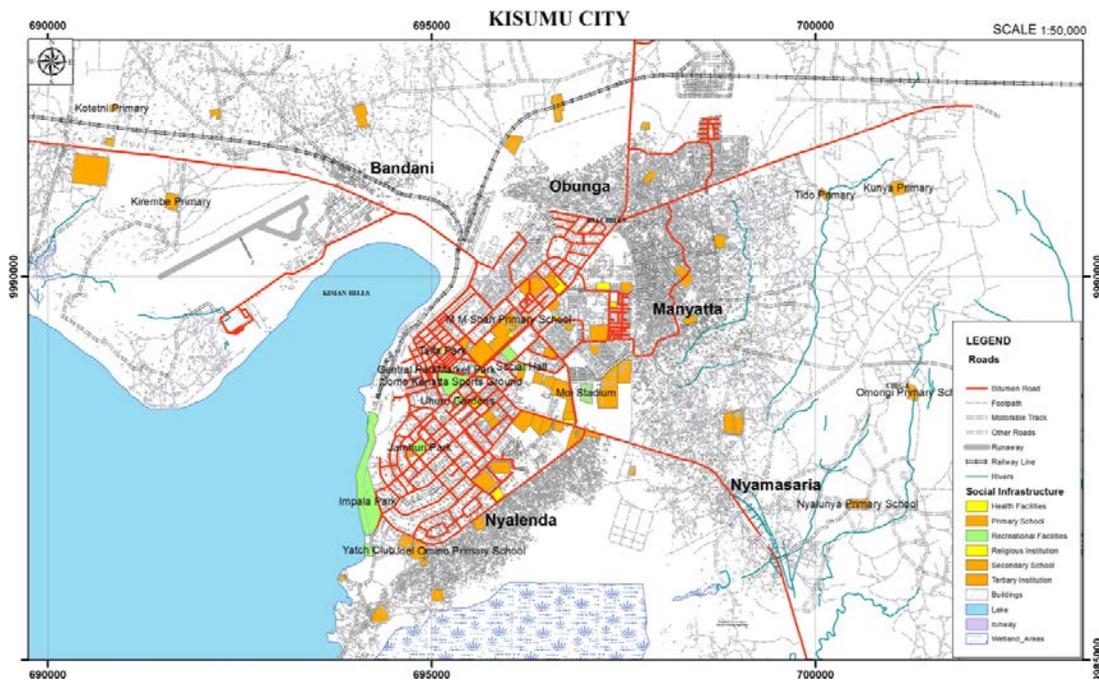


Fig 2 Map of Kisumu city
Source: Department of Physical Planning, 2015

III. RESEARCH METHODOLOGY

This research was conducted in two stages with the first stage laying the ground and providing a base for the second one. The first phase of this research entailed desktop survey where secondary data were collected. This survey essentially involved the review and analysis of the existing planning legislations, statutes and policy documents which contain provisions relating to urban planning and development in Kenya generally and in Kisumu city in particular. The review further focused on the historical urban development and the creation of spatial patterns in Kisumu city. Published and unpublished data related to the urban development processes of residential areas in Kisumu city were collected from the department of town planning of Kisumu city authority, Department of Physical Planning and Department of Surveys both of the Ministry of Land, Housing and Urban Development. The primary goal that was realized by this desk research approach was the conceptualization of the urban development processes and creation of spatial patterns in Kisumu city.

The second phase of this research entailed collection of primary data, through household surveys, key informants interviews as well as observation. During the household survey, data was collected through personal interviews using a semi-structured questionnaire with the heads of the households. Open-ended interview schedules were used to collect data from the key informants.

Household surveys yielded data on flood damage and/or loss. To measure the household damage or loss, types of self-reported data were collected. These included the total estimated loss in terms of money; the respondents were asked to report self-evaluation on the level of household damage to cloths, furniture and other household items, as well as the building itself. These questions were measured on a 4-point scale including: never suffered inundation by floods, no damage, minor damage and total damage.

While purposive sampling was used to pick the key informants, the sampling technique used to choose households to be interviewed involved a combination of stratified-sampling and systematic random sampling. The entire city was first stratified into two spatial units which covered both planned and unplanned settlements. In the planned (formal) settlements, Migosi was purposively selected since it was a planned settlement located in a potentially flood-prone area. The unplanned (informal) settlements were categorized further into two. These were the areas that have undergone upgrading process, of which Manyatta was selected; and those areas that have not experienced any form of intervention, where Nyamasaria was selected. In each of these sampling areas, systematic random sampling was used. In Migosi, a random sample was derived from the Kisumu Municipal plot register. While, for both Manyatta and Nyamasaria, where growth is organic, transect lines were established parallel to the major roads with an interval of about one kilometre. A transect walk was made to determine and mark the households after which simple random sampling was used to sample the households for the study.

For the analysis of household data, particularly on damages suffered in the past during a flood event, ordinal logistic regression was applied. Ordinal logistic regression was used to predict an ordinal dependent variable (extent of damage by

floods in the past) based the independent variable settlement type. Using SPSS, the ordinal logistic procedure was applied using the Polytomous Universal Model (PLUM) procedure.

IV. THE ORIGIN OF DUAL PATHWAYS IN DEVELOPMENT PROCESSES AND VARIATION IN URBAN PATTERNS IN KENYAN URBAN AREAS

The prevailing urban spatial patterns in Kenya trace their origins from the British colonial urban development policies (Home, 2012). The colonization of Kenya by the British heralded the transfer into the country of the urban planning systems that had evolved in Europe over the years. Wherever they settled in Kenya, the colonialist established urban cores which formed the settlement areas of the Europeans. Native Kenyans were not allowed to reside within these core urban areas. Instead, they established their own settlements outside the township boundaries (Home, 2012).

The European settlements forming the core urban areas conformed to the standards of construction and urban development that were in existence in Europe at that time. However, the application of the planning principles and techniques were restricted only to these European settlements while the native Kenyans were left to their own devices in terms of construction and occupation of houses within their settlements (Otiso, 2005). In other words, whereas the European settlement areas took the planned urban development pathway, the native settlements deviated from this and took a divergent pathway where development preceded planning. This marked the beginning of duality in development processes and subsequent variation in spatial patterns in urban areas in Kenya.

As the towns and urban areas in Kenya grew in population and expanded, the contiguous lands where the native settlements existed were inevitably engulfed to accommodate the expansion and development. However, this expansion into peripheral lands created a situation where two distinct urban spatial patterns that had evolved separately were brought together within the same township boundary.

Another complication brought about by this expansion and incorporation of native settlements into the township boundary was the nature of tenure. Whereas the land occupied by the core urban areas was state land under government leasehold control, those that were outside the township boundaries where the natives lived, were the reserves or trust lands (Home, 2012). Accordingly, while it was possible for planned development to take place on the leasehold land within the core urban areas, it proved quite impractical on the native settlement areas where land was held under customary laws (Majale, 1998).

After Kenya gained independence in 1963, the successive governments proved unable to undo the colonial urban development policies that created duality in urban development. Instead, the trends in urban development that ensued after independence tended to reinforce the old structural and spatial patterns (King, 1976). As such, the physical-spatial characteristics of the colonial towns to a greater extent remain unchanged. Such spatial patterns are exemplified by the existence of core urban areas whose developments are planned and regulated and the surrounding peripheral areas which have not benefitted from planned growth. Over the year, attempts have

been made to address the dissimilar urban spatial patterns existing within the same urban area through informal settlement upgrading. Nonetheless, even with the provisions of some form of infrastructure and attempts at planning, the spatial patterns in those former native settlements remains largely unchanged.

V. RESULTS, FINDINGS AND DISCUSSION

5.1 Urban development processes in Kisumu city and the creation of dissimilar spatial patterns

The findings of this study indicate that there are two parallel urban development processes operating side by side in Kisumu

city leading to variation in urban spatial patterns. The first is the formal or pre-planned development process while the second is the informal or unplanned urban development process.

The formal or pre-planned urban development occurred in Migosi settlement. This formal development process commenced with the preparation of a local physical development plan (LPDP) for the site-and-service scheme. The prepared plan was approved by the relevant approval authorities before it could be implemented. This preparation of a plan set the basis for the pre-planned urban development with its pre-determined spatial patterns (figure 3 presents an example).

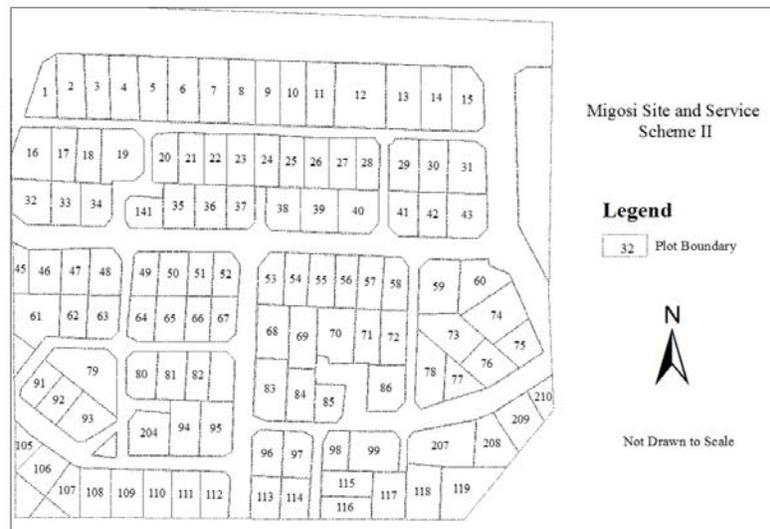


Fig. 3 Copy of part of the plan for Migosi settlement showing regular spatial patterns

Source: Department of Physical Planning - Kisumu Office

The second stage of the pre-planned development that obtained in Migosi was, servicing, which entailed provision of infrastructure and utilities such as storm water drainage system, roads and water reticulation system, among others. Once servicing was completed, the land was ready for construction of buildings, the third step in the pre-planned urban development process of the Migosi settlement. The construction of buildings was a subject to checks and permit systems by the urban authority. The permit system entailed the review, inspection and approval of proposed construction to secure compliance with the building code. In addition, the urban authority ensured that each building plot had adequate buildable area outside the floodway or any other area subject to flooding. Similarly, during the construction process, the urban authority ensured that the

buildings were sited on the highest practical site of the plot so as to prevent inundation by floods.

The final step in the development process in Migosi settlement was the occupation of the buildings that had been constructed. For this to be done, issuance of certificate of occupancy by the urban authority was mandatory. Such issuance meant that the structure was suitable to occupy from a safety point-of-view including propensity to flood risk. The development process in Migosi settlement thus followed the Plan-Service-Build-Occupy (PSBO) pathway. This PSBO pathway creates conventional urban spatial patterns as envisaged in urban planning policy and legislative framework. It is argued that such spatial patterns have in-built risk reducing attributes. The development process is schematized in figure 4.

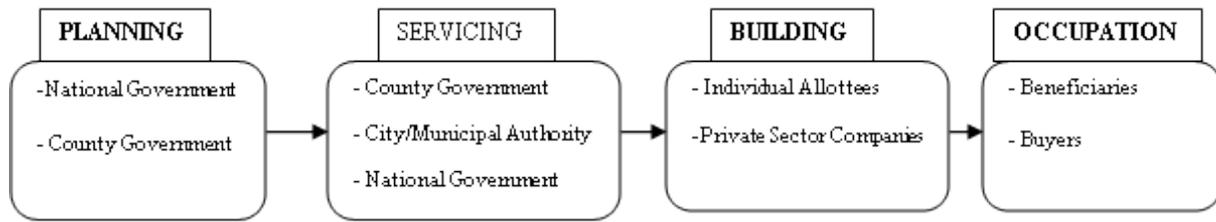


Fig. 4 Illustration of the formal development process in Kisumu city

Source: Authors' construct

The second form of urban development process that prevails in Kisumu city is the informal or organic urban development process. This form of urban development, explored by analyzing the cases of Nyamasaria and Manyatta, traces its origin to colonial period when the settlements were outside the township boundaries (Home, 2012). The emergence of these settlements is tied to the policies of racial exclusion and segregation phenomenon of the colonial of township. Both settlements fall in what was the Kavirondo Native Land Unit, which was created through the Native Trust Lands Ordinance 1930 for the native African population. Land rights within these land units were governed by native law and custom, hence customary law on ownership of land prevailed (Home, 2012).

Since they were originally outside the township boundary, the development process of the two settlements was never a concern for the colonial government. Instead, the initial development of these settlements was superintended by the customary laws. When Kenya gained independence, there was registration of the lands in the native land unit where both Nyamasaria and Manyatta were located. The method of registration involved preparation of a map called Registry Index Map (RIM) in which all the pieces of land in an area were shown and numbered. A registered land owner was issued with a title

deed as a proof of absolute ownership. After the registration, customary law ceased to apply to land in that registered area.

Nyamasaria and Manyatta settlements sprang from the parcels created through adjudication and surveying that were reflected in the RIMs. However, this process of adjudication and surveying without a prepared plan yielded land parcels that had marked disparities in terms of size, shape and arrangement. Because of this, the parcels of land which are considered as plots in these two settlements are arranged in distorted spatial patterns and irregular layouts arising from urban blocks of different sizes and shapes. It should be noted that even after the registration of the land, the owners still retained absolute ownership and any form of development was not subject to urban authority regulations or control. Therefore, control over subsequent land subdivision and construction of buildings within these former native settlements were technically beyond the jurisdiction of the urban authority. Instead, land subdivision for urban development was largely driven and controlled by land owners or developers. Because of this, informal subdivision of land for urban development ensued during the process of development of both Nyamasaria and Manyatta. The informal subdivision led to creation of spatial patterns that are distinctly different with those of regulated subdivisions (figure 5 presents an example).

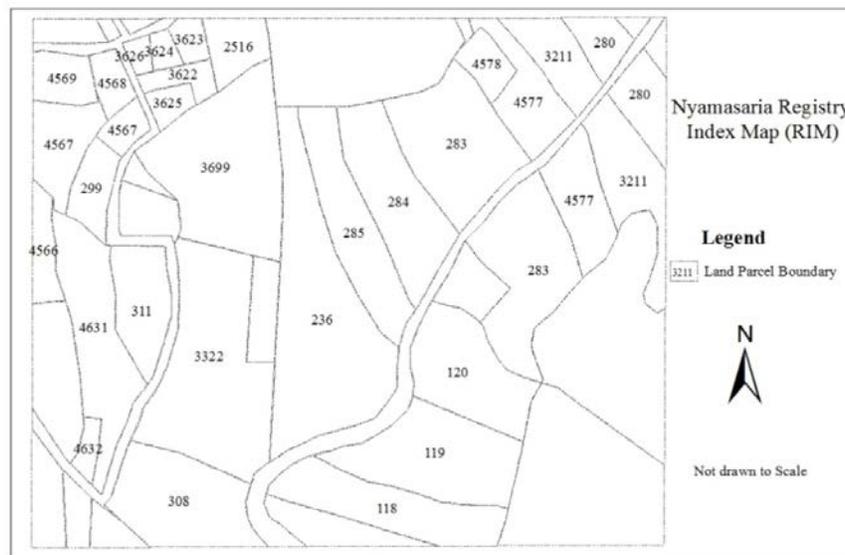


Fig. 5 Copy of the RIM of Nyamasaria showing plots of different shapes and sizes

Source: Kisumu Survey office

The construction of buildings in Nyamasaria and Manyatta took the rural-type build and occupy pathway. The landowners or developers never sought permission from the urban authority before construction, since local physical development plans that specify zoning requirements did not exist. Houses were built mainly through self-construction and in most cases would be done through incremental processes. Once the construction of buildings was done, occupation of the structures that had been built immediately followed. Given that this whole of process of development was largely informal, the occupation of buildings also proceeded informally without any form of authorization. Indeed there were instances where buildings were occupied even before the construction was fully completed. For example, in cases where the construction was incremental, examples abound of occupation preceding completion of the house construction.

After the construction of buildings and occupation had been done, the developers or occupiers informally connected utility services to the existing structures within the settlements. Such processes were organized by the individual households or owners

of the buildings well after the construction and occupation of the building had occurred. This, however, does not apply to all buildings within these settlements. There are some buildings that are not connected to the utilities such as electricity and piped water. These settlements that developed informally may, after sometime, be subjected to upgrading. This is what happened to part of Manyatta settlement. Whenever such process is undertaken, it encompasses further servicing, including provision of roads and drainages among other improvements, a form of what may aptly be referred to as reactionary planning. Nonetheless, such reactionary ‘planning’ did little to address the spatial patterns created by decades of informal development. The development process in Nyamasaria and Manyatta settlements follows the Build-Occupy-(SP) (BO-SP) pathway. This BO-SP pathway produces urban spatial patterns that are typically different from those envisaged in urban planning policy and legislative framework in Kenya. The development process is illustrated in figure 6.

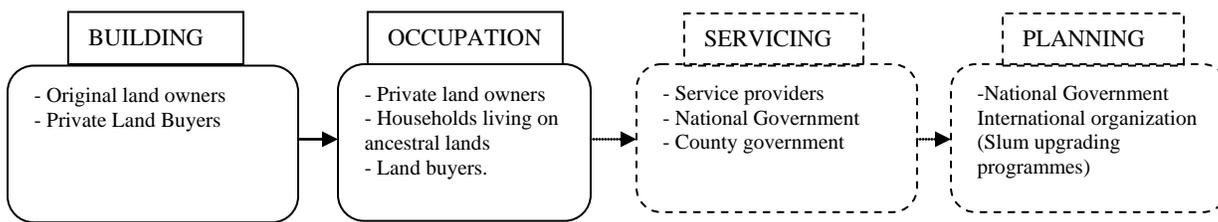


Fig. 6 Illustration of the informal urban development process in Kisumu city
Source: Authors’ construct

5.2 Damages suffered in the past after inundation by floods in the settlements

The study sought to find out if households residing in the three settlements had suffered damages in the past 10 years during a flood event. Floods usually damage buildings through two general mechanisms; structural damages from the force of floodwaters and the unsuitable building materials that are damaged by contact with water. From the household survey, Migosi settlement had no respondent that had suffered total destruction to his/her house during a flood event. Only about 20% of those who had suffered inundation by floods in the past reported to have suffered minor damages to their properties (table 1). Minor damage to house/properties took the form of damage to the household items, as well as parts of the building such as the walls becoming damp and mouldy and wooden doors swelling and refusing to shut.

In Nyamasaria settlement 26% of home-owners living on their ancestral land and 19% home-owners who bought land and built homes had suffered total damage to their houses. Similarly about 3 per cent of the respondents living in rented accommodation reported having suffered total damage to their rented premises within the settlement during a past flood event. Total damage in this case involved major structural damage including washing away of walls resulting in the collapse of the house and complete destruction of the dwelling. The field survey also established that there were other households that had suffered minor damages to their houses/properties during a past

flood event. About 18% of the home-owners who built houses on their ancestral lands reported having suffered minor damages to their houses. Another 12 per cent of home-owners who bought land and built houses responded that they had suffered minor damages to their houses during a past flood event. For the renters, 22% indicated that they had suffered minor damages to the houses and their properties. Minor damages occurred when flood water seeps into the houses through the door causing property damage such as degradation of floors, wall and personal belongings including mattresses and cloths.

In Manyatta, there were no home-owners who reported to have suffered total damage to their house/properties during a past flood event. However, over 62% of them reported to have suffered minor damages to their houses and properties during a past flood event. For those living in rented houses, 1 per cent responded to have suffered total damage to their houses/properties during a flood event in the settlement in the past. This rises to 13% among those living in rented houses in the settlement.

Table 1 Extent of damage during a past flood event

Home-owners										
	Frequency				N	Percentage				
	Never experienced inundation	Inundation with no damages	Minor damage	Total damage		Never experienced inundation	Inundation with no damages	Minor damage	Total damage	
Nyamasaria	00	35	13	11	74	00%	47%	18%	15%	100
Migosi	10	01	00	00	11	91%	09%	00%	00%	100
Manyatta	01	02	05	00	08	12%	25%	63%	00%	100
Renters										
Nyamasaria	07	50	17	02	76	09%	66%	22%	03%	100
Migosi	130	07	02	00	139	94%	05%	01%	00%	100
Manyatta	66	66	19	01	152	43%	43%	13%	01%	100

Source: Field Survey, 2014

5.3 Ordinal Logistic Regression

To determine the prediction of the extent of damage by inundation by floods in the past in the various settlements, ordinal regression was used. The procedure was done through Polytomous Universal Model (PLUM) with extent of damage suffered during a past inundation by flood being the dependent variable and settlement type (Place of Residence - PLAOFRES) being the independent variable. Our interest here was to determine the direction of the relationship between the variable settlement type (PLAOFRES (0) = Formal- Migosi; PLAOFRES (1) = Informal upgraded- Manyatta and PLAOFRES (2) = Informal without intervention- Nyamasaria) and the ordinal nature of the categorical dependent variable (extent of damage by floods in a past event). The table of the model fitting information (table 2) shows the difference between the two log-likelihoods. The chi-square has an observed significance level of less than 0.005 ($\chi^2 = 33.697$, $df = 2$, $p < 0.005$). This means that is possible to conclude that the model without the predictor is not as good as the model with the predictor.

Table 2 Model fitting information for extent of damage and settlement type

Model Fitting Information				
Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	58.826			
Final	25.129	33.697	2	.000

Link function: Logit.

Source: Authors' analysis

The Pseudo R² values (e.g. Nagelkerke = 0.326) (table 3) shows that the independent variable explain a significant portion of the variation in extent of damage by floods in the past. For example, place of residence of households explains about 33% of the variation in extent of damage by floods in the past. The rest is explained by other factors not included in the model.

Table 3 Pseudo R-square table

Pseudo R-Square	
Cox and Snell	.304
Nagelkerke	.326
McFadden	.134

Link function: Logit.

Source: Authors' analysis

The parameter of estimates table (table 4) show that PLAOFRES (0) is a significant predictor of the dependent variable (Wald = 16.680, $df = 1$, $p < 0.001$). The coefficients of the predictors are negative. This means that they are associated with poorer scores on the extent of damage by past flood event. For instance, an increase toward PLAOFRES (0) results in an odd ratio of $\exp(-4.568) = 96.351$ times decrease in odds of being in the higher category of extent of damage by past flood event. Similarly, an increase toward PLAOFRES (1) results in an odd ratio of $\exp(-0.131) = 1.139$ times decrease in odds of being in the higher category of extent of damage by past flood event. In other words, an increase toward place of residence being formal leads to 96.351 times decrease in odds of being in the higher category of extent of damage by past flood event. Nonetheless, an increase in a place of settlement being informal but upgraded result in only 1.139 times decrease in odds of being in the higher category of extent of damage by floods in the past. This suggests that if informal settlement is upgraded then the odds of being in higher category of extent of damage by floods become lower than when there is no intervention in the informal settlement. These results are a clear pointer to the fact that flood damage is not solely a function of rainfall, but is also driven by the settlement which is a product of urban development process. Thus, damages by floods are largely influenced by how a settlement is planned, designed and constructed.

Table 4 Results of the parameter of estimates

	Parameter Estimates							
		Estimate	Std. Error	Wald	df	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
Threshold	[Extent of Damage = 0]	-2.253	.379	35.354	1	.000	-2.996	-1.510
	[Extent of Damage = 1]	-.061	.231	.071	1	.791	-.513	.391
	[Extent of Damage = 2]	1.328	.279	22.582	1	.000	.780	1.875
Location	[PLAOFRES=0]	-4.568	1.118	16.680	1	.000	-6.760	-2.376
	[PLAOFRES=1]	-.131	.680	.037	1	.847	-1.465	1.202
	[PLAOFRES=2]	0 ^a	.	.	0	.	.	.

Link function: Logit.

a. This parameter is set to zero because it is redundant.

Source: Authors' analysis

VI. CONCLUSION

This study has established that there are two parallel development processes operating side by side in Kisumu city. These are the formal or PSBO-led urban development process and the informal or BO-SP-led urban development. Migosi settlement underwent the formal development process which commenced by preparation of a plan. This pre-planned development has worked toward mitigating flood risk because of inherent attributes including the requirement to provide for storm water drains and zoning regulations. While the provision of storm water drains has ensured that floodwater is collected and safely conveyed out of the settlement, the zoning regulations spelt out by the plan assisted in steering development away from potentially hazardous areas. Likewise, since it is a formal settlement, the construction of buildings in Migosi was subjected to the check and permitting system of the urban authority. Such buildings whose construction complied with the building code have in-built resilience and perform better structurally during any flood event. This explains why residents of Migosi do not suffer inundation by floods and the few who are affected by inundations do not suffer damages to their properties.

In contrast, the urban development processes that occurred in Nyamasaria and Manyatta settlements were not based on any prepared physical development plan. Instead, such development sprang from parcels of land created through adjudication and surveying. With the development in these two settlements proceeding without a plan, preventing occupation of unsafe areas has proved to be practically impossible. This, coupled with neglect of floodwater drainage infrastructure, has seen vulnerability to flood risk escalate over time in these settlements. Moreover, the construction of buildings in these two settlements is not necessarily subjected to the check and permitting system of the urban authority. This means that the buildings may not necessarily comply with the requirements of the building code which stipulates building safety standards. The uncontrolled development together with the unregulated constructions combine to make Nyamasaria and Manyatta vulnerable to flood

risk as evidenced by the damages suffered by households during a past flood event.

RECOMMENDATION

This study sought to explore the dual pathways in the process of urban development and their influence on flood damage in Kisumu City. Results confirm that the dual pathways in development processes indeed play a role in creating variations in urban spatial patterns. The areas that underwent formal urban development or PSBO pathway had typically different spatial patterns from the areas that grew organically or underwent BO-led urban development process. This variation in urban spatial patterns has, in turn, engendered disparity in flood damages among various settlements. Whereas, formal settlements are more resilient to flood risk, informal settlements are more vulnerable to flood risk. In view of the foregoing therefore, this study makes the conclusion that urban flood risks are explainable product of failures in urban development in Kisumu city.

Results demonstrate that urban flood risk in Kisumu city is a direct consequence of the use of urban land. Therefore, efforts to reduce the risk must logically occur within the context of land use planning. This study recommends that, as a necessity, urban development policies should address the ongoing informal urban development processes which create perilous urban patterns that increasingly expose the inhabitants to flood risk. Hence, the key elements in the prevention of flood risk are the proper land use planning of the settlements, provision of risk-reducing infrastructure and building control.

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CONFLICT OF INTERESTS

The author declares no conflict of interests.

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