International Journal of Managerial Studies and Research (IJMSR)
Volume 2, Issue 4, May 2014, PP 82-90
ISSN 2349-0330 (Print) & ISSN 2349-0349 (Online)
www.arcjournals.org

Effects of Urban Storm water Management Strategy in Reducing Flooding; a Case of Mombasa

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Abstract: *This paper looks at flooding reduction through effective stormwater management strategy in urban areas. The management of urban stormwater has recently been recognized as a complex problem facing Local Governments and Urban areas all over the world. This has called for a more integrated approach to urban storm water management for urban areas and for all cities. The study was carried out with the main objective of establishing the effects of urban stormwater management strategy in reducing flooding in Mombasa County.*

The challenges faced in urban stormwater management as found out include: inadequate planning in urban communities, Lack of stakeholder's participation and low level of community awareness in urban stormwater management. The data collected was analyzed quantitatively and qualitatively and was used to test the research findings. The results indicated that planning, stakeholders involvement and participation and public awareness and outreach campaigns greatly affects storm water management towards reducing flooding. It can therefore be suggested that from these three outcomes the storm water management may be said to have achieved envisioned and its long term impact of reducing flood risk. It is suggested that enforcement of policy and regulation on planning and development matters be given more attention and a more focused communication strategy need to be developed.

Public outreach and education campaigns further plays a pivotal role as the city management and county government often develop part of their education programs by considering more targeted information on particular topics. It is strongly recommended that an enhanced integrated stormwater management strategy be developed and be put into use for effective stormwater management for Mombasa County.

Keywords: *Storm water management; Integrated approach; Planning, Urban communities; Flooding; Stakeholders participation*

1. INTRODUCTION

Kenya experiences moderate floods every three to four years period .The pattern of floods is driven by weather patterns affecting coastal settlements, urban areas, river valleys, and most Parts of the country. The National Government cannot meet these challenges alone – all levels of government, the community and industry must work together, each contributing where they have the knowledge, experience and resources to do so.

In order to meet these requirements and to improve the overall stormwater management within areas under County control (internally and externally), County's Urban Stormwater Management Strategy need to be in place. The research study was specifically designed for and undertaken in Mombasa County's urban area with the following objectives in mind: to establish the effects of planning urban communities on urban stormwater management, to determine the effects of stakeholder's involvement and participation in urban stormwater management, to establish the effects of citizen public awareness campaign and outreach education in reducing flooding in Mombasa County and her environs. All these will lead to good urban storm water management practices in reducing flooding in Mombasa County. Based upon a review of the literature, this paper focused on the effects of stormwater management strategy in reducing flooding in Mombasa County. Although engineered infrastructure is a necessary component for drainage of urban runoff, non-structural approaches are important complementary measures, Taylor, A(2002). The overall Focus was on actions to prevent and mitigate problems related to flooding, as well as those related to pollution and deterioration of environmental health conditions.

2. THEORETICAL AND CONCEPTUAL FRAMEWORK

The study used a conceptual framework that is based on a synergy of the Piaget's theory of Cognitive development, Functionalism theory and the path goal theory of leadership whose modern development is attributed to Martin Evans and Robert House (1964). in this study the three theories complement each other in establishing the effects of planning, stakeholders participation and public awareness campaigns on Urban Stormwater Management (USWM) in reducing flooding in Mombasa County.

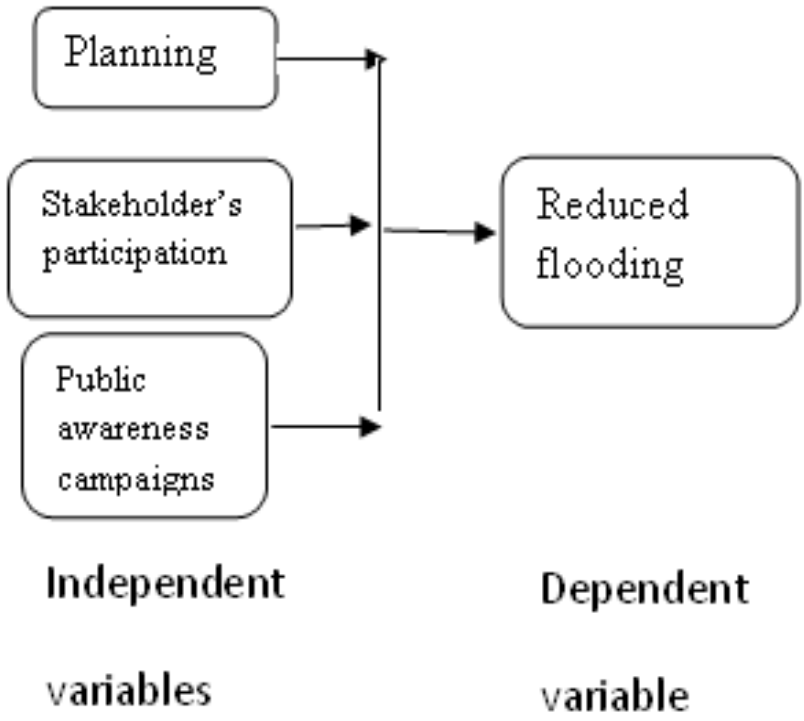

Fig1. *Conceptual Framework.*

3. METHODOLOGY

3.1. Description of the Study Area

The population sample was set of individuals selected from the target population and was intended to represent the population in the research study (Neuman, 2000).

In this case the target population was residents residing in the flood prone areas in Mombasa island (Kizingo, Majengo, Tudor and Shimanzi areas), Mainland north (Nyali, Kisauni, Mushomoroni and Bamburi areas), Mainland West (Changamwe, Kipevu, Magongo and Mikindani) and Mainland South Likoni (Bofu, Timbwani, Kiwirira and Mtongwe areas)

3.2. Sampling

To determine the effects of planning, Stakeholders involvement and participation and public awareness campaign and community education on stormwater management a survey was carried out to achieve the envisaged aims of the study. A total of 2800 respondents were targeted when conducting the research and a sample population of 280 respondents was chosen using area cluster random sampling method.

The instrument used was the questionnaire, where 280 questionnaires were distributed to respondents. This was an easy

4. RESULTS AND DISCUSSION

4.1. Response Rate

The researcher distributed 280 questionnaires to the respondents and received 185 questionnaires providing a response rate of 66%. *(See Table 1 below)*

Table1. *Response Rate*

District /Zone	No. of questionnaires distributed	No. of questionnaires received	Percentage (%)
Mombasa Island	70	52	74%
Kisauni	70	47	67%
Changamwe	70	43	61%
Likoni	70	43	61%
Total	**280**	**185**	

4.2. Summary of the extent to which planning affect urban stormwater management

The respondents were asked to indicate the extent to which planning affect stormwater management. Forty nine percent of those who responded reported very high extent, thirty four percent high extent while six percent indicated low extent. Four percent of the respondents reported very low extent and twelve percent did not respond (*Figure 2 below*).

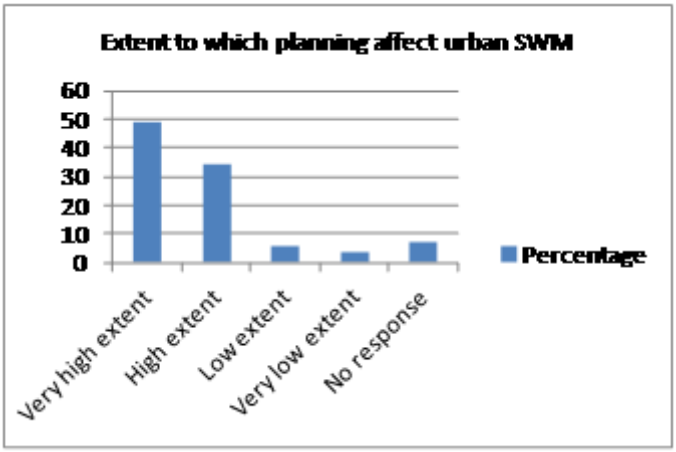

Fig2. *Extent to which planning affect stormwater management*

49% of the respondents agreed that planning to a very high extent plays a role in stormwater management while 34% agree to a high extent towards the same variable. A total of 11 respondents (6%) indicated low extend while 4% of the total respondents reported very low extent. Several respondents who did not know whether or not planning affect wrote no comments. These respondents represent areas where planning has been done and drainage infrastructure put in place.

This shows that the city management should make a concerted effort to increase the area coverage of this variable considerably. Currently the area coverage in terms of planning and stormwater management strategies for Mombasa County is slightly above 30%. This can be achieved by increasing public awareness and enforcing planning regulations and bylaws on land use planning within the County.

4.3. Summary of the Effects of Planning Urban Communities in SWDM Findings

Respondents were asked to report on the effects of planning of urban communities on stormwater management as regards to reduction of flooding. From the results obtained twenty eight percent (28%) reported that it led to reduced flooding and Nineteen (19) percent reported that planning resulted to improved stormwater drainage facilities. Seventeen percent (17%) of the respondents reported that planning leads to reduced informal settlements hence reduced flooding.

Nineteen percent (19%) of the respondents reported that planning of urban communities lead to reduced flooding risks while five percent (5%) indicated that planning urban communities lead to controlled encroachment of riparian wayleaves. About four (4%) of the respondents reported that

planning makes drainage maintenance easier while 10 % either did not respond or had no idea about the effect *(See Table 2 below)*

Table 2. *Effects of planning of urban communities on SWM*

What are the effects of planning of urban Communities on storm water Management?	**n**	**%**
Reduced surface runoff	51	28%
Improved storm water drainage facilities	35	19%
Reduced informal settlements	31	17%
Reduced flooding risks	32	17%
Controlled encroachment of way leaves	10	5%
Planned areas easien SWD maintenance	7	4%
Don't know/No response	19	10%
Total	185	100%

4.4. Summary of the Effects of Implementing the Land use Planning Policies and Regulations on SWM Findings

A total of 185 respondents who participated in the study, 33% reported that informal settlements(slums) are reduced as a result of implementing land use policies and regulations while 39% indicated unplanned developments are avoided.10% of the respondents reported that it led to reduction of ignorance of building by laws and regulations, while 5% indicated that it makes residents and stakeholders adhere to policies and regulations. A significant percentage of 13% either did not know the effects or did not respond to thei particular variable *(Table 3)*

Table3. *Effects of implementing the land use planning policies and regulations on stormwater management*

What are the effects implementing the landuse Planning in storm water Management?	**n**	**%**
Informal settlement reduced	61	33%
Unplanned development avoided	73	39%
Ignorance of building bylaws and regulations reduced	18	10%
Planning policies and regulations are adhered to	9	5%
No response	24	13%
Total	185	100%

4.5. Summary of effects of Stakeholders involvement in SWDM findings

From the survey study a total of 185 respondents indicated various effects that stake holders involvement creates when dealing with stormwater drainage systems. The majority of these respondents (31%) indicated it enhanced stormwater drains maintenance and 22 % reported it created a sense of ownership of the stormwater drainage systems to the stakeholders while seventeen percent of the respondents indicated that stakeholder's involvement create awareness of warning signs in flooding event and the same percentage of the respondents reported it led to proper solid waste disposal. 11% of the respondents reported that it reduce flood associated risks and a small percentage of 2% did not respond or did not know the effects *(See Table 4below)*

Table4. *Effects of stakeholder's involvement in urban Stormwater management*

What are the Effects of Stakeholder's Involvement in SWDM?	**N**	**%**
Proper Solid Waste Disposal	31	17%
Sense Of Ownership	40	22%
Maintenance Of Drains Enhanced	58	31%
Creat Awareness Of Warning Signs Of Flooding	32	17%
Reduced Flooding Risks	21	11%
No Response	3	2%
Total	185	100%

4.6. Effects of Stakeholder's Awareness Campaigns and Education on SWDM

The majority of the respondents (32%) indicated that stakeholder's awareness campaigns and education reduced encroachment on stormwater drains, while 23% of the respondents indicated that it led to proper solid waste disposal and participation resulted to protected drainage infrastructure due to a sense of ownership created to the stakeholders. 13% of the respondents indicated that it lead to the public being sensitized on flooding risks. The rest of the respondents out of the 185 respondents reported that the community was made aware of warning signs in case of a flood disaster event *(Table 5 below).*

Table5. *Effects of stakeholder's awareness campaigns and education on urban SWM*

Effects of stakeholder's awareness campaigns and education on urban SWDM	**n**	**%**
Solid waste properly disposed	36	23%
Reduced encroachment on stormwater drains	51	32%
Protected drainage infrastructure due to sense of ownership	36	23%
Public sensitised on flooding risks	21	13%
Community made aware of warning signs	16	10%
Total	185	100%

To achieve effective, meaningful participation, it is important to implement a well-defined, transparent, strategic approach.

Different stakeholder groups have different needs and requirements, based on their areas of interests, respective roles and responsibilities. There are various participation methods with varying degrees of stakeholder involvement: provision of information, public hearings, consultations, collaboration in decision-making and delegation of responsibilities

4.7. Need for stormwater management strategy in your Community/organization

In this particular survey respondents were asked to rate the public's perception of the need for a stormwater management strategy in their community/organizations. Of the 185 respondents 61% indicated that it was very needed while 21% indicated it was needed for effective stormwater management. Six percent of the respondents indicated that the strategy is slightly needed and

Three percent were undecided. 9% of the 185 respondents they did not respond to that particular question due to one reason or another (Figure 4).

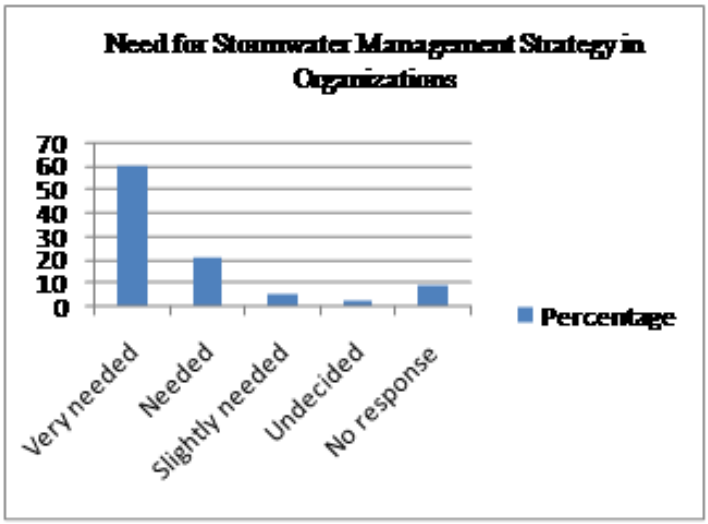

Fig4..*Need for Stormwater Management Strategy in Organizations*

Previous studies have revealed that it is of paramount importance to have a stormwater management strategy especially in urban communities. A vast majority of the respondents of 61% of the total respondents reported that stormwater management is very needed in their organizations/communities and 18% of the respondents reported either slightly needed, or did not respond all together. The general revelation is that there is every reason to have a stormwater drainage management strategy properly documented with proper and detailed work plans procedures and strategies to be adapted by the County.

5. CONCLUSION

Urban flooding presents one of the major challenges of Kenya urban areas and cities. Going by the possible changes in the nature of extra ordinary events resulting from the climate change (Kharin & Zwiers, 000; Masden & Figdor, 2007; prodanovic & Simonovic, 2007), together with increasing development and deteriorating infrastructure, urban flooding continue to increase as a thread to well being of residents. While addressing planning and infrastructure issues as an important means of reducing urban flood risk, Stakeholders involvement and participation also play a considerable role in urban stormwater management in flood reduction. Public outreach and education campaigns further plays a pivotal role as the city management and county government often develop part of their education programs by considering more targeted information on particular topics. Thus understanding the effects of stormwater management strategy in reducing flooding in urban communities is an important component of effective urban flood management.

The results of this survey indicated that planning greatly affect stormwater management in reducing flooding in Mombasa county. But the actual compliance to planning regulations and bylaws poses a big challenge to city and Mombasa county managements. To enforce existing land-use regulations, the administrator of a floodplain or city management/county government requires a series of legal powers. Land-use regulations or zoning ordinances usually provide such powers to administrators using various means of enforcement.

Public participation in government planning activities can assist governments both national and local in increasing public support for decision making and policy initiatives and increase the ability of decision makers to identify potential conflicts in policy and decision making process(Healey, 1992; Innes & Booher, 1999). Further, effective participation can increase the legitimacy of, and reduce cynicism about government initiatives (Forester, 2006). Thus, there is no doubt that public engagement is an important part of stormwater drainage management and more inclusive approaches need to be developed not only for Mombasa county but for other counties, cities and urban areas as well.

6. RECOMMENDATIONS

The results of this survey indicate that planning greatly affect stormwater management in reducing flooding in Mombasa county. But the actual compliance to planning regulations and bylaws poses a big challenge to city and Mombasa county managements. To enforce existing land-use regulations, the administrator of a floodplain or city management/county government requires a series of legal powers. Land-use regulations or zoning ordinances usually provide such powers to administrators using various means of enforcement. Arising from this study it is strongly recommended that Mombasa county government legislate the necessary bylaws, regulations and policies and back the same with the necessary enforcement to make the stormwater drainage management strategy more effective.

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Reflecting on previous studies, there appears to be a significant opportunity to increase awareness and mitigative behavior of residents in Mombasa County. Although the Mombasa city and lately the Mombasa county government has been relatively aggressive in the communication of stormwater drainage management (including public consultative forums and mass media), actual use of the city information was surprisingly low. The use of this information in practice and increasing the educational content and coverage relating to flood reduction may be a concern to the city and county government of Mombasa and the country at large.

This result of this survey provides a "snap- shot" of resident perceptions and behaviours. A similar survey and survey administration procedure if applied in future would provide an indication of the changing levels of the effects of public education and awareness campaign on stormwater drainage management. A similar survey can be done under same conditions in future to investigate the effectiveness of Mombasa county government education programms over a period of time.

The Mombasa County Government and Mombasa city need to coordinate all the County's activities related to stormwater management, as well as ensure best stormwater management is practised by all internal and external stakeholders. These issues and the requirement for improved and integrated stormwater management strategy should be incorporated and addressed in various pieces of State legislation and strategies including the County Integrated Development Plan (CIDP) for Mombasa County.

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