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ASSESSMENT OF SOCIO–ECONOMIC EFFECTS OF STORM WATER MANAGEMENT CHALLENGES IN ONGATA RONGAI

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Abstract: Storm water management is a big problem globally, with developing countries receiving further complications due to global warming. In Africa, and particularly in Kenya, urban planning for many developments is carried out without the involvement of experts. One of the negative consequences is poor drainage, which causes negative effects on socio-economic activities of the residents. In Ongata Rongai, Kajiado County, in Kenya, heavy rainfall floods the settlements with manifold effects; sanitation and other negative economic and environmental effects. This project investigated and assessed mainly the effects associated with poor storm water management in Ongata Rongai town, specifically assessing the socio-economic effects of storm water management challenges. Survey research design was adopted where a structured questionnaire that targeted a population of 2000 households in Laiser Hill sub-location was used. Three spatial clusters of households were done depending on their residential and commercial characteristics to arrive at sample size of 90. Quantitative primary data collected from households was analyzed using descriptive statistics and inferential statistics to test hypotheses. The study found out that socio-economic challenges are enormous as a result of poor storm water management in the town. This is further complicated by lack of established sewerage system to dispose septic tank contents and inadequate storm drains. A prolonged surface run off due to heavy rains in most cases seep into business premises destroying goods and blocking customer access, hence business closure. Storm water-related diseases have high case recordings at the area's government dispensary have also affected the town's economy negatively.

Key words: Environment, storm water, management, Effects, Socio–economic
Research Area: Social Science
Paper Type: Research Paper

1. INTRODUCTION

Urban storm water management is a topic that is becoming increasingly important for urban developers globally, with the extent of the issue becoming particularly apparent when there is heavy rainfall that floods settlements situated in the lowest parts of towns and the large number of urban structures. Storm water runoff after a rainfall or snowmelt incident is a natural process but in urban areas, due to anthropogenic impacts of a changing landscape, this is not the case (Ferguson, 1998).With the growth of towns, storm water management has become more and more complicated, especially in developing countries. This is characterized by urban population explosion over a short period of time, unplanned urban development patterns, severe poverty amongst some of the urban population, resulting in environmental problems (Novatech, 2007). These towns are faced with complete absence or inadequate sewer systems both in coverage and in performance especially because of inadequate waste management

strategies. Unplanned urban development patterns constitute a major obstacle to effective urban drainage. Flood plains and flood-prone areas are occupied either legally or illegally for the purposes of human settlement and business activities. The county authorities quite often lack the skilled manpower and budget to cope with the magnitude of the problem. It also lacks commitment, awareness and good organization which does need considerable amounts of money (Novatech, 2007).

Ongata Rongai town, a commercial centre in Kajiado, one of the 47 counties in Kenya, is a fast growing town with an annual growth rate of 28%. It has a 2015 population projection of 52,513 people (GOK: Kajiado County Development Profile, Ministry of Devolution and Planning May, 2013, pg11), however, according to the 2009 population census, Rongai has a population of 41000 people. The township also experiences high amount of rainfall annually, 844mm although with a lot of variability over the year (Kenya Meteorological Services, 2014).This generates a lot of runoff within the town and its environs. This situation is further compounded by the black cotton soils in the area which hardly drains water easily (Mulwa et al, 2005). Its storm water drainage system is inadequate and in a poor state. Sewage and wastewater systems do not exist and therefore residents use septic tanks to dispose their sewerage and waste water. These contents are in most cases released into open storm water drainage systems during the rainy season. This poses serious socio–economic and environmental problems to the residents and the animals living around these areas with the ministry of Public Health and Sanitation having recorded complaints from residents living downstream that their animals are dying of diseases from poisonous liquids upstream (The Sojourner, 2014 and The District Public Health, 2014 reports). Solid waste disposal points are inadequate thus; garbage is collected from residents and is then dumped on the roadside in the existing storm water drains blocking them leading to overflow of storm water. This overflow drains into residential areas, people's business premises and to the access roads making them impassable. The soaked garbage is mashed and rots releasing a bad smell and becoming a breeding ground for mosquitoes and flies, leading to disease outbreaks. This is a serious public health hazard that warrants urgent consideration.

Ongata Rongai is a town of high economic activity and is considered to be one of the four metropolitan towns in the process of expanding Nairobi City towards achieving vision 2030 (Nairobi Metro 2030: A world Class African Metropolis, 2008). The town is densely populated with business buildings and residential estates on either sides of the Magadi road, which crosses the town. These premises are challenged by the poor storm water management. Global climate change has affected weather events including rainfall patterns so that there are unpredictable seasons and rainfall intensity which cause flooding and their ultimate effects. This calls for investigation into effective storm water management practices that are resilient and adaptive to the changing climate especially in dealing with urban storm water runoffs (MOE, 2010).

Table 1: A comparison of mean, maximum, and minimum rainfall values between Ngong and Wilson stations from 1984 - 1993

Rainfall Variables		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Mean	Wilson Station	61.9	31.02	88.8	214.9	122.1	33.8	24.3	10.1	10.9	39.6	110.5	99.4
	Ngong Station	70.9	59.3	77.9	189.7	148	26.5	20.7	13.7	17.9	32.9	70.1	71.8
Max	Wilson Station	270.4	104	271	414.6	300.1	103.6	88.1	22.4	30.2	144.8	157.3	201.4
	Ngong Station	186.8	177.5	229.9	389.6	231.8	58.1	33	47	56.1	86.5	114.5	146
Min	Wilson Station	0	0	5.3	9.6	1.6	2.8	0	1	0	1.9	66.7	25.8
	Ngong Station	3.6	12	14.1	2.1	58.4	2.2	0	0	0	0	42.2	20.2

Source: *Kenya Meteorological Services, 2014*

2. MATERIALS AND METHODS

This Paper draws on research conducted to investigate the environmental challenges and effects associated with storm water management in Ongata Rongai urban centre focusing on the assessment of the socio-economic effects of storm water management challenges in the town. It utilized a survey design with descriptive and inferential methods of data analysis. A survey design was found to facilitate the collection of requisite data from primary sources using standardized questionnaires, personal observations and secondary sources from both published and unpublished sources. The study narrowed down to the target population of estimated 2000 households in Laiser Hill sub location which is mostly affected by storm water. The use of households was adopted from Nyariki (2009). The estimated population of 2000 households were grouped spatially into three clusters depending on their commercial and residential characteristics. The three clusters are, A (commercial cluster) of approximately 700 households and B (Transition cluster between the commercial and the residential population of the study area), also ranging from 700 households was considered densely populated and cluster C (more Residential cluster) of approximately 600 households.

The sample size formula of Freund and Williams (1983) was applied to arrive at the sample size.

$n = \frac{(p(1-p)z^2}{\text{ME}}$(Freund and Williams, 1983) ……Equation 1

Where:

- ME is the desired margin of error 9.7%
- *z* is the z-score, e.g. 1.96 for a 95% confidence interval,
- *p* is our prior judgment of the correct value of *p* 30% of the households
- *n* is the sample size established using the formula

$n = 1.96^2 \times (0.7 \times 0.3) / 0.097^2 = 89.7$

Using this formula, the sample size (n) covered in Laiser Hill sub location was established as 89.7, which was rounded off to 90 households.

A list of households obtained from the location administrative chief was used to randomly select the 90 households sample from the three clusters where adults of above 18 years were sampled. From Cluster A and B 35 households were picked because of their high population density while cluster C zone of low population density, 20 households were picked. After the first household was randomly picked from each cluster, the rest were systematically picked after the 15th household until all the required number from each cluster was attained.

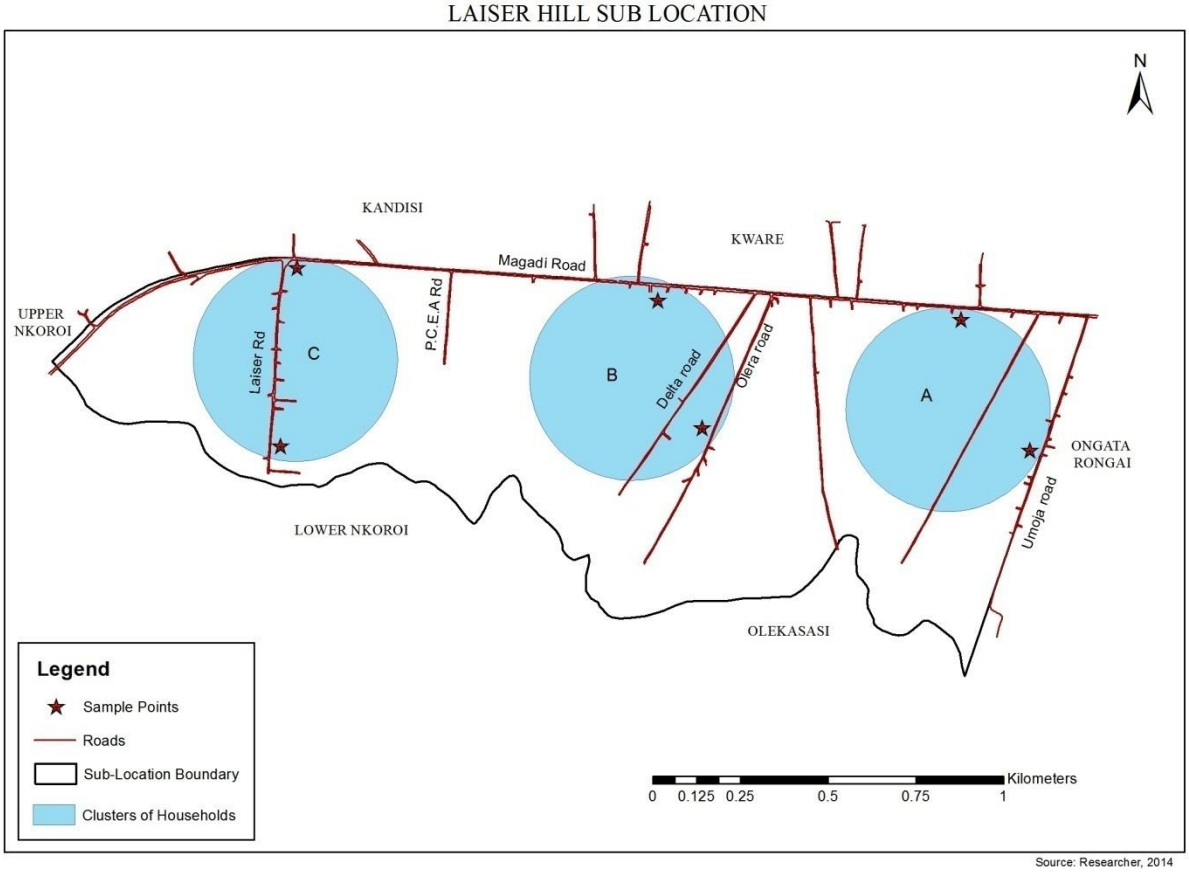


Figure 1: Clustered points in the study area

The quantitative data obtained from the field was subjected to processing and analyzing using descriptive and inferential statistics with the help of Statistical Package for Social Sciences (SPSS) tool.

Study Area: The study was conducted in Ongata Rongai, Kajiado County, Kenya.

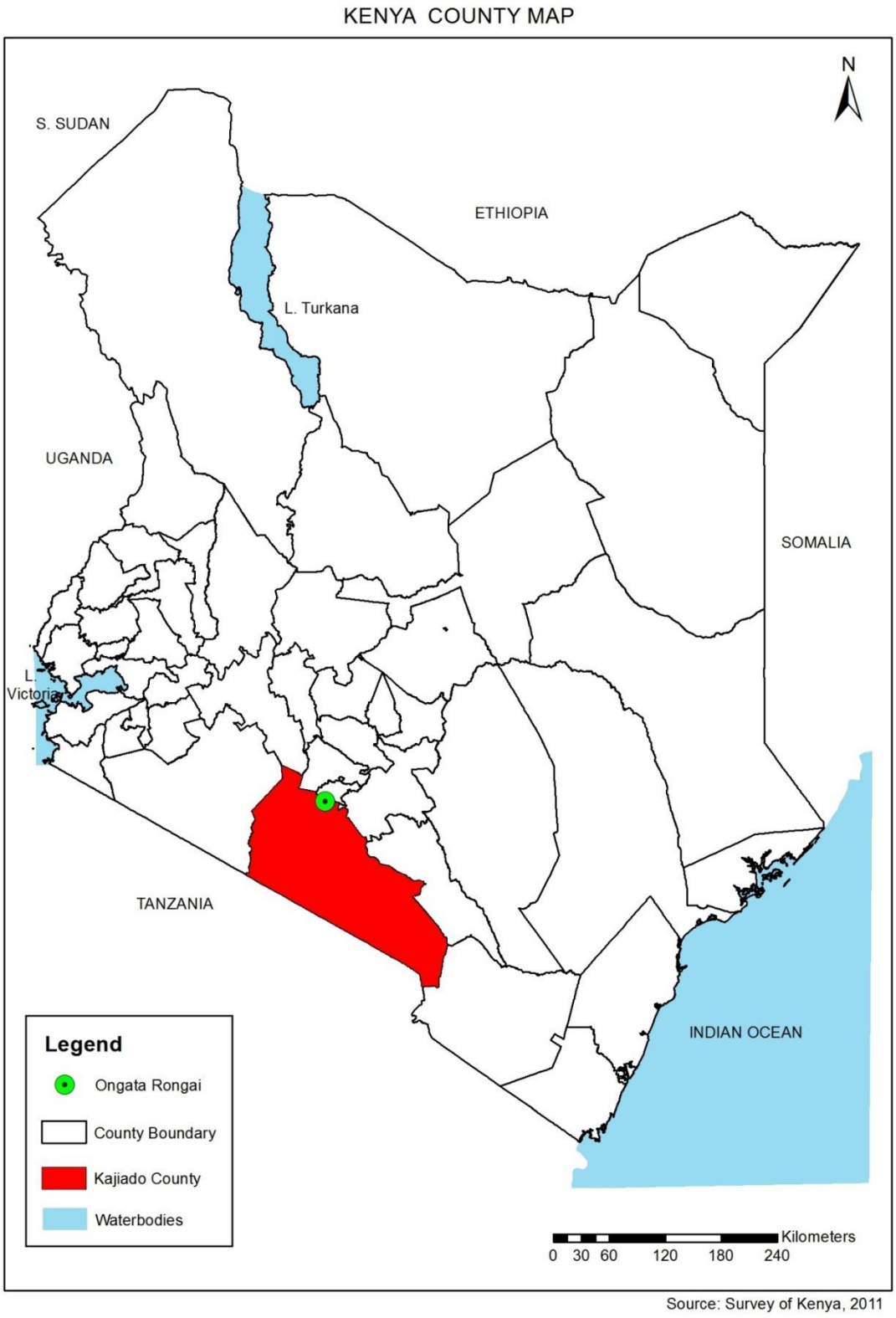
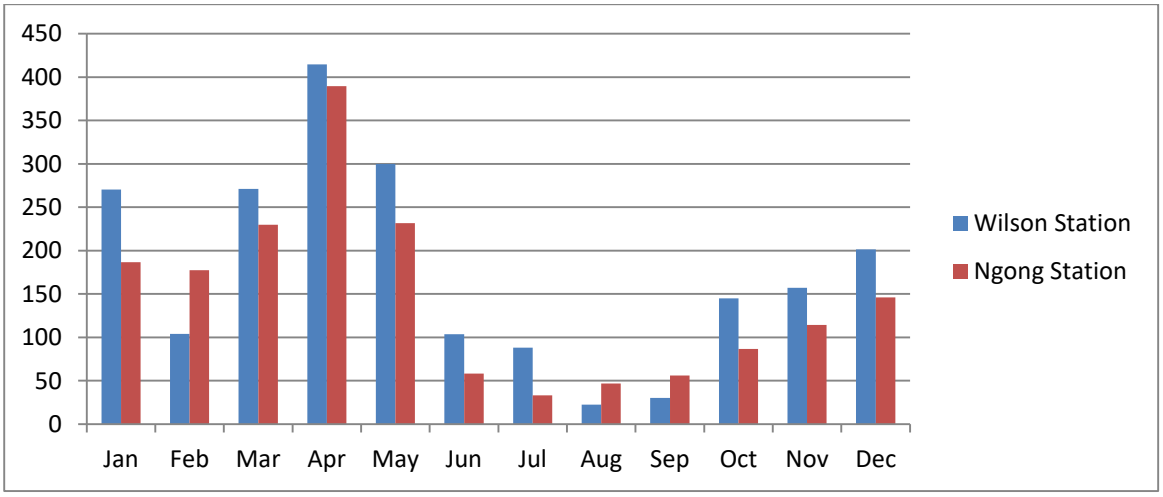


Figure 2: Location of Ongata Rongai in Kajiado County, in Kenya

3. RESULTS AND DISCUSSION

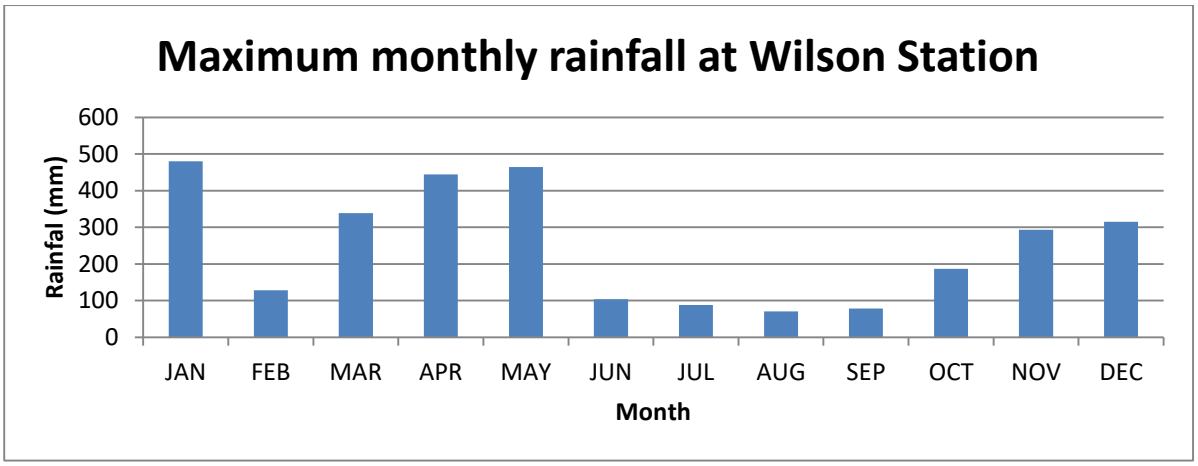
The data of the rainfall believed to generate runoff in this town was collected from two rainfall gauging stations in the area. The processed data generated a rainfall pattern that exhibits a bimodal distribution in the two rainfall gauging stations with maximum rainfall of over 30 mm throughout the year. The wet seasons are between March and May (long seasons) and between October and December (short seasons) for both stations. It is clear that the Wilson's station receives slightly higher rainfall than the Ngong' D.O.S office meteorological stations. The intensity of the runoff generated is what triggers the socio-economic challenges experienced due to poor storm water management. Some of these challenges include flooding of business premises and residential, environmental pollution due to poor sewage disposal, water borne diseases and damage to infrastructure. Flooded business premises and residential usually leads to business closure during the rainy seasons thus low income.

Figure 3: Comparison of maximum monthly rainfall between Ngong' and Wilson Stations from 1984-1993



Source: *Kenya meteorological services, 2014*

Figure 4: Maximum monthly rainfall at Wilson's station between 1980 and 2013

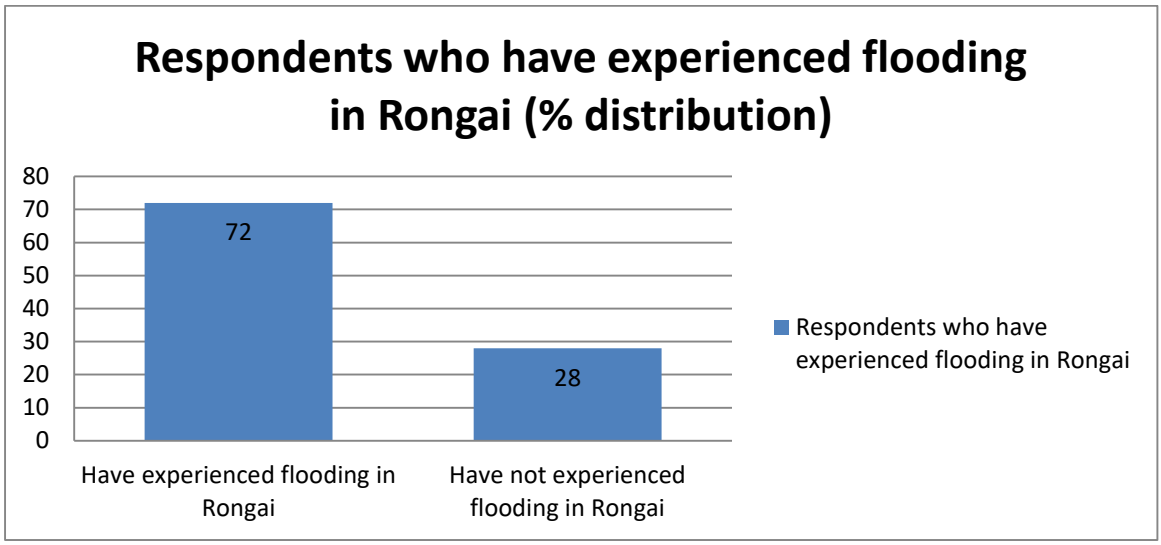


Source: *Kenya Meteorological Services, 2014*

The rainfall data from the Wilsons station was available from 1980 - 2013 unlike from Ngong station which was available from 1984 – 1993. This data shows two distinct rainfall seasons long (between March and May) and short (between October and December) seasons experienced in the study area. There is rainfall throughout the year though with variability and this explains the flooding experienced in the study area which has magnified socio-economic challenges in the town during these seasons.

An Investigation of Flooding experience in Ongata Rongai

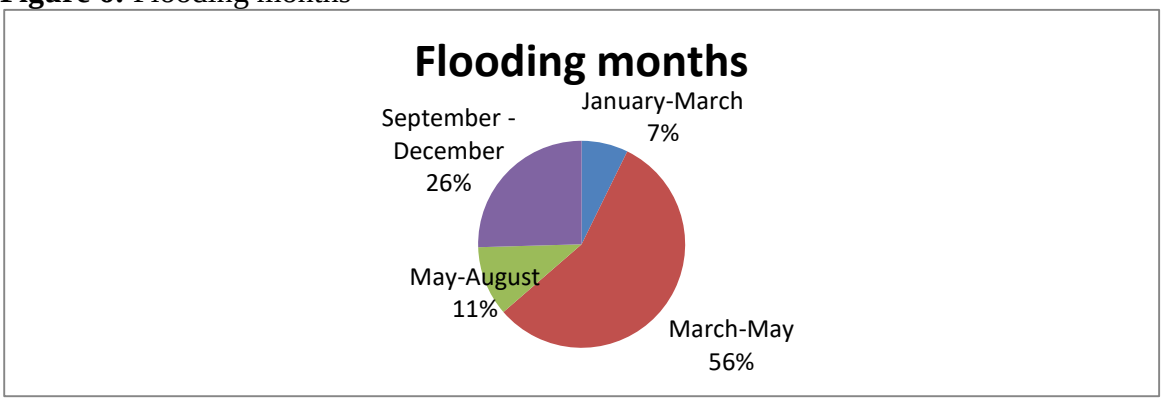
Figure 5: Maximum monthly rainfall at Wilson's station between 1980 and 2013



Source: *Researcher (2014)*

Responses of the occurrence and frequencies of flooding experiences in the town indicates that majority of the respondents have experienced flooding in the area with 72% indicating that they witness flooding twice in a year. This tallies with the meteorological report of annual high rainfall of 844 mm in figures 3 and 4 which shows that there is a bimodal rainfall pattern in the area. The black cotton soils in Ongata Rongai that poorly drain water and also the location of the town in upper Kajiado plains within the Athi drainage basin has further complicated the flow of storm water runoff thus the subsequent socio-economic effects experienced in the area as a result of improper handling of the heavy run off. The 28% who have not experienced flooding in Ongata Rongai as indicated in figure 5 could be visitors or newer comers who have been residents for less than a year.

Figure 6: Flooding months



Source: *Researcher, 2014*

A comparison of the flooding months indicated that 56% of the respondents usually experience flooding in the period between March and May, while 26% of the respondents usually experience flooding in the period between October and December. This coincides with the long and the short rainy seasons respectively. The respondents further indicated that these two periods always record the worst flooding months in Ongata Rongai. These results agree with the monthly rainfall data of Ongata Rongai, obtained from the Ngong' and Wilson Meteorology stations as seen in figures 3 and 4.

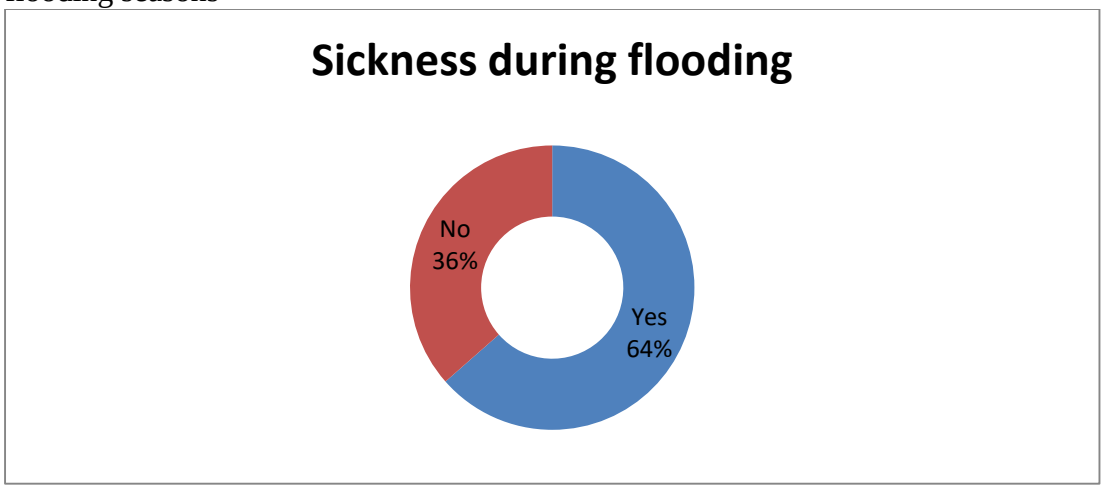
Socio–Economic Effects of Storm Water Management in Ongata Rongai Town

Respondents reported that the resulting huge run off accelerated a good number of negative impacts such as flooding of residential and business premises, making them inaccessible to both tenants and clients, many storm water-related illnesses, damage to infrastructure and impassable roads. These in turn cause adverse socio-economic effects, including straining meagre resources when a family member needs medical attention.

Sicknesses Associated With Storm Water Management

The survey indicates that respondents have fallen sick or have witnessed a household member falling sick during flooding seasons and this is presented as follows:

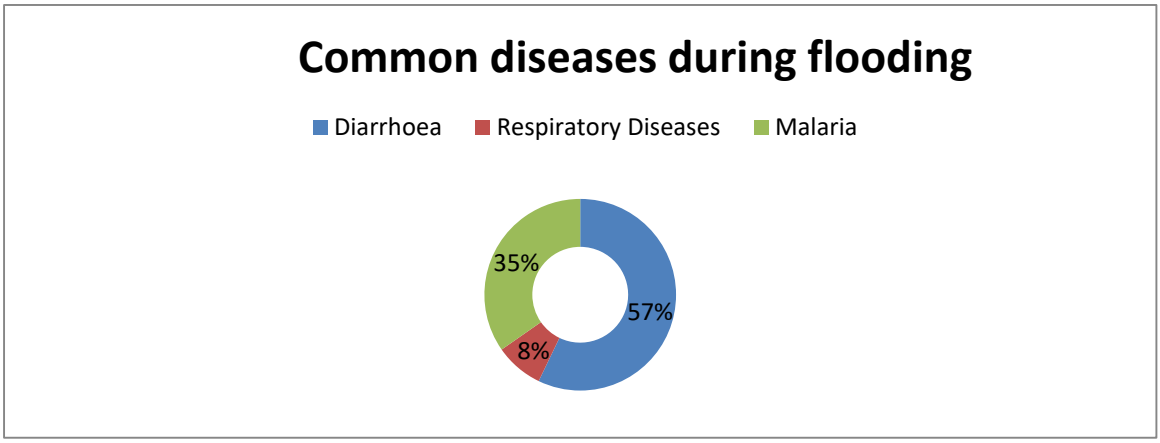
Figure 7: An investigation into whether the respondents or any member fall sick during flooding seasons



Source: *Researcher, 2014*

Majority of the respondents indicated that they have experienced sickness or seen a member of their household fall sick during the flooding season. Up to 64% of the residents answered this in the affirmative. This implies that at least during the rainy season there is at least member of the household who falls sick and this indicates a serious social problem which needs to be contained. Sickness due to water borne diseases is stated to be among the major socio economic effects of storm water management challenges in the study area.

Figure 8: Common diseases during flooding seasons

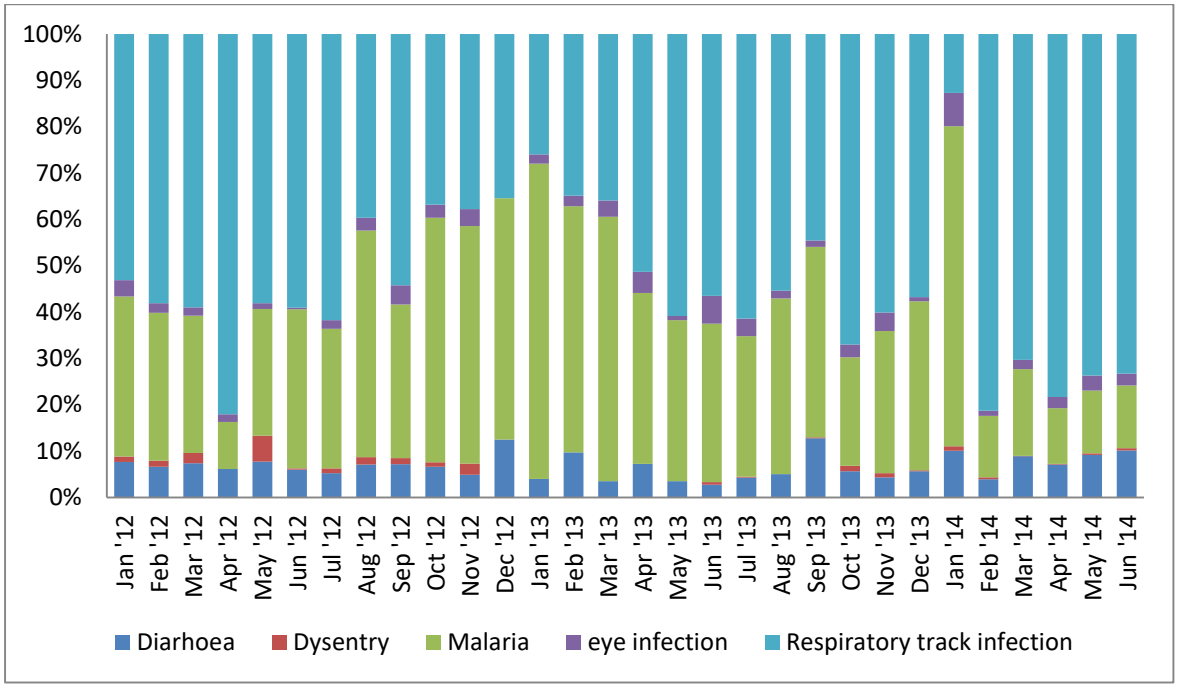


Source: *Researcher, 2014*

Ratings of common diseases during the rainy season indicated that malaria and diarrhea are the most common diseases that affect respondents and members of their households during the flooding months at 35% and 57% respectively as shown in figure 8. This is also given in figure 9 that shows the health records data of diseases common during the rainy season in Ongata Rongai between 2012 and 2014. When it rains, surface runoff and floods distributes microbes by transporting it in the surrounding residential and business premises. This is even worse when there is no adequate and proper storm water drains as is the case in Ongata Rongai town.

Hospital records were obtained from the area dispensary. These records were used to generate the data of the common diseases that the area residents suffer from and this was presented as below:

Figure 9: Secondary records from Saitoti dispensary (Mbagathi), Ongata Rongai, for diseases related to storm water between 2012 and 2014



Source: *(Ongata Rongai Saitoti (Mbagathi) dispensary, 2014*

Figure 9 shows results of the secondary data of common diseases during the rainy season received from Ongata Rongai Saitoti (Mbagathi) dispensary. The results shows the percentage number of cases recorded per month of common diseases associated with storm water management challenges, including respiratory tract infection, eye infection, malaria, and diarrhea. From the results, malaria, respiratory tract infection and diarrhea are the most common illnesses in the area. The results also show that these illnesses have high recordings during the flooding months or the rainy seasons with diarrhea and dysentery among the highly recorded* cases of storm water related illnesses. In as much as the precursor to sicknesses is poor sanitation and other immune factors, poor storm water management is also a contributing factor as the runoff from the storm water accelerates the spread of pathogenic microbes during the rainy seasons.

Effects Of Heavy Surface Run Off On Businesses Road Infrastructure And Traffic

Heavy downpour in the town affects business activities in many ways. Water flooding business premises and residential buildings makes them inaccessible, destroys goods, make services inaccessible, and in some cases business are forced to close down, hence affecting the incomes of the owners and employees of the affected businesses.

Table 2: Summary of the responses of social economic effects of storm water management challenges on businesses, road infrastructure and traffic.

	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree	Binary scale	
						No	Yes
Traffic jam	5	8	8	26	53	13	79
Stalled vehicles	3	11	19	27	40	13	67
Sewage disposal in storm water runoffs	4	7	12	32	43	11	75
Flooding	8	7	10	35	39	15	74
Business closure	12	15	18	24	31	27	55
Sickness	7	8	8	22	55	15	77
Inability to go to work	12	10	20	27	31	22	58
Reduced income	11	5	8	30	46	16	76
Low Customer turnout	10	3	10	23	55	13	78
Destruction of goods and properties	11	10	11	27	42	21	69

SOURCE: *RESEARCHER, 2014*

An assessment of whether storm water management challenges affect the social economic development of the study area was conducted. A summary of the investigation of the socio-economic effects of storm water and from binary scale results indicate that a majority of the respondents agree that storm water management challenges lead to increased traffic jams, stalling of vehicles, mixing of sewage with storm water runoffs, flooding, business closures, sickness, joblessness, reduced income, low turnout of customers, and destruction of goods and properties. However, the proportion of the respondents who agreed that storm water management challenges leads to business closure and inability to go to work was relatively weak, at 54% and 58% respectively as compared to other said economic parameters that turned between 67% – 79%. This could probably be because of the typical youthful population in the town who are determined and are aggressive in attempting to make a living despite all odds, including flooding. From the results, most of the respondents believe that storm water management challenges affect their social and economic aspects of life as given in Table 2.

The Social-Economic Effect Of Sicknesses Resulting From Flooding

Sicknesses resulting from flooding also affect residents' socio-economic life significantly.
Table 3: Summary of the responses of the social economic effect of sicknesses resulting from flooding

	Binary scale	
	Yes	No
Lost employment	47	53
Stopped going to school	79	21
Income reduced significantly	77	23
Business closed	57	43

Source: *Researcher, 2014*

Sickness affects somebody's mobility as well as activities to be carried out; loss of employment due to prolonged sickness, loss of schooling hours, significant reduction of income and business closure are among the responses given by the respondents as shown in table 3. When one is sick their daily chores is affected and in more severe cases one is forced to look for finance to meet hospital bills.

4. CONCLUSION

This case study has established that sewer, waste water, and storm water drainages are a huge problem. These have resulted in serious socio-economic challenges in in Ongata Rongai. A lack of established sewerage system is the ultimate cause of poor sewage disposal experienced in the area as the residents have to resort to the unreliable use of sewer exhaust services to dispose sewage once septic tanks are full. This is supported by significant levels of bacteria isolated from storm water sampled from storm drains. Blocked storm water drainages, poor planning of the town, and failure by the county government to properly implement water Policies are among storm water management challenges experienced in the study area.

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