

**IMPACT OF POOR WASTE MANAGEMENT ON BREEDING OF
Aedes MOSQUITO:
MOROTO SLUM, MOMBASA COUNTY**



Presented by:

Aarohi Choubey

Zahia Omar Abdalla

Rahini Dharendra Halai



Shree Swaminarayan Academy
Teach Through Expounding of Themes

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SUMMARY

Mombasa, the second-largest city in Kenya, is experiencing rapid population growth, leading to an increase in slum areas. Tudor Moroto Slum, located strategically within Mombasa Island, is one of the largest and fast-growing slums in the city, which has resulted in major environmental challenges such as poor waste management, shortage of water, and poor sanitation. This increase in population has contributed to the encroachment into the shoreline, with extensive growth of shanty structures. This study was aimed to evaluate the effects of poor waste management on the breeding of mosquitoes in the area, identify the species of mosquito and investigate their effect on the population of Tudor Moroto slum. The study found that *Aedes* mosquitoes largely breed in the waste found in Tudor Moroto Slum and that there were 145 positive cases of dengue fever recorded between January 2022 and February 2023. The study's results will contribute to the understanding of mosquito species within the area and the pathogens they may carry and inform the local community and government when an outbreak of diseases is likely to occur and the most effective control measures. The study recommends that the County Government in collaboration with the local community should come up with a sustainable waste management system, policies that regulate the use and disposal of single-use plastic bottles and containers, create industries that will help in reusing, recycling and reducing plastics, carry out awareness campaigns, and improve environmental management, including developing better drainage and sanitation systems in the slum area to help reduce mosquito breeding sites.

Key words: *dengue fever, Aedes mosquito*

RESEARCH QUESTIONS

1. Is there evidence of poor waste management within Tudor Moroto slum?
2. How does poor waste management contribute to the breeding of mosquitoes within Tudor Moroto Slum?
3. What are the species of mosquitoes prevalent in the slum?
4. Are there any reported cases of dengue and chikungunya in Tudor Moroto slums?

LITERATURE REVIEW

Introduction

Waste management is one of the greatest problems in the world today. More than 2 billion tons of solid waste are produced annually. As a matter of fact, it is one of the key contributors to climate change and environmental pollution. Thus, poor waste management poses a great danger to the ecosystem through air pollution, water pollution and soil pollution.

According to World Health Organization, (2022), poor waste disposal can harm human health. Harmful garbage or poor waste treatment techniques can cause direct harm to the local population. Negative health outcomes are more likely to affect children and other vulnerable populations. Poor waste management can block water drainage, harm the environment, and contaminate the water bodies. Cholera and vector-borne diseases like malaria, chikungunya, zika and dengue occur as a result of poor waste collection.

The growth of cities and towns in Sub-Saharan Africa has been brought by increase in population. When population increase there is strain on social amenities and increase in the production of domestic waste. According to Zahouli et al., (2017), poor management of waste is the main driving factor to the breeding of *Aedes* mosquito by creating more diverse and more productive breeding sites. Further, Fournet et al., (2016), show that poor waste management by the municipality in many African cities is found to be associated with increasing dengue risk in the population. These cities lack sanitation infrastructure, which include waste management systems, sewage and drainage systems, thus favouring the breeding of mosquitoes which are adapted to polluted environments.

Kenya being one of the countries within the tropics, has many favourable spots for the breeding of *Aedes* mosquito for instance Mombasa County, where Tudor Moroto Slum is located. The slum is

situated along the Indian Ocean and it lies on 4°2'22'S 39°39'48'E. It has a population of approximately 12,000 people.

Description of the problem

Poor waste management in cities is one major problem globally. The rapid increase in population and urbanization among other factors are some of those that have contributed to increased production of waste. The more the population in any given area, the more the household waste produced. Tudor Moroto Slum is one good example of an area with a rapidly increasing population. This is as a result of the growth of industries and business around Mombasa City, as the slum provides cheap and affordable housing for many of the workers in these industries. The rising population translates to shortage of housing and increased waste production especially in the slum area where there are no proper dumpsites.

The residents of Tudor Moroto Slum dump a lot of their waste outside the buildings and among the waste is plastic bottles. These plastic bottles together with other water retaining waste create favourable conditions for breeding of mosquitoes.

Another major problem in the area is shortage of water for domestic use. Many households fetch their water from the few boreholes around the slum and store in jerricans. Many of the jerricans are stored outside the houses uncovered and this makes mosquitoes to breed in them.

The drainage in Tudor Moroto Slum is very poor. The slum slopes towards the adjacent Indian ocean and it has many open drainage channels which carry sewage from the residential houses. There are however many patches of stagnant water which also create breeding ground for mosquitoes.

Poor waste management increases the possibility of contracting diseases related to poor sanitation such as dengue, malaria, zika and chikungunya which are transmitted by the *Aedes* mosquito.

Impact of the project to the community

The main aim of this project was to investigate on the impact of poor waste management to the environment and how it can contribute to the breeding of mosquitoes in the area. There has been increased production of household waste in residential areas. The management of this waste has proved to be very difficult evident from the many heaps of garbage in the slum. This slum is facing great environmental challenges; ugly sites of the garbage heaps, foul smell from the decomposing waste, hence creating breeding ground for disease causing germs and vectors such as mosquitoes. Moreover, it notable that plastic use is on the rise since a greater composition of the garbage heaps is plastic bottles which also spread to the sewers causing blockage.

Through the findings of this project, we intend to collaborate with the local community in Tudor Moroto Slum to create awareness and sensitize them on the importance of eliminating the breeding sites of mosquitoes. We also intend to share our findings with the Mombasa County Government, which will help the county to put in place policies that encourage reducing, reusing or recycling plastic, proper waste management practices, and eliminating mosquito breeding sites by covering water storage jerricans and draining stagnant water in the residential areas.

METHODOLOGY

Survey of the study site

We carried out a survey using the Google Earth Pro Application to identify the largest slum within Mombasa County and thus identified Tudor Moroto Slum. In order to get realistic results, we conducted three different field studies in which we identified potential breeding sites and collected samples of water with mosquito larvae from the slum. We used the GLOBE Observer Mosquito Habitat Mapper to identify the mosquito species prevalent in the area, then followed up with the Sub-County Hospital near the area to find out if there were reported cases of dengue, zika and chikungunya.

Equipment and Materials:

The following are the materials we used during the study.

1. Dropper
2. Paper towels
3. Bucket
4. Forceps
5. Magnifier /Hand lens
6. Macro pipette
7. Mobile device with GLOBE Observer Mosquito Habitat Mapper
8. A clip-on macro lens (60-100x)

Procedure:

i) Field Study

We visited Tudor Moroto Slum to find out if there was evidence of poor waste management practices in the area.



Figure 1: Collecting data at Tudor Moroto Slum along the shore of Indian Ocean

ii) Identification of mosquito breeding sites

We identified three different mosquito breeding sites in the area: plastic bottles, uncovered water jerricans and stagnant water.



Figure 2: Breeding sites of mosquitoes identified

iii) Collecting water samples with mosquito larvae

We collected water samples with mosquito larvae from the three identified sites.

iv) Identification of mosquito larvae



Figure 3: Identification of mosquito larvae

v) Visiting the Tudor Sub-County Hospital

We visited Tudor Sub-County Hospital which is located near the slum to find out if there are reported cases of dengue, chikungunya and zika which are caused by *Aedes* mosquito.



Figure 4: Collecting data at Tudor Sub-County Hospital

RESULTS

Finding from our field study

The survey of the Tudor Moroto Slum revealed that there was evidence of poor waste management that encouraged the breeding of the *Aedes* mosquito. Presence of discarded containers and single use plastic water bottles at the dumping sites provided a favourable habitat for their breeding. Outside most of the slum houses were water storage jerricans, most of which were not covered. Water collected from them had mosquito larvae.



Figure 5: Evidence of poor waste management at Tudor Moroto Slum (i)

Figure 5 above shows evidence of poor waste management in Tudor Moroto Slum. There were different types of waste scattered at the shore. Among them were plastic bottles, polythene paper, clothes and empty containers. It was observed that most of the plastic containers had some water in them which provided conducive breeding sites for mosquitoes. There were also open sewers draining into the ocean.

Apart from the dumping sites the areas around the houses showed that there no proper waste management. This was evidenced by open drainage channels with slow moving sewage which were blocked in some areas due to deposits of solid waste. As a result of this blockage there were numerous patches of stagnant water that provided breeding sites for mosquitoes.



Figure 6: Evidence of poor waste management in Tudor Moroto Slum (ii)

Figure 6 shows another evidence of poor waste management in the slum with patches of stagnant water and slow-moving sewage. There is also presence of single use plastic bottles and other solid waste blocking the drainage.

Larvae identification

The water samples collected from stagnant water, storage jerricans and plastic bottles had many mosquito larvae. Tables 1, 2 and 3 show the number of larvae collected and those positively identified as *Aedes* mosquito larvae from the samples during the three visits. There was no evidence of other types of mosquitoes within the area.

Table 1: Larvae identified from samples collected from the first field study

Mosquito breeding sites	Number of larvae	Positively identified <i>Aedes</i> larvae	Other types	unknown
Stagnant water from ditches	26	15	0	11
Water storage Jerricans	59	38	0	21
Plastic bottles	27	10	0	17

Table 2: Larvae identified from samples collected from the second field study

Mosquito breeding sites	Number of larvae	Positively identified <i>Aedes</i> larvae	Other types	unknown
Stagnant water from ditches	33	21	0	12
Water storage Jerricans	40	33	0	7
Plastic bottles	16	6	0	10

Table 3: Larvae identified from samples collected from the third field study

Mosquito breeding sites	Number of larvae	Positively identified <i>Aedes</i> larvae	Other types	unknown
Stagnant water from ditches	40	19	0	21
Water storage Jerricans	51	20	0	11
Plastic bottles	22	12	0	34

The positively identified larvae had the following features:

Larvae features	
- Stout blunt siphon - Presence of pecten - Single tuft of hair above the pecten - Saddle does not completely encircle the tail - Comb scales present - Presence of anal brush	

Figure 7: Features of larvae identified

Measured Date: 2023-02-23 Organization Name: Shree Swaminnarayan Academy Site ID: 153593 Site Name: 37MER796548 Latitude: -4.027481 Longitude: 39.717086 Elevation: 15.4m Measured At: 2023-02-23T08:56:00 Measurement Latitude: -4.0271 Measurement Longitude: 39.7176 Water Source: ditch Mosquito Habitats: still: lake/pond/swamp Mosquito Breeding Sites Mitigated: true Larvae Count: 21 Mosquito Adults: true Mosquito Pupae: true Data Source: GLOBE Observer App Comments: Murky smelly water, with dry leaves, insects and sticks.	Measured Date: 2023-02-23 Organization Name: Shree Swaminnarayan Academy Site ID: 153593 Site Name: 37MER796548 Latitude: -4.027481 Longitude: 39.717086 Elevation: 15.4m Measured At: 2023-02-23T09:27:00 Measurement Latitude: -4.027 Measurement Longitude: 39.7175 Water Source: ditch Mosquito Habitats: still: lake/pond/swamp Mosquito Breeding Sites Mitigated: true Mosquito Genera: Aedes Mosquito Species: albopictus Larvae Count: 15 Mosquito Adults: true Data Source: GLOBE Observer App Comments: Murky waters
Measured Date: 2023-02-23 Organization Name: Shree Swaminnarayan Academy Site ID: 153593 Site Name: 37MER796548 Latitude: -4.027481 Longitude: 39.717086 Elevation: 15.4m Measured At: 2023-02-23T09:43:00 Measurement Latitude: -4.0271 Measurement Longitude: 39.7176 Water Source: ditch Mosquito Habitats: still: lake/pond/swamp Mosquito Genera: Aedes Larvae Count: 20 Mosquito Adults: true Data Source: GLOBE Observer App Comments: Presence of stagnant water with dead plants	Measured Date: 2023-03-09 Organization Name: Shree Swaminnarayan Academy Site ID: 153593 Site Name: 37MER796548 Latitude: -4.027481 Longitude: 39.717086 Elevation: 15.4m Measured At: 2023-03-09T09:48:00 Measurement Latitude: -4.0268 Measurement Longitude: 39.7172 Water Source: adult mosquito trap Mosquito Habitats: container: artificial Mosquito Breeding Sites Mitigated: true Mosquito Genera: Aedes Larvae Count: 30 Data Source: GLOBE Observer App Comments: Plastic bottles with water lying on dirty water.

Figure 8: Larvae identification from the GLOBE Observer App

Cases of dengue fever recorded

The table below shows data collected on cases of dengue from Tudor Sub-County Hospital.

Table 4: Dengue fever cases recorded in Tudor Sub-County Hospital (Jan 2022 – Feb 2023)

Month	Tested Cases	Positives Cases
January 2022	13	10
February 2022	33	10
March 2022	0	0
April 2022	0	0
May 2022	7	1
June 2022	58	40
July 2022	27	18
August 2022	14	4
September 2022	12	4
October 2022	41	11
November 2022	14	7
December 2022	37	20
January 2023	13	9
February 2023	17	11
Total	286	145

According to the data collected from Tudor Sub-County Hospital, we noted that 145 cases out of the 286 patients tested positive of dengue fever.

DISCUSSION

Many plastic containers and bottles found in the dumping sites had water in them which provided a warm and moist environment favourable for breeding of *Aedes* mosquitoes. This proved that poor waste management in the area highly contributed to the breeding of *Aedes* mosquitoes. The uncovered jerricans used for water storage outside the houses also contributed to high breeding of mosquitoes within the slum area. This is an indication that it is important to put in place policies that can help eliminate the breeding sites of *Aedes* mosquito. The *Aedes* mosquito mostly bites during the day and cannot be simply controlled by sleeping under treated mosquito nets. Therefore, the most effective method of control is to destroy mosquito breeding sites. For instance, draining stagnant water and covering open sewers, covering water containers and cleaning them weekly, and practicing proper disposal of waste.

CONCLUSION

In conclusion, the study highlights the challenges posed by the rapid population growth and the resulting increase in slum areas in Mombasa, Kenya. It identifies Tudor Moroto Slum as one of the largest and fastest-growing slums, where poor waste management, shortage of water, and poor sanitation and drainage have led to major environmental and health challenges. The study focused on the impact of poor waste management on the breeding of mosquitoes in the area, identifying the species of mosquitoes and investigating their effect on the population of the slum. The study found that *Aedes* mosquitoes largely breed within the Tudor Moroto Slum, and there were 145 positive cases of dengue recorded between January 2022 and February 2023.

The study's recommendations include developing a sustainable waste management system, regulating the use and disposal of single-use plastic bottles and containers, creating industries that will help in reusing, recycling and reducing plastics, carrying out awareness campaigns, and improving environmental management, including developing better drainage and sanitation systems in the slum area to help eliminate mosquito breeding sites. Overall, the study's results will contribute to the understanding of mosquito species and the pathogens they may carry in the area and inform the local community and government when an outbreak of diseases is likely to occur and the most effective control measures.

Findings from our study shows that it is important to work together to investigate the earth as a system. The data obtained from the Tudor Sub-County Hospital helped in explaining the effect of poor waste management and its impact on the health of the local community. Sharing this information with the local community, the health service providers and the local county government will help in finding solutions to better waste management in Mombasa County.

ACKNOWLEDGEMENT

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We acknowledge Tudor Sub-County Hospital staff for supporting and collaborating with us in during the project.

We thank the local community at Tudor Moroto Slum for allowing us to carry out a research project in their locality.

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APPENDICES

Field Study Letters



SHREE SWAMINARAYAN ACADEMY

UNDER SHREE CUTCH SATSANG
SWAMINARAYAN TEMPLE CHARITABLE TRUST
P.O. BOX 41651, MOMBASA. TEL: 041-2005463
Mobile: 0711 900592 / 0737 900592
email: academy@swaminarayan.ac.ke
website: www.shreeswaminarayan.academy

Our Ref. L/1/23

Your Ref. _____

Date, 28/2/2023

Dear Parent/Guardian,

RE: GLOBE PROGRAM - FIELD TRIP TO MOROTO SLUM AND TUDOR CLINIC

This is to inform you that your child in the Globe Program will be going on a Field Trip on Thursday 2nd March 2023 to collect data for International Virtual Science Symposium (IVSS) 2023 projects. This year's IVSS theme is, "Global connections: Investigating the Earth as a System Together".

The objectives of the trip are:

- i) Explore the breeding sites of mosquitoes within Moroto Slums.
- ii) Investigate the effect of poor waste management on the breeding of mosquitoes.
- iii) Determine the species of mosquitoes found in Moroto Slums.
- iv) Collect data on cases of dengue fever reported in Tudor Clinic from 2022-2023.

During the trip, the students will be collecting primary data using a variety of methods to enable them to write up a Research Report for the IVSS 2023.



SHREE SWAMINARAYAN ACADEMY

UNDER SHREE CUTCH SATSANG
SWAMINARAYAN TEMPLE CHARITABLE TRUST
P.O. BOX 41651, MOMBASA. TEL: 041-2005474
Mobile: 0711 900592 / 0737 900592
email: academy@swaminarayan.ac.ke
website: www.shreeswaminarayan.academy

Our Ref. L/SSA/2/23

Your Ref. _____

Date, 28/02/2023

THE MEDICAL SUPERINTENDENT,
TUDOR SUBCOUNTY HOSPITAL
MOMBASA

RE: SEEKING PERMISSION TO COLLECT DATA ON OCCURRENCE OF DENGUE FEVER, CHIKUNGUNYA AND ZIKA VIRUS BETWEEN 2022 AND 2023.

We are an International School based in Mombasa offering the British curriculum. The Globe Club of the academy (affiliated to Kenya Space Agency) is seeking permission to visit your clinic on Thursday 2nd March 2023.

Currently a group of 10 students is participating in an International Virtual Science Symposium under the theme "Global Connections: Investigating the Earth as a System Together" where they will collect data on cases of Dengue Fever, Chikungunya Virus and Zika virus reported in your clinic between 2022-2023.

The purpose of this is to enable students complete their research study.

Thank you in advance as we look forward to your favorable response.

Yours faithfully,

A. Lazar (MRS)
Principal.