2025 IVSS Project: Celebrating 30 years of Globe.

Topic: **The impact of poor waste management on the populations of mosquitos in South Africa , KZN.**

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Picture of an Aedes Mosquito.

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Introduction

Mosquito populations in KwaZulu Natal have grown exponentially in the last 15 years. Over the last 15 years, South Africa has witnessed a significant surge in mosquito populations, posing a substantial threat to public health. The country's subtropical climate, coupled with changes in weather patterns, urbanization, and inadequate waste management, have created an ideal environment for mosquitoes to thrive.

According to data from the National Institute for Communicable Diseases (NICD), the number of reported mosquito-borne disease cases, such as malaria, dengue fever, and chikungunya, has increased exponentially over the past decade and a half. This trend is particularly concerning, as it suggests that mosquito populations are not only growing in numbers but also expanding their geographical range.

The rise of mosquito populations In South Africa can be attributed to various factors, including:

1. Climate change: Changes in temperature and precipitation patterns have created an environment conducive to mosquito breeding.

2. Urbanization: The rapid growth of urban areas has led to an increase in standing water, which provides a breeding ground for mosquitoes.

3. Ineffective waste management: Poor waste disposal protocols have resulted in an accumulation of waste, which can collect water and create mosquito breeding sites.

4. Lack of effective vector control measures: Insufficient vector control measures, such as mosquito surveillance and control programs, have contributed to the rise of mosquito populations.

The consequences of the rising mosquito populations in South Africa are far-reaching, with significant implications for public health, economic development, and environmental sustainability. The World Health Organization (WHO) has expressed deep concern over the rising cases of mosquito-borne diseases in Africa regions. According to the WHO, dengue fever cases have surged across all six WHO regions, with the number of cases approximately doubling each year since 2021, reaching over 12.3 million cases as of August 2024.

The WHO attributes this increase to factors such as unplanned urbanization, poor water, sanitation, and hygiene practices, climate change, and international travel. The organization has launched the Global Strategic Preparedness, Readiness and Response Plan (SPRP) to tackle dengue and other Aedes-borne arboviruses, aiming to reduce the burden of disease, suffering of individuals and deaths.

- Dengue Fever Cases: Over 12.3 million cases reported as of August 2024, with the number of cases doubling each year since 2021.

- Global Burden: Dengue Fever is found in tropical and sub-tropical climates worldwide, with over 3.9 billion people at risk of infection.

- Mortality Rate: Severe dengue can be fatal, with over 7,300 dengue-related deaths reported in 2023.

The WHO emphasizes the need for a coordinated response to prevent and control mosquito-borne diseases, including vector control, community engagement, and improved clinical management.

This project will delve deeper into the effects of improper waste management on the rapid rise in mosquito populations in South Africa over the last 15 years. This investigation will focus on the province of kwaZulu Natal and other southern regions of South Africa.

What is Poor Waste management?

Poor waste management refers to the inadequate or ineffective collection, transportation, treatment, and disposal of waste materials. This leads to severe environmental pollution and health risks. Some common examples of poor waste management include:

- Littering and dumping of waste in public open spaces such as fields
- Inadequate waste collection services such as the municipal trash collection service.
- Insufficient waste treatment facilities
- Open burning of waste which releases Carbon Monoxide and other greenhouse gases into the atmosphere.
- Uncontrolled dumping of hazardous waste such as batteries, medical waste and other unsafe waste products.

A picture of a Newcastle landfill in KwaZulu Natal.

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Poor Waste Management in relation to mosquito populations.

Poor waste management can contribute to an increase in mosquito populations in several ways:

1. Standing water: Improperly managed waste, such as discarded tires, plastic containers, and other items, can collect standing water, creating ideal breeding sites for mosquitoes.

2. Organic waste: Unmanaged organic waste, like food waste and yard trimmings, can decompose and produce nutrients that support the growth of mosquito larvae and in turn assist in the increase of mosquito breeding.

3. Clogged drains: Unsound waste management can lead to clogged drains, which can cause water to accumulate and create mosquito breeding sites as mosquitoes breed in standing water.

4. Lack of proper disposal: The erroneous management of waste, such as not covering trash cans or not disposing of waste regularly in an appropriate manner, can attract mosquitoes and provide them with a food source. This results in the mosquito populations thriving as a constant food source ensures the survival of the species.

As a result of ineffective management of waste, communities can inadvertently create an environment that supports the growth of mosquito populations, increasing the risk of mosquito-borne diseases such as Malaria, Dengue fever and Zika virus.

Mosquitoes natural behaviour.

Mosquitoes natural behaviour enables them to survive and thrive especially in environments where human activity directly impact the suitability of areas for breeding sites of mosquitoes. Such behaviours include:

1. Nocturnal behavior: Mosquitoes are mostly active at night, which enables them to avoid predators and conserve energy during the day.

2. Attraction to heat and moisture: Mosquitoes make use of their natural heat and moisture sensors to locate potential hosts, such as humans or animals.

3. Carbon dioxide detection: Mosquitoes have developed a Co2 detection mechanism which enables them to detect the carbon dioxide we exhale, and the carbon dioxide/monoxide released during the open burning of waste materials which assists them to find viable hosts.

4. Visual cues: Mosquitoes can make use of visual cues, such as movement and dark colors, to locate hosts.

5. Feeding habits: Female mosquitoes feed on blood from hosts to obtain protein for egg production, while males typically feed on nectar.

6. Resting behavior: Mosquitoes often rest in dark, humid areas during the day, such as under vegetation or in burrows or ceilings.

7. Breeding habits: Female mosquitoes lay eggs in standing water, which hatch into larvae and eventually become adult mosquitoes.

Mosquito breeding sites

Mosquitoes breed in standing water, which can be found in various natural and artificial habitats. Mosquitoes are able to breed in common habitats such as:

1. Standing water: Ponds, lakes, marshes, and swamps are ideal breeding sites for mosquitoes as mosquitoes naturally breed in this environment.

2. Artificial containers: Improperly discarded tires, buckets and other containers that collect rainwater can become unconventional mosquito breeding sites.

3. Drainage systems: Clogged drains, storm drains and sewage systems can provide a habitat for mosquito larvae to grow and develop.

4. Vegetation: Dense vegetation, such as trees and leaves of plants, can provide shelter and breeding sites for mosquitoes.

5. Tree holes: Holes in trees and other natural cavities can collect water and provide a habitat for mosquito larvae to grow and develop.

6. Irrigation systems: Irrigation ditches, canals, and reservoirs can become breeding sites for mosquitoes as it results in standing water.

The breeding process of mosquitoes

The breeding process of mosquitoes works as follows:

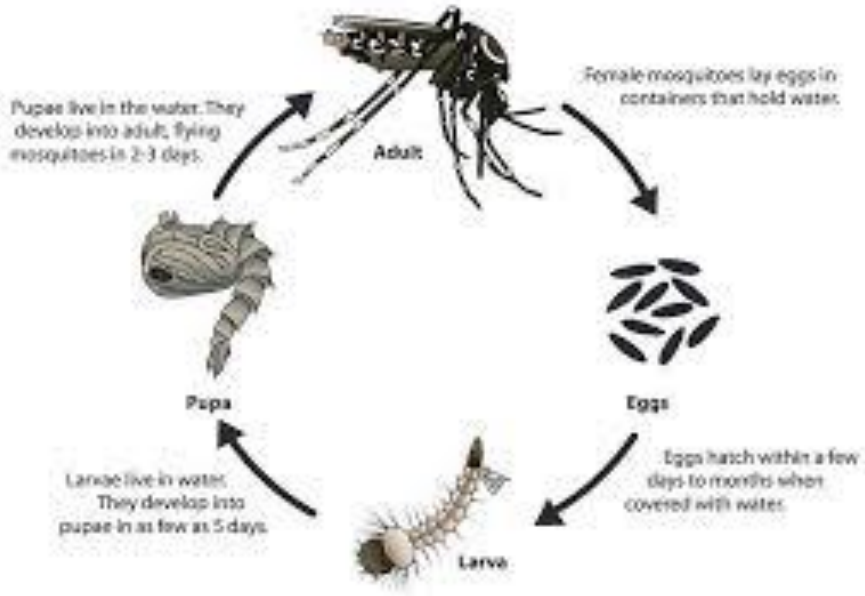
1. Female mosquito lays eggs: Female mosquitoes lay their eggs in standing water, typically in clusters or rafts.

2. Eggs hatch into larvae: The eggs hatch into larvae, which feed on micro-organisms and organic matter in the water.

3. Larvae molt: The larvae molt several times as they grow and develop.

4. Larvae become pupae: When the larvae are fully grown, they transform into pupae, which are non-feeding, resting stages.

5. Adult mosquitoes emerge: The adult mosquitoes emerge from the pupae, and the cycle begins again.

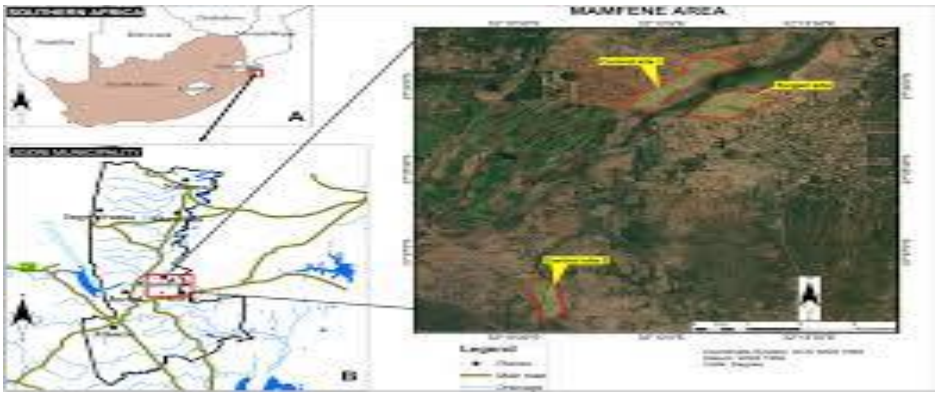


A diagram illustrating the breeding cycle of mosquitos.

Mosquito borne diseases

As a result of increased breeding sites leading to increased population sizes, there are several health risks posed by mosquitoes. Mosquito borne diseases mean that the transmission of the diseases is carried out by mosquitos. Mosquitoes become carriers of diseases that negatively impact human populations. Such examples of mosquito borne diseases include:

1. Malaria: Is a mosquito borne diseases by which an infected Anopheles mosquito bites an individual. The saliva from the bite mixes with the individuals blood and a parasite known as Plasmodium is transmitted. If left untreated, Malaria can result in Anemia, Organ failure, Respiratory distress, Coma like state and even death.
2. Dengue Fever: Dengue fever is caused by the Dengue virus. An infected Aedes Aegypti mosquito bites an individual which results in the transmission of the virus. Although there is no treatment, there are measures which can be taken towards mitigating the symptoms of Dengue fever. Dengue fever can result in to Dengue Hemorrhagic fever (DHF) which leads to Dengue Shock syndrome (DSS).



Why proper waste management is key to decreasing mosquito borne disease in South Africa

Proper waste management is crucial in decreasing mosquito-borne diseases in South Africa for several reasons:

1. Reduces breeding sites: Mosquitoes need standing water to breed therefore having proper waste management effectively eliminates potential breeding sites, such as discarded tires, containers, and other items that can collect water which may .

2. Prevents water accumulation: Effective waste management ensures that waste is disposed of properly, reducing the likelihood of water accumulating in areas where mosquitoes can breed and thrive.

3. Decreases mosquito populations: By dashing the number of breeding sites and preventing water accumulation, proper waste management can help decrease mosquito populations, thereby reducing the risk of mosquito-borne diseases.

4. Protects public health: Mosquito-borne diseases, such as malaria, dengue fever, and Zika virus, pose a significant threat to public health in South Africa. Proper waste management is a crucial factor in a comprehensive strategy to prevent and control these diseases.

5. Supports sustainable development: Proper waste management is essential for achieving sustainable development goals, including

those related to health, environmental protection, and economic development.

In South Africa, proper waste management can be achieved through:

1. Regular waste collection: Ensuring that waste is collected regularly at weekly intervals.

2. Proper disposal of waste: Disposing of waste in designated areas, such as landfills, and ensuring that waste is not dumped illegally in urban areas.

3. Recycling and composting: Promoting recycling and composting to reduce the amount of waste that ends up in landfills.

4. Community education and awareness: Educating communities about the importance of proper waste management and the risks associated with mosquito-borne diseases such as Dengue fever and Malaria.

5. Collaboration and partnerships: Collaborating with stakeholders, including government agencies, private sector companies, and community based organizations, to develop and implement effective waste management strategies in order to lead to the less waste being produced by the citizens.

Conclusion

In closing, the research conducted and presented in this project does indeed show a indirectly proportional relationship between the population size of mosquitos and the poor management of waste in South Africa. Research shows a dramatic hike in population size of mosquitos as a result of the decline in effective waste management.

It is worth noting that mosquito habits can be natural or artificial, as a result of human activity. In order for there to be improvement in the issue of mosquito borne diseases spreading due to the growth of the populations of mosquitos, humans need to take accountability for their actions and work towards disposing of waste in a more hygienic and conducive fashion. Without this, the current trend of growing mosquito populations leading to an increase in mosquito borne diseases will only worsen year by year resulting in more fatalities.

Application for Globe badges

1. I am a data scientist badge: One has made use of data collected from online resources such as Google Earth, The World Health Organization's website, Past research IVSS projects including but not limited to the 2023 project conducted by learners, Aarohi Choubey, Zahia Omar Abdalla and Rahini Dhirendra Halai, of the Shree Swaminarayan Academy who investigated the impact of poor waste management on the breeding of Aedes Mosquito in Moroto Slum, Mombasa County. Another past student IVSS used in one's own project is the study of mosquito borne diseases awareness, life cycle, attitudes and practices among the rural populations in Ifako Ijaiye, Lagos State Nigeria conducted by Anni Abdulrahman, Adedokun Tobi and Sanni Aliyah along with their globe teacher Sanni Nojeem aka Teacher Sanni. One has used figures from 2015 to the present to discuss the decline in effective waste management in South Africa and how this decline resulted in the incline of mosquito populations.

2. I am a collaborator badge: One has collaborated with a fellow globe student and vlogger, Buhle Buthelezi to discuss the trajectory of one's project as well as to weigh each others projects to critically assess them. We, in our own separate projects, have also collaborated with our globe educators Mrs Helena Joubert and Mr Lukas Venter for guidance on our projects and for tips on how to improve.

These collaborations had significant benefits within one's project as well as the communication between one and globe vlogger, Buhle Buthelezi which positively impacted ones research project and demonstrated true collaborative skills.

3. I am an Earth System Scientist badge: One has made use of globe data bundles and protocols such as the mosquito protocol on the globe app to gain more knowledge on how mosquitoes are investigated in terms of population size, breeding sites and number of larvae. This assisted in one's understanding of how mosquitoes influence the earth as a system and how they are in connection with the lithosphere and hydrosphere in order to carry out their natural functions of breeding and feeding.

4. I am a problem solver badge: One, through conducting this project, has gained immense knowledge of intricacies of the issue of poor waste management in relation to mosquito populations and with doing so one has come up with various possible solutions to this issue including but not not limited to, revised methods of collecting waste by means of not just dumping it in landfills but rather sorting waste material into their respective sections and destroying them immediately. This would not only result in less landfills, but would also remove the factor of artificial habitats for mosquitoes to breed in.

5. I make an impact badge: Upon completion of my project, one made several calls to ones local municipal offices and spoke to an official within the waste management department to which one raised several concerns on the ineffectiveness of the waste removal system in South Africa, moreover KwaZulu-Natal and Umhlathuze as our district. The official explained that the municipality along with the mayor were making provisions to ensure swift and effective removal of waste not only in homes but also cleaning up waste in the streets.

6. I work with a stem professional badge: One has worked with two stem professionals within one's school being Mrs Helena Joubert and Mr Lukas Venter who have had immense input into one's project and provided necessary guidance in areas where one got confused on certain topics.

7. I am a stem storyteller: One has, upon completion of the project, shared information not only on the project but Globe as well as a large number of learners showed interest in knowing what one was investigating and why one was doing research on mosquito. Many learners showed interest in taking part in the next IVSS and also enquired about how to join globe with one successfully applying to be a globe vlogger after one provided information on what Globe is.

8.

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