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Utilizing GIS cloud for monitoring and mosquito control

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Abstract: The rise in mosquito-borne diseases highlights the urgent need for effective monitoring and control strategies. Geographic Information Systems (GIS), particularly in cloud environments, offer innovative solutions for pest management. As technology advances, the integration of GIS in pest control strategies will continue to evolve, paving the way for more effective and sustainable mosquito management practices. This article discusses the application of GIS Cloud in monitoring mosquito populations, its benefits, methodology, and a case study that illustrates its effectiveness in mosquito control. The public health department collected data from field surveys and integrated it within GIS Cloud. By using GIS Cloud, our users access the full power of desktop GIS, allowing for activities such as geospatial analysis, spatial intelligence, the creation of customized mapping reports, and publishing geographic analysis on the web. By analyzing spatial data, health officials could implement community programs to reduce breeding sites, leading to a significant decrease in mosquito populations in targeted areas.

Keywords: *GIS, GIS cloud, Mosquito, Monitoring, WebGis.*

1. Introduction

Mosquitoes are vectors for several significant diseases, including malaria, dengue fever, Zika virus, and West Nile virus. The need for effective monitoring and control of mosquito populations is paramount in public health Xu, et al. [1]; Fletcher-Lartey and Caprarelli [2] and Javaid, et al. [3]. QGIS Cloud [4] provides a dynamic platform for targeted mosquito management by allowing real-time analysis of spatial data related to mosquito populations and their habitats.

Geographic Information Systems (GIS) have been used in many research studies.

Ali, et al. [5] used Geographic Information Systems (GIS) to assess the groundwater quality of several wells in the Al-Sharqat district, Iraq, for irrigation purposes.

Sarkisian, et al. [6] implemented GIS to optimize transport flows in road transport. They show that implementing GIS allows for more precise planning and management of transport infrastructure, reducing traffic jams, and improving road safety.

Tïgen and Özcan [7] used GIS to design corridors connecting the core natural areas with the urban centers.

Issa and Belaroussi [8] used GIS data in constructing a 3D city model.

The integration of Geographic Information Systems (GIS) [9, 10] into mosquito monitoring allows effective tracking and management of mosquito populations.

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2. Materials and Methods

2.1. The Importance of Monitoring Mosquito Populations

Monitoring the environment is crucial to identify and manage populations of harmful insects and pests. Effective monitoring can help to assess levels of infestation, understand the lifecycle of pests, and implement timely pest control measures.

To effectively manage and control mosquitoes, understanding their environmental dynamics is essential. Monitoring mosquito populations helps in:

- Identifying Breeding Sites: Mosquitoes breed in stagnant water and understanding the geography of these sites is crucial for a targeted intervention.
- Assessing Risks of Disease Transmission: Mapping mosquito hotspots allows for monitoring potential disease outbreaks and implementing preventive measures.
- Improving Resource Allocation: Data-driven insights allow pest control agencies to allocate resources efficiently, focusing on high-risk areas.

2.2. GIS Cloud and Its Advantages

GIS Cloud is a powerful online platform that allows users to efficiently manage and analyze geographic data [11, 12]. It provides tools for mapping, data integration, and analysis that can significantly enhance decision-making processes in various fields, including environmental management [13].

GIS Cloud provides a robust platform for collecting, analyzing, and visualizing spatial data related to mosquito habitats, breeding sites, and population dynamics.

GIS Cloud is a user-friendly platform that enables the visualization and analysis of geographic data without the need for extensive hardware or software investments. The primary advantages of GIS Cloud in mosquito monitoring include:

- Real-Time Data Collecting: GIS Cloud allows the integration of data from various sources, such as field surveys, remote sensing, and public health reports, in real time. This facilitates timely decision-making.
- Enhanced Visualization: The platform provides robust mapping capabilities that can illustrate mosquito population densities, breeding sites, and environmental factors that influence mosquito behaviour.
- Collaboration and Sharing: GIS Cloud enables multiple stakeholders, including public health officials, researchers, and community organizations, to collaborate and share data efficiently.

Application of GIS Cloud in Pest Control GIS Cloud can be utilized to collect and analyse data on pest distribution and habitats. By integrating various data sources, pest control professionals can visualize where infestations occur and identify trends over time [14-16]. This spatial awareness allows for targeted pest management strategies, reducing the need for widespread pesticide application, and thus minimizing environmental impact.

Benefits of Using GIS Cloud The integration of GIS Cloud in pest control offers numerous advantages:

- Efficiency**:** Real-time data collection and analysis enable quicker response times to pest outbreaks.
- Cost Reduction**:** By focusing on specific areas that need treatment, resources can be allocated more effectively, lowering costs associated with pest management.
- Improved Outcomes**:** Enhanced data analysis leads to more effective pest control strategies, resulting in improved health and safety for communities.

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3. Methodology for Using GIS Cloud in Mosquito Monitoring

Implementing GIS Cloud for mosquito monitoring involves several key steps:

3.1. Data Collection

Field teams collect data on mosquito populations, breeding sites, and environmental conditions using GPS-enabled devices. Key data points include:

- Location coordinates
- Type of habitat (e.g., stagnant water bodies, marshes)
- Mosquito species identified
- Number of larvae/adults observed
- Environmental parameters (temperature, humidity)

3.2. Data Upload to GIS Cloud

The collected data is uploaded to GIS Cloud using mobile or web applications. The platform supports real-time data synchronization, allowing for immediate availability of field data.

Data are collected through various methods, including:

- Field Surveys: Collecting data on mosquito populations and their breeding sites through physical inspections.
- Public Health Data: Integrating data from health departments regarding mosquito-related diseases.

3.3. Data Integration

The collected data is then uploaded to the GIS Cloud platform, where it is combined and processed to create comprehensive datasets for analysis.

GIS Cloud provides centralized data storage with easy access and management features. Users can:

- Organize data by categories (e.g. location, date, species).
- Update records with new observations
- Share data with stakeholders for collaborative analysis.

3.4. Data Analysis and Visualization

Using the analytical tools within GIS Cloud, stakeholders can:

- Create spatial maps showing the densities of the mosquito population and the locations of the breeding sites.
- Perform statistical analyses to identify trends and correlations, such as the relationship between environmental factors and mosquito populations.

GIS Cloud enables spatial analysis to identify patterns and trends in mosquito distribution. Techniques include:

- Heatmaps to visualize high-density areas of mosquito populations
- Buffer analysis to assess impact zones around breeding sites
- Temporal analysis to track changes over time

3.5. Strategic Implementation

The insights gained from GIS Cloud analysis assist in:

- Identifying priority areas for mosquito control interventions
- Allocating resources effectively for field operations
- Monitoring the impact of control measures over time

Based on the analysis, targeted mosquito control measures can be developed, such as

- Focused pesticide applications in high-density areas.

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- Community education initiatives on stagnant water management to eliminate breeding sites.

4. Results

GIS cloud was used to monitor and manage mosquitoes. The public health department collected data from field surveys and integrated it into GIS Cloud. This allowed real-time mapping of mosquito populations, facilitating targeted interventions and timely public health alerts.

The public health department used GIS Cloud to track mosquito breeding sites and disease cases. By analyzing spatial data, health officials could implement community programmes to reduce breeding sites, leading to a significant decrease in mosquito populations in the targeted areas.

Below we present some results of the project implementation in Gis Cloud software.

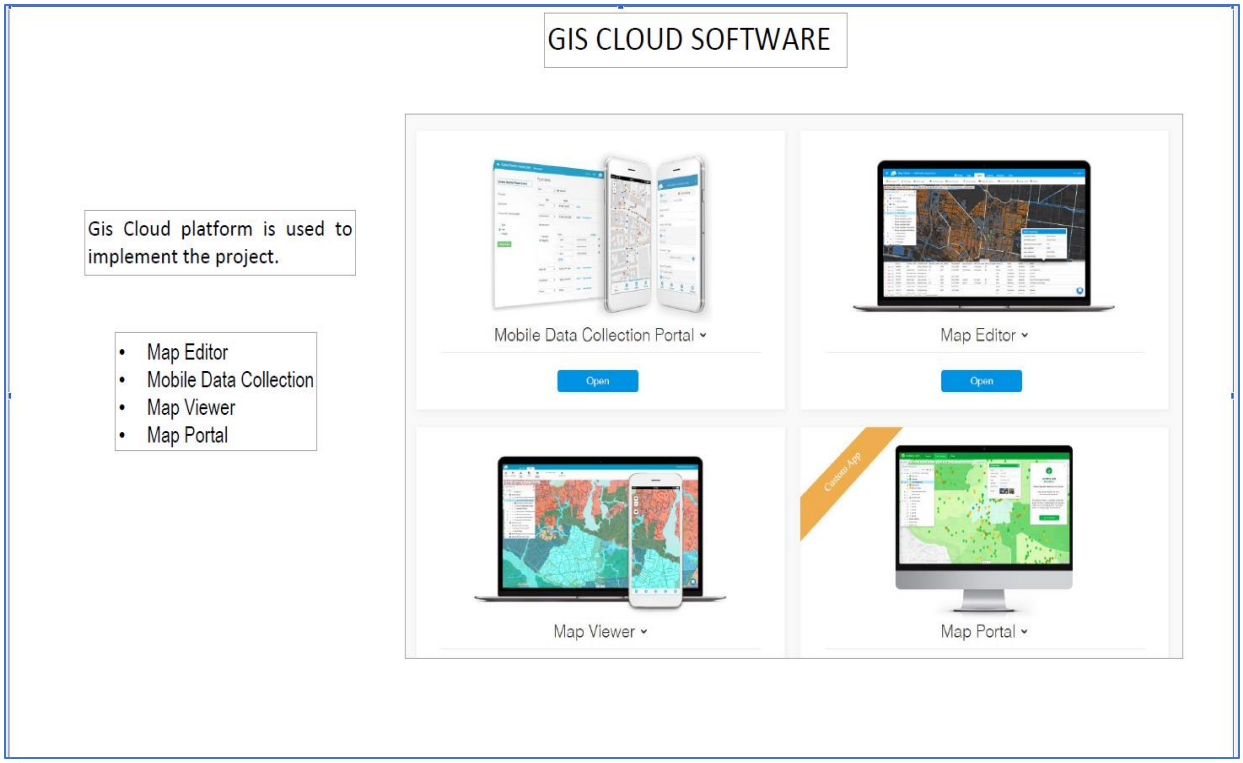

Figure 1.
Gis Cloud Software.

The layers and their respective attributes are modeled according to the requirements set by the Contractor.

The data used includes:

i) point files (layers);
ii) polyline files (layers);
iii) polygon files (layers);
iv) raster files (layers).

Are designed 4 layers groups: Lagunes_Parks, Urban Zone, Cellars_Wells, Canals_Pond, with a lot of the relevant layers. The algorithms are implemented over 210 layers.

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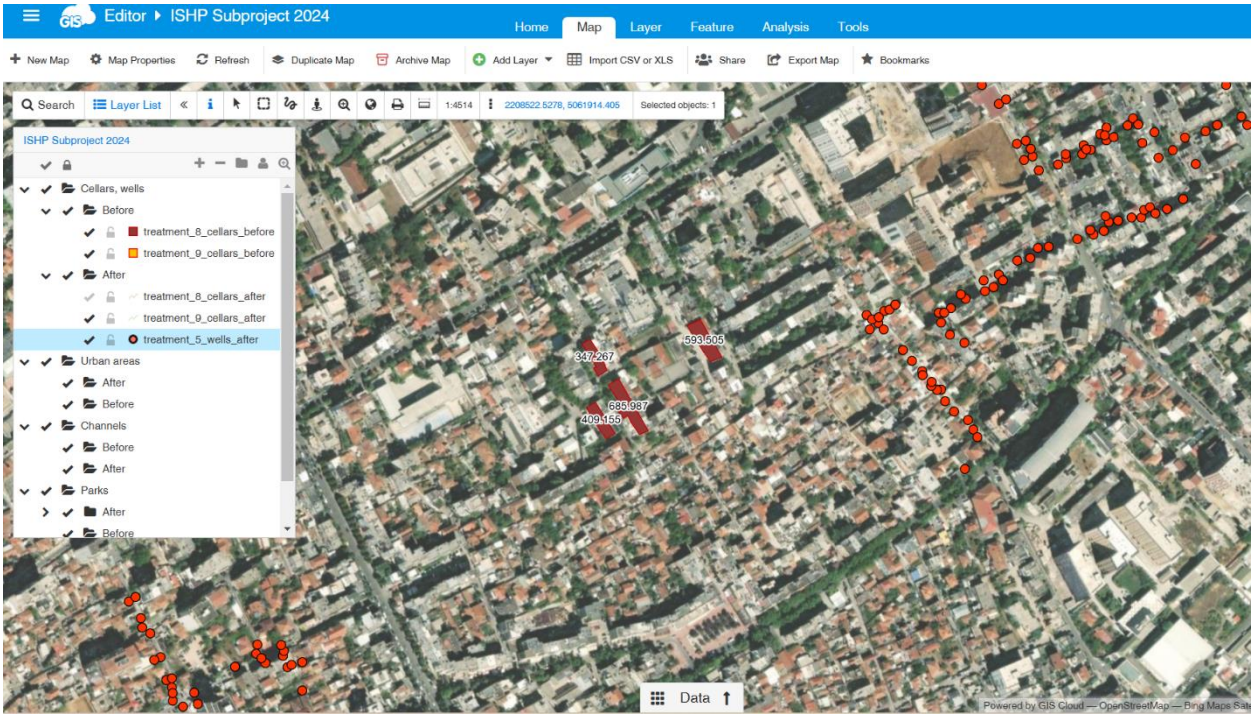

Figure 2.
Editor Map, Gis Cloud.

The Mobile Data Collection module is used. Implemented forms in accordance with the requirements set by the contractor are used to collect detailed information.

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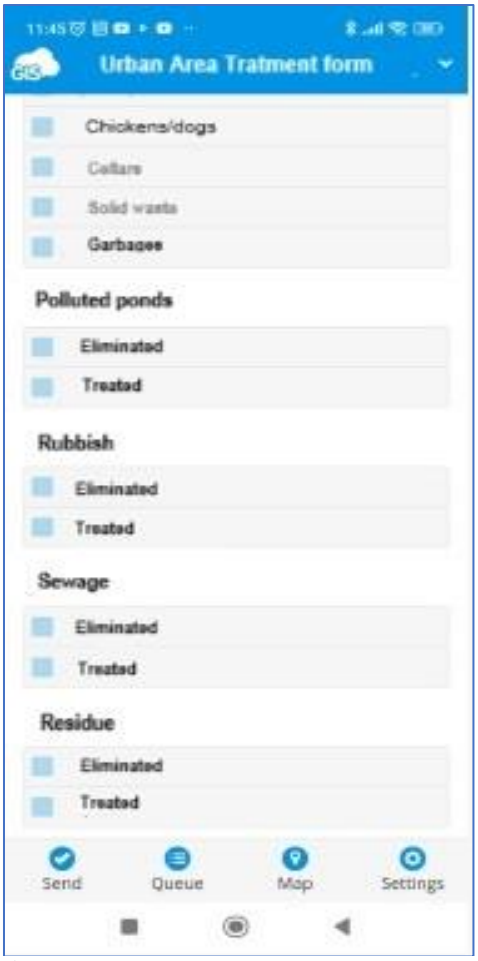

Figure 3.
Partial view of the module: Mobile data collection.

4.1. Challenges and Future Directions

While the use of GIS Cloud for mosquito monitoring shows significant promise, several challenges must be addressed.

- **Data Quality and Standardization:** Ensuring consistent data quality and standardization across different sources is critical for accurate analysis.
- **Resource availability:** Not all regions have the resources necessary to deploy GIS technologies effectively.
- **Public Engagement**: Encouraging community participation in reporting breeding sites can enhance data collection efforts.

Future advances in GIS technology, including machine learning and predictive modelling, have the potential to revolutionize how mosquito populations are monitored and controlled.

5. Conclusions

GIS Cloud represents a transformative tool for monitoring and managing mosquito populations. By leveraging real-time data, improving collaboration, and enabling targeted interventions, GIS Cloud can significantly improve public health outcomes related to mosquito-borne diseases. As technology advances, the integration of GIS into pest control strategies will continue to evolve, paving the way for more effective and sustainable mosquito management practices.

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Using GIS Cloud for mosquito monitoring improves the ability to manage mosquito populations effectively by providing comprehensive tools for data collection, analysis, and visualization. This methodology supports informed decision-making and targeted interventions, ultimately contributing to better public health outcomes.

Integrating modern technologies like GIS Cloud in environmental monitoring and pest control is essential for creating healthier ecosystems. Using these advanced tools, pest management strategies can become more efficient and environmentally conscious, ensuring better outcomes for both public health and the environment.

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Transparency:
The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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