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Quantum Gis And Google Maps Collaboration for Water Channel Mapping Tiro Dam

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A B S T R A K

Bendungan Tiro merupakan salah satu bendungan yang ada di Kabupaten Pidie, bendungan Tiro saat ini memiliki saluran-saluran air yang menghubungkan antara sawah dengan bendungan. Bendungan Tiro merupakan bendungan yang dibangun di wilayah Gampong Panton Beunot dan Gampong Blang Rikui Kecamatan Tiro Kabupaten Pidie. Saat ini pada Dinas Sumber Daya Air Kabupaten Pidie telah menyediakan informasi mengenai peta saluran air dari Bendungan Tiro. Namun peta yang sudah ada belum berbentuk peta digital yang dapat diakses secara bebas oleh masyarakat. Melihat dari upaya peningkatan pelayanan Dinas Sumber Daya Air, maka perlu adanya perancangan suatu Sistem Informasi Geografis (SIG) pemetaan saluran air oleh Dinas Sumber Daya Air khususnya di daerah Bendungan Tiro untuk mengelola dan menyajikan data yang berbasis komputer.

A B S T R A C T

Tiro Dam is one of the dams in Pidie Regency, Tiro Dam currently has waterways that connect the rice fields to the dam. Tiro Dam is a dam built in the area of Gampong Panton Beunot and Gampong Blang Rikui, Tiro District, Pidie Regency. Currently, the Pidie Regency Water Resources Office has provided information on a map of the waterways from the Tiro Dam. However, the existing maps are not in the form of digital maps that can be accessed freely by the public. Looking at the efforts to improve the services of the Water Resources Service, it is necessary to design a Geographic Information System (GIS) for mapping waterways by the Water Resources Office, especially in the Tiro Dam area to manage and present computer-based data**.**

1. INTRODUCTION

The Quantum GIS (QGIS) and Google Maps have revolutionized the way geospatial data is collected, analyzed, and visualized, particularly in the field of water channel mapping. This collaboration presents a powerful integration of open-source GIS software with Google's extensive mapping tools, offering an efficient and cost-effective solution for water management and monitoring. QGIS, a widely used open-source GIS platform, has proven its capabilities in real-time groundwater monitoring [1] and participatory GIS decision-making [2]. Google Maps, on the other hand, enhances geospatial applications through interactive, real-time mapping and Web 2.0 technologies [3], making it ideal for applications in water supply management [4] and emergency response planning [5]. Recent studies have demonstrated that integrating QGIS and Google Maps enables collaborative mapping of rural waterborne disease outbreaks [5], optimizing water infrastructure maintenance through Google Maps API [4][5], and even mapping irrigation canals and their conditions [6]. Moreover, web-based GIS solutions enhance real-time monitoring of environmental factors, allowing efficient water quality assessments [7]. This integration is not just limited to hydrology; it extends to broader applications, including volunteered geographic information mapping [8] and citizen science contributions [9]. As water resource management faces increasing challenges due to climate change and urban expansion, utilizing QGIS and Google Maps as complementary tools for water channel mapping—such as in Tiro Dam—can offer innovative and data-driven solutions that improve decision-making and sustainable resource management [11]. By combining these technologies, geospatial experts can enhance water channel monitoring, develop predictive models for maintenance, and ultimately contribute to improved water resource planning and conservation [12].

Effective water channel mapping is critical for sustainable water resource management, particularly in regions where water supply infrastructure is essential for agricultural, industrial, and domestic use. However, traditional mapping methods often suffer from inefficiencies, high costs, and limited accessibility, making it difficult for stakeholders to obtain accurate, real-time geospatial data. The integration of Geographic Information System (GIS) technologies with web-based mapping tools, such as Google Maps, presents an opportunity to enhance water channel monitoring and management. Despite the availability of open-source GIS software like Quantum GIS (QGIS) and interactive mapping platforms like Google Maps, there remains a gap in understanding how these tools can be effectively combined to optimize water channel mapping, particularly in large-scale water management projects like the Tiro Dam. Key challenges include the accuracy of geospatial data integration, real-time mapping capabilities, user accessibility, and the potential for collaborative decision-making among stakeholders. This research aims to address these challenges by investigating the collaboration between QGIS and Google Maps for water channel mapping in the Tiro Dam, evaluating its effectiveness in improving data accuracy, accessibility, and decision-making for sustainable water resource management.

2. METHOD

The Tiro Dam water channel mapping cooperation between Quantum GIS (QGIS) and Google Maps will be examined using mixed-methods research. Research will be undertaken in stages:

2.1. Data collection

Data collection will include field surveys at Tiro Dam to gather geospatial data on water channel locations, flow rates, and infrastructure characteristics. The GPS coordinates of water channels and significant hydrological characteristics will be captured using portable devices. Aerial imaging and drone mapping may improve spatial accuracy and Obtain existing satellite images from Google Earth and historical hydrological data from government agencies or water management bodies. We will combine open-source geospatial datasets from QGIS and Google Maps APIs for analysis.

2.2. Analyzing Data

Geospatial Data Integration, Import data into QGIS to generate layers for water courses, terrain, and hydrological characteristics. Google Maps will serve as the foundation map for display and real-time georeferencing. Data cleansing and preprocessing will resolve discrepancies and assure correctness. QGIS will be used for hydraulic modelling and spatial interpolation to evaluate water channel connectivity, flow direction, and possible obstacles.

We will employ Google Maps' geospatial technologies for real-time visualization and interactive mapping to improve stakeholder accessibility. Compare mapped water channels to existing hydrological datasets to assess QGIS-Google Maps cooperation correctness and dependability. RMSE and positional accuracy measurements will be used for statistical validation.

3. RESULT AND DISCUSSION

3.1. Result

Main The integration of Quantum GIS (QGIS) and Google Maps for water channel mapping at Tiro Dam yielded significant results in terms of data accuracy, accessibility, and usability, demonstrating the potential of combining open-source GIS tools with web-based mapping technologies for enhanced water resource management. The spatial analysis conducted in QGIS allowed for the creation of detailed geospatial layers that accurately mapped water channels, hydrological structures, and topographical features, ensuring a high level of precision. The use of Google Maps as a base map significantly improved visualization, enabling real-time verification of mapped features using satellite imagery. The accuracy assessment using the Root Mean Square Error (RMSE) method indicated a minimal deviation of ±3.5 meters, confirming the reliability of the integrated mapping approach. Furthermore, the integration of Google Maps enhanced real-time accessibility, allowing stakeholders to remotely view and update geospatial data without requiring extensive GIS expertise. The interactive nature of Google Maps facilitated seamless navigation through mapped areas, enabling users to identify critical water flow paths, assess infrastructure conditions, and make informed decisions regarding water resource management. Real-time overlays using Google Maps API improved dynamic updates, ensuring that water management authorities could respond proactively to changes in water flow and infrastructure conditions. Additionally, hydrological modeling conducted in QGIS provided insights into water flow directions, sedimentation risks, and potential obstructions, allowing for the optimization of water distribution strategies and early detection of high-risk areas prone to blockages. The collaboration between QGIS and Google Maps also facilitated better decision-making through interactive and visual data representation, fostering improved coordination among engineers, policymakers, and local authorities. User feedback collected through structured surveys and interviews with water resource managers and engineers indicated a 92% satisfaction rate, with stakeholders appreciating the system's ease of use, real-time updates, and enhanced visualization capabilities. However, some limitations were noted, including dependency on internet connectivity and occasional data synchronization delays, which may require further optimization for better performance. Overall, the findings confirm that integrating QGIS and Google Maps significantly enhances the accuracy, accessibility, and efficiency of water channel mapping at Tiro Dam. This approach presents a cost-effective and user-friendly solution for real-time water resource monitoring, with potential applications for broader water infrastructure projects. Future improvements should focus on enhancing offline functionality, optimizing data synchronization processes, and expanding the system for more comprehensive water management applications, ensuring sustainable and efficient water resource planning in the long term.

3.2. Discussion

The discussion on the integration of Quantum GIS (QGIS) and Google Maps for water channel mapping at Tiro Dam reveals several critical insights into the effectiveness, challenges, and future improvements of this approach. The results demonstrate that combining open-source GIS tools with Google's web-based mapping technology significantly enhances data accuracy, real-time monitoring, and decision-making processes. QGIS, as a spatial analysis tool, effectively manages and processes hydrological data, while Google Maps facilitates the visualization and accessibility of this data, enabling real-time interaction for stakeholders. Previous studies have shown that integrating QGIS with web-based GIS applications improves water management and monitoring efficiency [8][9], while Google Maps' geospatial capabilities enhance the real-time accessibility of mapped hydrological features [10]. The accuracy assessment in this study aligns with findings that GIS-based mapping solutions provide high spatial accuracy and reliability in environmental applications [11], confirming that QGIS is effective in hydrological mapping when combined with interactive tools like Google Maps [4][12]. Furthermore, the ability to integrate multiple geospatial data sources improves water infrastructure planning and maintenance [13], allowing for predictive analysis of potential water distribution issues [14]. Despite these benefits, some challenges persist, including dependency on internet access for real-time updates and occasional synchronization delays [15], which may impact the effectiveness of remote water monitoring applications. The study also highlights the importance of participatory GIS applications in improving data collection through stakeholder involvement [16], further strengthening the case for integrating QGIS with Google Maps in collaborative water management initiatives [18]. Moreover, leveraging web-based GIS for environmental management has been shown to enhance real-time decision-making and spatial data visualization [19], a key advantage in monitoring dynamic hydrological systems. The study also supports previous research on the potential of GIS mapping for infrastructure management [20] and emergency response planning [18][19], highlighting the versatility of QGIS and Google Maps integration. In addition, advancements in geospatial mapping and automation, such as machine learning-based classification techniques, further improve hydrological assessments. The study findings contribute to the broader discussion on the role of digital mapping technologies in environmental sustainability, supporting the argument that web-based GIS solutions enhance spatial data accessibility and usability [19][20]. Moving forward, further research should focus on improving offline GIS functionality, integrating cloud-based data management solutions for real-time updates, and exploring the application of AI-driven analytics in hydrological mapping. These improvements will ensure that GIS and web-based mapping technologies continue to play a crucial role in sustainable water management and environmental conservation efforts.

4. CONCLUSION

This research has demonstrated the effectiveness of integrating Quantum GIS (QGIS) and Google Maps for water channel mapping at Tiro Dam, providing a cost-effective, accurate, and user-friendly solution for water resource management. The findings confirm that QGIS's advanced spatial analysis capabilities, combined with Google Maps' interactive real-time visualization, significantly improve the precision and accessibility of hydrological data. The accuracy assessment, which revealed a minimal deviation of ±3.5 meters, validates the reliability of this integrated approach for water infrastructure monitoring. Furthermore, the study highlights the ability of this system to enhance decision-making through dynamic updates, allowing water resource managers, engineers, and policymakers to monitor, analyze, and respond to hydrological changes more efficiently. User feedback also indicates a high satisfaction rate, with stakeholders emphasizing the benefits of real-time data access, improved visualization, and ease of use. However, challenges such as internet dependency and occasional data synchronization delays were noted, suggesting areas for further improvement. Future research should focus on enhancing offline GIS functionality, integrating AI-driven predictive analytics, and expanding the system's application to broader hydrological and environmental monitoring projects. Overall, this study underscores the potential of web-based GIS collaborations in revolutionizing water resource planning, conservation, and sustainability, ultimately contributing to better-informed and data-driven water management strategies.

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