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Transforming Revenue Generation: Leveraging Drone Technology for Efficient Meter Reading in Disaster/Flood-prone Areas

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Abstract

In the wake of natural disasters or emergencies, accurate meter readings are crucial for utility companies to maintain revenue streams and ensure fair billing. However, traditional manual meter reading faces significant challenges in disaster-affected areas, including accessibility issues, safety concerns, and resource constraints. This study carried out by Ghana Water Limited explores the potential of integrating drone technology into meter reading operations, with a focus on parts of the Greater Accra region that are prone to flooding and other environmental hazards. Through a comprehensive analysis of existing infrastructure, regulatory frameworks, and technological advancements, this research aims to provide a roadmap for the successful implementation of drone-assisted meter reading in disaster zones, with a particular emphasis on Tetegu, a community in the Greater Accra region of Ghana which is vulnerable to flooding due to its coastal location and low-lying nature. A converter and a mobile device were affixed to the drone donated by the WaterWorx project after software and hardware configurations were completed. By the end of the exercise, 553 meters were read in just fifteen minutes, a task that will take 5-7 days or more using the traditional methods. The scatter plot gave an R^2 of 0.9897 while the correlation (R) between the Drone readings and the Manual readings was 0.994818. By leveraging the agility and versatility of unmanned aerial vehicles (UAVs), utility companies can streamline meter reading processes, enhance data accuracy, and minimize disruptions to revenue generation.

Key words: Drones, Revenue, Meter Reading, Flood-prone areas

Introduction

Utility companies play a vital role in providing essential services to communities, and their revenue streams are intrinsically linked to accurate meter readings (Beacon Power Services, 2023). In the aftermath of natural disasters or emergencies, traditional meter reading methods face substantial obstacles, such as restricted access to affected areas, compromised safety for field personnel, and logistical difficulties (Sheu, 2007). These challenges can lead to delays in billing cycles, revenue losses, and potential customer dissatisfaction. According to the Public Utilities and Regulatory Commission (Public Utility Regulatory Commission, 2020) Regulations, a public utility shall read a credit meter in a consistent cycle through monthly or quaterly meter readings on a specific day of each month. However, this directive becomes difficult to adhere to for months in localities which are prone to floods in the rainy season.

The integration of drone technology into meter reading operations presents a promising solution to address these challenges. Unmanned aerial vehicles (UAVs) offer a unique combination of agility, versatility, and remote data collection capabilities, making them well-suited for navigating disaster zones and accessing hard-to-reach areas (Mohsan et al., 2023). By using this technology, utility companies can streamline meter reading processes, enhance data accuracy, and minimize disruptions to revenue generation.

This study focuses on Tetegu in the Greater Accra region, which is particularly vulnerable to flooding due to its coastal location and low-lying nature. The town's dense population and diverse infrastructure make it an ideal testbed for exploring the potential of drone-assisted meter reading in disaster zones.

This study aims to provide a comprehensive roadmap for the successful implementation of drone-assisted meter reading in the Accra region, addressing infrastructural, regulatory, and technological considerations. Through a collaborative approach involving key stakeholders and a rigorous assessment of potential benefits and challenges, this research endeavors to pave the way for a more resilient and efficient utility sector, capable of withstanding the impacts of disruptive events while keeping essential services for the communities they serve.

Study Area

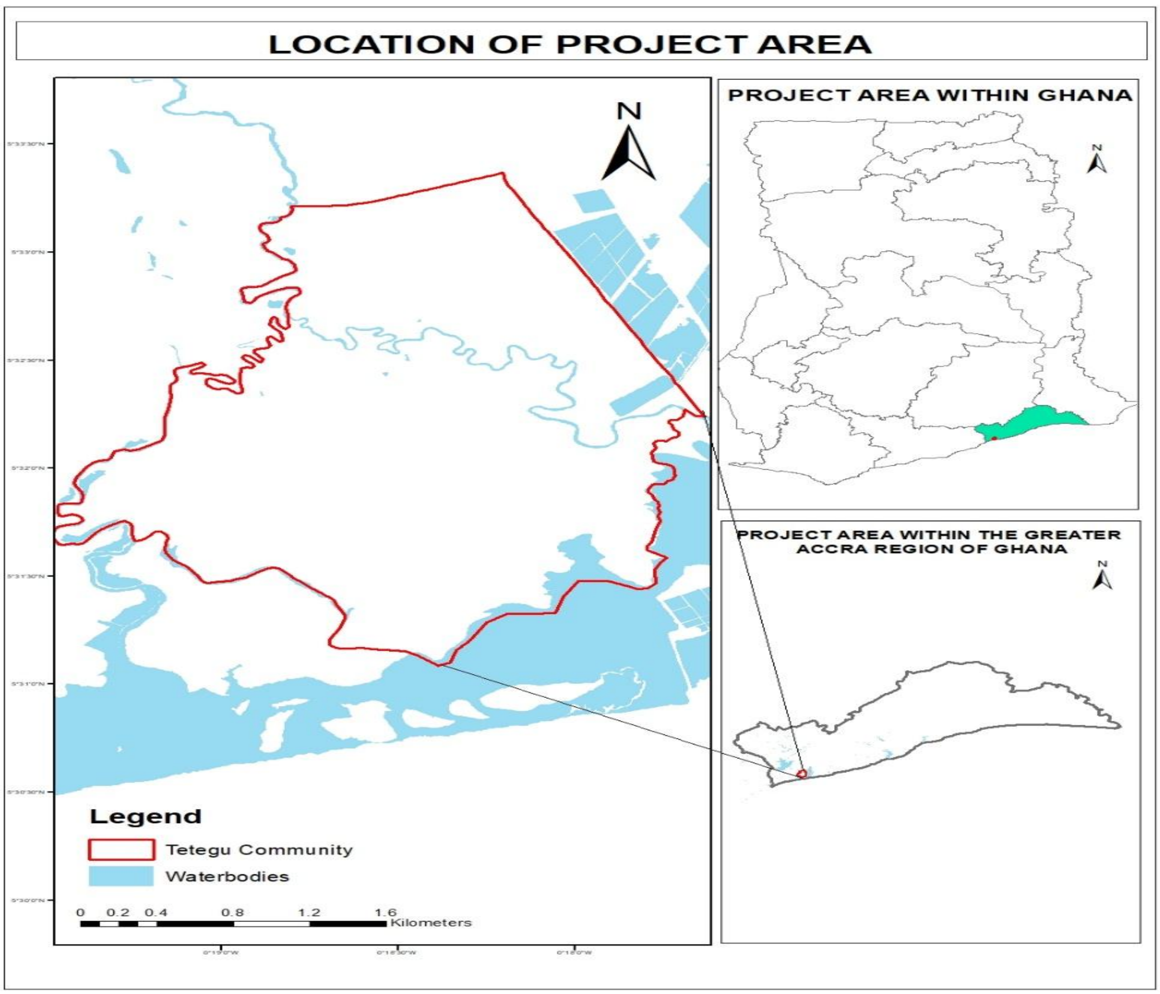

Figure 1: A map showing the Study Area

Tetegu is a community lying at the west coast of the Greater Accra Region of Ghana. It is located between Longitudes 0º19'30"W and 0º17'30"W and Latitudes 5º31'0"N and 5º33'15"N. The community covers a total land area of about Eight square kilometers (8.0km²) and has an estimated population of over 5000 inhabitants.

The Densu river flows through the community towards the sea. The presence of the river flowing through the community makes it susceptible to flooding when the river exceeds its banks and during periods of continuous heavy rainfall. Utility services have been extended to the Community and especially in 2018, the World Bank sponsored Greater Accra Metropolitan Area Sanitation and Water Project (GAMA-SWP) extended about 5.5km pipeline mains and subsidized new service connections to over 500 customers. Currently, the Ghana Water Limited has over 2500 customers connected to the over 22km of pipelines within the community.

Data and Methods

Methodology

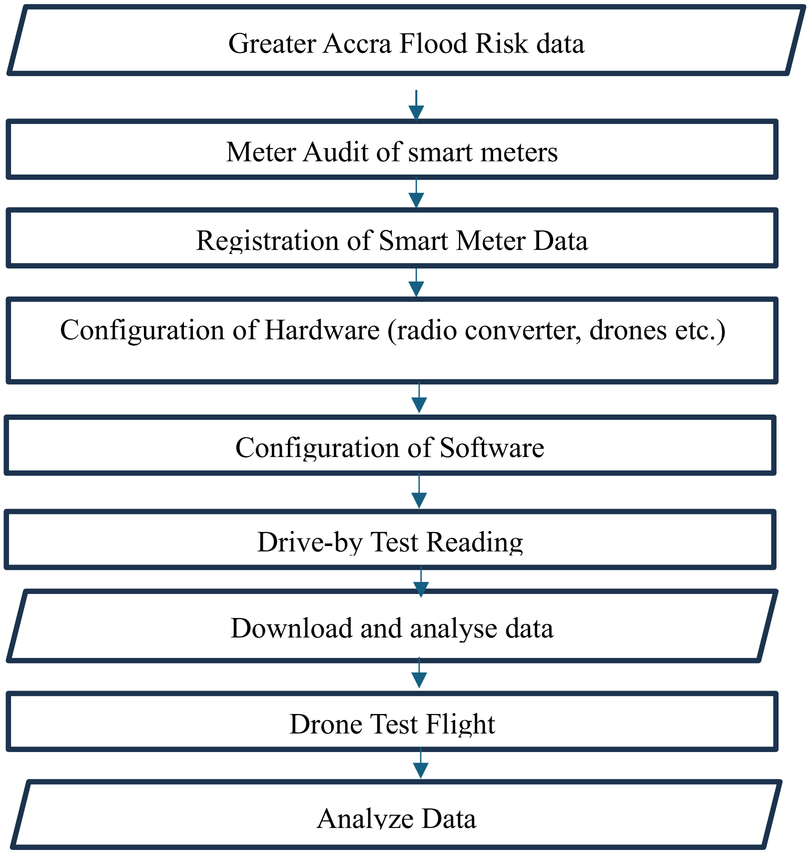

Figure 2: *Flow chart of the method used for the Automatic Meter Reading using drones.*

Table 1: *Data (from GWL) and Other Resource*

Item	Resource	Source
1	Mapped & Validated Distribution network	GWL
2	Topo Map	GWL
3	Points of Interest	GWL
4	Customer location data	GWL
5	ESRI Enterprise ArcGIS Software	GWL
6	ESRI Survey123 software	GWL
7	ESRI ArcMap 10.8	GWL
8	Microsoft Excel	GWL
9	Microsoft Word	GWL
10	Mobile phone	GWL
11	Laptop Computers	GWL
12	4X4 Pickup vehicle	GWL
13	Drone	WaterWorx Project

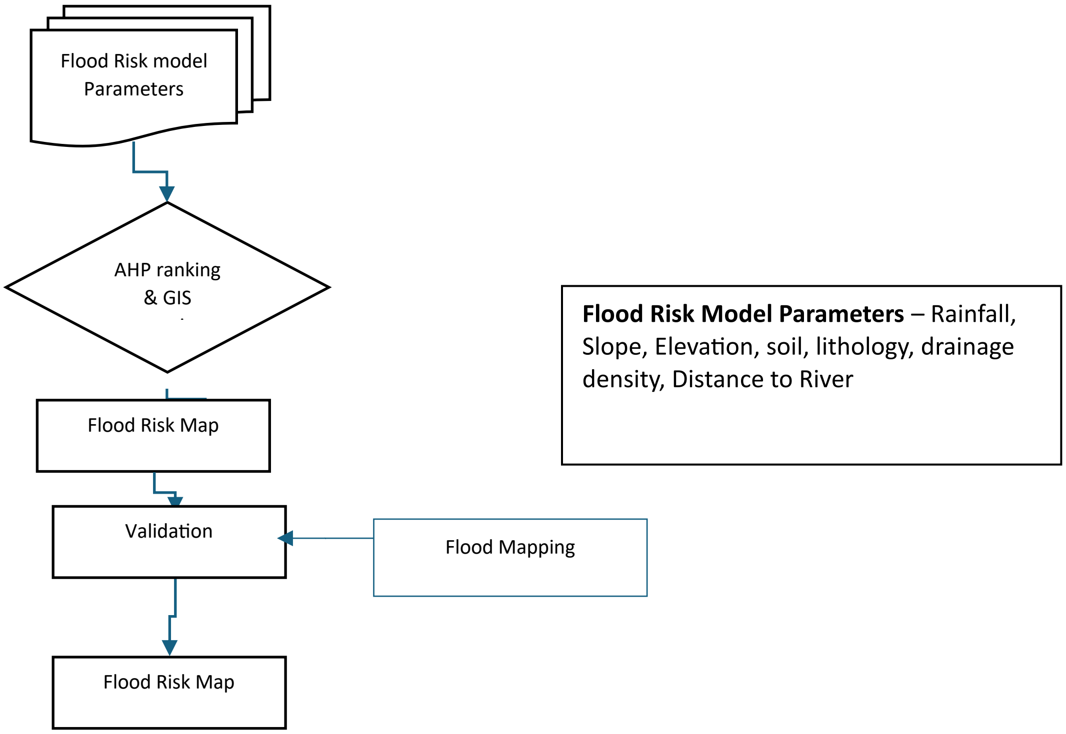

Figure 3*:Flow chart of the process to generate the Flood risk map (source: Flood prediction using GIS and Machine Learning, FIG,2023)*

The Ghana Water connected customers were overlaid a flood risk map obtained from a colleague author. Over 90% of these customers were found to be within the high flood risk zone of the community as shown in the maps below.

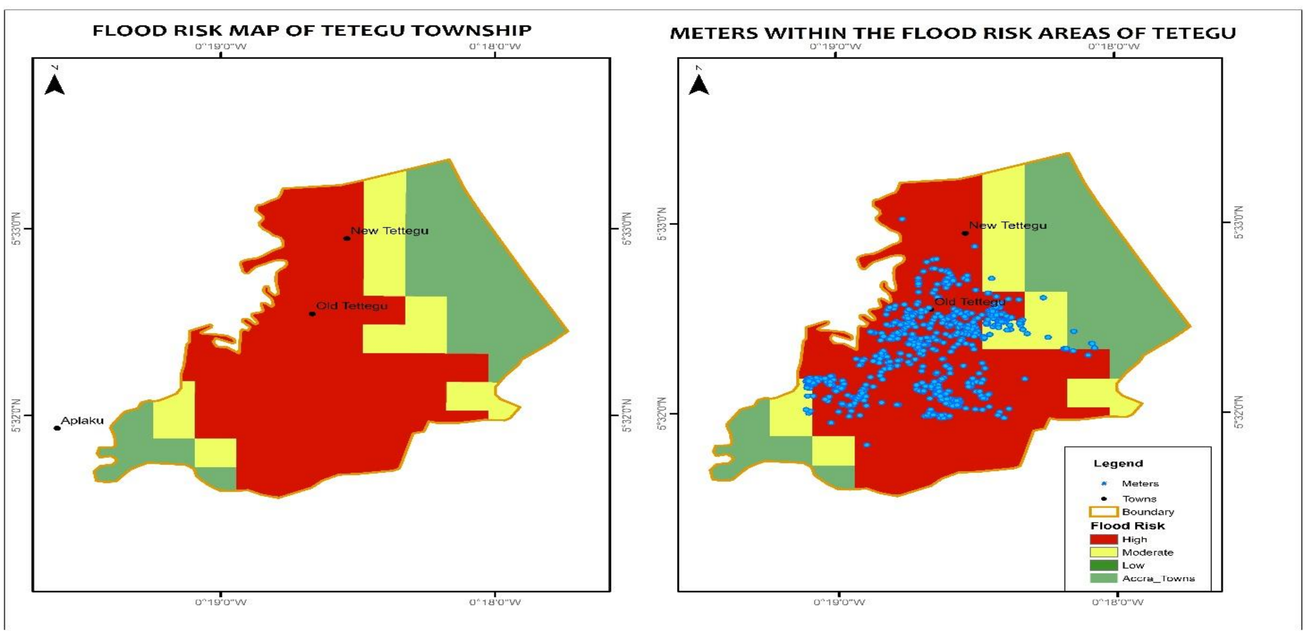

Figure 4: *Flood Risk map for Tetegu (source: Flood prediction using GIS and Machine Learning, FIG,2023)*

A meter audit done on the water meters available in the community revealed the presence of both ultrasonic and mechanical meters.

These ultrasonic smart meters were installed for customers who were connected to the grid under the subsidized GAMA-SWP. The meters were particularly selected due to numerous considerations which included the fact that they have no mechanical parts, are IP 68 approved, that is, protected against the penetration of water and dust, have built in wireless M-bus for drive-by remote reading and having up to 16 years battery life. These are but few of the advantages considered in choosing these meters.

After the audit, there were found to be about 624 ultrasonic meters. The ultrasonic meters were then registered into the relevant applications to enable a successful drive-by as prescribed by the manufacturers. A converter and a mobile device were the hardware needed for a drive-by remote meter reading. The drive-by was successfully executed. Readings uploaded were comparable to the ones captured manually on the GWL billing portal by the meter readers.

The next step was the drone meter reading which involved configuration of hardware and software. The converter and the mobile device with the installed relevant app were attached as the payload to the drone.

Figure 5: *A converter and a mobile device onboard a drone.*

The flight was executed in two plans to save the drone from crashing in case the battery ran down while in flight.

Figure 6: *A drone doing a "fly-by"*

Results

The results from the study indicated that the meter reading of all the customers within the study area was accomplished in 15 minutes of drone flight time compared to 5-7 days' work to be done on foot in normal time. The total number of meters read for the flight period was 553. 71 meters could not be read due to a few reasons which included the speed of the drone.

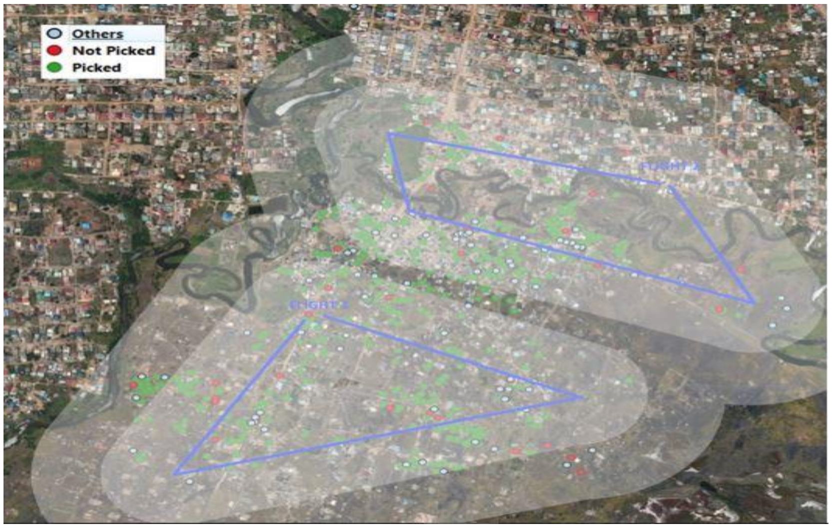

Figure 7: Meters read after drone flight

1. There is a significant positive relationship between Manual Reading (May Reading) and reading obtained using Advanced Meter Reading (AMR) technology
2. Model is highly accurate: 98.9% of variation in AMR values can be explained by May Readings
3. The Mean Absolute Percentage between the two sets of readings is very small (0.68%).

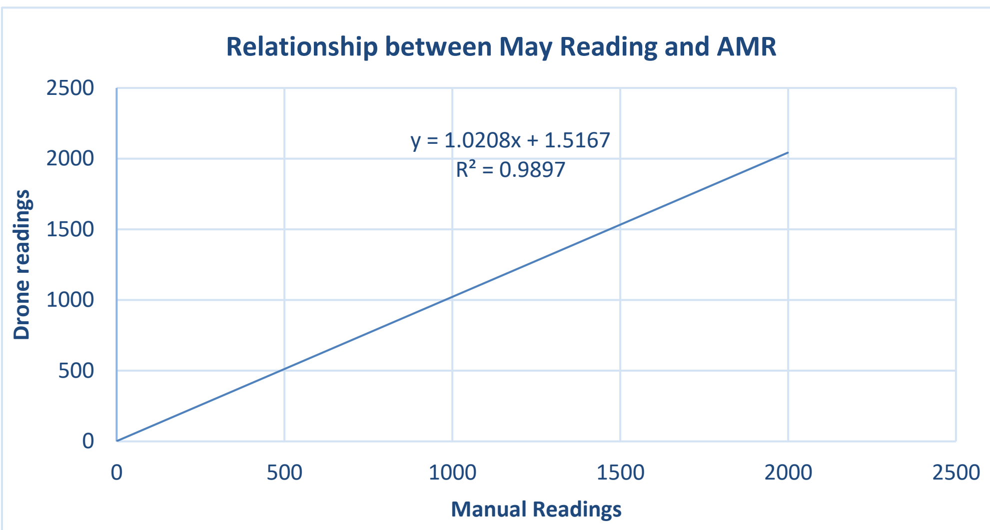

Figure 8: *Scatter plot showing the correlation between the drone and manual readings*

The table below is a comparison between the manual readings taken before the exercise and the drone-assisted meter readings. Depending on the time elapsed between the two readings, some meters showed similar readings, while others had slight differences.

Table 3: A table comparing readings

S/N	Customer Number	Meter serial number	AMR (Drone)	Manual Reading	Remark
1	02024322XXXX	76646985	556.304	546	OK
2	02024322XXXX	76646987	949.67	949	OK
3	02024322XXXX	76646988	834.993	834	OK
4	02024322XXXX	76646989	471.773	470	OK
5	02024322XXXX	76646990	379.198	369	OK
6	02024322XXXX	76646991	434.362	430	OK
7	02024322XXXX	76646992	493.208	468	OK
8	02024322XXXX	76646993	276.03	276	OK
9	02024322XXXX	76646994	314.073	314	OK
10	02024322XXXX	76647005	550.276	542	OK
11	02024322XXXX	76647008	244.446	239	OK
12	02024322XXXX	76647009	229.085	221	OK
13	02024322XXXX	76647010	907.718	871	OK
14	02024322XXXX	76647011	647.602	627	OK
15	02024322XXXX	76647012	203.209	197	OK
16	02024322XXXX	76647013	288.462	282	OK
17	02024322XXXX	76647014	423.884	416	OK
18	02024322XXXX	76647095	1864.885	1823	OK
19	02024322XXXX	76647096	77.427	75	OK
20	02024322XXXX	76647097	159.537	159	OK
21	02024322XXXX	76647098	646.763	632	OK
22	02024322XXXX	76647099	42.129	40	OK
23	02024322XXXX	76647100	477.366	466	OK
24	02024322XXXX	76647101	752.576	741	OK

Discussion

Revenue Generation

Data acquired from meters read with UAV using advanced meter reading technologies (AMR) reflected actual consumption volumes devoid of human errors. Challenges associated with the inability to access customer premises were also eliminated, leading to an increase in the accuracy of billing and consistent revenue generation.

Enhanced Operational Efficiency

In the test run carried out in the study area Tetegu, 553 meters were read in 15 minutes. This reduced an estimated 5-7 days or more of manual meter reading to 15 minutes. The rippling effect of this is that staff involved in meter reading can have additional time dedicated to other key responsibilities including customer management, which is difficult to carry out in addition to the traditional meter reading routines.

Increased Safety

This method which was developed sought to ensure that there is safety to GWL field meter readers in times of flooding. This eliminates physical on-site meter reading during flooding which has its own attendant risks.

Data Accuracy and Consistency

Readings were able to match the customer accounts and meters in the database at an accuracy of 99% to ensure that accuracy and consistency were achieved for billing to be carried out as seen in Table 3 above.

Conclusion

The integration of drone technology into meter reading operations holds immense potential for revolutionizing revenue streams and ensuring business continuity for utility companies in disaster-affected areas. By leveraging the capabilities of UAVs and smart meters, utilities can navigate the challenges posed by natural disasters or emergency situations, streamline operations, and maintain accurate billing practices. AMR technology is an accurate means of reading water meters.

Recommendations

i. The drone assisted meter reading should be employed occasionally even on dry days as a check on some of the meter readings being captured manually.
ii. There is a need to integrate these readings captured remotely into GWL's E-billing system to ensure the continuous meter reading we all anticipate.
iii. Follow-ups should be conducted on some of the accounts which had large differences between manual reading and drone assisted reading.
iv. Manufacturers of Smart meters or drones can invent new types of drones with a converter and a mobile device as payloads

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