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A GIS Evaluation for Accessibility to Wash Facilities in Mantapala Refugee Settlement

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Abstract
The paper sets to address the challenges of planning, implementing and monitoring of Water Sanitation and Hygiene (WASH) interventions in Mantapala Refugee Settlement (MRS) through combination of the paper-based method and geographical information systems (GIS). This method was used to assess the accessibility of WASH services by monitoring the interaction with other infrastructure such as the distance between water points and households. To incorporate spatial, qualitative and quantitative concepts, the research adopted the socio-spatial grounded theory and a non-experimental design specifically a cross-sectional study. The study identified 51 water points which translated to providing 31.88 litres per person per day (l/p/d) of clean water, with 75.69% of households covering less than 200 meters to fetch water. 21.88% of the households had decent latrines, 70.71% had permanent substructures and 7.41% had no latrines. 62 households walked less than 50 meters to the constructed refuse bays out of 3,574 households. The study concluded that organizations should consider employing this approach because decisions can be made with adequate information, leading to the optimization of scarce resources. Additional features such as contours made it possible to identify and avoid constructing dump sites/landfills along the flood-prone areas as well as a basis for designing drainage networks and solid waste management plans.

Keywords
Geographical Information system (GIS), Mantapala Refugee Settlement (MRS), United Nations High Commissioner for Refugees (UNHCR), Water Sanitation and Hygiene (WASH)

1. Introduction

Mantapala Refugee Settlement (MRS) was established at the end of 2017, as a response to the high number of asylum seekers from the neighbouring Democratic Republic of Congo (DRC), who crossed over to Zambia with the hope of finding a haven (UNHCR, 2019). The settlement is located approximately 30 kilometres from Nchelenge central business district in Luapula Province of Zambia and has a population of 15,000 individuals, who occupy 3,574 households which span a land cover of 1,800 hectares (UNHCR, 2019). Like many other settlements and camps, Mantapala is faced with developmental challenges such as the provision of decent sanitation facilities and clean and safe drinking water for persons of concern (UNHCR, 2018; Ahmed, et al., 2021).

2. Literature Review

To curb these gaps, several humanitarian WASH partners including United Nations Children's Fund (UNICEF), Norwegian Church Aid (NCA), New Apostolic Church Relief Organization (NACRO), Zambia Red Cross Society, World Vision Zambia (WVZ) and Oxfam came on board to carry out developmental activities, using both the Central Emergency Response Fund (CERF) and their resources (UNHCR, 2018). The various WASH partners chaired by the Government of the Republic of Zambia (GRZ) and the United Nations High Commissioner for Refugees (UNHCR) formed the WASH coordination working group with the aim of utilizing the available resources in the most cost-effective manner. With the available human resource, the working group adopted the paper-based method (UNHCR, 2018). In this approach, data is collected and consolidated manually into a spreadsheet for review and sharing with other key players such as donors (Agung, 2017; Newman, et al., 2020; Mambwe, et al.. 2021). It was, however,

observed that the paper-based approach was not adequate for organizations to make an informed decision because of its inability to provide a geographical linkage between the WASH services and the users as well as to infrastructure, both existing and new (Bohnet, 2015; Day, 2018). This made it difficult to trace interactions between WASH services (boreholes, toilets, washing facilities and solid waste sites) and other facilities/features within the settlement such as households, clinics, playgrounds, schools, and rivers (Achilli, 2015; Evans, 2017).

3. Methods

3.1 Research Design

To incorporate spatial, qualitative, and quantitative concepts, the research adopted a *grounded theory*, particularly the *socio-spatial grounded theory*. The research further employed a non-experimental design, specifically, a *cross-sectional study*. This is because the study took place at that time point and conclusions were made based on the observations at this moment in time. This study provided representations of WASH facilities in Mantapala Settlement by describing existing facilities and how they are used. Data was collected on the households, WASH facilities and other infrastructure in Mantapala Settlement both through mapping of the settlement and questionnaires.

3.2 Data collection (Mapping WASH facilities)

Location coordinates for each desired feature were collected (i.e. water points, dumpsites, institutional and household latrines and all existing infrastructure such as schools, houses, roads, clinics etc.) using a handheld GPS receiver device and then loaded into QGIS software to generate the map for the entire settlement. It covered the entire population of 3,574 households (approximately 15,000 persons of concern) within the Mantapala settlement.

3.3 Data collection (sample households for the survey)

This study adopted a *stratified random sampling approach.* This method was preferred because the population of interest was segmented into 19 blocks each with a different number of households (HHs).

This was done in the following steps by:

1. Calculating a representative sample size (n) given by:

   $$n = \frac{N}{1+N(e)^2}$$ (Yamane T. 1973).

   Where:

   $n =$ Signifies the sample size, $N =$signifies the population under study, $e =$signifies the margin error

   This method was preferred because there was a finite population.

   In this case we had,

   N=3,574 HHs,

   e=5%,

   n=3,574/1+3,574(5%)², where n=360, being the sample size

2. Obtaining the proportion of the number of households in each block to the total number of households.

   For example, block 8 had 99 HHs.

   Its proportion of the number of HHs is 99/3,574 = 0.028

3. Then, the corresponding proportion for each block in the preceding calculation was then multiplied with the total sample size calculated in step 1 to obtain the representative sample size for each block.
   For example, block 8 with proportion of 0.028 will have, n=360 x 0.028 = 10 HHs.

4. After which the households to be sampled were then randomly selected. Example: All HHs in block 8 were assigned a number, after which ten (10) of all the representative HH numbers were selected via a random number generator in excel and these were selected to be part of the sample.

3.4 Questionnaire

The study used closed-ended questions to collect data from the selected households using a questionnaire. This questionnaire aimed at collecting data relating to water sanitation and hygiene (WASH) at the household level. It captured information on sources of household water for daily use. It further captured information on the level of awareness in terms of public health risk, how household waste is generally disposed and information on the usage of household latrines i.e. to capture the population practising open defecation.

4. Results and Discussion

4.1 Water supply and coverage

The settlement has a total of 51 water points of which three are mechanized and 48 are equipped with 'Indian Mark II' water pumps. The population against the number of boreholes puts the water coverage at 31.88 litres per person per day (l/p/d), which is well above the sphere standard of 20 litres per person per day (l/p/d). Besides the crude 31.88 l/p/d water coverage, 75.7% of residents cover less than 200 meters while 24.3% need to walk more than 200 meters to access clean and safe water. This is summarized in Table 1.

In comparison to the paper-based method, which was demonstrated in this research using questionnaires, it can be observed that the use of GIS is more accurate in the water coverage of 31.88 l/p/d as opposed to the 25 l/p/d which was analyzed from the questionnaire responses. The ability of a GIS to link geolocation to the facilities allowed for the planning of where the additional 10 water points could be positioned to reduce the coverage distance between water points and facilities within the sphere standards distance of less than or equal to 200 meters (=<200 meters) as shown in Figure 1. With such information, the resource is well utilized, and the risk of duplication is minimized.

Table 13. Summary of water point distribution in Mantapala Refugee Settlement (MRS)

Block	Total Number of Households	Number of households not accessing water within a 200-meter distance	% not accessing water within a 200-meter distance
Block 19	74	73	98.65
Block 18	121	102	84.30
Block 17	314	92	29.30
Block 16	259	80	30.89
Block 15	225	20	8.89
Block 14	250	70	28.00
Block 13	160	0	0.00
Block 12	175	0	0.00
Block 11	167	141	84.43
Block 10	200	12	6.00
Block 09	166	11	6.63
Block 08	99	28	28.28
Block 07	174	14	8.00
Block 06	206	0	0.00
Block 05	196	110	56.00
Block 04	211	44	20.85
Block 03	180	33	18.33
Block 02	239	39	16.32
Block 01	158	0	0
Total	**3,574**	**869**	
Average population covering more than 200 meters to fetch water			**24.31%**

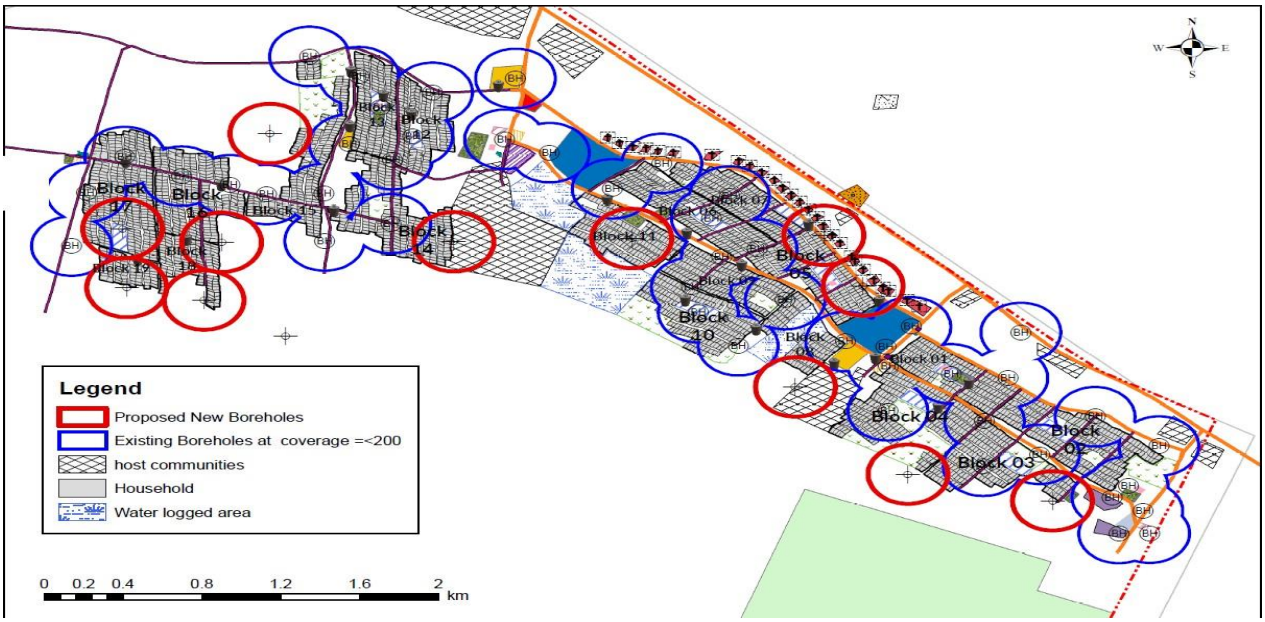

Fig. 1. Proposed new and existing boreholes

Household latrine coverage and hygiene promotion

From the mapping in Figure 2 and Table 2, it can be seen that 21.9% (782) of the households have decent latrines – permanent sub and superstructures, 70.7% have only permanent substructures with temporal superstructures while 7.4% (265) have no decent latrines.

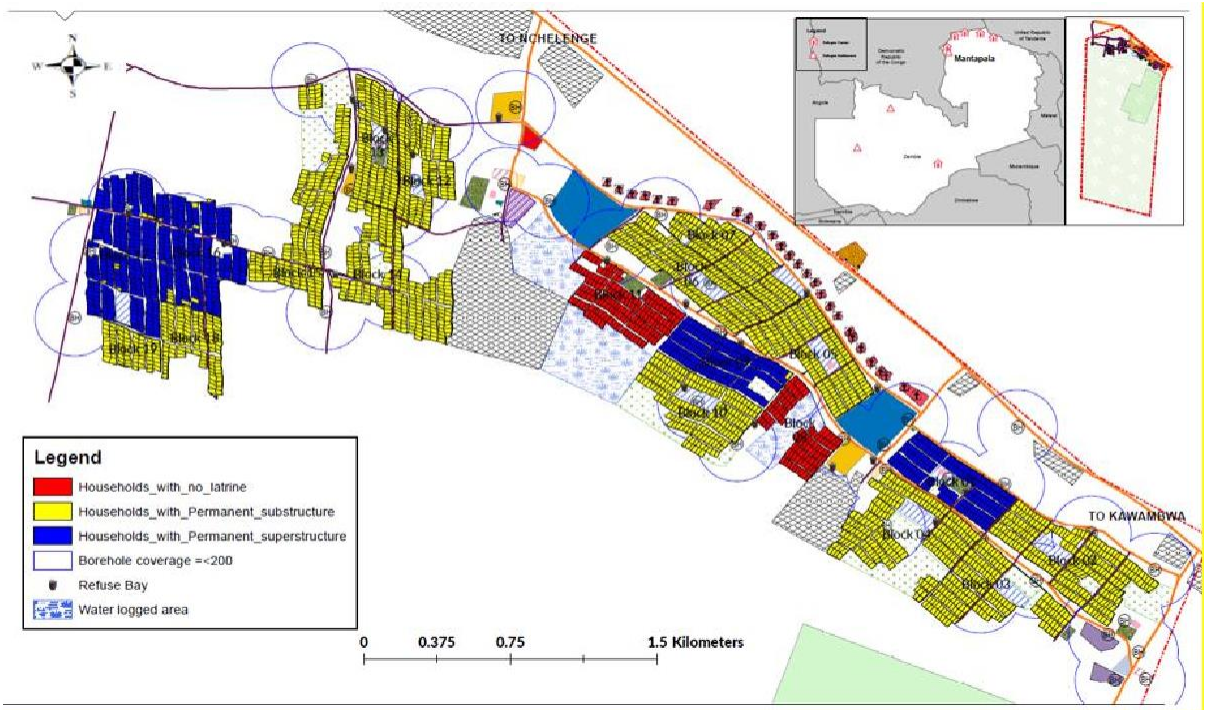

Fig. 2. Status of household latrines

A decent latrine is one that provides privacy,is structurally stable and that does not contaminate the environment or pose a risk to the user. According to UNHCR/Sphere standards, 85% of households should have access to decent shelter. In this regard, stakeholders should consider focusing resources to complete the 70.7% and 7.4 % of households who have temporary and no latrines, respectively.

Table 14. Summary of the type of latrines in the settlement

Type of Toilet	Number of Households	Blocks
Permanent super and substructure	782	17, 09 and 01
Permanent superstructure and temporal substructure	2,527	02,03,04,05,10,12,13,14,15,16,18,19
No latrine	265	09 and 11
Total Households	**3,574**	

4.3 Solid waste management

In this study the waste referred to is domestic waste, particularly at the household level and in public places, such as marketplaces and schools.

Results on solid waste management presented in Figure 3, indicated that only 62 out of 3,574 households had access to refuse bays within 50 meters of their houses.

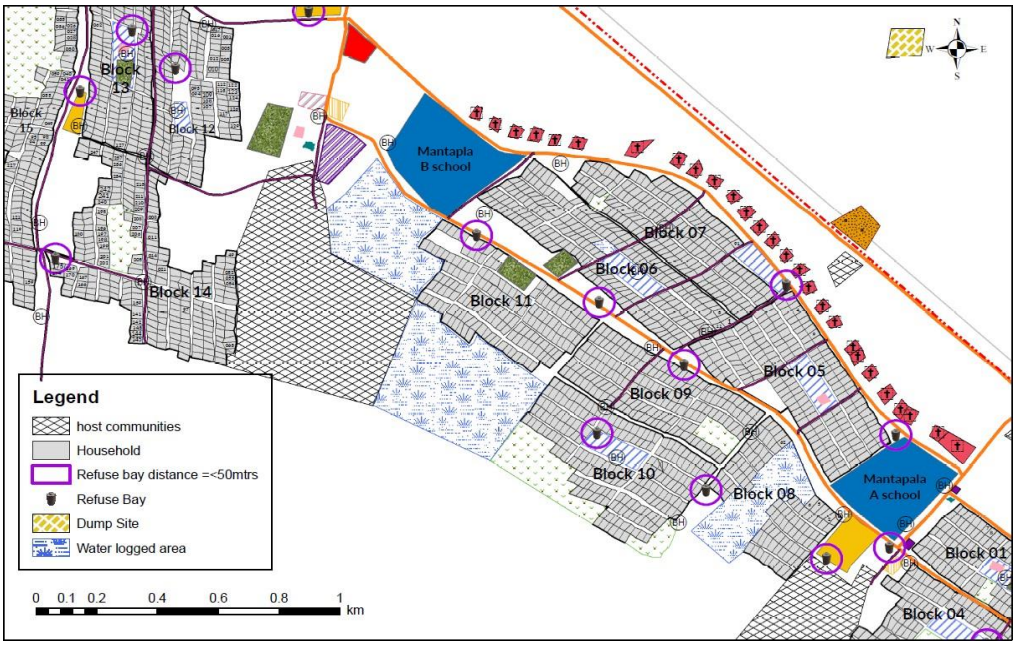

Fig. 3. Distribution, coverage of refuse bays and location of dumpsite.

In Figure 4, contours were applied to show the drainage path of the area and hence plan on how to position the required services. It was therefore suggested in this research that it would be cost-effective to relocate the dumpsite and select an alternative location since its current location is very close to the drainage path and poses a high risk of flooding and water contamination.

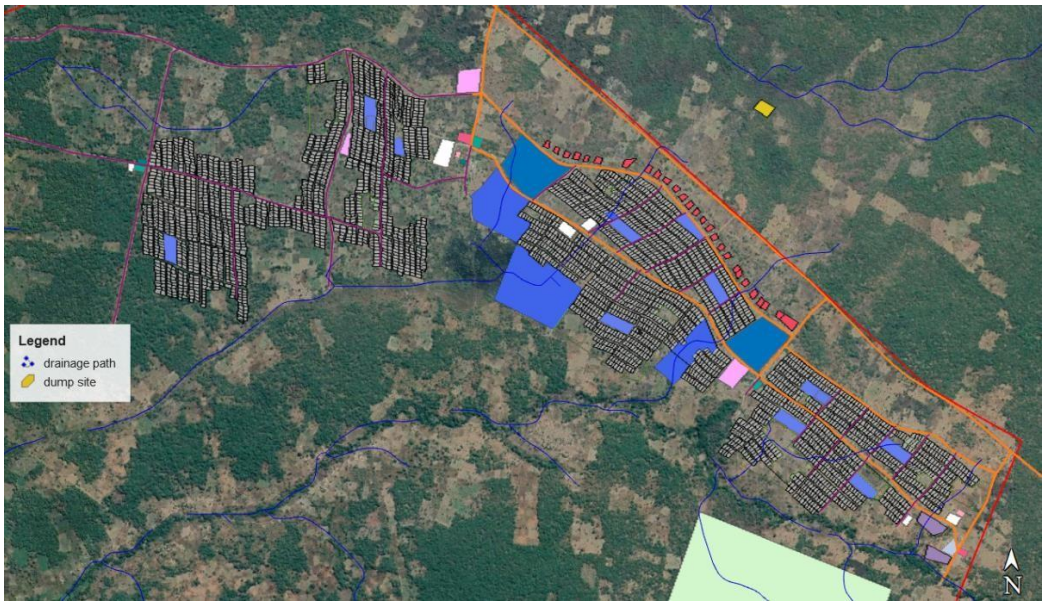

Fig. 4. Drainage path/contours and location of the dumpsite

5. Conclusion

This research aimed at demonstrating how GIS can be used to assess the accessibility of water, sanitation, and hygiene facilities in Mantapala Refugee Settlement of Nchelenge district. The findings demonstrate that GIS is a vital tool in the planning, implementation and monitoring of WASH programs conducted by various stakeholders. Displaying information using maps gives a more visual and conceivable picture of the study area, thereby understanding the spatial entity distribution in the settlement. This has made it possible to have a more accurate way of comparing WASH situation in the settlement, such as the distance from farthest structure to water point, number of persons accessing each water point, distance between latrines and water points, against sphere and UNHCR standards. This then becomes a basis of decision making. Contours enabled the identification of areas that are flood-prone and wouldassist in placing various infrastructure such as drainages, roads, boreholes, and shelter. From this study, it can be concluded that Mantapala Settlement is well covered in terms of the water supply as most of the population accesses water within the recommended distance, however the immediate focus should be put on the construction of householdlatrines to ensure that all households and drainage network are covered. This is necessary in order to reduce the risk of flooding and ground contamination.

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