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Geographical Information Systems (GIS) as a decision making tool for rural water services

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This paper presents the best practices of World Vision Uganda (WVU) in integrating GIS with conventional planning and management decision support tools to improve evidence-based planning, reporting and resource acquisition for water service delivery. An online GIS field reporting system was designed to track and monitor the Water, Sanitation and Hygiene (WASH) interventions within communities. Staff and community members were trained in geo-spatial data collection processes using Global Positioning System (GPS) equipments. The GIS data was analysed in ArcGIS to determine the level of accessibility and functionality of these water sources. The catchment of each water source was identified and the gaps in access to water sources was visually noted and prioritized during subsequent water resource planning and allocation. GIS has streamlined and simplified the traditional process of collecting data by creating a single repository for project data to be recorded, reviewed, approved, updated and analyzed to track progress towards achievement of impacts.

Introduction

The Uganda Ministry of Water and Environment (MoWE) reported that majority (85%) of the Country's population lives in rural areas where community-wellbeing is very dire. This is due to a myriad of inter-related problems such as wide spread poverty, the reliance on distant sources of polluted water and high level of exposure to human excrement in the environment (SNAP, 2009). Access to safe water and sanitation in rural areas is low averaging at 65% for safe water and 70% for sanitation, and that for hand washing facilities is estimated at 24% in the rural areas and 33% in urban schools (MoWE, 2010).

There was an urgent need, therefore for World Vision Uganda to intervene in this sector to significantly improve child well-being by enabling families and communities to achieve sustainable access to safe water, improved sanitation facilities and hygiene practice. Unfortunately over the last two and a half decades, World Vision Uganda just like other development agencies has been grappling with the challenges of rationally allocating the limited resources and demonstrating program impacts to the target beneficiaries. This was mainly due to the prevalence of weak linkages between programme interventions and the target beneficiaries, limiting rationalization of resources for maximum impact.

The conventional planning, monitoring and evaluation practices could not effectively address this gap due to complexities involved in identifying the target beneficiaries and decision-making in allocating the scarce resources. This caused misallocation of the water sources in community characterized by over and under provision in certain areas. The reporting and accountability systems were also weak hence limiting the project's chances of quantifying impacts.

Background

World Vision Uganda (WVU) is committed to improving community access to sustainable and safe water sources and good sanitation by establishing safe and clean water sources in the community; enhancing community capacity to maintain the water sources and improving sanitation and hygiene levels in the community. The application of GIS in humanitarian development including water resource planning and management has continued to grow over the last two and a half decades. GIS provides a blend of enhanced

analysis and improved visualisation for a variety of project needs (ESRI, 2011). The power of GIS has been realized in strengthening project planning, coordination, monitoring and evaluation and hence facilitating evidence based programming.

In 2011, World Vision International developed an online GIS field reporting system to track and monitor all the WASH interventions aimed at achieving the project' objectives. This system has streamlined and simplified the traditional process of collecting data by creating a single repository for project data to be recorded, reviewed, approved, updated and analyzed to track progress towards achievement of impacts. Accordingly, WVU has employed the application of GIS solutions to map out the locations of all the water sources, geo-spatial analysis undertaken to determine the level of accessibility and functionality of these water sources. This has provided opportunities to determine the catchment of each water source constructed and hence informing the management on potential areas that need to be prioritized during subsequent water resource planning and allocation.

Methodology

The GIS adoption process has been contextualized as: mapping of the existing water resources using the GPS devices, integration of the geo-spatial data into the monitoring and evaluation (M&E) system, reporting and utilization of the GIS products as management decision support tool in water resource allocation. These are explained below:

- The GPS mapping of community water resources is always participatory. The field staff mainly the engineering assistants, parish development committees, sub-county leadership and the community members actively participate in this process to ensure the ownership of the process as well as geo-spatial data generated. The mapping is implemented using the professional Garmin- Oregon 550 GPS units. The figure below illustrates the flow of data from the field to the online system and sharing of the final GIS products for decision-making in community water service delivery.

Figure 1. Flow of data from the field to the online system

- The geo-spatial data collected on the existing WASH interventions is integrated into the WASH online GIS reporting system to facilitate data sharing and collaboration with the different stakeholders including the donors and support offices
- The geo-spatial data[1] is also downloaded to other applications such as Excel and ArcGIS Desktop[2] for further analysis. This clearly identifies areas that need critical attention in allocating subsequent water

resources. The GIS products such as maps are also shared with the community members and their leadership to inform decision making as well as donors to lobby for more funding.

- WVU has continued to implement GIS solutions through ESRI GIS Desktop application[3] and WASH online reporting system platforms. This has streamlined and simplified the traditional process of collecting data by creating a single repository for project data to be recorded, reviewed, approved, updated and analyzed to track progress towards the achievement of impacts.
- However, capacity building is important in implementing GIS adoption process. Therefore, WVU has continued to offer trainings and orientation of project staff as mapping assistants through GPS data collection processes. This prepares the mapping assistants to effectively undertake the geo-spatial data collection process.

Results achieved

WVU has employed the application of GIS to map out the locations of different water sources to determine the level of accessibility and functionality of the water sources. With the geo-spatial analysis involving use of geo-statistical and geo-processing tools[4] of buffering, WVU has been able to determine the catchment of each water source constructed hence informing management on resource planning and allocation as indicated in the map below.

From the map it was realised that majority (60%) of the households didn't have access to safe water within the National Standard walking distance of 1km. Therefore, WVU became deliberate in targeting beneficiaries for provision of more safe water facilities with specific emphasis on the disadvantaged community members.

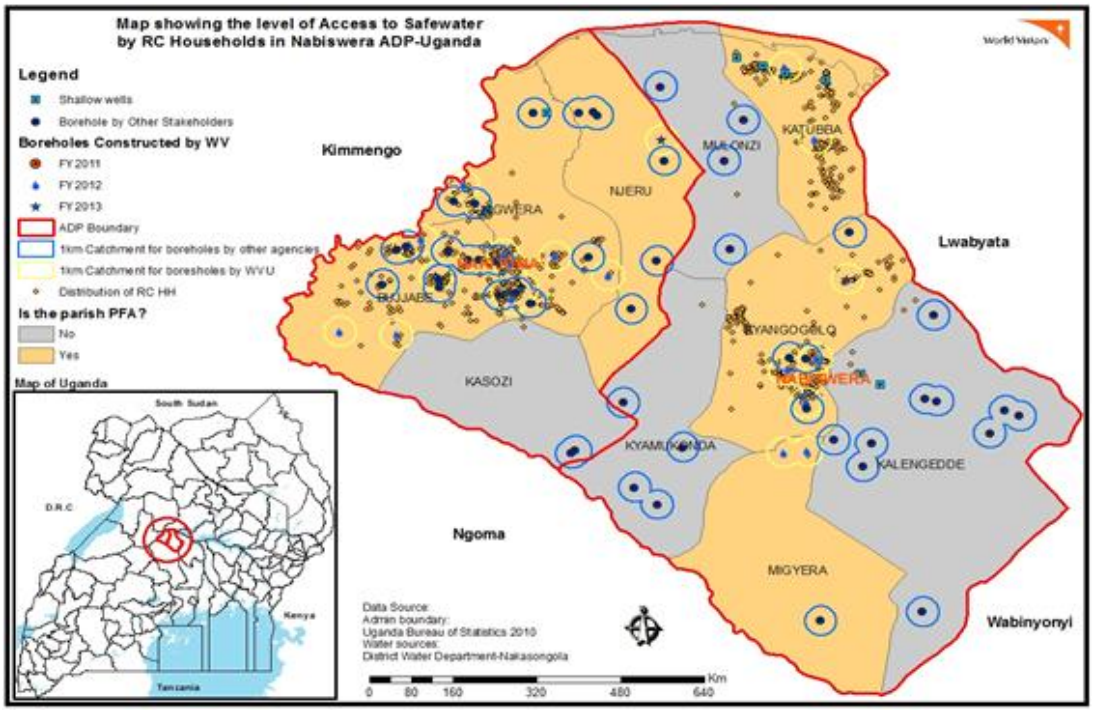

Figure 1. Level of access to safe water

Further, WVU programs' focus and impact areas are curved to specific geographical locations. GIS has offered an opportunity to strengthen the linkage and geographically reference WVU WASH program interventions to the target beneficiaries to maximize and demonstrate progress towards the achievement of project outcomes. GIS has also contributed to improved practices of data collection, analysis and reporting with a combination of tables, diagrams and maps and hence evidence based management decision support tool.

Lessons learnt

- Support from the top management is critical to the success of GIS adoption process. For instance, WVU commenced the adoption campaign with an imperative process of envisioning and resource mobilization where support from top management was invaluable. In particular, the identification of a champion and a very passionate member of the senior management team about GIS application as a tool for water resource planning and allocation is the key to its acceptance and effective utilization.
- GIS capabilities have also been fully realised through consolidation and integration into the existing planning, monitoring and reporting systems and structures. Therefore, it became much easier to sustain the adoption process and build the momentum within the existing system. The existing staff capacity was built in adopting GIS as management decision support tool other than hiring external consultants.
- Membership into GIS professional bodies is also important. WVU right from the beginning of GIS adoption process has been a member of the Geo-Information Management (Geo-IM) Workgroup in Uganda and this greatly contributed to the success of GIS application as decision-making tool as well as sharing of data and experiences. Upto date data is always critical in implementing GIS projects. Therefore, membership into the GIS working group resulted into free data acquisition for the existing agencies implementing GIS in programming in Uganda.
- Integration of GIS in planning for resource allocation improves program efficiency and effectiveness since decisions are made from an informed point of view. Notably, decisions made without adequate, timely and reliable data are normally adhoc, irrational and in most cases politically motivated hence leading to over/under provisioning of services. The outcome of such decisions rarely meets the expectations of the intended beneficiary. This challenge has been addressed with GIS adoption. In particular, WVU now allocates resources based on the need and spatial distribution of the existing safe water facilities as presented in the map.
- The engagement of the community representatives and members during GPS data collection process enables a comprehensive data capture since these are people who are very familiar with the geography of the area and know where the features of interest are located. This has also proven to be an important tool facilitating effective utilization of the key findings from the GIS mapping process. In summary, participatory mapping approaches have been used to ensure that all the facilities are mapped to avoid missing critical data that would inform decision making in resource allocation.
- It is also important to update and validate data obtained from secondary sources. For instance, the secondary datasets obtained from Uganda Bureau of Statistics (UBOS) on the existing water sources were verified with the community representatives to ascertain the quality. Through this process we learnt that a lot of facilities such as water sources were not captured. Therefore, this enabled us to identify the gaps and integrate in the geo-spatial data collected.

Conclusion

The application of GIS in improving sustainable access to safe water has not been used to replace the existing initiatives or programs. It has focused on strengthening the existing M&E processes. Therefore, GIS has offered an opportunity to strengthen the linkage and geographically reference WVU program interventions to the target beneficiaries to maximize and demonstrate progress towards the achievement of increased access to safe water-an indicator of child well-being outcomes. GIS has also contributed to improved practices of data collection, analysis and reporting with a combination of tables, diagrams and maps and hence evidence based management decision support tool.

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Notes

[1] Geo-spatial data is information that identifies the geographic location and characteristics of natural or constructed features and boundaries on the earth, typically represented by points, lines, polygons, and/or complex geographic features.

[2] ArcGIS is a geographic information system (GIS) for working with maps and geographic information. It is used for: creating and using maps; compiling geographic data; analysing mapped information; sharing and discovering geographic information; using maps and geographic information in a range of applications; and managing geographic information in a database.

[3] ArcGIS for Desktop application is ESRI's software level that allows you to analyse your data and author geographic knowledge to examine relationships, test predictions, and ultimately make better decisions.

[4] Geo-statistical and geo=processing tools in GIS are used to manage your data in ArcGIS software. For instance, the buffering tool creates buffer polygons around features for specified distance as applied in the above map.

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