

APPLICATION OF GIS TECHNOLOGY IN EVALUATION OF MAKUENI COUNTY GOVERNMENT IN ENHANCING ACCESS TO WATER TO RESIDENTS OF MAKUENI COUNTY, KENYA

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ABSTRACT

GIS is a computer based system for capturing, storing, analyzing and displaying spatial data thus allowing the visualizations of different kinds of information like patterns and relationships of features on the earth's surface. One such application is the use of GIS in monitoring water resources and availability and the extent of water scarcity through the analysis of distances that locals from given regions have to travel in order to access this precious commodity. Water scarcity is prevalent in the Arid and Semi Arid regions of Kenya, for example, the Makueni County, of Ukambani region. This persistent water problem affects many livelihoods and deny people the opportunity for sustained economic and social progress. Previous effort by past government administrations have not achieved much; there was however, greater hopes with the coming of the devolved systems of governments through the new constitution promulgated in 2010, it was believed that service delivery and access to critical resources like water would increase. This study sought to explain how this can be done as well as attempting to evaluate the actual contribution of Makueni county government in increasing water supply to the community. The study made use of global positioning system GPS in locating water supply point in Makueni county and applying geographic information system GIS in computing distances between water supply points in Makueni County, and overlaying this on the demographic maps of the said counties from which the analysis of the distances can be done. The study found that there were more boreholes established in Makueni between 2013 and 2016 than those established in the area between 1940 and 2013. This was interpreted to mean that in the four years of devolution, the county of Makueni had contributed to enhancement of access to water than what had been done by the colonial government and independent between 1940 and 2012.

Key Words: Environmental degradation, impact, water quality

BACKGROUND OF THE STUDY

Water is a basic need that must be provided to all citizens and this is an obligation on the side of the government according to the constitution of the republic of Kenya (GOK, 2010). According to this constitution, people must have access to a certain quantity of water per day and the water must be free from contamination. Insufficient water in the body may lead to dehydration and this kind of situation may be deadly (Farrell-Poe, 2000).

People require water for a wide range of activities essential to their livelihoods, including both domestic (drinking, washing, cooking and sanitation) and productive needs (vegetable gardening, livestock, brewing beer, brick making, etc).

Due to perennial water shortage, the local community has picked up the practice of roof catchment and installation of and storage tanks to harvest rain water by the help of the county

government which issued 100 tanks to every ward. The majority of the population depends on surface and sub-surface dams for water, which often do not hold sufficient water due to high evaporation rates during the dry seasons. The vast area of the county and the population is therefore inadequately supplied with water with an average distance from a water point high at 8 kms. This has there led to severe water shortages for domestics, livestock, crop and industrial use. Being an ASAL region the county hardly receives sufficient rainfall. The ground water resources are low and saline because of the basement rock system. This has greatly affected agricultural and livestock production as most farmers are forced to depend on rain fed agricultural production. The county has therefore improved access to water through digging of boreholes in order to reduce the distance from a water sources. This has allowed the county's residents to devote time to other economic disciplines rather than wasting much time in search of the precious commodity.

Some of the water related problems experienced in the county include; decreasing quality of water ,water scarcity, dysfunctional municipal water infrastructure that have resulted in the potential water crisis widely publicized in the media. All the above facts necessitate effective service delivery from the county government of Makueni under its jurisdiction, also has a responsibility to supply water to the communities under its jurisdiction including households which is the focus of the study. Water plays a pivotal role in the success of projects.

PROBLEM STATEMENT

As has already been pointed, water is a critical resource for human livelihoods including cooking, drinking among others. As it currently stands, the water demand in Makueni county is 22,113m³/day and the developed sources have an average production of 13,607m³/day. However, there are only two major rivers; Athi which is permanent and Thwake which is semi-permanent. Other includes Kaiti, Muooni and Kikuu all of which are seasonal. People can only increase their access sithr through personal initiatives and investment and through reliance on the government to provide the critical resource. The process of increasing water access through private investment is an expensive affair considering the huge amounts of investment it has to take an individual to sink a borehole or build a dam. Again, despite the county considered arid and semi arid, efforts in the past have achieved little for the residents in terms of water supply, although, many agencies and nongovernmental organizations always claimed of the considerable work they have done in the past, despite the little proof of such. In fact, very, little work has been done to evaluate and document the actual progress that has been in the line of water supply in the area, no work has attempted to determine the change in the actual progress in water services delivery in terms of distances to access point, number of new watering points and the number of people who have been reached. It was the interest of this research to determine the progress made in the provision of water access to the locals using GIS technology and to evaluate the performance of the county in the line of provision of water services from the research findings.

JUSTIFICATION OF THE STUDY

This study is important because the Constitution of Kenya 2010 under article 43 (1) (a) Article 43 defines the right of each person to clean and safe water in adequate quantities. Article 58 requires the State to put in place affirmative action programmes designed to ensure that minorities and marginalized groups have reasonable access to water, health services and infrastructure. Besides, Kenya identified issues of environment and water as key in the

realization of Vision 2030 and this included identification rehabilitation of degraded water catchments areas.

The study was also necessary considering the importance attached to environmental issues in the UN 2030 Agenda for Sustainable Development which Kenya is a signatory. Specifically, Goal 6 that ensures access to water and sanitation for all besides ensuring availability and sustainable management of water and sanitation for all and to protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

Thus, this study was found necessary for generating information and awareness about the progress made by the county government in the provision of water supply since the beginning of devolved county system of governance.

RESEARCH OBJECTIVE

The main objective of this study is to evaluate the performance of devolved system of governance in increasing accessibility and supply of water services to citizens of Makueni County.

RESEARCH QUESTION

The question to be answered is: Has the county government of Makueni done well to increase the provision of water access and supply in Makeueni County

RESEARCH DESIGN/METHODOLOGY

Study area

Makueni County covers an area of 8,034.7km square is one of the forty seven counties in the country. The county borders kajioda to the west, Taita Taveta to the South, Kitui to the east and Machakos to the north. It lies between latitude $1^{\circ}35'$ and $3^{\circ}00'$ S and longitude $37^{\circ}10'$ and $38^{\circ}30'$ E. The county lies in the arid and semi-arid zones of the Easter region of the county. The major physical features in Makueni County include the volcanic chyulu hills which lie along the southwest border of the county in Kibwezi west constituency, Mbooni hills in Mbooni consistency and Kilungu hills in Kaiti constituency which rises to 1900m above sea level. The county terrain is generally low-lying from 600m above sea level in Tsavo at the southern end of the county. In the year 2012 the projected population in the county was 922,183 consisting of 449,036 males and 473,147 females. The main rivers in the county is Athi River, which is perennial and fed by tributaries such as Kambu, Kiboko, Kaiti, Thwake and Mtito andei, which drain from various parts of the county. A few other streams flow from the Mbooni and kilungu hills but their flow becomes irregular as they move to the low-lying Areas.

The lower side which is very dry receives little rainfall ranging from 300mm to 400mm. The depressed rain in the lower part of the county hardly sustain the major staple food of maize and beans. Over the time county has experienced climate change and variability which includes insufficient rain and prolonged dry spells among others. Water scarcity has also become worse due to this condition. To mitigate the effect of water scarcity, the County government has resulted into digging of boreholes and construction of sand dams which are capable of retaining water.

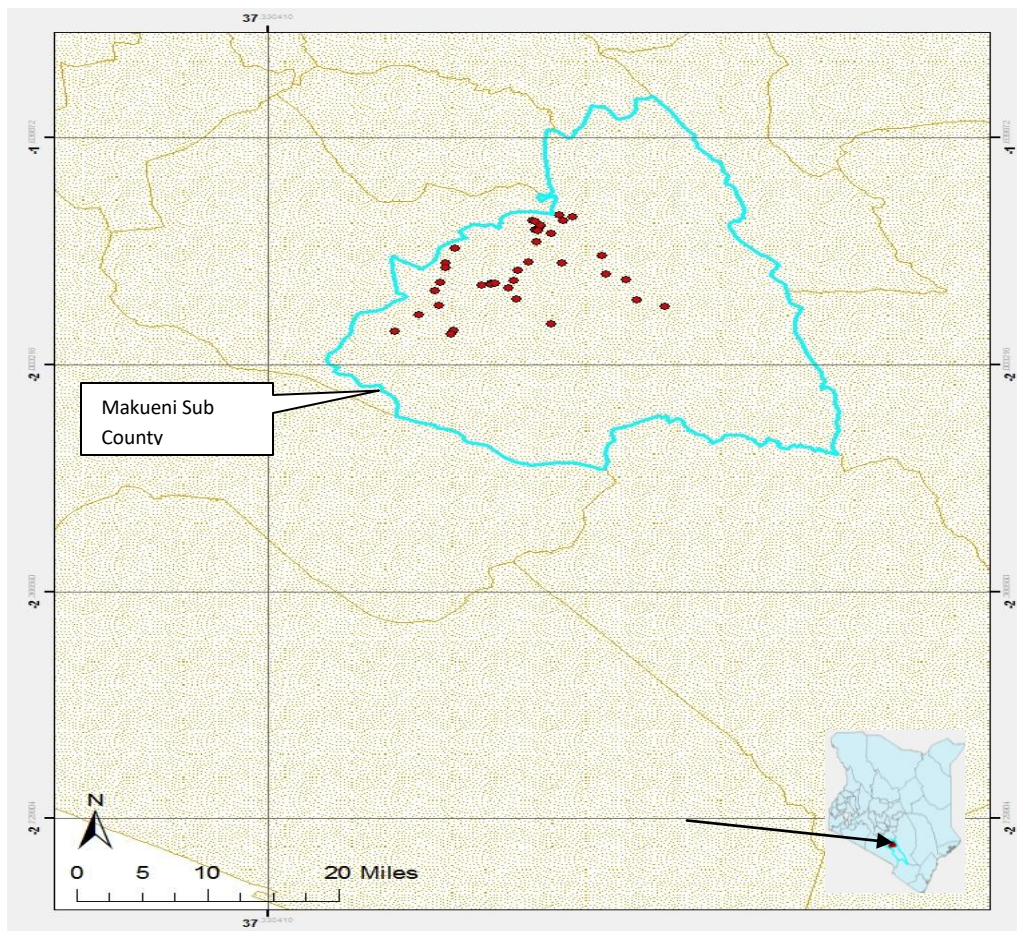


Figure 1: Map of the study area

Data collection

The data collection was achieved through GPS survey which was done in mid August 2016 using an *etrex 30* GPS receiver device. During the GPS surveys, other collection techniques like photography, interview and observation were used. The base maps used were downloaded from online sources and included Kenyan administrative boundaries, river density.

Data analysis

The GPS data collected was organized in excel and formatted as delimited text files for use in ArcGIS software. The maps were sorted according to clarity, relevance and resolution. GIS analysis was achieved through ArcGIS 10.31 installed in the university computers systems and server through a license partnership with ESRI East Africa. The spatial data collected (coordinates & images) were imported as shape files layers, they were then overlaid on the base data map in the software from where changes in the catchment status were observed from the temporal resolution images, analysis of change and areas were performed. The draw tool in the

toolbar was used in determining the distances between points. The coordinates were plotted to show key boundary areas and important points in the study area like hill peaks, water collection points, eroded spots etc.

Other statistical analyses were accomplished in MS excel. The Data analyzed was presented as map outputs, table summaries and figures. Pictures taken from the area were also included as outputs.

RESULTS AND DISCUSSIONS

Access to water sources (Distance to nearest water points)

The average distance to nearest water source is 8 kilometers with regards to rivers, which are seasonal leaving the residents with little options during the driers seasons. Figure 1 show the average distances between one river sources to the other, measured at both their nearest and widest points. Before, households used to access water from river, and as seen in table 1, the average distance was between 10 to 25km to the nearest river (see also figure 2). Unfortunately, these rivers are mostly seasonal and often dry in most parts of the year. Intervention of county government has greatly reduced the distances by digging and construction of dam in the sub county. Plate 1 whos some of the water points including dams and boreholes that serve residents nowadays.

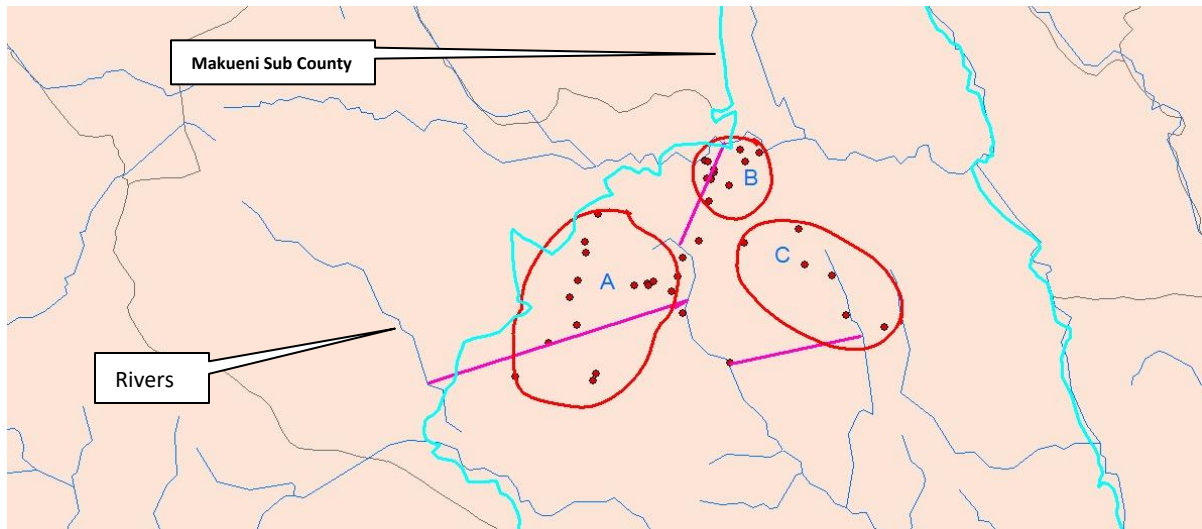


Figure 2: Map showing the study areas and the measured distances from one natural river to the next.

Table 1: Summary of distances between one river and the other

Zone	River	River	Distance (km)
A	Kikuu	Mumbuni main	25.74
B	Arthi	Mumbuni main	12.02

C	Mumbuni main	Tributary	10.09
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Temporal analysis

The analysis attempts to evaluate the performance of the government agencies both past and current to establish how much they have done to improve the access to water among residents of Makueni. Figure 3 shows a classified plot of the boreholes with reference to the years when they were done. From the visual impression, it can be seen that many dam and boreholes have been done in the past five years (from 2010). The map shows the efforts of the Makueni county government on improvement of construction of dams and boreholes in different years. By the end of 2012, there were 17 boreholes and 4 dams (Table 2), however, but by the end of 2016, the number of boreholes have gone up to by 19 by year 2016 and two more dams were constructed. This has translated into an average increase in access of 48% (Figure 4). The study found that there were more boreholes established in Makueni between 2013 and 2016 than those established in the area between 1940 and 2013. This was interpreted to mean that in the four years of devolution, the county of Makueni had contributed to enhancement of access to water than what had been done by the colonial government and independent between 1940 and 2012.

Table 2: Numbers of dams and boreholes done between 1940 and 2016

Period	Number of Boreholes	Number of Dam	Total(dams and boreholes)
<1960	3	2	5
1970-2000	4	1	5
2001-2007	7	0	7
2008-2012	2	2	4
2013-2016	17	2	19
TOTAL	33	7	40

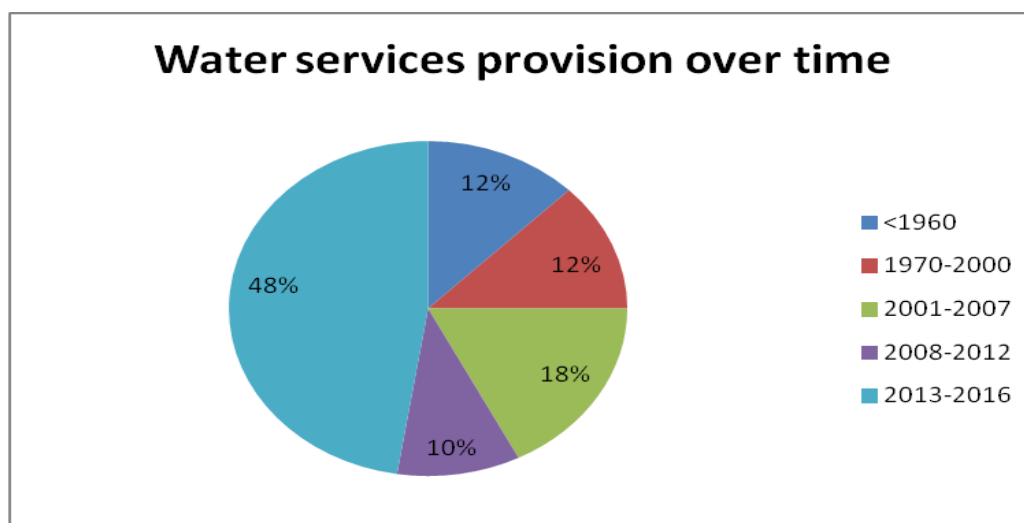


Figure 3: Watering point at one of the boreholes

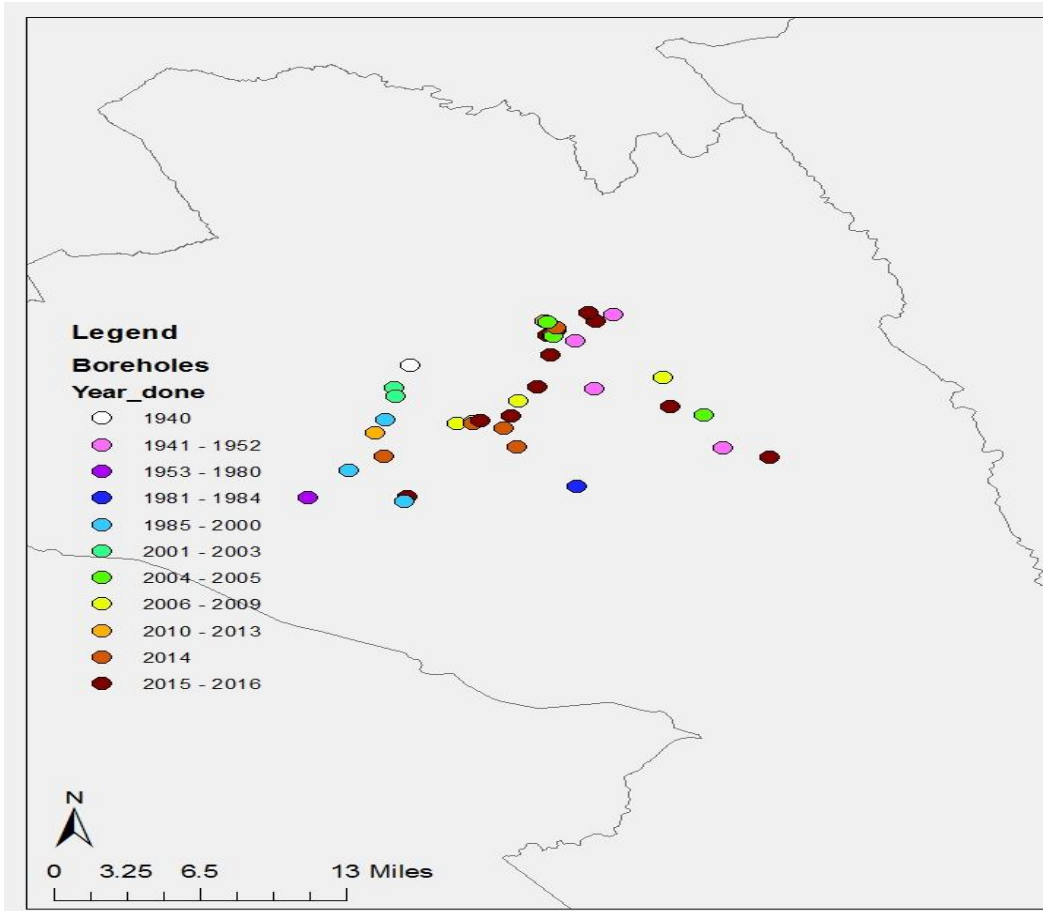


Figure 4: Temporal classification of water points (when they were constructed)

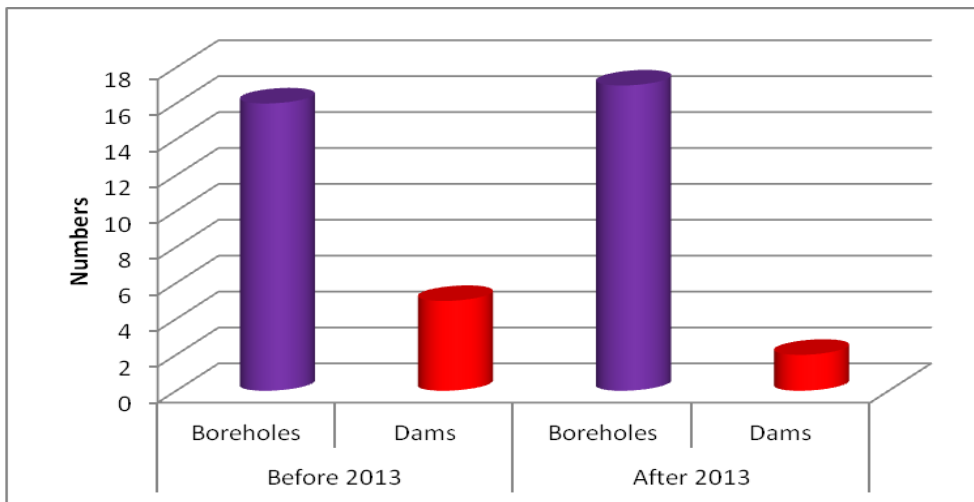


Figure 5: Number of dams and boreholes done before and after devolved governance



Plate 1: Some of the watering points in Makueni County

CONCLUSION AND RECOMMENDATIONS

As has already been pointed out, before the devolution of county government, the households used to access water from the rivers. This distances they used to travel before boreholes are dug were enormous, however the distances have been minimized due to construction of dams and boreholes, and this has helped many households in terms of access to water resources.

The study found that there were more boreholes established in Makueni between 2013 and 2016 than those established in the area between 1940 and 2013. This was interpreted to mean that in the four years of devolution, the county of Makueni had contributed to enhancement of access to water than what had been done by the colonial government and independent between 1940 and 2012.

The researcher recommends the following:

- 1) Local community around the water services should establish communities to manage the water resources and establish community cooperatives for circulation of income for water service within the community for sustainable development.**

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