MAPPING GEOGRAPHICAL FEATURES: CASE STUDY OF BUNGOMA COUNTY

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Background to Geographic Information System

It is not very easy to give an exact definition of GIS as it means different things to different authors due to its multi-disciplinary origin and multi-application fields. GIS is an acronym for Geographic/Geographical Information Systems/Science. A number of Authors, authorities and/or societies have defined GIS in a number of ways. One of the authors is Aronoff, S. (1989), who defines Geographic Information systems as computer-based systems used to store and manipulate geographic information. A GIS is designed for collection, storage, and analysis of objects and phenomena where geographic location or geo-referencing is an important characteristic and critical to the analysis or exploration. Geographic Information System is manual or computer-based set of procedures used to store and manipulate geographically referenced data.

A GIS is a computer-based system that provides the following four sets of capabilities to handle geo-referenced data: Input; Data management (data storage, and retrieval); Manipulation and Analysis, and; Output (Aronoff, S. 1989). GIS is a powerful set of tools for collecting, storing, retrieving at will, transforming, and displaying spatial data from the real world for a particular set of purposes (Burrough, P.A. 1986). GIS is a database management system technology that integrates spatial data with large sets of related information (ESRI, GIS Arc/Info, 1989). GIS has characteristics including mapping, storage, and manipulation of dynamic comprehensive database; merge data for different analyses and new information; provide quantitative, qualitative, and spatial descriptions of planning decisions; a variety of digital formats can be read, and; final data can be transformed to other databases (ERDAS Inc, 2015). GIS is among others also a tool for accessing, integrating and distributing large sets of spatially referenced data in large number of applications (ESRI, 2008).

Work on GIS began in late 1950s, but first GIS software came only in late 1970s from the lab of the ESRI. Canada was the pioneer in the development of GIS as a result of innovations dating back to early 1960s. Much of the credit for the early development of GIS goes to Roger Tomilson. Evolution of GIS has transformed and revolutionized the ways in which planners, engineers, managers among others conduct the database management and analysis.

Statement of the Study Problem

The earth's limited resources are usually under constant pressure due to limited supply and unlimited demand. This has resulted in multiple problems requiring multiple approaches to solutions. Solving such problems requires multi-disciplinary, multi-agencies, and multi-sector approaches in order to understand the problems, i.e. an integrated approach and information are the key to solution. With GIS one can be able to map different areas and be able to identify which areas are prone to flooding, soil erosion, deposition of eroded materials, which areas are safe for establishment of infrastructure including settlement and recreation. The study used GIS, an integrated approach to map physical and human features in Bungoma County. The output product of GIS processes was an integrated map document, database, for the development of the County.

Study Objective

The main objective of the study was to map the physical and human features in Bungoma County.

Significance of the Study problem

In the recent past GIS has gained a tremendous trend in mapping environmental and human features across the face of the earth. The model of mapping features in the study area has not been fully utilized because it is an expensive venture but it is worth it. Despite the bottleneck with embracing the technology, the researcher put in efforts and was able to buy relevant data and subsequently mapped the physical and human features found in Bungoma County. The final output document, map document, formed the database that can be used by the County government of Bungoma, environmental experts, policy analysts and farmers for the wellbeing of the people of Bungoma County. Farmers can easily identify areas that are suitable for farming. Therefore the study was relevant.

Literature

Several studies have been conducted in the area of mapping natural and human features. Chepkania, L.S. (2018) did a study on assessment of soil erosion factors in parts of Bungoma County drained by River Kibisi. In his study Chepkania found out that terracing is the best practice for soil conservation and soil management for Bungoma County. A similar study on soil loss equation has been done by Reshma, P. and Uday, K. (2012) in Upper South Korea Basin.

The study is relevant to the current study and gives foundations to build upon especially in mapping potential areas for farming.

Kemunto, E.A. (2013) did a study on the Role of geo-information in enhancing tourism in National Parks case study of Amboseli National Park demonstrates the importance of Geo-information. A topographic map and other data from Kenya Wildlife Service were used in the study to create a geo-database and a digital map of the Park using GIS software. Features were digitized on the scanned map and other data in form of shape files added as overlays. An attribute table was created to link the spatial data with their characteristics in order to provide more information for analysis. From the findings of the study, it was concluded that with coordinated and long-term spatial data collection techniques, the capabilities and application of Geo-information in tourism will grow significantly and this will greatly increase the revenue from tourism as well as improve the tourism status in the country. The study is relevant to the study of mapping natural/environmental and human features in Bungoma County so that resources including land and scenic are distributed and utilized equally across the entire County.

Ndumbi H.M. (2016) did a study on Mapping flood vulnerability using GIS, in Nairobi Central Business District (CBD). The study's main objective was to map flood vulnerability in the Nairobi CBD. To achieve this objective, four flood vulnerability factors namely elevation, land cover, soil and drainage were studied and mapped. They were then combined through a model to reveal the flood susceptibility. An additional flood vulnerability factor of rainfall was studied and analyzed separately to add onto the interpretation of the model. The final product was a Flood Vulnerability Map that was produced indicating the different degrees of flood vulnerability at different locations in the CBD. The map document shows the degree of flood vulnerability at different locations in the Nairobi CBD at a scale of 1 to 5 starting from very low vulnerability to very high vulnerability. The study is relevant to the current study because they all deal with mapping features both natural and man-made in coming up with a map document to assist in planning and utilizing the resources for the wellbeing of man.

Bwisa, M.M. (2016) did a study on Mapping tourist attractions, a case study of Bungoma County. GIS had been used in the project because of its capabilities of collecting, storing, manipulating, analyzing, presenting and disseminating geographical information. The project

aimed at locating the exact positions of the attractions on the ground, map and expose them to attract more tourists as well as assist planners, the private sector and the County government to improve its sector well.

A geo-database of the tourist destinations and facilities including health facilities, security centers, shopping malls and hotels was created using data obtained from various sources including Kenya Wildlife Service, Google Earth, Bungoma County open data website, tourist websites and actual data collection from the ground.

Tourist attractions in each of the five sub-counties of Bungoma were mapped individually using QGIS software before the final map featuring the entire county was produced. Maps featuring tourist facilities in the region were also created. These maps provide necessary information needed for the wellbeing and enjoyment of tourists visiting Bungoma County. The study is relevant and gives more light to the study currently.

The evolution of slope instability studies (Alexander, E.D. 2008) is charted from its descriptive, field-based origins to recent higher levels of understanding. There has been a shift from static to dynamic modeling of slope processes using digital simulation and computer graphics, and automated cartography, GIS and remote sensing which have enabled regional studies at last to predominate over site-based ones. The study proved difficult to reorient landslide studies to tackle slope instability problems with greater sensitivity to the stakeholders' needs. Worth noting, are the social, administrative, political, cultural and perceptual aspects of landslides that have been neglected. There are signs of a new interest in these important aspects relevant to current study.

The County Government of Makueni is among the few counties in Kenya that have complied with Section 107 of the County Government Acts, 2012, that requires Counties to prepare a 10-year Geographic Information System based spatial plan. It provides a vision and common direction for policies and programs that guides long term development plans. Bungoma County should follow suit and the current study is relevant and provides the needed information for spatial planning and utilization of resources in the County (Mutua, F. and Mwaniki, D. 2017).

The high rate of urbanization being witnessed in most of the counties is impacting negatively on other complementary land uses. Consequently, there is need to use spatial planning as a means of integrating adaptation and mitigation to climate change and disaster risk reduction in all the 47 Counties of Kenya. By mapping out the counties, it becomes easier to manage land allocation and enhance various social amenities such as schools, hospitals, markets and public recreational areas (Mutua, F. and Mwaniki, D. 2017).

Study area

Bungoma County is home to an estimated 1.7 million people and sits on an area of 2,069 km² (Figure 1). Bungoma is third populous County after Nairobi and Kakamega. It borders three Counties i.e. Kakamega on the South, Trans Nzoia on the North and Busia on the West. It also enjoys a vast shared international border with Uganda. Bungoma County has 9 constituencies and 45 County Assembly wards. The 9 constituencies, Sub-Counties, include Kanduyi, Bumula, Webuye East, Webuye West, Kabuchai, Sirisia, Tongaren, Kimilili and Mt. Elgon (CGB, 2018).

The Wards in Bumula are Bumula, Khasoko, Kabula, Kimaeti, Siboti, South Bukusu, West Bukusu. In Kanduyi Bukembe-East, Bukembe-West, Khalaba, Musikoma, Sang'alo East, Sang'alo West, Township and Tuuti-Marakaru. Kabuchai has four wards including Bwake-Luuya, Kabuchai-Chwele, Mukuyuni and West Nalondo. In Webuye East we have Maraka, Mihuu and Ndivisi wards. In Webuye West, we have Bokoli, Miendo, Matulo, Sitikho and Misikhu. Sirisia has three wards including Kulisiru/Malakisi, Lwandanyi and Namwela. The huge Tongaren has six wards including Ndalu, Naitiri-Kabuyefwe, Milima, Soi Sambu-Mitua, Tongaren and Mbakalo. Kimilili has four wards including Kamukuywa, Kibingei, Kimilili and Maeni (CGB, 2018, Chepkania, L.S. 2018).

Bungoma County has immense sub-tribes and cultures including the Bukusu, Teso, Sabaot, Tachoni, Batura, Kabras, Banyala, Bongomek and Banubi. The fusion of the different cultures and traditions has boosted County's potential as a destination for cultural tourism. With the diverse cultures, Bungoma has remained peaceful County in the region even in the heat of politics – a fact that has seen many other communities pitch homes and businesses in the County lifting its profile as an investment hub.

Bungoma County is strategically located and is the gateway to Uganda into Eastern and Central Africa countries including Rwanda, Burundi and Southern Sudan. The County enjoys two shared border points with Uganda through Lwakhakha and Chepkube. Malaba in Busia is 43km from the County's Central Business District. Its vantage position in the region makes it suitable for trade with Uganda and countries on the Northern Corridor. Bungoma County is served with extensive network of roads, two airstrips, Bungoma and Webuye, and a rail system on which a cargo train ply. The infrastructures enhance mobility of people and movement of goods from one place to another (CGB, 2018).

Bungoma County's economic strength is rooted in agriculture encompassing production of sugarcane, tobacco, coffee, onions, vegetables, sunflower, maize and dairy cattle. Tongaren and Naitiri are the region's breadbasket in maize production. Bungoma records heavy rainfall throughout the year and is home to several high rivers, which are used for small-scale irrigation. Fertile lands, rivers with falls that can generate electricity, tourist sites and hard-working people give Bungoma the potential to stand as a commercially high potential investment County. There are economic activities including trade, booming hotel industry and a vibrant retail, supermarkets, sector (CGB, 2018, Chepkania, L.S. 2018).

In Bungoma, historical sites, scenic hills, rivers and waterfalls, make it a destination for tourists. Chetambe Fort, the Golan Heights of Bungoma, Bukusu and Tachoni watched the advancing colonialists, is a tourist attraction site. The fort, built behind a protective 12-foot defensive ditch by Chetambe Ifile. Nabuyole falls on the River Nzoia, also attract tourists.

Mt. Elgon forms a ring around the County to the north and part of the east. Apart from sightseeing, it forms part of the Kenya-Uganda border with caves that open in Kenya onto Uganda. There is another beautiful waterfall on River Kuywa at Teremi, one with great potential for a hydro-electricity power plant. Awaiting the tourists eyes are three trees of historical significance, planted by founding President Jomo Kenyatta, Uganda's first President Milton Obote and Elijah Masinde, a revered Bukusu leader of Dini Ya Msambwa. Twenty kilometres south, another two landmarks stand – the Mwibale wa Mwanja and Sang'alo hills. From the summit of Mwanja Hills, there is a superb view of Mumias Town and Mumias Sugar Miller in neighbouring Kakamega County, Bungoma and Webuye, and endless view of sugarcane and

other crops. In the caves and thick forest foliage that envelope Mt Elgon reside wild animals. The pigmy elephants that wander between Kenya and Uganda Kenya. Maeni, about 10km from Kimilili, is home of the Dini Ya Msambwa, Church of Spirits, of Elijah Masinde. Today, Dini Ya Msambwa is fading out but whose place in Kenya's liberation history is marked with an indelible ink. The people of Bungoma have passed on their culture from one generation to the next through the spoken word (Khubita and Kumuse), music and dance as well as oral narratives. The different sub-tribes have taken every stage of transition – from birth, circumcision to marriage and death as a platform to pass on their messages to young generations. Through music and dance – known for both its energy and grace – Bungoma has earned a reputation as a County of storytellers. The County's famous dance styles have gone on to earn global recognitions with contemporary musicians deploying dance. Kamabeka, the electric shaking of shoulders, has also caught on in party scenes (CGB, 2018).


FIGURE 1: STUDY AREA
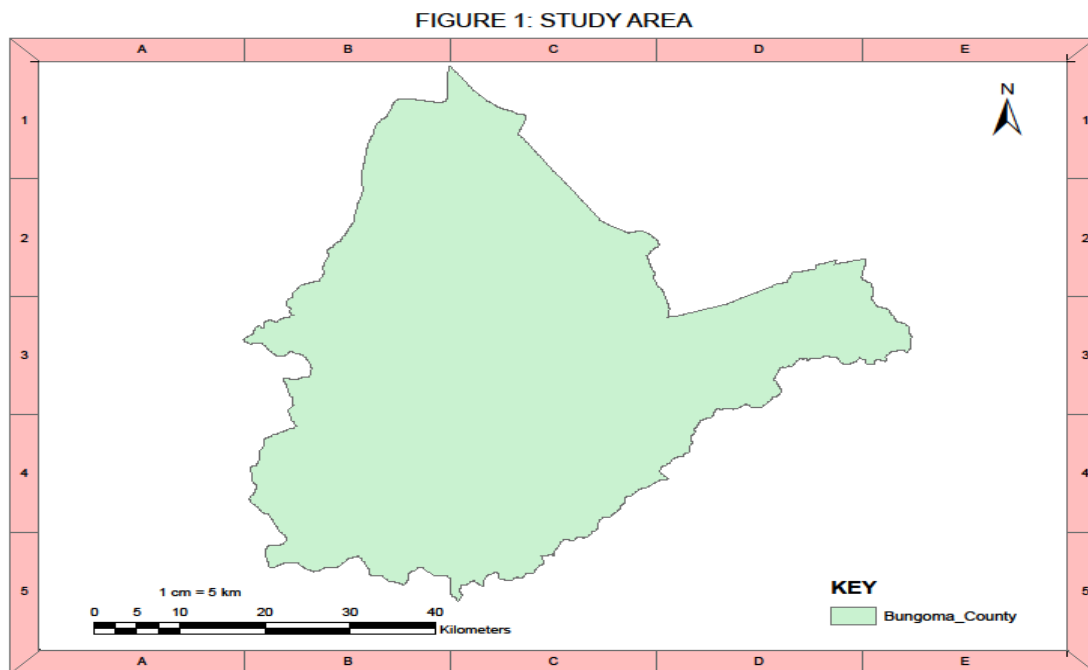
Source: ESRI 2012, Manipulation: Chepkania, L.S. (2019)

Method

In any GIS environment, four basic functions including data Input, data management, data manipulation and analysis, and data output are carried out. The data input component converts data from their existing form into one that can be used by the GIS. In this case the data is for

Bungoma County. Geo-referenced data are commonly provided as paper maps, tables of attributes, electronic files of maps and associated attribute data, and air photos increasingly in the form of satellite imagery. Data input is the major problem in the execution of a GIS due to cost and time. Data input methods and data quality standards for Bungoma County were carefully considered well before data entry began. The various methods of data entry were evaluated in terms of the processing to be done, the accuracy standards to be met, and the form of output to be produced. Data management functions included activities needed to store and retrieve data from the database. In the case of the study, the data had been stored on local disk D. The way data are structured and the way files can be related to each other place constraints on the way in which data can be retrieved and the speed of the retrieval operation. Data manipulation and analysis functions determine the information that can be generated by the GIS. To anticipate the way in which the data in a GIS will be analysed requires that the users be involved in specifying the necessary functions and performance levels. In the current study the researcher used Arc GIS 10.3, software, to manipulate and analyse data. Finally, output or reporting functions of GIS varies more in quality, accuracy, and ease of use than in the capabilities available. Reports may be in the form of maps, tables of values, or text in hard copy or soft-copy. The functions needed are determined by the user's needs.

FIGURE 2: BUNGOMA COUNTY PHYSICAL AND HUMAN FEATURES
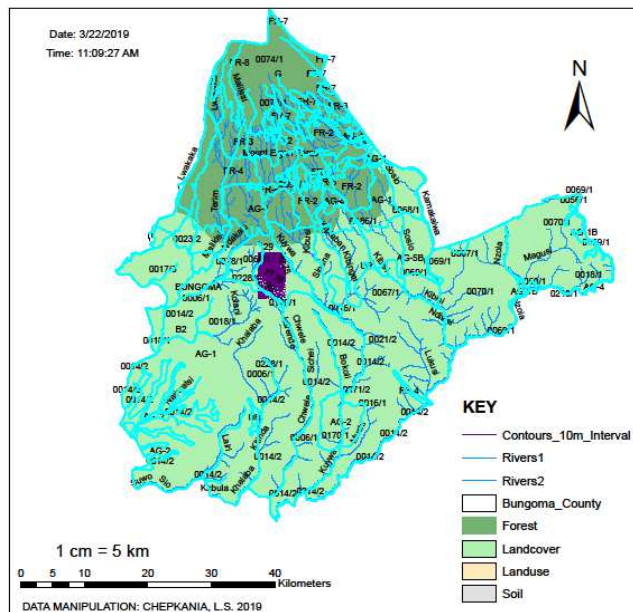
Source of Data: ESRI 2012, Analysis and Manipulation Chepkania, L.S. (2019)

Mapping Bungoma County

The highest point (slope) in the study area is 2030 M above sea level. These are areas of Mount Elgon Forest. Lowest areas (valleys) are 1560M above sea level. One can determine where to carry out farming based on the slope of the study area. Steep areas are not suitable for farming due to cases of erosion and other external land forming processes including mass wasting.

The major rivers in the study area include Rivers Suwo, Kipsangui, Kimothon, Kamakaiwa, Lwakhakha, Sikhendu, Lairi, Nzoia, Kissowai, Kabukara, Bitonge, Khalaba, Chemanani, Ririma, Malikisi, Kibindoyi, Ndakalu, Kabewyan, Kibingei, Kibisi, Toloso, Sosio, Kuywa, Suam, Naliwatsi, Chwele, and Bokoli. These rivers exhibit dendrite pattern of river flow.

Tributaries of the main rivers include Nambirima, Muchi, Lukusi, Kamukuywa, Cheptoigan, Wabukhonyi, Cheborani, Namarambi, Mitakuyu, Miyuke, Misimo, Ndivisi, Tambari, Kamakaiwa, Mugusi, Musindet, Sosio, Ruafwa, Kabuyefwe, Kipsangui Koptita, Chebumon, Chogoi, Kibusi, Kipchororo, Kimilili, Laboot, Chwele, Khalaba, Kibingei, Bokoli, Sichei, Kitinda, Lurende, Muyayi, Misikhu, Kolani, Nanjikobe, Kituni, Namilama, Namawanga, Kibisi, Kapkateny, Kiptaban, Kimobo, Kamusinga, Chepsitati, Ndakalu, Mwaimwai, Sinuna, Kibuk, Terim, Malikisi, Kikwechi, Lutonyi, Yabeko, Kabula, Kuywa and Sio.

The study has one natural forest at Mount Elgon. Land cover for study area compose of rain fed herbaceous crop, open low shrubs (65-40% crown cover), open shrubs (45-40% crown cover), open trees (65-40% crown cover), closed trees, very open trees (40-15% crown cover), forest plantation- undifferentiated, closed shrubs, scattered (in natural vegetation or other) rain fed tree crop (field density 20-40% of polygon area), scattered (in natural vegetation or other) rain fed herbaceous crop (field density 20-40% of polygon area), urban and associated areas, rural settlements and irrigated herbaceous crops.

Soil mapping has provided resource information about Bungoma County. It helps in understanding soil suitability for various land use activities. It is essential for preventing environmental deterioration associated with misuse of land. GIS helped in the study area to identify soil types and to delineate soil boundaries. It was also used for identification and classification of soil. Such information for example from Soil map can be used by farmers to retain soil nutrients and maximize yields.

A map is the most common way of reporting information from a GIS database. So these systems are not only for creating maps but also most importantly the collection of information about the geographic features such as building, roads, pipes, streams, ponds and many more that are located in the County.

The soils which the study extracted from GIS attribute table for Bungoma County included mountain slope soils (**M9**), volcanic foot ridges (**R1**), upland soils (**U115**), bottom land (valley) soils (**B11**), and foot slopes (**F1**). The above soil types are a sample from the many soil types found in the study area. The GIS soils data extracted from the study area (Figure 2) included **M9**= Very clayey soils. These are Mountains and major scarps soils (steep; slopes predominantly over 30%; relief intensity more than 3000 m (mountains) or more than 1000 m (major scarps); altitudes up to 4250 m, **M5**= Alluvial soils, **R1**= Clayey loam soils, **R2**= Sandy loam soils, **F1**=Sandy clayey soils, **F16**= Clayey soils, **U113**= Sandy loam soils, **U115**= Clayey loam soils, **U117**= Loamy soils, **U120**= Loamy soils, **Um10**= Loamy soils and **B11**= Clayey soils. **F** =Foot slope soils (at the foot of hills and mountains; gently undulating to rolling; slopes between 2 and 16%; various altitudes), **B**= Bottomland soils (flat to gentle undulating; slopes between 0 and 5%; various altitudes; seasonally pounded), **U** =Upland soils with slope of 5%, and **R** =Volcanic foot ridges soils (dissected lower slopes of major older volcanoes and older lava flows, undulating to hilly; slopes between 5 and 30%; altitudes between 2000 and 3000 m; Mt. Elgon.

Summary and Conclusion

GIS can be used to create more effective and efficient farming techniques. It can also analyze soil data and to determine the best crop to plant like maize, sugarcane, onions among other crops in Bungoma County and how to maintain nutrition levels to best benefit crop to plant. It is fully integrated and widely accepted for helping government agencies and devolved governments to manage programs that support farmers and protect the environment. This GIS model if fully implemented to the latter can increase food production in different parts of the County so that the food crisis is avoided.

Land cover is the feature that covers the barren surface. Land use means the area on the surface utilized for particular use. The role of GIS technology in land use and land cover applications is that we can determine land use/land cover changes in different areas for example rural settlement

and natural forest changes at Mount Elgon. Also it can detect and estimate the changes in the land use/ land cover pattern within time. It enables to find out sudden changes in land use and land cover either by natural forces or by other activities like deforestation.

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