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Use of Geo-Information Systems for Educational Services Provision and Planning in Asal Areas: *A Case Study of Garissa County - Kenya*

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Abstract: ***The analysis of the use of Geo- information systems in education planning and management is of great importance in obtaining fundamental information for management of the education sector at different scales and regions within different countries. An essential tool for pertinent results is satellite images providing on the same scale a greater number of data to assess the land use and land cover changes all over the years. The purpose of this study is therefore to investigate how modern Geo-technologies can be used to solve some of the Planning and service provision challenges in education sector especially in ASAL areas where such services are highly required. Through case studies of Garissa district , the study seeks to undertake an inventory mapping of Garissa residents settlement patterns and population , road network and utilities , climate change patterns , vegetation and graze area distribution patterns etc .The integration of spatial and non spatial information will be useful to improve the provision and access of services especially library facilities to the residents of remote areas within Garissa county. The focus is on establishing the current levels of uptake, examining the potential usefulness of modern Geo-technologies as a management tool and identifying the principal barriers towards wider implementation. It is expected that the outcome of this project would assist the national and county governments in Kenya and the rest of the world who may wish to use the same GIS model in their decision making, control and planning needs on their various services they are expected to deliver to their citizens.***

Keywords: ASAL- Arid And Semi Arid Areas, GIS- Geographical Information Systems,2SFCA- Two Floating Catchment Area, SM-Schools Mapping, PPGIS- Public Participation Geographical Information Systems.

1. Introduction

1.1 Background to the Study

Education in every sense is one of the fundamental factors of development. No country can achieve sustainable economic development without substantial investment in human capital. Education enriches people's understanding of themselves and world. It improves the quality of their lives and leads to broad social benefits to individuals and society education raises people's productivity and creativity and promotes entrepreneurship and technological advances. In addition it plays a very crucial role in securing economic and social progress and improving income distribution. Societies with highly educated population across the world translate into long term benefits including higher productivity of enterprises and higher incomes. Education's main role in modern society remains enlightened and empowerment .Education also improves the quality of life , reduces ignorance and exposes frontiers and opportunities not previous handled . Analysts believe that the demand for new information in modern society is at an all time high; the gap can only be filled using education. Despite being the best investment in ones life, education provides one with the best opportunities of becoming successful in the modern society. In terms of the knowledge , qualities , skills , attitudes and capacities, education enables individuals to become conscious subject of their growth and active responsible participants in systematic process of building a new world order.

Education, if looked at beyond its conventional boundaries, forms the very essence of all our actions. What we do is what we know and have learned, either through instructions or through observation and assimilation. When we are not making an effort to learn, our mind is always processing new information or trying to analyze the similarities as well as the tiny nuances within the context which makes the topic stand out or seem different. If that is the case then the mind definitely holds the potential to learn more, however, it is us who stop ourselves from expanding the horizons of our knowledge with self-doubt or other social, emotional, or economic constraints. Education is real important factor in human life. Because if you get the knowledge about certain thing, you will be able make a better decision[11] from Learn Quran Online School). [12]), emphasizes the importance of education in society is indispensable and cohering, which is why society and knowledge cannot be ever separated into two distinct entities.

1.2 Role of Education in Community Development

Receiving a good education helps to empower one , thus making one be strong enough to look after oneself in any given situation. It keeps one aware of your given surrounding as well as the rules and regulations of the society you're living in. It's only through knowledge that one can be able to question authority for its negligence or discrepancies. It is only then that one can avail his/her rights as a citizen and seek improvement in the structural functioning of governance and economy. It's only when a citizen is aware about the policies of its government can he be able to support or protest the change. As a whole, people

can bring about development only when they know where improvement is necessary for the greater good of mankind. Education helps one understand him better, it helps one to realize his potential and qualities as a human being. It helps one to tap into latent talent, so that one may be able to sharpen his skills.

Another importance of education is that it helps one gain sufficient academic qualification so that you are able to get suitable employment at a later stage. A decent employment would be combined with hard-earned remuneration or salary through which one can look after your personal expenses. One's promotion can occur in two given situations, which are, that either because of having the necessary higher academic qualification or a college degree which allows one a safe passage, or that one may have amassed enough practical experience which allows him to be a suitable candidate for the employment sort. People continuously improve their profile and their knowledge base so as to go higher up on the competitive ladder. Those who have amassed enough education, steer the path of development and progress for their country. It is these individuals who go ahead and become teachers, scientists, inventors, welfare activists, soldiers, and politicians who work together to form the very backbone of the society. Without this pool of intellect, the economic and social framework would crumple and fall, paving its way for anarchy, degradation, and violence. While this intricate balance of growth is maintained, there will be a continuous rise in progress in all quarters of life, whether that be personal growth, or development of the nation as an entity. This progress has a very important role to play for the coming generations, which will reap the benefits of our hard work, as they develop it further. At the same time, the negative impact of our actions shall have its collateral damage on the coming generation as well. One would want to take charge and control over his own life and income. This is when he decides to become a self-employed individual, who would like to watch his / her own ideas take realistic form. One would prefer being the one offering job opportunities to others and aid in providing income to them. At this stage of entrepreneurship, One may use your own expertise as well as that of other trained and skilled associates.

Education and studying regularly, gives people of all age groups something substantial and challenging to do. It helps them think and use their idle hours, doing something productive and worthwhile. Education need not be purely academic and may include reading for leisure or as a passion for literature, philosophy, art, politics, economics, or even scientific research. Education plays its continuous role in all spheres of life. The reason being, that if we are aware of the drawbacks of a decision and we know about the possible contingencies and the collateral damage, our consequent actions would be wiser, which would help us to keep danger at bay at all times. This research study attempts to look into the possibility of using Geographical Information Systems to manage educational facilities and adequately plan for provision of support educational materials that will go a long way to alleviate the literacy challenges

1.3 Problem Statement

The Kenyan Government faces a myriad of problems in relation to service provisions to the locals in the ASAL regions like Garissa. One such problem is related to location of facilities that the government owns e.g. schools, libraries, dams, land and other public utilities themselves in relation to the population they are expected to serve and adjacent facilities. Other problems include inaccessibility of some regions, constant migration of people in search of pasture and poor location of public utilities. Education services in this case include:

- Mobile/ Stationed libraries
- Educational Theaters
- Newspaper Vendors
- Schools /Colleges educational services.
- Other educational support services etc

There is thus lack of coordination in investment especially infrastructure , public utilities and human resources resulting in inequitable and imbalance in education literacy due to poor access of these essential educational services and public utilities e.g. Public libraries which has reading materials for literacy enhancement. This has led to under-performance in the public sector, eschewed job distributions or continued ignorance experienced in some regions. An increasing number of educators consider GIS to be one of the most promising means for enhancing literacy among the disadvantaged communities who largely depend on government or donor support for survival , utilities and service provisions. Garissa County being in a rural economy and like any other rural economy is characterized by population illiteracy , constant migration in search of pasture or due to disasters and increased problems to access of health facilities compared to their urban counterparts . This is partly due to spatial factors such as non optimal distribution of available library facility and long distances and partly due to non spatial factors like poverty and illiteracy. Also the county suffers from one of the highest prevalent droughts and inter-clan conflicts in the country due to its socio economic dynamics.

1.4 Research Questions

The following broad questions were used to guide the research processes:

(i) What are the problems faced in provision of educational services in ASAL areas in Kenya?
(ii) What are the problems facing education services provision in Garissa county?
(iii) How can GIS be utilized in analyzing and planning for education provision in Garissa County?

1.5 Study Objectives

The main objective of this study is to:
1) Investigate the problems facing efficient education provision in ASAL areas in Kenya using Garissa as a case study?
2) Study the problems facing education service provision in Garissa County.

3) To demonstrate how can GIS be utilized in analyzing and planning of education services in Garissa County.

1.6 Study Justification

Garissa county being within the Northern frontier faces enough numerous challenges over the years. Apart from low literacy level and poor schools performance, inadequate public resources, skewed resource allocation, under-development and conflicts, their arises other major problems of public resources planning e.g. libraries, dispensaries, schools, dams etc. The service provision in the optimal locations of both the facilities and allocation of staff based on community demands is a real challenge. Optimal allocation can be studied through spatial accessibility. GIS provides various algorithms such as two floating catchment area(2SFCA) method, gravity kernel etc that easily analyses and measures accessibility , and can subsequently be used to estimate the optimal distance and shortest routes that can be used in service provision to all irrespective of class , income or age.

GIS can provide a powerful spatial databases and database management tools which when integrated with its mapping and analysis capabilities , can be used to analyze and plan the supply of various material and non material commodities e.g. library materials to many residents leading to optimal utilization of the available public resources. Analysis of the settlement patterns from covered regions using GIS enables specialized need based procurements of humanitarian commodities as well as library materials thereby, reducing the cost of transportation.

1.7 Scope of the Study

Garissa region was selected as the topical study case because of various reasons:

1. Garissa faces myriad of infrastructural and educational challenges
2. Time and resources required for data collection is limited
3. Garissa county education standards have over the years been dismal compared to other counties.
4. Garissa County is accessible.

The focus of this study is to identify, develop and test the usage of modern Geo technologies that can be used in each and every level in service provision especially educational services by both government and non government departments operating in ASAL areas. This study therefore provided a modern, technical based alternative namely GIS as a measure of allocating, planning and managing educational resources and services in Garissa County.

2. Research Methodology

2.1. Result Outline and Approach

Fig 2.1 Summary of research process methodology

- Literature Review
- Problem Definition/ Identification
- Fieldwork: Data Collection And Sampling
- Data Down Loading, Inputting, Preprocessing And Processing
- Generation of Inventory Map
- Digitizing- Roads, Contours, Rivers, Administrative Boundaries
- Generation of Spacial Accessibility Map
- Verification And Processing :Schools Data, Settlement Data, Population Data
- Reclassification And Compilation
- Annalysis of Data- Buffering, Proximity, Short Route, Network Analysis.
- Result: Maps,Charts, Graphs, Population Density Map.

2.2 Literature Survey

The scope of the literature search covered both general and specialized bibliographical tools such as Web of Knowledge (WoK) and the Library and Information Science Abstracts (LISA); indexes, abstracts, directories, catalogues of library holdings, including the University of Sheffield's OPAC "Star" and the Kenyan Library catalogue. Internet sites were also searched, as well as professional and governmental publications and surveys.

2.3 Data sources

***a*)Primary data sources**

The primary data used in this research include: frame work data such as administrative boundaries, roads and towns that gives the entire analysis orientation, sublocation centroid to serve as village points data, education facilities distribution location (x,y) and attribute data ,and population data.

b) Secondary data sources

- Spatial data: existing maps, photos, imageries etc.
- Attributes/Statistical data: Existing records/ statistical e.g demographics, schools' data e.t.c
- GPS data collection for additional information

Formal and informal interviews

Table 2.1: Various data Sources

Source	*Data*
Ministry of Education	Schools location data, Enrollment and Teachers.
Ministry of Planning and National Development	Census data
Ministry of Lands and Settlement	Existing Topo. Maps, R.I.Ms Administrative boundary maps.
Ministry of Roads and Public Works	Roads data

2.4 Data Collection

The data used for this project includes scanned topo-sheets and administrative boundary maps, demographic data of the county, school locations and related attributes and data collected using GPS. Framework data: includes all the data needed to orient the administrative boundaries of the districts, locations, sub-locations, towns/ market centres, dams/ water points, grazing areas and road network within the county. Secondary data was obtained from the university's GIS laboratory and others from the survey of

Kenya. Population data was obtained in hard copy from the central district bureau of statistics. It helped to describe the settlement patterns of the population in the study region.

2.5 Data Preprocessing and Processing

i) Data Preprocessing

As each data set is obtained from different source, some preprocessing became necessary to enable interpolation of the data set in one platform while others were cleaned or converted into digital form. The educational facilities locations (x, y) and attribute data was obtained from the ministry of education in excel format and converted to shape files: The topographical and administrative boundaries maps were obtained in hard copy and later scanned and re-projected into projected coordinate system (WGS-1984-UTM-ZONE-36N) from their original geographical coordinate system. The major town centres and colleges location (x, y) data was downloaded from the handheld GPS, cleaned and integrated with the spatial attribute data for educational facility in a table form ready for use in ArcGIS, the software used in the analysis.

Framework Data: This data consisted mainly of road networks, administrative boundary units at divisional level and major town centres in the area of study**.** For each division, a geographical centroid was computed in ArcMap of ArcGIS to serve as population points**.**

ii) Data Processing

Nearly all the data processing was done using Arc Map (ArcGIS Software) except the generation of the digital elevation model that used 3D Analyst and ArcScene of ArcGIS suit. Also computations of various index ratios such as teacher to student ratio, ratio of secondary schools to primary schools, school age population to schools ratio etc was done in excel software and then linked to the appropriate Shape file in columns.

2.6 Data analysis and presentation techniques

The facility locations were plotted in ArcMap and the frame work added to give it orientation. On the inventory map , floating buffers was generated and facility to population computed. The accessibility index at each village point was determined through kriging method as well as district boundaries and settlement patterns reclassified to give it meaningful values.

2.7 The Study Area

Garissa County is one of the largest in Kenya: it covers an area of 54,000 square kilometers, which is slightly more than 9% of the total size of the country. The county borders Wajir to the North, Tana River and Isiolo counties to the West and The Republic of Somalia to the East. Its capital town is Garissa. Garissa has six constituencies namely: Garissa Township, Ijara, Dadaab, Lagdera, Fafi and Balambala. It has a total population of 623,060, of which 334,939 are male and 288,121 female (census 2009). The Population density is 14 PER SQ. KM and unfortunately OVER 55% of the population live below the poverty line.

The county is low lying, with altitudes ranging between 70m and 400m above sea level. The area is hot and dry, receiving rainfall in the range of 150mm -300mm annually. Frequent droughts, low literacy levels, poor education performance among school going students, high poverty index and unreliable rains that do not favour agriculture activities and the growth of pasture for livestock rearing. Tana River runs along the western boundary of the county and is the only permanent natural source of water for Garissa town and the surrounding areas. Seasonal Rivers (laggas) provide water during the wet season for both human and livestock, although they greatly interfere with road transportation. The county also hosts the Boni forest, a section of which is the Boni National Reserve, a protected wildlife conservation area. Pastoralism is a major economic activity among the communities who inhabit the county. However the tourism sector is also growing with a number of hotels and resorts coming up. The dry and arid landscape could be exploited to offer tourism packages that encompass camel-back expeditions and camping activities. The region could also be opened up to dessert rallying activities similar to those carried out in different regions in the world.

Some strengths of Garissa County include

1. Natural resources as livestock, river, pasture, wildlife, land, solar and wind energy, mineral resources, medicinal plants
2. Tourist attractions as Giraffe Sanctuary, Arawale & Boni National Reserves.
3. Main Economic Activities as Livestock Keeping and Trading, Bee-keeping, Sand Harvesting.

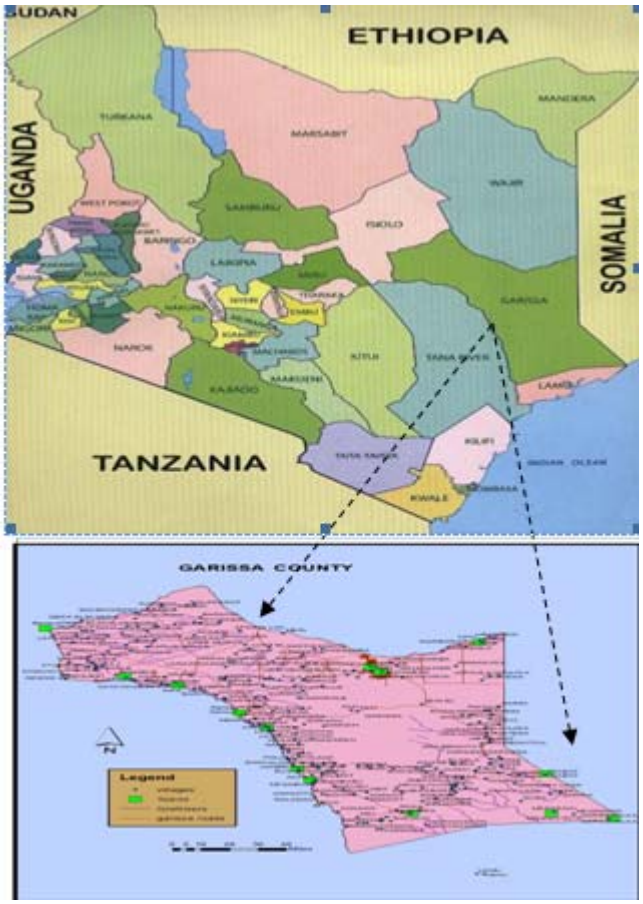

Figure 2.2: Map Of Kenya
Source: World atlas map

Figure 2.3: Map of Garissa County

Source: Regional Centre for Resource and Mapping, 2004

2.8 Conceptual model on application of modern Geo-technologies in education planning

The main factors that dictate and determine effective and efficient educational facility planning and services provision include:

1. Spatial accessibility (Distance /Time)
2. Proximity and availability(Gravity model)
3. Optimal location(proximity)

Spatial accessibility/ (Distance / Time to nearest service)
Travel impedance (Distance or Time) to the nearest service is a simple and commonly used measure of spatial accessibility [15,19]. However, nearest service impedance only captures proximity between population and service locations with no account taken of availability (either the capacity of the service provider or the size of the population). Additionally, bypassing the nearest service is frequently observed where populations commonly have more than one educational service to choose from [21,23] . Thus, the nearest service is an effective measure of spatial accessibility where overlapping catchment exists such for primary educational services.

Proximity and availability (Gravity models)
A gravity model provides a measure that accounts for both proximity and availability [24]. This model assumes that the attractiveness of a service diminishes with distance and associated increasing travel impedance. Unlike nearest service , the gravity model does capture bypassing where the closest service is most likely to be chosen. Additionally, both supply and demand are captured within the gravity model. Most critism of the gravity model has concentrated on the difficulty in selecting or empirically determining the distance – decay function [27,29] . Invariably the gravity model overemphasizes the decay function leading to results that are heavily spatially smoothed[32] with a high concentric pattern of accessibility emerging . When applied to rural areas, this pattern is exacerbated in the case of relatively isolated towns, where little overlap of educational services exists. The gravity model can be used to estimate:

- Traffic flow
- Migration between two areas
- The number of people likely to use one central place

The Gravity Model

$$\frac{\text{population}_1 \times \text{population}_2}{\text{distance}^2}$$

Optimal Locations

In a general GIS context the word allocation indicates the process of identifying specific areas, districts, road segments etc. surrounding a centre; areas that should 'serve' the particular centre concerning the in- or outflow of people or goods, generally known as demand. There may be more or less demand than the centre can 'handle' - specified by the supply or capacity of the centre. In this study however, since land is privately owned and already subdivided into small portions with almost nobody willing to sell, optimum location for new secondary schools is based on the existing public primary schools that have reasonable land that will allow for expansion and are located away from existing public secondary schools.

The above factors are therefore used in developing a GIS based concept model as demonstrated in the figure below:(**see figure 3.3 below)**

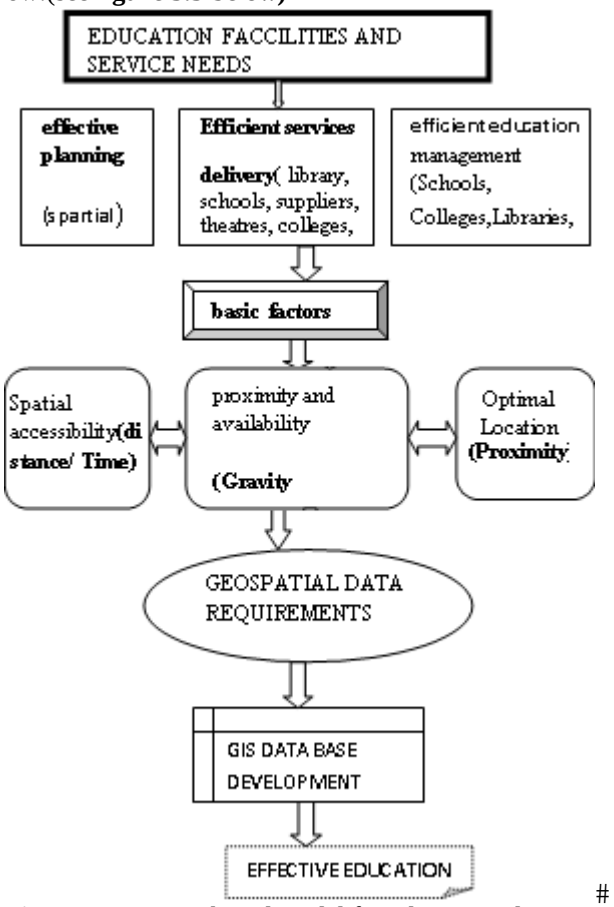

Figure 3.3: A GIS based model for education Planning #

2.9 Role of modern technologies in educational planning and Service Provision

Modern technologies e.g GIS, RS, mobile phones, GPS etc is typically used in most application fields as an advanced and technologically- elegant tool. Even if GIS is considered as simply a "better" tool, the progress in presentation, representation, and flexibility appear to justify consideration of the benefits that GIS provides to micro-planning as potentially highly significant. Among the possibilities for GIS to improve education micro- planning, the following are identified [33]

1) Modern technologies helps make the presentation of data more attractive than traditional static maps.
2) Projecting tabular data onto maps helps in recognizing "unexpected" situations which, now noticed, call for closer examination.
3) Through considering geographical (spatial) factors, the analysis becomes "finer" and more precise, increasing the likelihood that ensuing strategies are more pertinent.
4) More flexible assistance can be provided in prospective planning at multiple levels or units of analysis: national, regional, provincial/district, and local.

3. Research Findings, Analysis and Result Presentation

Research Findings

3.1 Kenyan Situation Analysis

3.1. 1 Education planning needs in Kenya ASAL areas

Education equips people with the capacities to make informed choices about their lives and a positive contribution to society. It facilitates the realisation of other rights, provides an exit out of poverty, and reinforces social cohesion and integration. Educated women challenge social norms and invest in the health and welfare of their families and in the education of the next generation. And in pastoral areas in particular, where the productivity of the livelihood system requires an appropriate balance between people and ecology, education is an important route out of pastoralism. For all these reasons, education is fundamental to development in Northern Kenya and other arid lands.

The status of formal education in Northern Kenya is poor (Fig. 4). Learning facilities are inadequate: there is no university, only one teacher training college, one technical training institute, and very few TIVET institutions (Technical, Industrial, Vocational and Entrepreneurship Training). The number of teachers is insufficient, with very few recruited locally, and there is little attention paid to Early Childhood Development. As a result, the region achieves very low rates of enrolment, transition, completion and literacy, and performs poorly in the national exams. It is reported that only one student from North Eastern Province has achieved a straight 'A' since the 8:4:4 system was introduced in 1985.The situation is generally worse for girls than boys, given the subordinate status of girls and women in most pastoral societies. In addition to their domestic responsibilities, certain cultural practices such as female genital mutilation and early marriage curtail girls' education. However, the ratio of women to men with no educational attainment is actually lower in pastoral areas than at the national level, suggesting that a lack of educational opportunities in the areas where they live may be as important a constraint on girls' education as social or cultural barriers.

3.1.2 Kenyan Education System

The System of Education in Kenya is divided into three main categories, Primary, Secondary and higher educational. The first level which is also free and compulsory admits pupils from the age of three to about fifteen years of age and comprises baby class to standard eight. The secondary level comprises form one to form four with age brackets of between 13 to 20 years. The final level includes middle level colleges and universities.

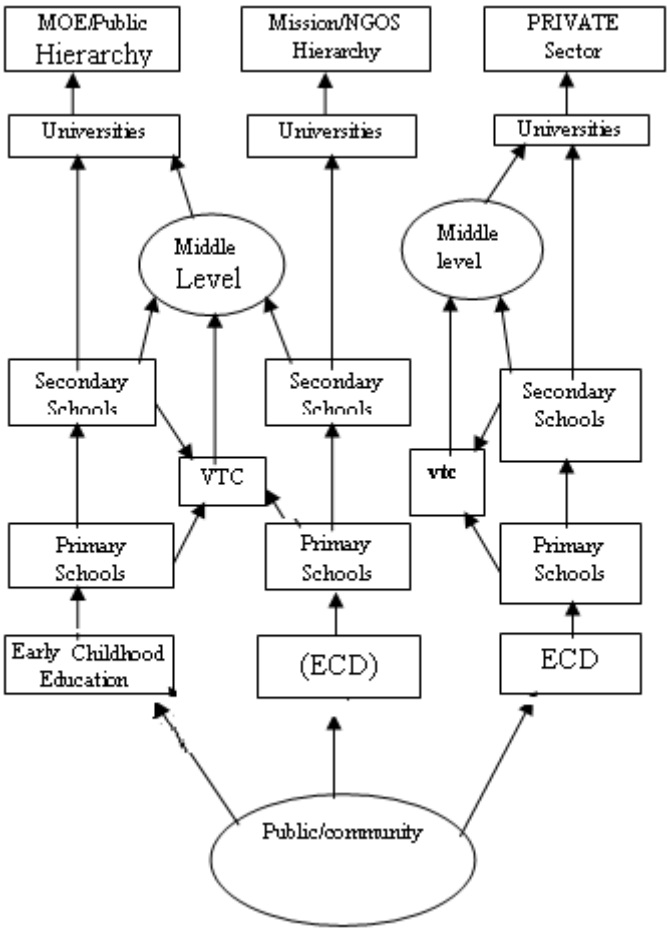

Figure 4.4: Kenya's Education System

3.1.3 Education in ASAL region in Kenya distinctive features:

- Arid counties have low population density.
- Mobility is essential to pastoral production.
- Girls and women have a subordinate status to that of boys and men in most communities.
- There is a particularly high opportunity cost to pastoral households in educating children.
- Poor infrastructure in the north in particular makes the provision and monitoring of services difficult.
-

3.1.4 Challenges in the current system of education provision to nomadic peoples

At point of delivery

- Funding: building and maintaining schools in harsh and remote rural areas is costly.
- Staffing: difficulties in securing school staffing in harsh and remote rural areas.
- Training: difficulties in securing quality teaching in schools in pastoral areas (well trained teachers often go somewhere else or leave at the first opportunity).
- Equipment: difficulties in providing adequate teaching and learning materials to remote locations.
- Legacy: difficulties in overcoming a legacy of antagonism to nomads' livelihoods, where formal school-based education was allowed to be instrumental to policies of cultural assimilation and forced sedentarisation (therefore posing a threat to pastoral production strategies).

At point of reception

- Mobility: although key to the production strategy of the nomadic household, mobility poses a serious .
- Challenge to a system heavily reliant on school-based education.
- Scattered populations: often an advantage for production but a problem for realising economies of scale In school-based education.
- Unpredictable disruptions of service: on top of routine mobility for production, insecurity and environmental events of great magnitude such as floods and prolonged droughts can significantly disrupt the rigid routine of school-based education.
- Children's work commitments: children's involvement and responsibilities within the household's economy from an early age competes with the requirements of school calendars and timetables.
- Resistance to schooling girls: apart from labour requirements, parents are particularly reluctant to send girls away from the familiar contexts where they can be protected and controlled.
- Non-literate parents: the fact that adults/parents often lack basic education means that children cannot receive help at home as far as formal education is concerned.
- Liquidity: even relatively small school-related costs are perceived as difficult to meet as pastoral households usually have little liquidity and the economic benefits of schooling are not easily evident.

3.1.5 Other challenges

Vocational institutions

- Enough Instructor's guides have not been developed.
- Low student enrolment in all technical training institutions due to lack of social awareness, negative attitude towards vocational education coupled with poor employment prospects after graduation as well as right curriculum requirement.

Limited resources in Voc-Tech Education and Training Sector have resulted to:

- Lack of basic tools and equipment needed to input skills and competencies required for wage employment or self employment
- Lack of qualified and poorly remunerated teaching staff who also lack adequate skills and competencies in modern instructional techniques required for effective training in a dynamic and competitive labour market
- Lack of adequate managerial skills and competencies needed to mobilise local resources for sustainable development and efficient management of technical training institutions.
- Lack of specialised examiners and curriculum development experts.
- Lack of effective mechanism for pooling and sharing resources within a particular region for the benefit of the wider community.
- Lack of adequate capacity to co-ordinate, monitor, evaluate and supervise the implementation of new training programmes.

Special education

- Acute shortage of specially trained teachers in all special education programs/schools
- Acute shortage of technical and support staff: - Braille transcribers, audiologist speech therapists, interpreters, physiotherapists, occupational therapists, teacher aid producers etc. at Primary, Secondary and Vocational levels.
- Inadequate specialized equipment and instructional materials in all schools. For example the hearing aids for the deaf (hearing impaired), Braille material and white cane for the visually impaired, wheel chairs and crutches for the physically handicapped etc.
- Special Education programmes have not been fully main streamed into Early Childhood Care and Development (ECCD).
- There has been no systematic survey done to identify and determine the exact numbers of children with disability, age, gender and type and degree of disability.
- The current regular curriculum and examination is insensitive to the needs of the handicapped.
- Most of the Programmes are Donor funded and yet the issue of their sustainability has not been adequately addressed.

Cost and Financing

- Parents of the handicapped children are generally poor and the PTAs are too small to adequately finance school projects. This has resulted in serious dropouts due to the cost sharing policy.
- There is also lack of bursary at primary and vocational levels for the handicapped children.
- Inadequate funds allocation for provision of specialized equipment, teaching/learning aids and specialized furniture.

3.2 Situation analysis –Garissa County

The mapping of educational facilities along with the information on administrative boundaries and biophysical layers such as, major road networks, rivers and settlements provides the ground reality in terms of geographic coverage and the social reality.
The educational facilities were then classified appropriately as primary and Secondary and given appropriate cartographic symbols. The x ,y location data of these facilities was then plotted in Arc Map and the framework data added to give it orientation**.**

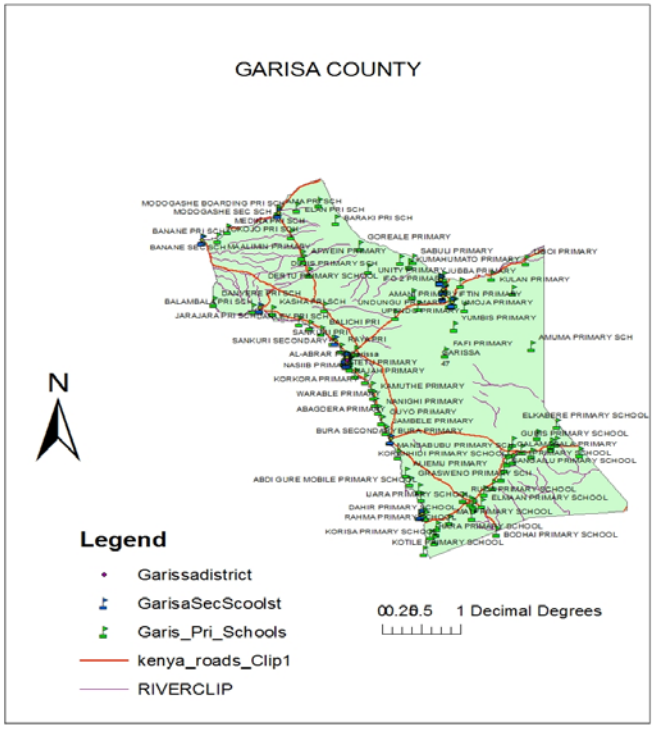

Figure 4.7: Garissa county schools distribution inventory base map

3.2.1 Educational challenges and opportunities in Garissa County

One of the main challenges facing the education system in Garissa is that it is not sufficiently adapted to the local context. For example, term dates are rigid, the curriculum does not resonate with local experience, and facilities are constructed without thought to cultural and environmental norms. The context itself is challenging, with a highly mobile population, poor infrastructure, long distances between schools, and some negative cultural practices and attitudes. Community participation in education is limited, poverty levels are high, and learners with special needs face isolation and discrimination.

3.2.2 Human development inequality in Garissa county

In line with Kenyan Vision 2030, the foundations for development are all investments in public goods such as:
1. Infrastructure
2. Security, peace building and conflict management
3. Human resource development, labour and employment
4. Public sector reforms
5. Natural resource management and land reforms
6. Drought management and climate change
7. Science, technology and innovation

In Garissa County, these basic enablers of development are either inadequate or lacking. This is holding the region back – deterring investment, undermining productive potential, draining resources into prolonged emergency response, and frustrating local initiative and innovation. The impact on human development is demonstrated by the fact that in 2005, seven districts in the north of Kenya had a Human Development Index lower than that of Sierra Leone, at that time the lowest-ranked country in the world. The level of inequality between Northern Kenya in particular and the rest of the country underscores the importance of investing in

these foundations. At the national level these foundations are the springboard from which Kenya will achieve middle-income industrializing country status. But in arid and semi-arid counties, they are the starting point for addressing far more basic challenges of chronic poverty, vulnerability and insecurity.

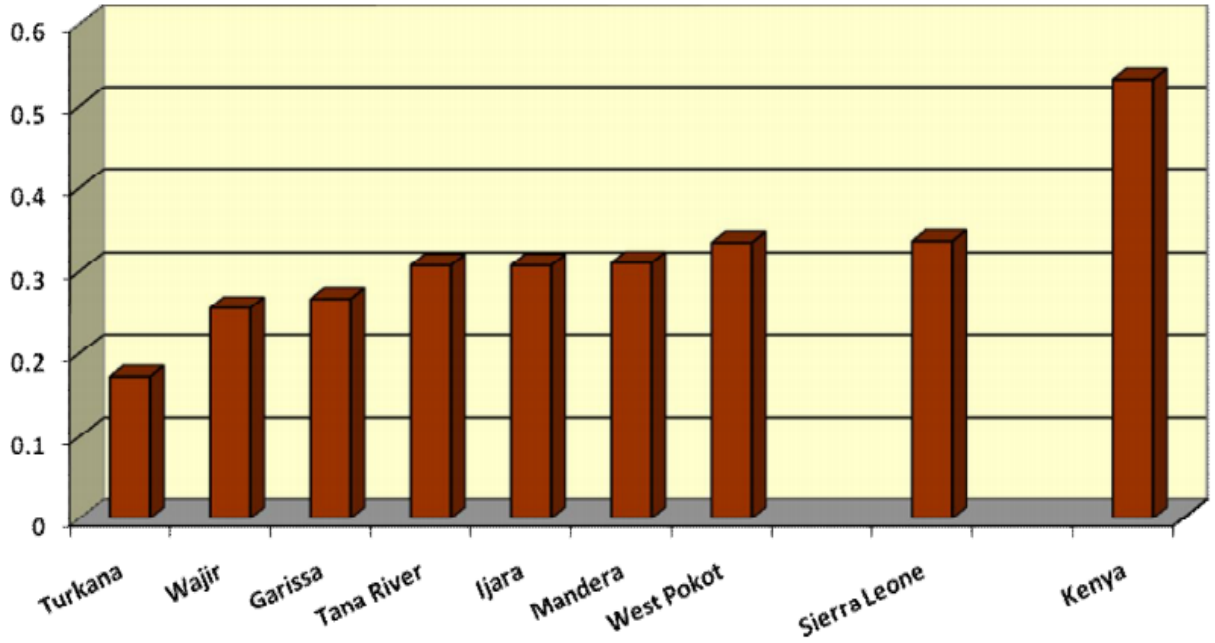

Figure 4.8: Inequality in human development
Source: UNDP, 2006: Kenya national human development report 2006: human security and human development: A deliberate choice.

3.2.3 GIS analysis of education facilities

The analysis was carried out using Arc GIS extensions (spatial and network analysis). Buffering, Overlays, proximity, shortest path, clipping as well as intersections assisted in the analysis to determine various access route distances to the facilities. A buffer was used to define an area of inclusion or exclusion around the major roads. Buffer analysis therefore determined service area of educational facilities as it created polygons to a specified distance around the institutions.

- **Educational accessibility analysis**

The closest facility solver was used to measure the cost of traveling between incidents and educational facilities and determines which are nearest facility to one other. When finding closest facilities, you can specify how many to find and whether the direction of travel is toward or away from them. The closest facility solver displays the best routes between incidents and facilities, reports their travel costs, and returns driving directions.

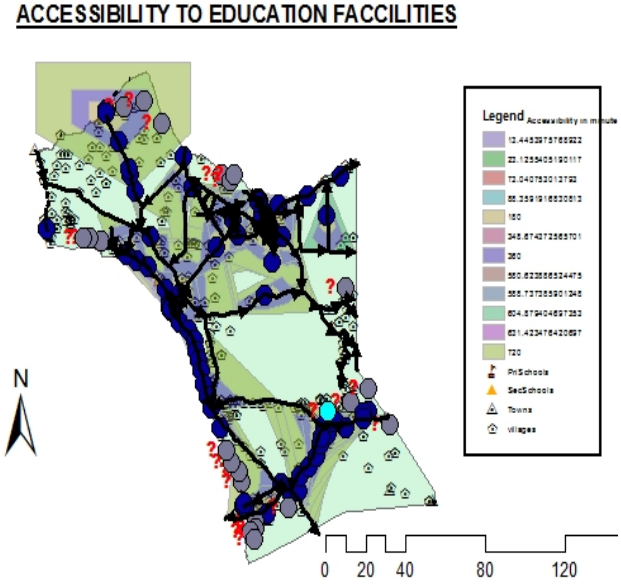

Figure 4.13: Educational Institution Accessibility

- **County roads network analysis /route analysis**

Solving a route analysis meant finding the quickest, shortest, or even the most scenic route, depending on the impedance chosen to solve for. If the impedance is time, then the best route is the quickest route. If the impedance is a time attribute with live or historical traffic, then the best route is the quickest route for a given time of day and date.

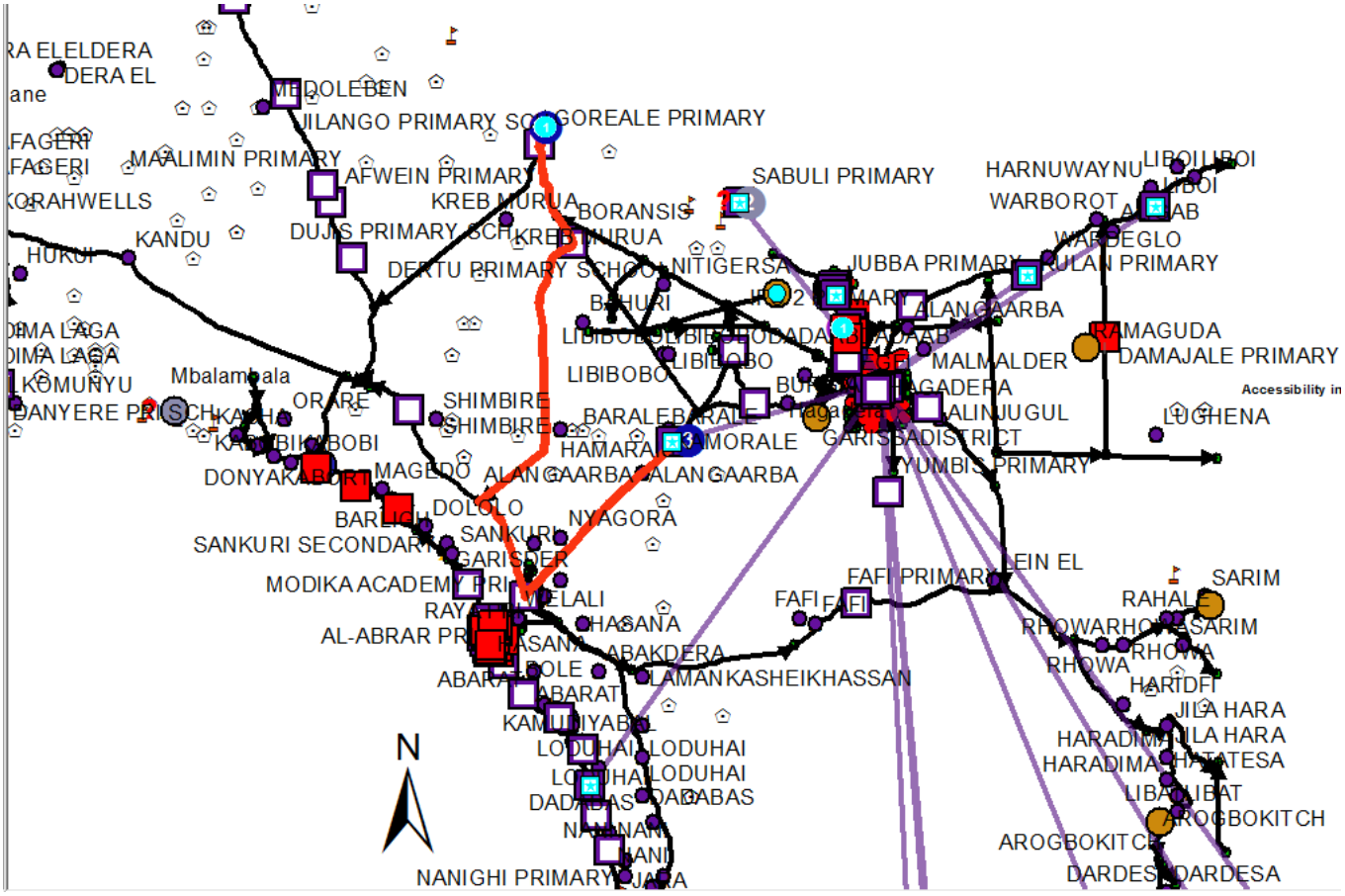

Figure 4.10: Garissa county road network analysis

- **Educational support facilities analysis/closest facilities**

This was used to measure the cost of traveling between incidents, major towns and educational facilities and determine which are nearest to one other. The closest educational facilities were displayed with the best routes between incidents and facilities, reports of their travel costs, and driving directions.

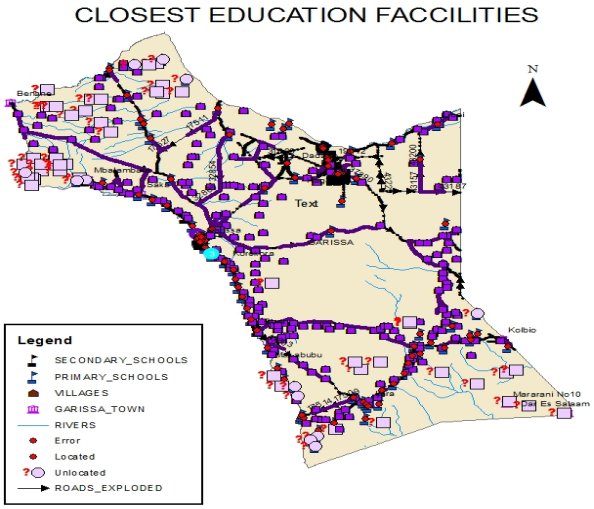

Figure 4.11: Educational closest facilities

- **Educational facilities serviceable areas analysis**

This was used to find service areas around any location on a network within the Garissa County. A network service area is a region that encompasses all accessible streets (that is, streets that are within specified impedance). For instance, the 5-minute service area for a point on a network includes all the streets that can be reached within five minutes from that point.

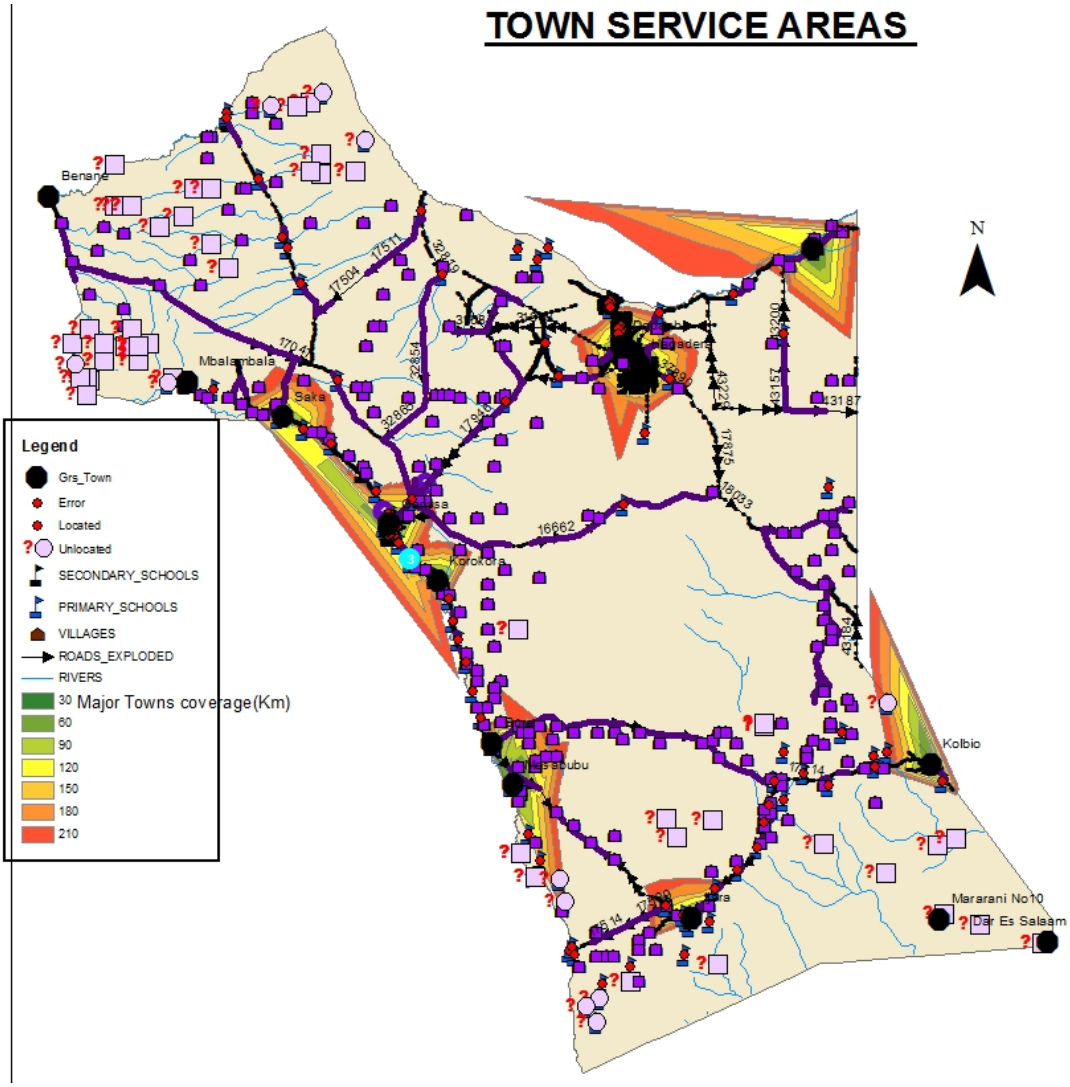

Figure 4.12: Institutions serviceable areas

- **Education facilities location and allocation analysis**

This was used to solve the competitive schools facility Location problem. It was used to choose facilities that maximize market share of the competitive facilities. Gravity model concepts were used to determine the proportion of demand allocated to each educational facility. The set of schools that maximizes the total allocated demand is chosen. See figure below:

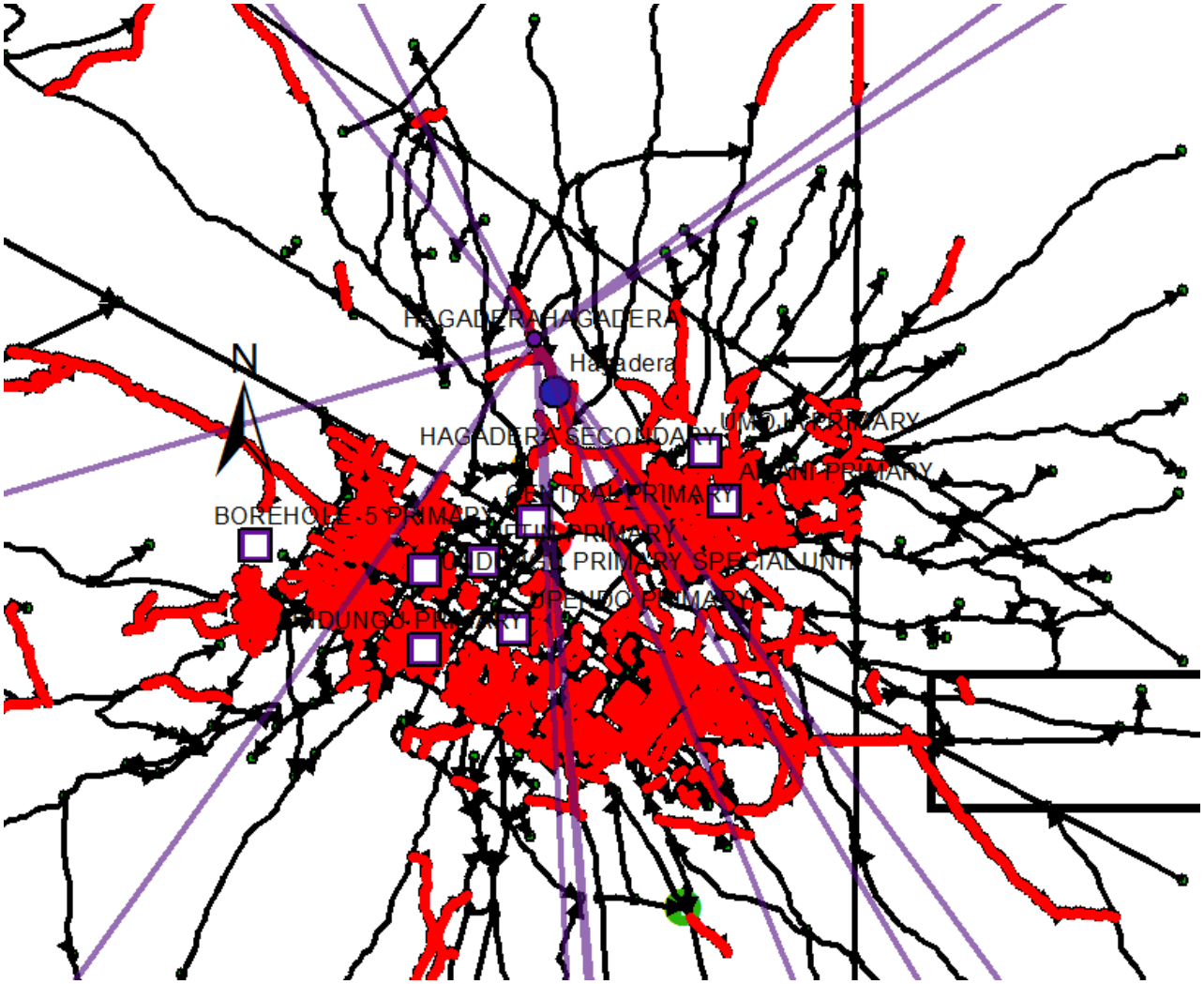

Figure 4.13: Location and allocation of institutions

3.3 Results presentation

3.3.1. Educational challenges in Garissa County

The main challenges facing the education system in Garissa is that it is not sufficiently adapted to the local context. For example, term dates are rigid, the curriculum does not resonate with local experience, and facilities are constructed without thought to cultural and environmental norms. The context itself is challenging, with a highly mobile population, poor infrastructure, long distances between schools, and some negative cultural practices and attitudes. Community participation in education is limited, poverty levels are high, and learners with special needs face isolation and discrimination.

3.3.2 Education accessibility

The analysis shows that 84% of primary schools in Garissa county are located within 1km travel distance from motorable roads while 89% of secondary schools are within the same travel distance. This means that majority of educational facilities in the county can be accessed by educational administrators in the shortest travel time in minutes. The remaining schools are all within a distance of 4km from motorable road except for institution further from the main road networks. **See fig 4.9.**

3.3.3 Institution's routes determination

The best route to the institutions is the route which had the lowest impedance or least cost in the Garissa County. Costs attributes involved in the routes was used as the impedance when determining the best route to use in the educational service provision. Finding the quickest, shortest, or even the most scenic route to the educational institutions within the Garissa county, depends on the impedance chosen to solve for. If the impedance is time, then the best route becomes the quickest route. If the impedance is a time attribute with live or historical traffic, then the best route is the quickest route for a given time of day and date. **See fig 4.10.**

3.3.4 Education institutions serviceable areas

Concentric service areas showed how accessibility varies with impedance. Service areas created helped to identify how much land is required to set up an institution in Garissa county , how many people can use the institution , or the resources within the neighborhood or county. A service area analysis was useful in determining the area of accessibility schools within a given cutoff cost from the villages. One could find service areas around any location on a network. This encompassed all accessible streets and roads (that is, streets that are within specified impedance). For instance, the 5-minute service area for a point on a network includes all the streets that can be reached within five minutes from

that point. Service areas created helped to evaluate accessibility. **See fig 4.12.**

3.3.5 Educational support facilities /closest facilities.

This involved the cost of traveling between incidents, major towns and educational facilities and determination of nearest facilities to one other. The closest educational facilities were displayed with the best routes between incidents and facilities, reports of their travel costs, and driving directions. For instance, the closest facility problem was used to search for schools within a 15-minute drive or walk of the from the villages. Any school that takes longer than 15 minutes to reach are not included in the results. The closest facilities between the incidents in the county is as shown in **fig 4.11**

3.3.6 Education facilities Location and allocation

The set of schools that maximizes the total allocated demand was chosen .Schools location was considered the most important factor leading to the success of setting up of a private- or public institutions of learning. Thus, private-sector institutions can then profit from a good location of schools, whether in the village or in major towns within the County. Hagadera Location was chosen as the optimal location that could help fix and minimize overhead costs and keep accessibility high. Educational support services and facilities, such as schools, hospitals, libraries, fire stations, and emergency response services (ERS) centers, their optimal location, allocation could determine where high-quality service to the Hagedera community at a low cost could be sort. **See fig 4.13**

4. Conclusion

The research findings have indicated that education authorities would benefit from using GIS as an additional decision support tool, but that successful implementation is not easy. In appreciation of the fact that education authorities are all at different stages with regards to GIS use and that there is a large degree of overlap in the recommendations for those authorities in the initial stages of uptake and those who are experienced in using the tool, they remain general, and are therefore just as applicable in both circumstances.

The level of inequality between Northern Kenya in particular and the rest of the country underscores the importance of investing in these foundations. At the national level these foundations are the springboard from which Kenya will achieve middle-income industrializing Garissa country status. But in arid and semi-arid counties, they are the starting point for addressing far more basic challenges of chronic poverty, vulnerability and insecurity.

The project showed the power of GIS in analyzing positional related data and its enormous potential in solving educational planning problems. Using simple GIS tools like selection by attribute and location, it was seen that GIS can solve problem of disparity and lack of balance between demand and supply of educational facilities based on the inventory map. Also, using the visual display of the various demand maps and graphs, GIS provides a powerful forecast to aid decision making on what action to take where for example from the inventory mapping it's clear that there are serious challenges like rough terrain, mismatch of population to allocation of Primary schools to secondary schools and high student to teacher ratio in the villages. Parents and education stake holders can also make informed decisions when choosing schools for their children using these accessibility indices, closest facility analysis, location allocation analysis and route analysis and serviceable areas in meeting demand for noble educational services within a particular location.

The results of accessibility analysis of these facilities can be used in prioritizing the roads to be improved to bitumen standards by looking at number of educational facilities and town centers that the road serves together with topography.

5. Recommendations

Given that implementing GIS as a decision support tool within education management has proven easier and more successful in those authorities where change is considered the norm and the transfer of knowledge is encouraged it is recommended that education authorities attempt to foster an organizational culture, which lends itself to continuous learning and data sharing. If GIS is to be used as a decision support tool for education services management, it is recommended that there is a well placed "super user" of GIS within the management team (an example would be the Library Performance and Quality Manager) who has desktop access to, and is fully trained in, a superior GIS product such as the market leader MapInfo Professional.

The benefits being:

- A coordinated approach with no duplication of work
- A pooling of valuable resources
- The sophisticated functionality provided by high specification software
- Maximum control and optimal work turnaround times as a result of immediate software access
- A closely knit relationship between GIS, additional sources of management information and the whole library management process.

Rather than devising an individual strategy for GIS, it is recommended that GIS is included in a larger scale, departmental strategy and that careful consideration is given as to where this management tool can be best placed within the education authority's long term strategic plan.

In order to strengthen human capital in Northern Kenya-Garisa and other arid lands, education stake holders needs to:

- Develop and improve appropriate infrastructure for education, training and health care at all levels, including tertiary and higher education.
- Increase the number of appropriately trained education, health and nutrition professionals and develop mechanisms to attract and retain high-calibre education officers.

- Introduce affirmative action programmes for people from Northern Kenya and other arid lands, particularly women, to enter all public training institutions.
- Target a percentage of bursaries at students from Northern Kenya and other arid lands, particularly girls who wish to pursue tertiary and university education.

6. Issues for Further Research

The empirical findings presented in this study provide a valuable baseline to monitor any future developments, with the data providing an excellent starting point for future studies of the uptake and uses of GIS within the education sector and management. While a number of interesting issues came out of this research, further exploration is required in the following areas:

1) Given its urgency, an in-depth study concerned with how GIS can be used specifically for community profiling.
2) The influence of the organizational context in determining the most appropriate place for GIS to sit in terms of both personnel and strategic development.
3) The impact of GIS on performance measurement within public libraries and institutions of learning.
4) The optimum database design to maximize compatibility with GIS.
5) The impact of awareness training on the extent at which GIS is utilized to its full potential within the education sector.
6) The value of GIS in marketing and promoting the education service delivery.
7) The impact that employing GIS to determine mobile library routes has on the public satisfaction of this service.

Further research could be done to incorporate the exact enrollments especially for primary schools where this research used projected data computed from the 2009 population census. Other non spatial factors like literacy, age, sex, religion, economic status and ethnicity could also be incorporated to check their influence on education sector.

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