

GIS Based Assessment of Urban Facilities and Utilities Planning: A Case of Gida Ayana Woreda, Oromia Region, Ethiopia

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ABSTRACTS

GIS Based Assessment in Urban Facilities and Utilities Planning: A Case of Gida Ayanaworeda, Oromia Region, Ethiopia. This research is mainly concerned on GIS based assessment in urban facilities and utilities planning in Gida Ayana town, Oromia Region, Ethiopia. Application of GIS technology in urban facilities and utilities planning has recently absorbed attention and has a power of assessing already installed urban physical settings in harmony with demographic, spatial, local development plan and service demand directives. Keeping in the view of importance of GIS in urban planning, the study was conducted in Gida Ayana town where road transportation, water supply and consumption for domestic use and accessibility to fixed line telephone are characterized by shortfalls. The general objectives of the study is to create geo database for urban transport facilities, water supply lines and fixed telephone lines utilities, and to show their spatial arrangement by employing GIS technology. Specifically, the study is designed to create GIS database for road transportation network that enable to evaluate the existing network system in the study area, to show applications of GIS in urban utilities planning, to evaluate accessibility of water supply distribution using GIS in the study area and to analyze the spatial arrangement of fixed line telephone accessibility.

Keywords: GIS, Urban Planning, assessment, road network, Health center, market, water supply, Education.

INTRODUCTION

Background of the Study

The term utilities can also refer to the set of services provided by these organizations consumed by the public: electricity, natural gas, water, sewage, telephone, and transportation. Utilities is make use of state of being useful or important that is profitable and facilities is make easy or easier service or natural ability of building the provide for particular purpose. Utilities are transforming themselves intelligently by salvaging useful parts of existing systems and incorporating new technologies to extend their capabilities and Public utilities like gas, electric, water and telecommunications. Utilities (water, electricity and gas) are essential services that play a vital role in economic and social development. Quality utilities are a prerequisite for effective poverty eradication. Governments are ultimately responsible for ensuring reliable universal access of service under accountable regulatory frameworks. Increased competition in the utilities

sectors in recent years has entailed changes in regulatory frameworks and ownership structures of enterprises, in addition to business diversification. These have impacted job security and working conditions in the sector. Adequate staffing levels and training in the use of new technologies are important for ensuring efficiency and safety in the workplace.

Working with the technology of GIS at the local level particularly at less developed nations like Ethiopia is not shining. Even though using GIS benefits local government in the area of increasing efficiency, improving accuracy, automating tasks, and increasing access to government, there was no considerable room set to GIS for managing urban utilities in Ethiopia in general and Gida Ayana town in particular. In Gida Ayana town, the GIS Based planning utilities is not properly functioning. Therefore, having lack of this problem can cause the unplanned construction of utility infrastructures, which may later create destruction of buildings, poles and drainage line. It is on this ground that, the study employed GIS technology to improve public access to information and facilitate GIS based

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assessment in urban facilities and utilities planning in Gida Ayana town, which may contribute for the further implementation of the work by the town.

Statement of the problem

Among main challenges, facing urban centers particularly those in the developing countries is how to provide adequate level of public infrastructure and services for growing urban population. Many problems prevailing in urban areas are linked to lack and unsustainable use of one or more urban utilities (Mewed, 2011). The recommendations of the MDG Africa Steering Group in 2008 clearly indicated that the sub-Saharan Africa including Ethiopia is not only characterized by lack of transport, power, communication networks, water, and other infrastructural services but also not carefully installed programs that poses ever constraints on economic growth and expansion of poverty (MDG, 2008). Urban utilities and facilities planners require solutions that address day-to-day work needs while also fostering the ability to effectively predict and respond to chronic urban problems. GIS tools provide the necessary planning platform for visualization, modeling, analysis, and making relationship (ESRI, 2011). On this ground GIS based assessment of urban utilities and facilities survey is exceedingly

Important since it deliver grant access to valuable information for evidence based policy making as well as planning, monitoring and evaluating programs. Many cities/towns in Ethiopia face immense challenges in its land-use planning that stem from the fact that almost many thousands of people live and work within slums, congested areas, lacking of basic urban utilities and facilities. These problems have been deep-rooted in Gida Ayana town for long period of time (OFED, 2010) and the problems attached to the issue should be addressed quickly. Besides the town lacks geographic databases that help for planning. Therefore, there is an urgent need to carry research on the existing problem compatible to GIS environment, which are considered useful for better planning and management. This will greatly enhance efficiency and facilitate urban utilities planning operation of public facilities within the town.

Objectives of the project

General objective

The overall objective of the project is to develop GIS Based Assessment in urban utilities planning in Gida Ayana town.

Specific objectives

- To identify the problem over the infrastructure.
- To show applications of GIS in urban utilities planning.
- To create GIS database of Gida Ayana Town urban utilities planning

Project questions

- Is there well-developed and connected transportation network system in the study area? How GIS can be solve the problem of the utilities planning?
- How GIS can be applicable over infrastructure?

Delimitation of the study

This study is confined to Gida Ayana Town, East Wollega Zone, and Oromia. It covers GIS Based assessment of Gida Ayana Town utilities planning. GIS environment can be used to analyze spatial arrangement of urban utilities?

Significance of the study

- This study will contribute as a spring board for other concerned bodies/ researchers who will conduct in these related issues.
- It will help the town administration to give decision on urban utilities planning and implementation.
- It also contributes the usage of GIS for the urban planning infrastructure.

GIS now supports various basic and advanced spatial analytic approaches in public facilities planning. GIS can be used even more than to generate maps showing where various urban facilities exist, but also with extensive use of GIS technology in the field of water and telecommunication distribution environment simulation, and integration of data operation and spatial analysis, becoming important basis for urban infrastructure planning. Planners and engineers can use this spatial information to make decisions about zoning designations and building documents.

Limitation of the study

Although this research was carefully prepared, it is still need to aware of its limitations. There were unavoidable limitations. Because of time limit the study only confined to the analysis of three entities of the town services including road network, water supply and fixed line telecommunication coverage. This may not reflect the overall picture of assessment of urban facilities and utilities situation of the study area.

REVIEW OF RELATED LITERATURE

General concepts and definition of terms

The term utilities can also refer to the set of services provided by these organizations consumed by the public: electricity, natural gas, water, sewage, telephone, and transportation. Utilities are transforming themselves intelligently by salvaging useful parts of existing systems and incorporating new technologies to extend their capabilities and Public utilities like gas, electric, water and telecommunications.

Facilities are making easy or easier service or natural ability of building provide for particular purpose.

It is wise to have a brief overview of GIS before exploring its applications. Accordingly, many scholars considered the definitions, components and historical development of GIS. In 1950s.

GIS was developed to produce maps. Currently GIS technology has evolved and grown its objectives are expanding. The major definition given to GIS is organized collection of computer hardware, software, geographic

data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced data (ESRI, 2010). Its objective is to improve overall decision making by visualizing data and seeing new patterns. GIS technology integrates common database operations such as query and statistical analysis with the unique visualization and geographic analysis benefits offered by maps (Haywood et al, 1998). Therefore, GIS has become to symbolize a technology, an industry, a way of doing spatial work. Generally GIS can be considered as an integrated system of computer hardware, software, and trained personnel linking topographic, demographic, socio-economic, utility, facility, image and other resource data that is geographically referenced.

Application of GIS in transportation.

The urban road network plays a key function in the urban spatial structure. Currently many researches are interested to look into road network analysis. However one of the most significant problems attributed to urban spatial analysis is how to evaluate the accessibility of road network. It is good news that GIS takes care of spatial analysis method on road network. The main objectives in routing across networks are to minimize the cost of the route that can be measured in a function of distance, time, or impedance in crossing the network. Shortest path routing has been fully integrated into GIS software packages.

Application of GIS in water supply utilization.

Urban drinking water supply network is made of over ground and underground intake, pumping, improving the quality of the water, storage and transport to the user's connections in GIS environment. The GIS water utilities modeling is designed for water that manages different complex systems like ability to service many thousands to many millions of people. By providing a geographically referenced view of water network analysis, GIS software particularly ARCGIS aids in visualizing and understanding real-world engineering and business problems.

Technology has emerged with solution of sustaining data on existing utilities. Obviously, effective management and planning requires updated maps and information and recent developments in the area of Science and Technology like GIS, GPS and remote sensing have come up with powerful tools. These advanced technologies can very effectively be used to handle the present day complex problems related to optimum utilization of available resources and infrastructure. Today it is possible to produce accurate mapping of the underground infrastructure facilities (Zhang, 2006).

Application of GIS in Telecommunication.

ESRI Software Company developed ARCGIS software to provide a common platform for integrating spatial data with information from existing support software. Network providers

become more efficient when they use ARCGIS to analyze infrastructure and operations. Using ARCGIS, companies can analyze large portions of data when there is a direct correlation between capital costs and distance. The spatial perspective offers new ways to understand

service areas and satisfy customers. In the worldwide telecommunications industry is moving rapidly, resulting in tough competition and an ever-increasing scope of services offered to customers. On the other side our world is changing rapidly. A GIS can integrate location-based data from databases all over the world to help people resolve and streamline everyday business issues. The application of GIS in the domain of telecommunication is an evolving technology compared with traditional information collecting and evaluating database systems which is sorting, analyzing and also illustrating. Geographical information systems with their powerful data handling and spatial analysis capabilities are ideal for meeting the information needs of telecommunications infrastructure development (Robert, 2009). Telecommunication is the most profound and important spatial structure opting large spatial data integration and management.

DESCRIPTION OF THE STUDY AREA AND RESEARCH METHODOLOGY

Description of the study area

Location

AYANA is a town found in Gida Ayana Woreda, East Wollega Zone, Oromia Region, Ethiopia. The geographic location of the woreda extends from 9°52'40.47" latitude and 36°37'13.97" longitude.

Figure 3.1: Map of the study area.

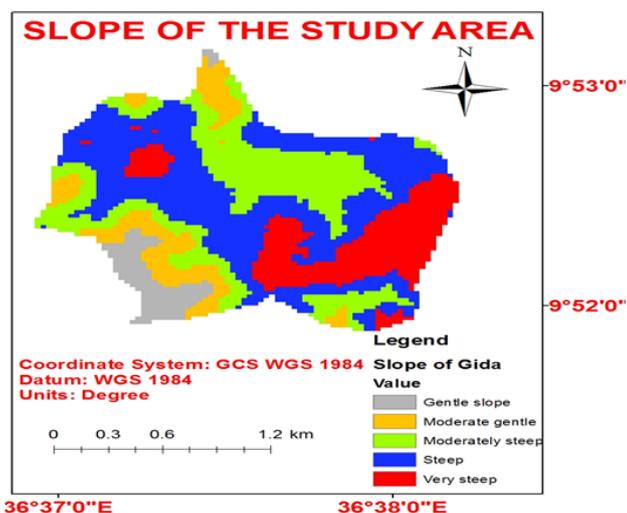


Slope of the Study area

Slope gradient of study area is generated from DEM Data with 30m resolution using the shape file of study area and respectively by using surface analysis tool masking in Arc GIS 10.2 software. As shown from map the steepness of study area ranges from gentler slope very steep based on their degree of

classification. Most parts of study area has gentle slope and some parts are flat slope.

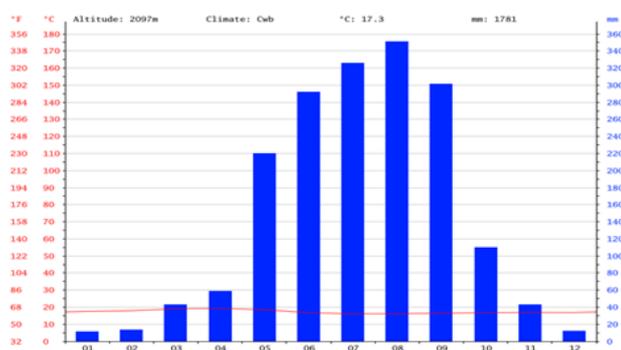
Figure 3.2: Slope of the study area.



Climate

The climate is warm and temperate in Gida Ayana. In winter, there is much less rainfall than in summer. According to Köppen and Geiger, this climate is classified as Cwb. The average annual temperature is 17.3 °C in Gida Ayana. About 1781 mm of precipitation falls annually in a year. Source: (National Meteorology Agency and own computation). See the following picture.

Figure 3.3: Graph of climate in the study area.



Water utility

Gida Ayana water supply is significantly underdeveloped in terms of both quality and quantity. The most significant sources of water for the town are tap water, springs, rivers, well and pond. The coverage of water consumption in Gida Ayana town is poor and falls short of the national and regional level.

Education

Provision of educational service in Gida Ayana town has been carried out in many levels of schools or education centers. Accordingly, the town has 3 kindergartens, 4 primary School.

Data Source

Primary Sources are immediate, first-hand accounts of a topic, from people who had a direct connection with it. Secondary data refers to data that was collected by someone other than the use. Secondary Sources are one step removed from primary sources, though they often quote or otherwise use primary sources. They can cover the same topic, but add a layer of interpretation and analysis. For this research I used the secondary data.

Data preparation

After collecting all the necessary data the next step was tracked to preparation of the data for analysis. This required changing of data formats, building the road network database, digitizing fixed line telephone terminal points, connecting demographic and social economic data to each administrative unit to manipulate statistics, editing and joining attribute data and adding missing attributes.

Software used in Analysis

ARCGIS 10.2 advanced (ARC Info) concurrent use with Network Analyst extension was used for network analysis, proximity analysis and producing map. Google Earth was used to produce shape file of the infrastructure and map of the study area.

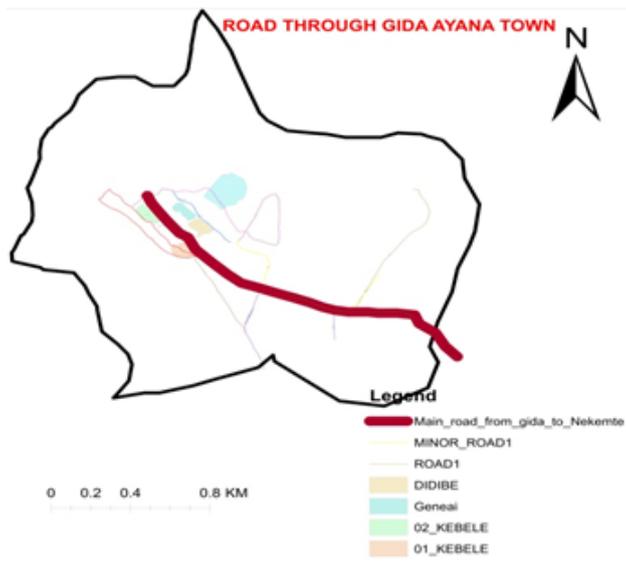
RESULTS AND DISCUSSION

Road Network Analysis

Road is a thoroughfare, route, or way on land between two places that has been paved or otherwise improved to allow travel by foot or some form of conveyance, including a motor vehicle, cart, bicycle, or horse. The urban road network plays a key role in the overall urban spatial structure. It is the main social economic activities and transportation carrier. Network analysis enables to solve problems, such as finding the most efficient travel route, generating travel directions, finding the closest facility, defining service areas based on travel time. Hence building geo-database where these spatial data are stored and sustained is highly important urban development plan. Transportation planning is the process of defining future policies, goals, investments, and designs to prepare for future needs to move people and goods to destinations. As practiced today, it is a collaborative process that incorporates the input of many stakeholders including various government agencies, the public and private businesses. Transportation planners apply a multi-modal and/or comprehensive approach to analyzing the wide range of alternatives and impacts on the transportation system to influence beneficial outcomes. Also commonly referred to as transport planning internationally, and is involved

with the evaluation, assessment, design, and siting of transport facilities (generally streets, highways, bike lanes, and public transport lines).

Figure 4.1: Map of road in Gida Ayana town.



Market centers

Market center have basic role as for as urban economics activities are concerned. The market centers for exchanging various goods and services in the town generally lack proper places, infrastructure and arrangement. The commercial activities in the market include grain trade, coffee, vegetables, traditional clothes and other consumable goods. In terms of location and size, the area is one of the densely populated areas surrounded by residential houses where there is lack of access roads for both vehicles and pedestrians. Since this market is located at the center of the town, its prospect to expand is very slim. The market places for cattle, though it has specific place, due to its improper location found nearly crossing the central areas of the town, usually creates traffic congestion. From sanitation point of view, the current site is also improper due to the presence of many residential houses in the surrounding.

Sheep and goat market situated on roadside is also another problem for smooth traffic movement. According to the information obtained from the municipality of Gida Ayana town, there are three daily markets in very limited places of the town. This results the emergence of other small market places scattered in various areas. Most of them including the legal markets are functioning on roadsides where there is traffic flow. Moreover, poor liquid and solid waste management practices are also common problems in these market places. Considering all the above problems prevailed in the market places, the government and the society attention should be given towards proper planning and management of the facilities.

Figure 4.2: Map of market center in Gida Ayana town.



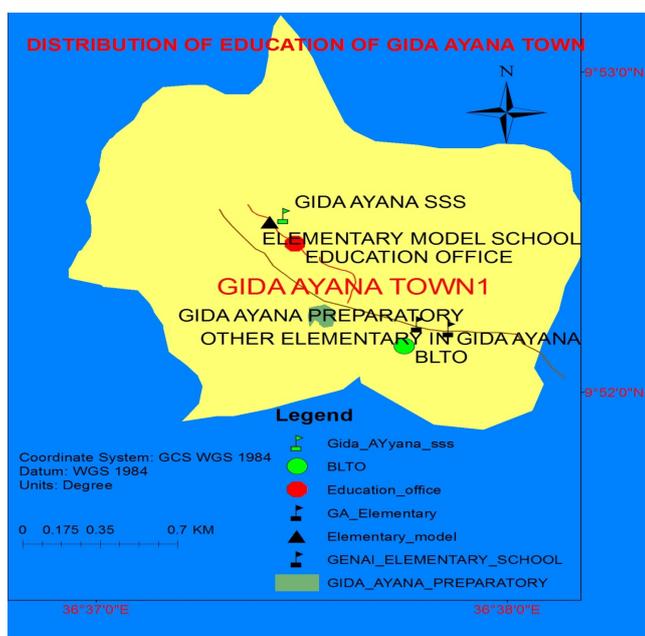
Education

Education is the wealth of knowledge acquired by an individual subject matters or experiencing life lesson that provide understanding of something. Education requires instruction of some sort from an individual or composed literature. The most common forms of education result from years of schooling that incorporates studies of a variety of subjects. The only purpose of education is to pursue the truth, To help the individual realize his own potential ,To teach organized, disciplined, systematic subject matter , To hand down the cultural heritage of the rate, To ensure the survival of our country. The main purpose of education is to strengthen your mind so that you can move easily. Learn to deal with specific challenges you will face throughout your life. Even though you will forget most of what you learned in school, the intense effort your mind. Just like how physical conditioning tones your body (even though it serves almost no practical purpose).Education plays an important role in education should be a means to empower children and adults alike to become active participant in the transformation of their societies. Learning should also focus on the values, attitudes and behaviors which enable individuals to learn to live together in world characterized by diversity and pluralism.

Education is considered as important variable in enhancing the participation level, adoption of conservation measures and improving production and productivity of agriculture. Farm families live and make decisions with regards to resource allocation in a complex internal and external environment. The lack of education or access to information associated with poverty may cause farmers to be less aware of land problems, or to attribute such problems to causes beyond their control, and thus may reduce their efforts to address such problems. In these regard 62.5% of the respondents had never attended school and the rest respondents (i.e. 27.5%) had attended primary,

secondary and above secondary formal education. Here, the data indicated that the number of respondents who did not attend formal education is high compared to those who attended formal school. In addition to the above fact (Kebede, 2006), in his finding suggested that educated farmers are more likely to follow the practices of land management than non-educated farmers. Hence, education provides farmers with the knowledge of these practices and their recommended levels. Most of the farmer household heads in the area are not educated and thus have little access to information about newly introduced land management and water conservation practice. The age of household head has been taken as an important demographic variable in this study. This is assumed to influence the household's decision to participate in land degradation and farmland management. As explained in the literature the older the household head, the more conservative to participate in farmland management. Farmers in this age group are assumed to have a good understanding of problems of land degradation due to access to information, and as a result, usually more interested in land conservation practices.

Figure 4.3: Map of the education in Gida Ayana town.



Health Center

Urban planning, also called city and regional planning, is a multidisciplinary field in which professionals work to improve the welfare of persons and communities by creating more convenient, equitable, healthful, efficient, and attractive places now and for the future. The centerpiece of urban planning activities is a "master plan," which can take many forms, including comprehensive plans, neighborhood plans, community action plans, regulatory and incentive strategies, economic development plans, and disaster preparedness plans. Traditionally, these plans include assessing and planning for community needs in some or all of the following areas: transportation, housing, commercial/office buildings, natural resource utilization, environmental protection, and health-care infrastructure. Urban planning and public health share

common missions and perspectives. Both aim to improve human well-being, emphasize needs assessment and service delivery, manage complex social systems, focus at the population level, and rely on community-based participatory methods. Both fields focus on the needs of vulnerable populations.

Throughout their development, both fields have broadened their perspectives. Initially, public health most often used a biomedical model (examining normal/abnormal functioning of the human organism), and urban planning often relied on a geographic model (analysis of human needs or interactions in a spatial context).

However, both fields have expanded their tools and perspectives, in part because of the influence of the other.

A healthcare center, health center, or community health center is one of a network of clinics staffed by a group of general practitioners and nurses providing healthcare services to people in a certain area.

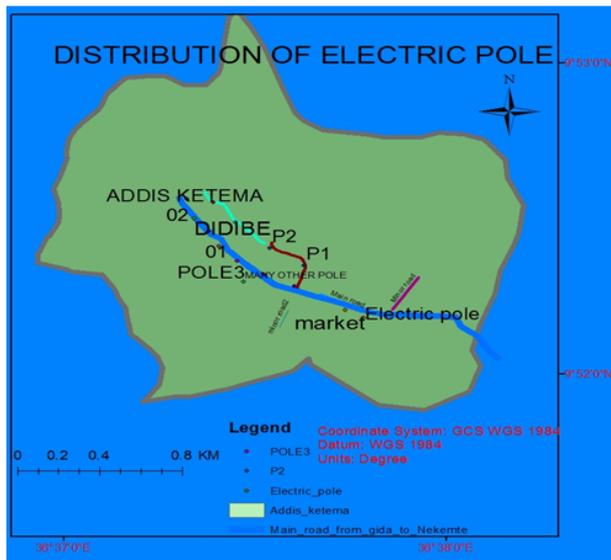
Figure 4.4: Map of the Health center in Gida Ayana town



Utility Poles

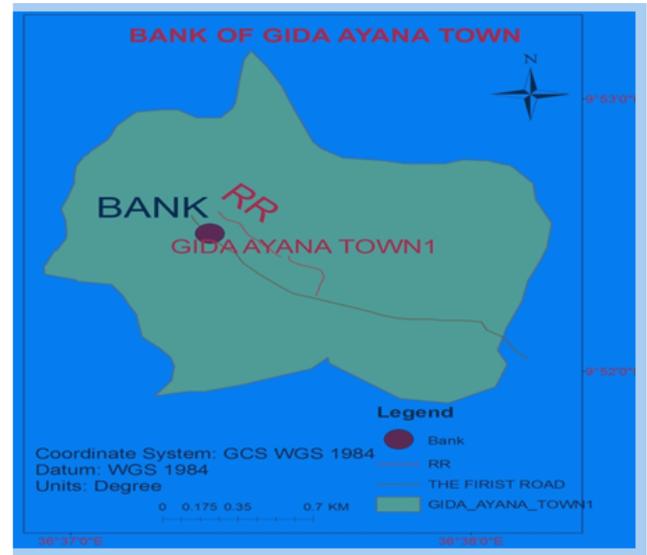
Utility pole is a column or post used to support overhead power lines and various other public utilities, such as electrical cable, fiber optic cable, and related equipment such as transformers and street lights.

Figure 4.5: Map of the distribution of electric pole in Gida Ayana town.



deal with cash, domestic and foreign, and to receive the deposits of money and to loan those monies to third-parties.

Figure 4.7: Map of Bank of Gida Ayana town.



Water Utility

Water is a transparent, tasteless, odorless, and nearly colorless chemical substance that is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. Gida Ayana town water supply is significantly underdeveloped in terms of both quality and quantity. The most significant sources of water for the town are tap water, springs, rivers, well and pond. The coverage of water consumption in Gida Ayana town is poor and falls short of the national and regional level. Generally, it is reported that 68.3% of the town's households have access to water sources regarded as safe in 2008. The national level coverage of safe water for urban centers is 92.4% and that of Oromiya urban center is 91.03%. This shows that Ayana safe water coverage (68.3%) is less than the national and regional level (OFED, 2010).

Figure 4.6 : Map of the drainage water in Gida Ayana town.



Conclusion

The main objective of the project is to develop GIS Based Assessment in urban utilities planning in Gida Ayana town and build road network, education and health center geospatial database in GIS environment and to assess their spatial arrangement in the study area. GIS is demonstrated as a powerful tool throughout geo database building, managing large and spatial data analysis. The tools embedded in Arc GIS particularly Arc GIS 10.2 has many options through which a large spatial dimension is modeled. These help the study to assess the accessibility of existing road network patterns.

This inaccessibility to different facilities and services including transportation route caused major conflict during taking taxi and creates congestion in traffic movement. Availability of adequate quantity and quality of water supply is a key requisite in maintaining a healthy environment. However, GIDA is not fortune to satisfy water demand for the needy population.

The requirement of water for domestic purposes including for sanitation and gardening Was obtained from taps, spring, well, river, pond or combined sources. There is mismatch between water supply and demand in both spatial coverage and quantity. In any angles of water supply analyses made in the study area flashes red light and clearly indicate critical drinking water supply shortage. The distribution of fixed line telephone in the town similar to other facilities and utilities concentrated in the central part of the town. The outlying areas have poorer to the service. Finally, it was concluded that GIS is a powerful tool to manage spatial data for the reason that it has a great facility for geographic features and their attributes in a computer database. GIS is also key to evaluate urban facilities and utilities planning through providing spatial relational Information. Urban facilities and utilities planning have naturally spatial dimension and this is the most compelling evidence that GIS is excelling in assessing the arrangement of urban services. The advantage of

Bank

Bank is a financial institution that accepts deposits from the public and creates credit. Lending activities can be performed either directly or indirectly through capital markets. Due to their importance in the financial stability of a country, banks are highly regulated in most countries. Corporation empowered to

using a GIS for analysis of GIDA urban facilities helped the identification of the accessible and inaccessible areas through pointing areas require attention, visual cross checking with statistical data, and provide a platform for presenting the analysis on map in a way that government officials can review their plan.

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