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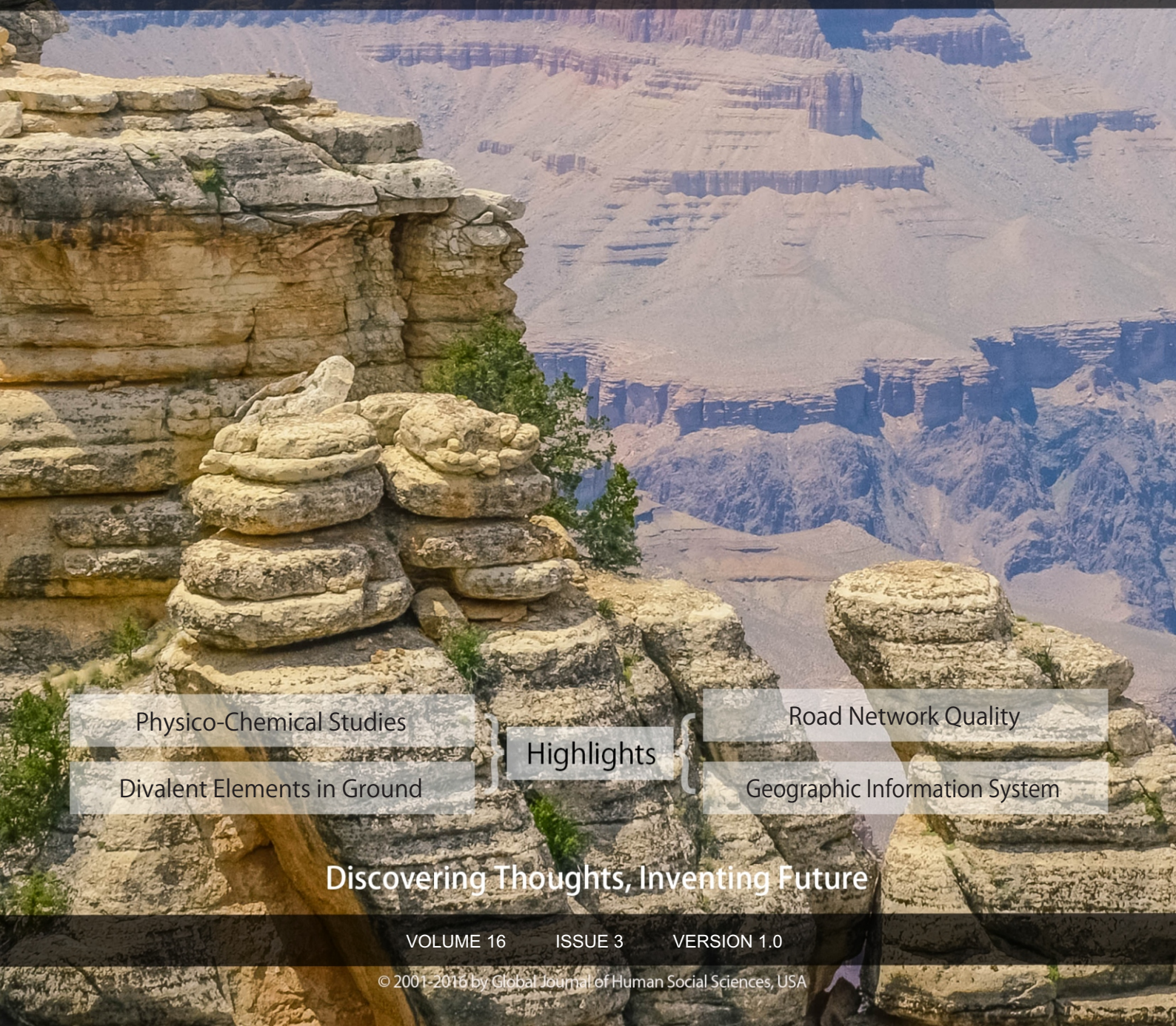

Physico-Chemical Studies

Divalent Elements in Ground

Highlights

Road Network Quality

Geographic Information System

Discovering Thoughts, Inventing Future

VOLUME 16 ISSUE 3 VERSION 1.0

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Contents of the Issue

i. Copyright Notice
ii. Editorial Board Members
iii. Chief Author and Dean
iv. Contents of the Issue

1. Physico-Chemical Studies on Treatment of some Divalent Elements in Ground Water. *1-5*
2. Synergy between Traditional and Introduced Sustainable Land Management Practices in Ethiopia. *7-16*
3. Impact of Coal Mining on the Environment in Mainganga Community of Akko Local Government, Gombe State, Nigeria. *17-24*
4. Health Facilities Distribution Mapping in Addis Ababa, Ethiopia. *25-39*
5. An Assessment of Road Network Quality in Jos City, Nigeria: Using Geographic Information System (GIS). *41-52*
6. Land use and Land Cover Change Detection of Ganakbari Mauja in Savar Upozila. *53-63*

v. Fellows
vi. Auxiliary Memberships
vii. Process of Submission of Research Paper
viii. Preferred Author Guidelines
ix. Index

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Physico-Chemical Studies on Treatment of some Divalent Elements in Ground Water

By Prof. Dr. M. K. Moustsfa, Prof. M. A. Hussien, Prof. M. E. Mohamed & A. A. Mohamed
Sohage University

Abstract- When there is no surface water we must think in use groundwater, but groundwater need treatment, Treatment of underground water one of the most difficult treatment methods, that because under groundwater contain high amount of total dissolved salts(TDS), and there is great difficulty in control the source of underground water, iron and manganese from the famous divalent elements in groundwater, the Egyptian standard for the concentration of iron is (0.3 ppm) and for manganese is (0.4 ppm) the increase in concentration for iron and manganese case change in the taste of water and sometimes effect on the human health. We will show in this study physical, chemical study for treatment of iron and manganese in groundwater.

Keywords: *groundwater; iron and manganese treatment, aeration, chlorination, $KMnO_4$.*

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"Physico-Chemical Studies on Treatment of some Divalent Elements in Ground Water"

Prof. Dr. M. K. Moustsfa [α], Prof. M. A. Hussien [σ], Prof. M. E. Mohamed [ρ] & A. A. Mohamed [ω]

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Keywords: groundwater; iron and manganese treatment, aeration, chlorination, KMnO4.

I. Introduction

Groundwater is an important resource to act as a natural storage that can buffer against shortages of surface water. However, due to the stratum composition, the groundwater often contains iron and manganese ions.

While the concentrations in excess, the water becomes red-brown, and endues the scaling problems in pipeline system. Thus, the water quality standards have specified their limitations, where Fe is less than 0.3 mg L-1 and Mn is less than0.05 mg L-1.

In the traditional process, Fe and Mn in groundwater are initially oxidized using aeration and/or chemical oxidant such as chlorine, hypochlorite, chlorine dioxide, ozone or potassium permanganate following the remove by filtration.

The selection of various oxidants depends on which kinds of pollutants in water, as well as their effects on the water quality. Capital cost is also an important consideration. After the oxidation process, the Fe and Mn oxides are then removed through the sand filter. Moreover, previous studies have indicated that the presence of Mn oxide particles accelerates the formation of Fe-Mn oxide, contributing to the removal of Fe and Mn from groundwater [1].

Author α: Professor, of Physical Chemistry, Faculty of Science, Sohage University, Egypt. e-mail: elghoul_alaa@yahoo.com
Author σ: Lecturer, of Inorganic Chemistry, Faculty of Science, Port Said University, Egypt.
Author ρ: Lecturer, of Inorganic Chemistry, Faculty of Science, Sohage University, Egypt.
Author ω: M.Sc. Degree Student, Faculty of Science, Port Said, University, Egypt.

Granular activated carbon is often used to enhance the adsorption of Mn^{2+} in filtration process [2-5]. However, the drawback is frequent regeneration or new carbon replacement.

In recent years, membrane process has been applied in water and wastewater treatment. Compared to the traditional physical/chemical treatment, membrane process illustrates more advantages in water quality enhancement, including space saving, and reduced amounts of chemicals used and sludge produced [6].

However, high capital and maintenance costs are considered to be major drawbacks. Due to the dramatic improvements of membrane science and technology, the manufacturing cost of membranes has been decreased significantly. Many water treatment plants in US have used membrane process as one of major treatment units [7].

Meeting the water treatment standards using the existing equipment is considered to be the major problem for many water treatment plants. Membrane separation technology has been utilized to remove metal oxide particles and to improve the performance of the existing process [8].

II. Materials and Methods

a) *Forms of Occurrence of Iron and Manganese in Water*

Iron and manganese occur in dissolved forms as single ions (Fe^{2+}, Mn^{2+}) or in undissolved higher forms mainly as $Fe(OH)_3$ or $Mn(OH)_4$, respectively. They can also be present in colloid form (bound to humic substances). The form of their occurrence depends on oxygen concentration, solubility of Fe and Mn compounds in water, pH value, redox potential, hydrolysis, the presence of complex-forming inorganic and organic substances, water temperature, and water composition (e.g. CO_2 content).

b) *Effect on Water Quality*

Adverse effects of higher Fe and Mn concentrations in drinking water can be summarized as follows:

- iron (II) and manganese (II) ions are oxidized to higher forms in a water distribution system and this results in the formation of hydroxide suspensions causing undesirable turbidity and colour of water,

- the presence of iron and manganese bacteria in water supply system causes change in water quality (smell) and bacterial growth in pipes,
- in the case of the occurrence of iron (II) and manganese (II) ions at the consumer's point, iron and manganese are oxidized and precipitated under suitable conditions (e.g. in washing machines, boilers).

Following the above-mentioned facts, higher concentrations of iron and manganese in water cause technological problems, failure of water supply systems operation, water quality deterioration and, in water with slightly higher concentrations of oxygen, they form undesirable incrustations that result in the reduction of pipe flow cross-section.

c) Methods of Iron and Manganese Removal

The principle of most methods used for iron and manganese removal is that originally dissolved iron and manganese are transformed into undissolved compounds that can be removed through single-stage or two-stage separation.

Oxidation and hydrolysis of these compounds is done under strict conditions with respect to water properties and type of equipment for iron and manganese removal.

Single-stage water treatment (filtration) is designed for iron and manganese concentrations to 5 mg·l-1, and the two stage treatment (settling tanks or clarifiers and filters) is used for water with iron and manganese concentrations higher than 5 mg·l-1. In case water contains higher concentrations of Ca, Mg, and CO_2 (eventually H_2S), aeration is done before settling or filtration.

Removal of Fe and Mn from groundwater and surface water can be done by several methods:

- oxidation by aeration,
- removal of Fe and Mn by oxidizing agents (O_2, Cl_2, O_3,$KMnO_4$),
- removal of Fe and Mn by alkalinization (by adding thelime),
- contact filtration for removal of Fe and Mn,
- removal of Fe and Mn by ion exchange,
- removal of Fe and Mn using membrane processes,
- removal of Fe and Mn using biological filtration,
- removal of Fe and Mn using in situ method.

Fe^{2+} and Mn^{2+} oxidation rate as well as hydrolysis of emerging oxides of higher iron and manganese oxidation forms in groundwater depends on the pH value.

Various graphic dependencies of these relationships with respect to oxidation time are listed in literature. The pH value should be equal or greater than 7 in removal of iron from groundwater.

For removal of manganese without catalyst, the pH value should be equal to or greater than 8 [3].

Removal by using the oxidized film on grains of filter medium is one method for elimination of dissolved manganese.

The film is formed on the surface of filter medium by adding permanganate potassium (not only KMnO4 but also other strong oxidizing agents).

The film serves as a catalyst for the oxidation process. Grains of filter medium are covered by higher oxides of metals. In such a case, it is related to special filtration so-called "contact filtration" – filtration by using manganese filters. The oxidation state of the film of MnOx(s) filter medium is important in removal of dissolved manganese.

Manganese removal efficiency is a direct function of MnOx(s) concentration and its oxidation state. The films with different ability to remove dissolved manganese from water are formed on the surface of various filter media [10-14].

III. Results and Discussion

Aeration

Groundwater passing through different layers of soil and due to its water properties and its high solubility, contain elements and minerals of material in the soil that sometimes can be dangerous for the health of consumers or at least undesirable in terms of cognitive beautiful. Iron and manganese are from constitutive of the soil and rocks of the Earth's surface. Water penetration through soil and rock can minerals such as these elements have dissolved and bring them into solution. The problems of iron and manganese in groundwater in domestic installations, commercial, industrial and refineries are created, and because much of the community water supply from underground water supplies will be removed where iron and manganese concentrations exceeded it is necessary.

Table 1 : Results obtained from ground water aeration

	PARAMETERS	UNITS	EGYPTIAN STANDARDS	BEFORE TREAT.	AFTER TREAT.
1	RES. CHLORINE	PPM	5	0	0
2	TURBIDITY	NTU	1	0.85	0.25
3	PH		6.5-8.5	7.53	7.72
4	IRON	PPM	0.3	0.282	0.041
5	MANGANESE	PPM	0.4	0.963	0.602

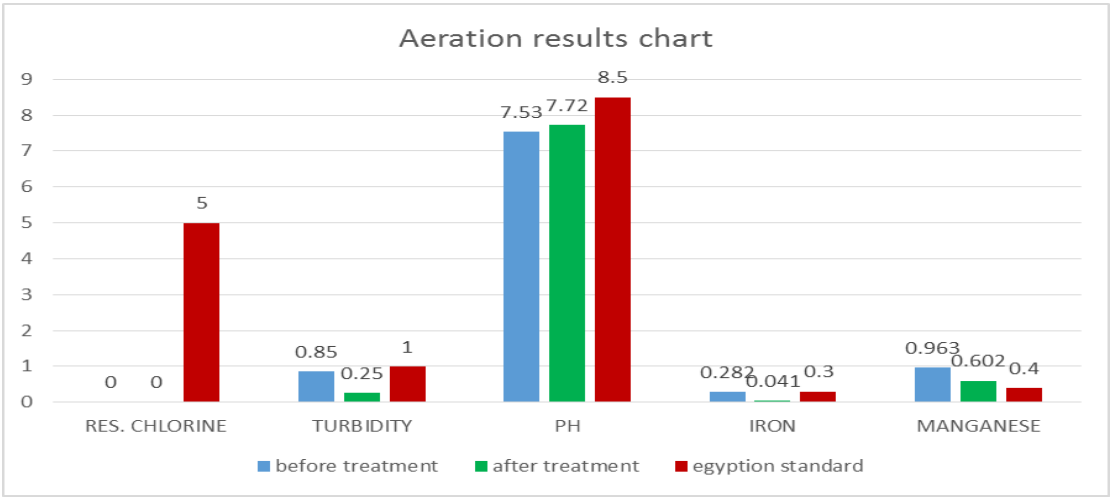

Fig. 1 : Results obtained from ground water aeration

1-we don't use chlorine .[26]
2- reduce of turbidity come from filtration[15] .
3- increase of pH come from volatility of CO_2.[16]
4- aeration high effect on Iron than manganese as the second need chemical treatment[17].

a) Chlorination

Chlorine is the most commonly used disinfectant employed for killing bacteria in water. In addition chlorine, as an oxidizing agent, is used to remove undesired inorganic species such as ammonia, iron and manganese[18]:

Table 2 : Results obtained from ground water chlorination

	PARAMETERS	UNITS	EGYPTIAN STANDARDS	BEFORE TREAT.	AFTER TREAT.
1	RES. CHLORINE	PPM	5	0	2
2	TURBIDITY	NTU	1	0.68	0.51
3	PH		6.5-8.5	7.62	7.55
4	IRON	PPM	0.3	0.281	0.242
5	MANGANESE	PPM	0.4	0.614	0.561

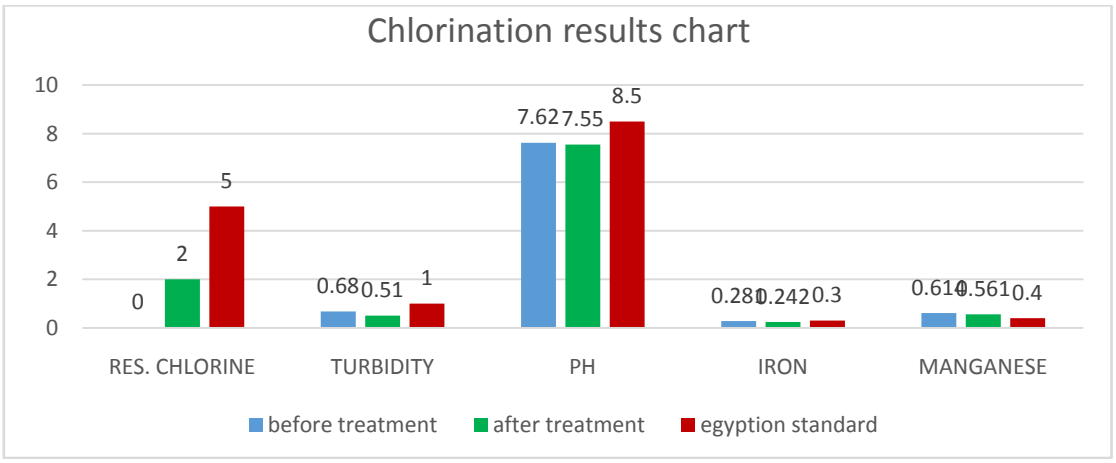

Fig. 2 : Results obtained from ground water chlorination

1-turbidity decrease after filtration.[26]
2- PH decrease under the acidic effect of chlorine[19] .
3- the decrease of IRON and MANGANESE is little because that chlorine is a weak on oxidation of them[20] .

b) Chemical treatment by $KMnO_4$

Potassium permanganate ($KMnO_4$) is used primarily to control taste and odors, remove color, control biological growth in treatment plants, and remove iron and manganese.

In a secondary role, potassium permanganate may be useful in controlling the formation of THMs and other DBPs byoxidizing precursors and reducing the demand for other disinfectants [21].

c) Iron and Manganese Oxidation

A primary use of permanganate is iron and manganese removal. Permanganate will oxidize iron and manganese to convert ferrous (+2) iron into the ferric (+3) state and +2 manganese to the +4 state.

The oxidized forms will precipitate as ferric hydroxide and manganese hydroxide [22].

The precise chemical composition of the precipitate will depend on the nature of the water, temperature, and pH.

The classic reactions for the oxidation of iron and manganese are:

$$3Fe^{+2} + KMnO_4 + 7H_2O \rightarrow 3Fe(OH)_3(s) + MnO_2(s) + K^+ + 5H^+$$

$$3Mn^{+2} + 2KMnO_4 + 2H_2O \longrightarrow 5MnO_2(s) + 2K^+ + 4H^+$$

Table 3 : Results obtained from groundwater chemical treatment by $KMnO_4$

	PARAMETERS	UNITS	EGYPTIAN STANDARDS	BEFORE TREAT.	AFTER TREAT.
1	RES. CHLORINE	PPM	5	0	0
2	TURBIDITY	NTU	1	0.67	0.24
3	PH		6.5-8.5	7.66	7.23
4	IRON	PPM	0.3	0.184	UDL
5	MANGANESE	PPM	0.4	0.943	0.291

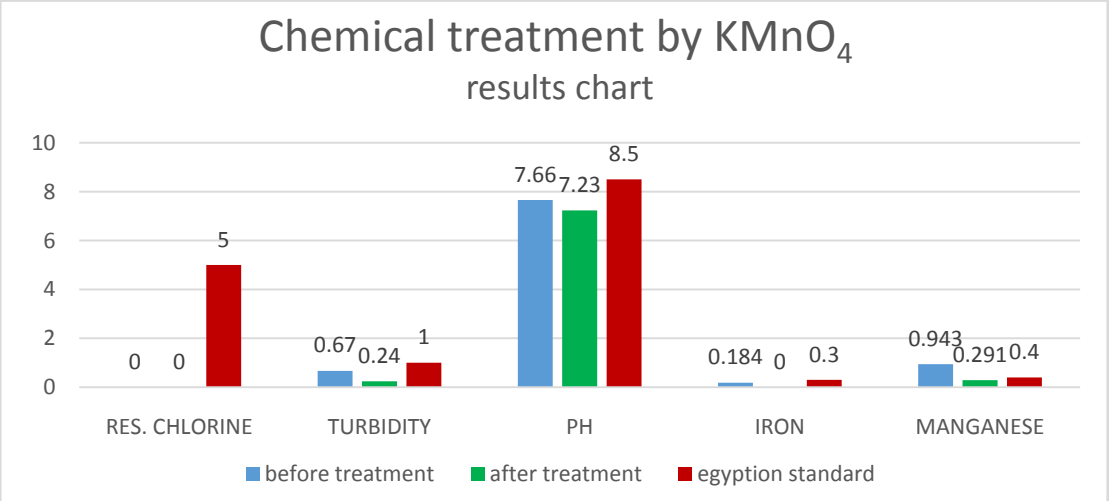

Fig. 3 : Results obtained from groundwater chemical treatment by $KMnO_4$

IV. Chemical Treatment by $KMnO_4$ Discussion

1- turbidity decrease under the effect of filtrations.[26]

2- pH decrease because that the $KMnO_4$ is consumed alkalinity[23] .

3- IRON decrease under the effect of oxidation by $KMnO_4$ [24].

4- MANGANESE decrease under the effect of oxidation by $KMnO_4$.[25]

V. Conclusion

Underground drinking water treatment difficult but when mastery will provide a lot and we will get a rich mineral salts drinking water and conform to the specifications aeration will help in getting rid of iron, chemical treatment, help in getting rid of iron and manganese.

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Synergy between Traditional and Introduced Sustainable Land Management Practices in Ethiopia

By Abbadi Girmay & Gebre Yohannes Girmay
Tigray Agricultural Research Institute

Abstract- The current development effort of Ethiopian government emphasizes on market-oriented commodity production through specialization and diversification of enterprises that are complementary to specialized commodities. This household based package formulation is natural resources conservation based approach. Farmers of Hararge have rich and ecologically sound traditional land husbandry practices/knowledge base. “Traditional tie-ridging” is practiced for in-situ moisture conservation and intensification of cropping systems at plot level. RW is contained in the farm plot. There are some similar experiences in Tigray but should be further exploited to expand and introduce cash crop/ agroforestry in the rugged and undulating areas of Tigray. There was also good integration of biological and physical SWC techniques. Enterprises should be diversified, integrated and market-oriented to improve the livelihood of farmers. Important knowledge gained from Hararge to fill gaps in Tigray & other drylands of Ethiopia comprises water harvesting (in-situ moisture/ water harvesting through tie-ridges), irrigation (crop diversification and intensification), zero grazing and integrated & intensive watershed management approach.

Keywords: water harvesting, eastern and northern ethiopia, dry land areas, sustainability.

GJHSS-B Classification : FOR Code: 770502

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Abbadi Girmay [α] & Gebre Yohannes Girmay [σ]

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Keywords: water harvesting, eastern and northern ethiopia, dry land areas, sustainability.

I. Introduction

The agricultural potential and natural resource bases of the Tigray Region have been continuously exploited for a long period of time without appropriate conservation practices for sustainable use. These inappropriate use and lack of attention by the previous regimes have led to cyclic drought, environmental degradation, decrease in productivity and deep-rooted poverty. The government of FDRE has designed a development policy to bring about sustainable development in a short period of time. The Regional Government of Tigray has also adopted the Rural Centered Agricultural Development-Led Industrialization (ADLI) Strategy with the following main directions: Ensuring food security, nature conservation and environmental protection, employment opportunity, improved livelihood, market-oriented agricultural production and poverty reduction through mitigation of root causes of poverty.

The current development effort of Tigray Regional government emphasizes on household package formulation based on area specialization (market- oriented commodity production) and diversification of enterprises that are complementary to specialized commodities. This household based package formulation is natural resources conservation based approach in which water harvesting is central and the core component of packages: water harvesting-centered household package approach. This approach favours integration and linkage of crop-livestock- natural resource base sectors to enhance ecologically, socially and economically sound sustainable land management principles and practices. The household based package was prepared and is implemented based on agro-ecological potentials, priorities, opportunities and existing and desired infrastructures for production and post-harvest aspects. To date an exemplary and huge environmental rehabilitation and development work has been done and majority of degraded lands have been rehabilitated in Tigray and had given lessons to other regions.

Currently, environmental rehabilitation and agricultural development efforts in Tigray are supported with a tremendous water harvesting works (ponds, shallow and deep wells, series of ponds, run off and river diversion, dams, roof and rock catchments, in-situ moisture conservation and catchments treatment) to tackle recurrent drought and to bring about the desired agricultural transformation, sustainable development and alleviate poverty. These development endeavors should be translated into economic terms and our grass-root community (farmers) should gain economic benefits and generate income to improve their livelihoods (Abbadi et al, 2003).

Author α: (PhD), Tigray Agri. Research Institute (TARI), Mekelle. e-mail: abbadigirmayreda@gmail.com
Author σ: (PhD), Mekelle University, LARMEP, Mekelle. e-mail: Gebreyohannes.girmay @gmail.com

II. Materials and Methods

a) Case studies

Kombolcha, Alemaya and Fedis weredas of East Hararge and Doba and Mesella weredas of West Hararge Zones were visited. The visit included introduction by zonal and wereda heads, field visit and interaction with experts and farmers, direct observation of farm lands and catchments and wrap-up meeting and open discussion with were da and zonal personnel to share experiences of both counterparts.

b) Area description

East and West Hararge Zones have varied traditional agroclimatic zones including "kola", "weina dega' and "dega". Rainfall is bimodal and erratic and climatic aridity increases to the East and South East. Landforms vary from plain to undulating rugged topography (Table-2). The farming systems of these zones are characterized as follows:

- Mixed crop-livestock system
- Small land holding size
- Market-oriented cash crop/livestock production system
- Intensive traditional land resource management practice
- Labour intensive working tradition of farmers and farming activity is done all year round (365 days).
- Diversified and intensified cropping systems of perennial and annual mixed crops that enhance income generation minimize risk and soil degradation.
- Zero grazing system that excludes livestock from farm lands where cut- and- carry feeding system practiced.
- Livestock number per capita is very small and practice of oxen plough is minimum and non-existent in most cases where hand digging is the dominant tillage practice.
- Rich and ecologically sound traditional land husbandry practices/knowledge base but lack technical backup.

Table 1 : Contrasting environments and farming systems

Hararge	**Tigray**
Zero grazing	Free grazing
Row planting	Broadcasting
Bimodal rain fall and erratic	Erratic
Perennial and annual mix cropping	Dominantly annual cereal crops
No oxen cultivation	Oxen cultivation
Farmland not far from residence	Fragmented

Table 2 : Area description of visited weredas

Wereda	Population	Density (Persons/ Km^2)	Rainfall (mm)	Altitude (m. a. s. l.)	Land holding (Ha)	Soil texture	Topography	Agroclimatic zones
East Hararge Zone								
Kombolcha	120,063	258	600-900	1600-2400	0.5	Clay loam / sandy loam	Plain & undulating	26% Kola 74% W/Dega
Alemaya	204,982	393	600-900		0.25-0.5	Clay loam	Plain	68%W/Dega 32%Kola
Fedis	222,835	109	400-800 in kola 600-1200 (W/Dega)	500-2118	0.75-1.25 (W/Dega) 1-3 (kola)	Red brown clay loam with 1-1.5m depth	80% plain	86%Kola 14%W/Dega
West Hararge Zone								
Doba	143,000		Erratic				Steep, Rugged, undulating	5% Dega 41%W/Dega 54%Kola
Mesela	159,000	231		1200-1700			Rugged	20%Kola 80%W/Dega

c) *Experiences from China show that*

- Massive watershed management with project approach
- Zero grazing: enforcement: doubled livestock population and not destocking through availing quality and enough feed source from treated watersheds
- Intensive watershed treatment

Have resulted in sound environmental rehabilitation and improved rural economy within a decade (Ayalneh, 2004, Azene, 1997).

III. Results and Discussion

Intensive field visits and open discussions were done to share experiences. Summary of these experiences gained at farm land (plot) and watershed/catchment level and promising techniques,

technologies, skills and knowledge for possible adoption into Tigray's situation and recommendation on adjustment, biophysical and socio-economic setups, technical (research and extension service) backups are presented below.

a) Water Harvesting (WH) and Moisture conservation

Rainfall is erratic in intensity and distribution in dry lands of Ethiopia. Rain water Harvesting (RWH) and storage minimizes the risk of frequent crop failures due to drought. East and West Hararge zones have some innovative methods of water harvesting techniques to store and conserve water on farmlands for efficient water utilization to enhance farm productivity.

i. *Run-off diversion*

Run-off diversion into farmlands to feed tie-ridges and enhance in-situ moisture harvesting is a common practice of the visited weredas. Farmers in the visited weredas practice this water harvesting mechanism (e.g. 605 ha in kombolcha and 1500ha in Alemaya weredas) to maximize run–off water to alleviate moisture stress. There are also efforts to utilize run-off water and traditional run-off diversion is common practice in some weredas and efforts should be made to utilize excessive run–off lost after each rain shower.

ii. *Shallow Wells*

A lot of shallow wells have been dug to irrigate crop fields with spate irrigation with motorized pumps. More than 1500 in kombolcha, 1548 in Alemaya and considerable number of shallow wells in other weredas have been dug. More than 1600 waters pumps in Kombolcha and 3600 water pumps in Alemaya were purchased by farmers to irrigate their field. The farmers have interesting water lifting mechanism to up lift water from shallow wells in to up hills. They utilize relay of motorized water pumps to lift water to undulating and sloppy areas to irrigate their fields. This allows cultivation of cash crops in sloppy areas. There are some similar experiences in Tigray but should be further exploited to expand and introduce cash crop/ agroforestry in the rugged and undulating areas of Tigray.

Fig. 1 : Shallow well

iii. *Ponds*

A large number of ponds have been constructed recently in East and west Hararge. These ponds are fenced with dry and live fences to stabilize ponds and protect entry of livestock and children. Fencing ponds can have similar advantage in Tigray and farmers should be advised to fence their ponds for sustained use of their ponds and to protect ponds from entry of livestock and children.

Fig. 2 : Typical plastic lined pond in Tigray

iv. *Conveyance and storage of excess run-off using cut off drain in to large reservoirs*

Shortage of water for agricultural production in dry land areas of Ethiopia is mainly related to the temporal and spatial distribution; meaning water is not always available in the right place at the right time. During the rainy period, rain water is left to flow over different landscapes. It also causes flooding, massive soil erosion, land slides and destruction of rural and urban infrastructure like roads, SWC structures, farm lands and residence houses. Farmers at Mesela wereda have vital experience in channeling excessive run off from town roof catchment through ditches into far distance (5km) and storing the runoff into large naturally occurring well (sink well). This effort shows that there is great potential to collect excessive run off from towns and catchments and to convey run off to the desired distance and store it in natural reservoirs or artificially made large wells and use it when water is critically needed to the desired purpose. This experience created an opportunity to maximize and explore all available ways of water harvesting techniques for optimum water harvest in Tigray. Efforts should continue to utilize all possibilities of water harvesting mechanisms.

Figure 3 : Natural reservoir at Mesella wereda, West Hararge

b) Intensification of agroforestry on farmlands

Agroforestry species can be intensified and integrated on irrigated areas.

Figure 4 : Traditional Agroforestry

c) Integrated Watershed Management

We observed good experience catchment treatment at Keraba watershed of Doba wereda of West Hararge. We observed integrated and intensive catchment treatment using integrated and intensified SWC technologies. There was integration of different type of physical SWC techniques based on slope gradient and soil depth of the catchment area. These include:

Hill side terraces, microbasins, eye brow basin, hearing bone, cut off drain, stone and soil bunds, tie-ridging and trenches.

Figure 5 : Integrated Watershed Development in West Hararge

There was also good integration of biological and physical SWC techniques. There was intensive inter-terrace management. The terraces are well designed to harvest rainwater. This enhanced agroforestry practice in sloppy areas. Biological entities include: Grass strips, fodder trees, fruits and indigenous and exotic tree species.

Agroforestry in hilly and communal areas allows

- Bund Stabilization
- Income generation
- Animal feed
- Bee flora
- In-situ moisture/water harvesting that enhances discharge of water sources down stream
- Overall environmental rehabilitation

Figure 6 : SWC structures, West Harage

Catchments were excluded from livestock interference and human settlement and allowed land use change in hilly areas into forest/agroforestry areas and resulted in complete vegetation cover and discharge of water in the catchment discharge area. The catchment was distributed to different grass root community organization for local management, ownership and development and had positive effect in minimizing conflicts among land users. The potential of this catchment approach should be explored to adapt to other regions.

Figure 7 : Catchment treatment and gully stabilization resulted in ground water recharge

d) Diversification of income generation and asset building

Diversification cash crops, fattening, dairy, poultry and other enterprises were good experience gained to improve the livelihood of our farmers to gain economic benefits from rehabilitated water sheds. They can be allocated to landless youths and enterprises could be diversified, integrated and market-oriented.

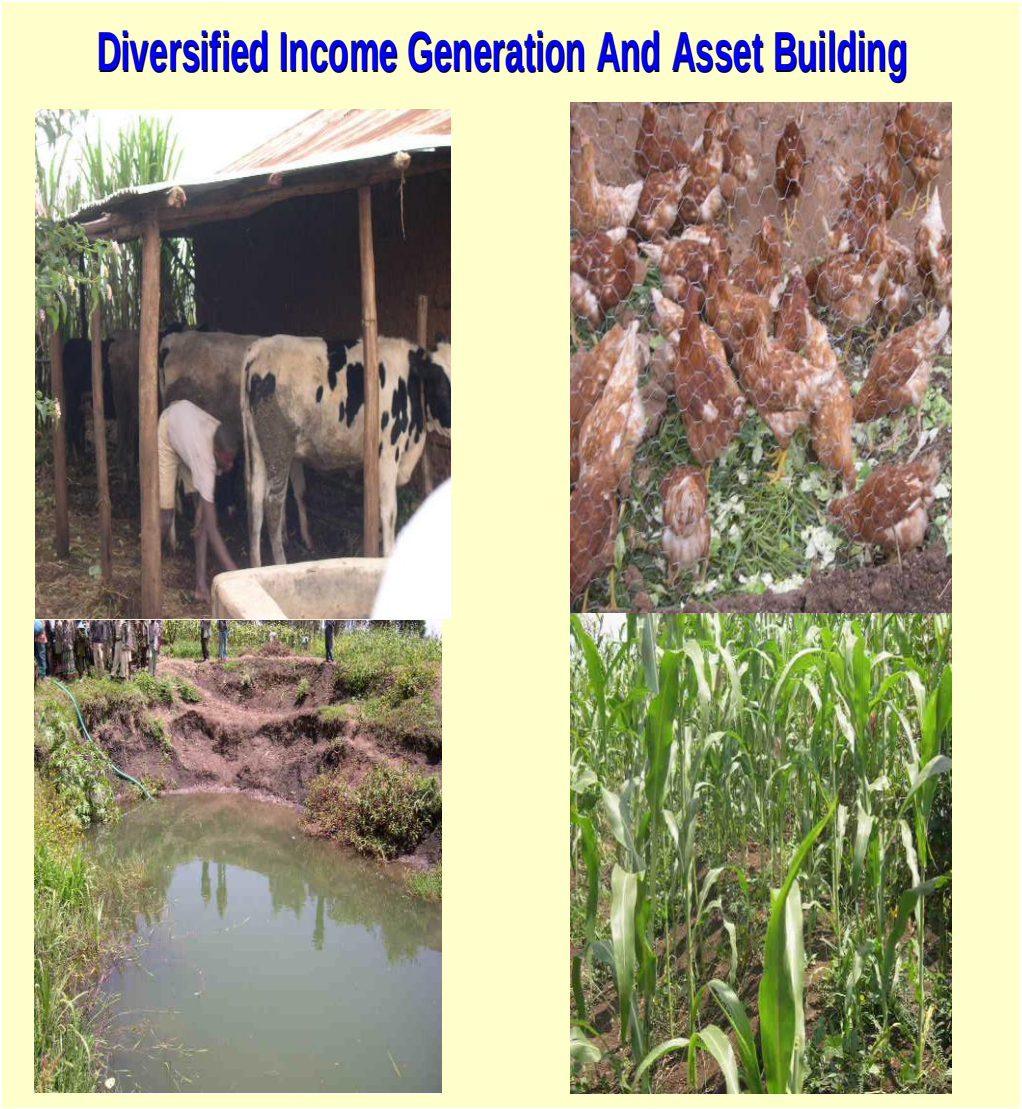

Figure 8 : Income diversification

IV. Concluding Remarks

a) Taking in to account contrasting environments, farming systems, socioeconomic setups variability is mandatory in adopting technologies. We need to adjust such traditional knowledge gained from Hararge to fit to the existing circumstances of Tigray and other drylands of Ethiopia. We may need to start some of these activities at pilot and model level (pilot learning sites- PLS) to scale up and scale out diffusion of new and introduced RWH innovations.

b) Important knowledge gained to fill gaps of current water harvesting-centered development efforts are:

- Water harvesting (In-situ moisture/ water harvesting through tie-ridges)
- Irrigation(crop diversification and intensification)
- Community ponds and reservoirs
- Zero grazing and
- Intensive and integrated watershed management approach

c) Empowering current grass-root community development efforts through:

- Working culture: need for transformation of working culture
- Mobilizing public and local resources

- Enhancing indigenous knowledge of RWH and labour intensive rather than capital intensive approach
- Strong policy, research and advisory support

d) Further integration of current joint development efforts on RWH by government agencies, NGOs, donors, and the grass-root community is imperative to accelerate and revitalize natural resources conservation–based agricultural development strategy to achieve sustainable development and reduce poverty in Ethiopia.

e) Network of professionals working on different aspects of land management, development and utilization is badly needed to address multidimensional and cross-sectoral issues and impacts of SLM development and intervention endeavors.

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Impact of Coal Mining on the Environment in Mainganga Community of Akko Local Government, Gombe State, Nigeria

By Maina Benjamin, Kachalla Aliyuda & Comfort C. Amin Dawa
Gombe State University

Abstract- The discovery of coal in Maiganga village has attracted the location of coal mining industry in the area to mine an estimated proven cold reserve of 4.5 million tons. Coal mining has a significant impact on people lively hood and the environment, the environmental shock ranges from environmental degradation to destruction of wildlife and their habitat while on the other hand coal mining contribute to national gross domestic product. Data for the study were collected by means of geo-information techniques, questionnaire, oral interview and field observation. Generated data were analysed through digital image processing using IDRISI Taiga and Arc GIS Software. Descriptive statistics was used to present result obtained. Result revealed a significant conversion of land cover features to mining pits by coal mining activities which forces resident of Maiganga to migrate from their original settlement. Observation reveals that most of the mining pits were not reclaimed. The study also shows that mining activity has negatively affected the communities' lively hood, because most of the respondents complained of inadequate basic infrastructure in the area such as roads, pipe borne water, hospital and other basic public amenities.

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Impact of Coal Mining on the Environment in Mainganga Community of Akko Local Government, Gombe State, Nigeria

Maina Benjamin [α], Kachalla Aliyuda [σ] & Comfort C. Amin Dawa [ρ]

Abstract- The discovery of coal in Maiganga village has attracted the location of coal mining industry in the area to mine an estimated proven cold reserve of 4.5 million tons. Coal mining has a significant impact on people lively hood and the environment, the environmental shock ranges from environmental degradation to destruction of wildlife and their habitat while on the other hand coal mining contribute to national gross domestic product. Data for the study were collected by means of geo-information techniques, questionnaire, oral interview and field observation. Generated data were analysed through digital image processing using IDRISI Taiga and Arc GIS Software. Descriptive statistics was used to present result obtained. Result revealed a significant conversion of land cover features to mining pits by coal mining activities which forces resident of Maiganga to migrate from their original settlement. Observation reveals that most of the mining pits were not reclaimed. The study also shows that mining activity has negatively affected the communities' lively hood, because most of the respondents complained of inadequate basic infrastructure in the area such as roads, pipe borne water, hospital and other basic public amenities. The study recommends Environmental Impact Assessment (EIA) and land reclamations by the mining industry in order to minimise the effect of coal mining on the environment. Furthermore the living condition of the affected communities needed to be given outmost priority to avoid hostile confrontation from the community as occurred in the past.

I. Background to the Study

Environmental sustainability according to Sutton (2004) is 'the ability to maintain things or qualities that are valued in the physical environment'. Sustainability has become an issue today because the earth is under threat from unsustainable use of natural resources. For example biodiversity is threatened by extinction of many species in most ecosystems around the world. This unsustainable use of natural resources has resulted in greater need to protect the system from degradation.

Exploitation of mineral resources has been an important tool for national development in more than a few developing countries, for example, Nigeria is blessed with abundant mineral resources, which have contributed massively to the national wealth and socio-economic benefits, as different types of environmental damage and hazards accompany mineral development. The contribution of coal mining industries to the economic development of both developing and developed countries can never be over emphasised. For instance report confirms that coal industry has profoundly impacted Canadian economy and communities through employment, taxes and royalties to governments.

Coal is very important in the manufacturing steel and it is also an important source of chemicals used in manufacturing medicine, fertilizers, pesticides, and other products. Coal mining has a significant impact on the biophysical environment, some of these impacts can be quantified by estimates while others are hard to estimate, it also has serious social consequences on people's health and the environments they live in. Most literature point to the positive impacts of mining, such as job creation and businesses development and overlook the environmental consequences.

According to Cunningham (2002) Coal mining is a dirty and dangerous activity, in coal mine significant volumes of earth must be displaced to mine coal, coal mines and the resulting rock waste can harm the environment. Surface mining has resulted in a great deal of damage to the landscape. Many surface mines have removed acres of vegetation and altered topographic features, such as hills and valleys, leaving soil exposed for erosion resulting from ecological disturbance to pollution of air, land and water, instability of soil and rock masses, and radiation hazards.

The environmental damage has in turn resulted to waste of arable land, as well as economic crops and trees. On the other hand coal mining has it positive impact on the society which includes creation of employment, provision of basic amenities by the mining industry to the affected community and the increase Gross Domestic Product (GDP) of a country through economic activities, Withggott, S. Brennan (2011). Since much of the damages are inevitable and if the minerals must be developed, both the government and the mineral industries must be involved in taking precautionary and remedial measures that can minimize the ill-effects of mineral exploration.

The discovery of coal at Maiganga village of Akko local government of Gombe State has attracted the location of Coal mining industry at the site. The

Author α ρ: Department of Geography, Faculty of Science, Gombe State University, Nigeria. e-mail: benmaina82@gsu.edu.ng
Author σ: Department of Geology Faculty of Science Gombe State University, Nigeria.

mining industry is expected to mine an estimated proven Coal reserve of 4.5 million tons at the site, (Bakura M. B., 2007). This reserve is expected to satisfy Cement factory of Ashaka power requirement for more than 25 years and 2 million tons reserve will be further exploited. Observation reveals that mining activities is on advanced stage and a lot of environmental damage has taken place at the site and the affected communities complain of pollution, lack of drinking water and other social amenities.

It is the purpose of this study in a nutshell to analyses the effect of coal mining on the environment in Maiganga village and also attempt to examine the possible precautions and remedies that can be applied in order to mitigate the effect of adverse environmental impact of coal mining activities, furthermore the research also provided insight into a number of issues that coal mining creates for communities and the surrounding environment.

a) The Study Problem

Mining generally has a significant impact on both people lively hood and the environment, the shock ranges from environmental degradation which can completely eliminates existing vegetation, destroys the genetic soil profile, displacement or destroys wildlife and habitat, degrades air quality, It also alters current land uses, to some extent permanently changes the general topography of an area mined. (Babagana Guti, *et-al.,* 2012).

Generally mining of solid minerals in Nigeria accounts for only 0.3% of its GDP, due to the influence of its vast oil resources, as most domestic mining industries are underdeveloped, leading to Nigeria having to import minerals. Nigeria still holds large coal reserves, estimated to be at least 2 billion metric tons. The discovery of bituminous coal suitable for use in coke production for the iron and steel industries opens up potential new domestic markets. (Nigeria Ministry of Solid Minerals Development, 2008).

In Gombe state, an estimated proven reserve of 4.5 million tons of coal has been discovered, the coal reserve is expected to satisfy Ashaka Company's requisite for more than 25 years. As part of its social responsibility will undertake the complete resettlement of Maiganga village and provide basic infrastructures such as feeder road, school, mosque, a church, dispensary and skills acquisition centre for their women and the youth and boreholes for the affected communities. But unfortunately Chairman, Maiganga community Development Association, Mal. Gibar Sobta, tell Daily News correspondent on July 27 2014 that the company fail to fulfill their promises. According to him after 8 years of relocating the community, the company has only built 66 houses, one borehole and an already dilapidated two blocks of classrooms out of what it promised the community. He added that the houses they built for the community are of very low quality, in less than eight years of relocation, the houses have started collapsing.

Based on the aforementioned problem, the following research questions were raised:

- What is the extent of environmental degradation caused as a result of coal mining in Maiganga from 2005 to 2015?
- How those mining coal in Maiganga impacted people livelihood?
- Are there reclamation measures in the study area?
- How can environmental sustainability be enhanced in the study area?

b) Aim and Objectives

The main aim of this research is to assess the level of environmental degradation resulted from coal mining activities and it impact on the community's livelihood. While the objectives are as follows:

- Find out the level of environmental degradation caused as a result of coal mining in Maiganga from 2000 to 2015.
- Asses impact of coal mining on people livelihood.
- Asses' reclamation measure in the mining site.

c) The study area

The study was conducted in Gombe state, Akko local government area, (Fig. 1). Located between longitude 09^0 59'24.1"N longitude 11^0 09' 12.4". The study area which is Maiganga covers a land area of about 20129.47 Acres (48.16 Km^2) bounded to the south by Billiri to the west by kumo town, located on longitude 9°59'19.65"N and 9°59'3.03"N, latitude 11° 8'31.29"E and 11° 9'44.63"E (Fig. 1).

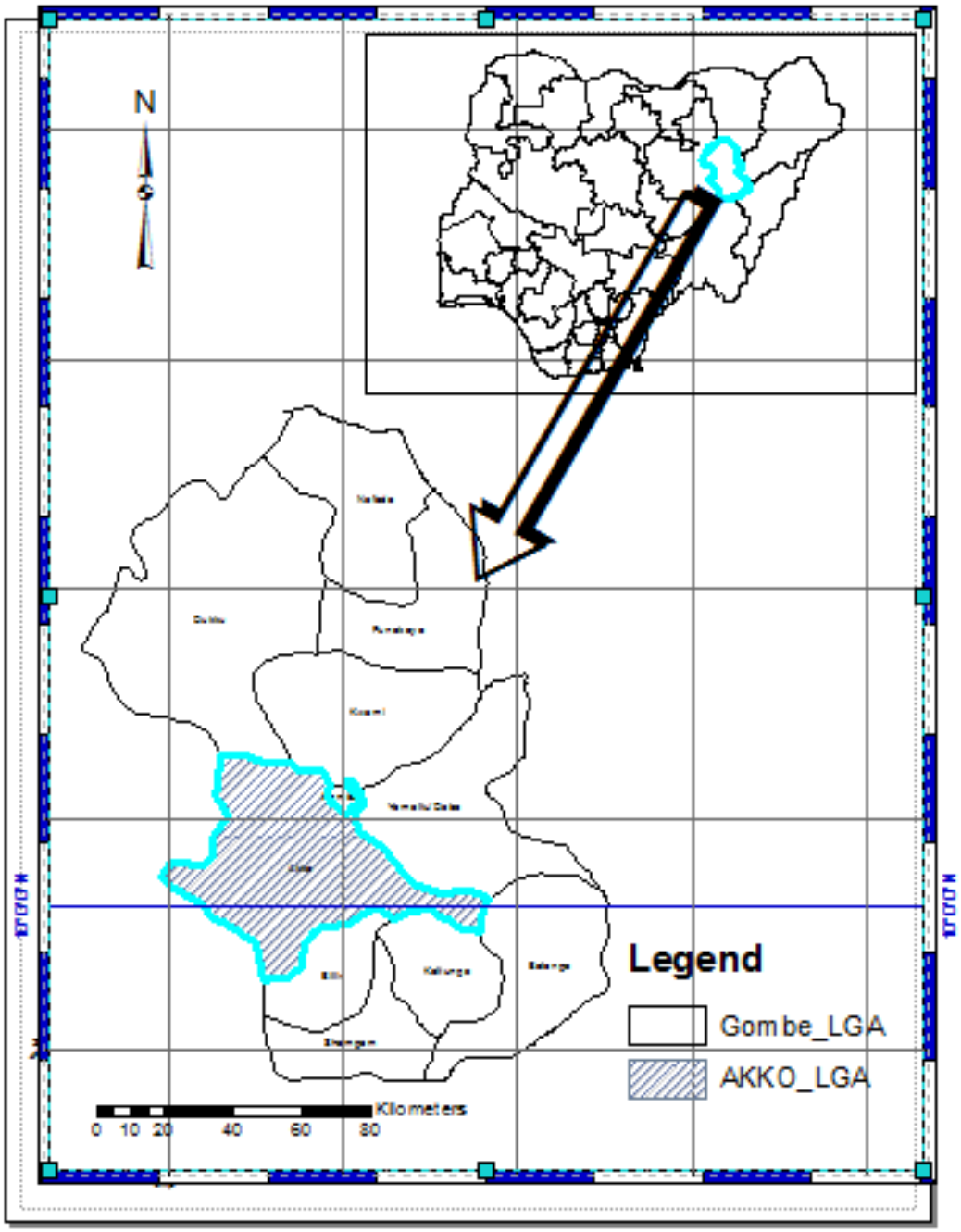


Figure 1 : Gombe state showing Akko Local Government

The study area is characterizes by wet and dry season largely determine by the properties and movement of Inter tropical convergence zone (ITCZ). In relation to the koppen's climatic classification the study area is almost entirely within AW types of climate. It is seasonally wet from April to October and dries from October to March. Rainfall ranges from 850 mm to 1000 mm; the rainfall concentration reaches it maximum in July/August. Much of the rainfall especially in July and August are associated with storms of high intensity. The mean maximum monthly temperature is 37^{0}C, Occurring in March – October while from December to February the temperature lowers to 21^{0}C. Relative humidity has the same pattern being 94% in August and dropped to less than 10% during harmatan December/January. Bose .A.M, (2009).

The study area is on the complex geologic crystalline bedrocks. Although the ancient crystalline basement complex sedimentary rocks underlie much of the area, the complex is formed during the Late cretaceous period, which has influence the topography of the area. Subsequently extended to the east and also

there is discontinuous escarpment rising in some places particularly along kumo road to form sand stone and Clift with over 150 meters above the surrounding plains.

The soil are typically ferruginous, they are dark in colour with the pH value of 4-6 pending of the location. The soil is intensively formed as a result of incomplete weathering activities of the basement complex rock. Traditional management practice such as bush clearing, annual burning and livestock grazing have made the soil in the study area susceptible for erosion and reduce it water holding capacity.

The vegetation comprised of sparse canopy with spindling of under shrubs and sparse growth of grasses to more open grasses of lessees height. Major trees species in the area include *butyrosper, Mumparadoxum. Tamarine indica, parkia boglobossa, balanite agifika, afzelia Africana, fabia, albida* among others, on the other hand the community are made up of different tribes which include Jukun, Tangale and Fulani which made up of the majority tribe in the study area. The population of Maiganga according to the NPC population census 2006 is about 3,520 people. Their main economic activities is Agriculture which include cultivation of different types of crops such as maize, beans, soya beans, guinea corn groundnut, rice, millet and sorghum.

II. Methodology

a) Data sources for the analysis

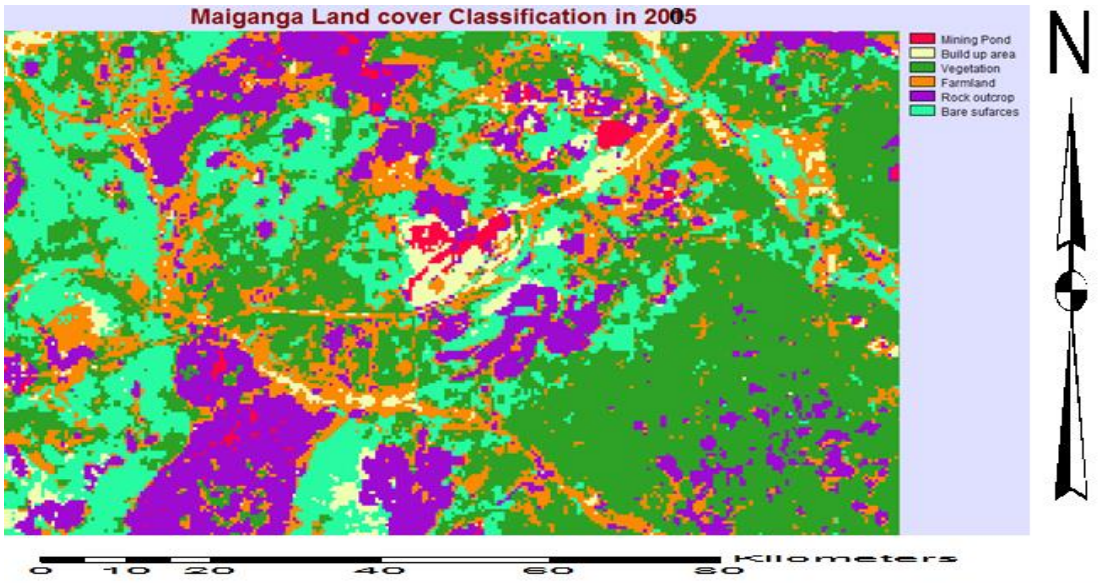
For the Purpose of this study data were sourced from Field reconnaissance survey, Field observation, Field interview, Questionnaires, Remote sensing and Geographic information system. Similarly supporting data was also sourced from relevant literature.

b) Satellite Imagery and Digital Image Processing

High resolution satellite images of Land sat ETM of 2005 and 2015 where acquired and used for the land cover features detections. Efforts were made in acquiring satellite images of the study area in the same session. Digital image processing was carried out in order to improve the pictorial quality of the images for easy interpretation. The satellite images were processed using IDRISI Taiga Software. The colour composite used for the bands of Land sat ETM are 3, which means that on the RGB band 3 will be on Red, band 2 on Green and band 1 on Blue. This combination produces a False Colour Composite (FCC) with vegetation appearing as red and build up area in blue. Supervised classifications were carried out for the classification using maximum likelihood algorithms. To save time and get detailed and relevant information, systematic sampling technique were applied to represent the entire population of the study area, which was used during the field interview and administration of questionnaires. Collected data were analyzed and interpret using descriptive statistics for clear understanding.

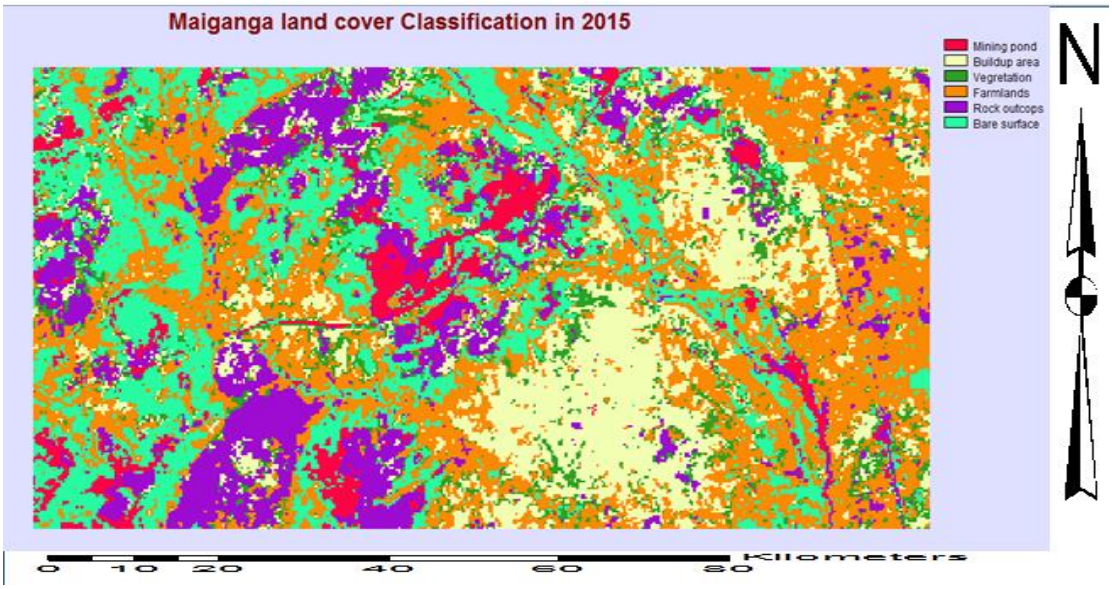
III. Result and Discussion

Land cover features were identified and delineated on Land sat ETM of 2005 and 2015 respectively. The analysis shows significant conversion of vegetation, farmlands and settlement into mining site and mining ponds from 2005 before mining begins to 2015 in the study area as presented in Figure 3 and 4.



Source: Authors analysis, 2016

Figure 3 : Land Cover features classification of study area in 2005

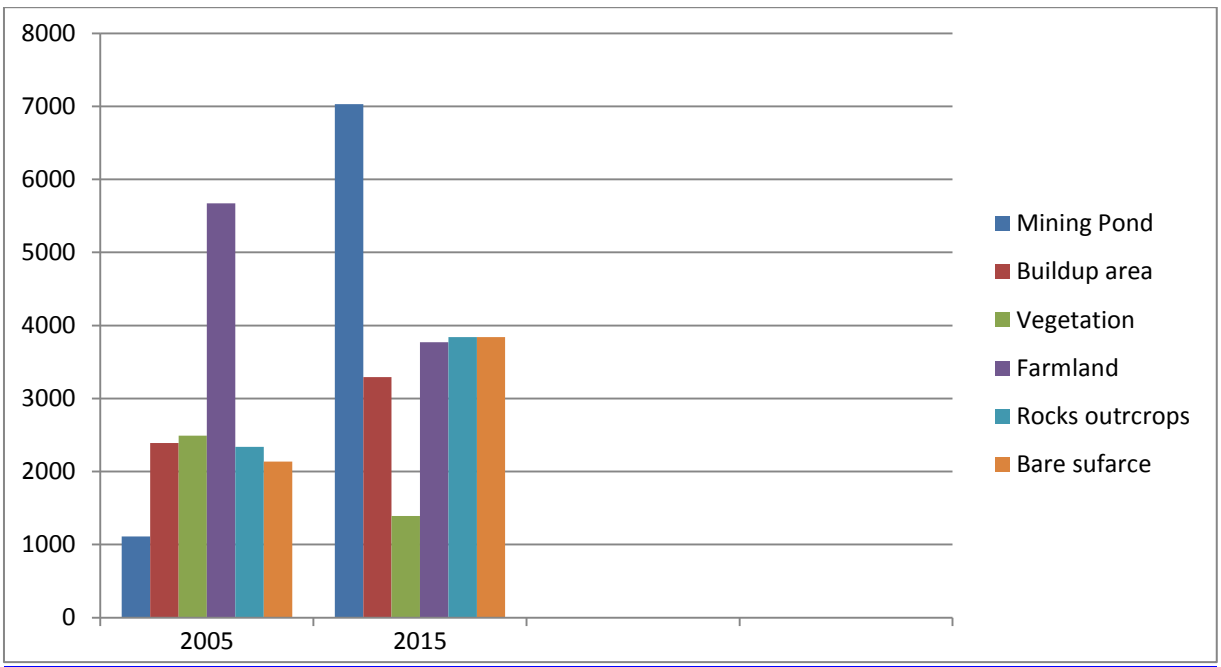


Source: Authors analysis, 2016

Figure 4 : Land Cover features classification of study area in 2015

The satellite image classification analyses indicate drastic changes in all land cover features analysed, as indicated in land cover map of 2005 before the mining began in 2007 and that of 2015 after nine years of mining at the study area. Image classification indicates that mining pond stand stood at [172.58] acres and Buildup area stood at [713.23] acres respectively as of 2005, while as of 2015 mining pond has increase drastically from [172.58] Acres to [1131.56] acres in 2015 and build up area increases from [713.23] acres to [3211.71] acres. This can be seen clearly in land cover feature classification map of the study area of 2005 and that of 2015 as shown in figures 3 and 4 respectively. Field observation has shown that mining pond expand and get enlarge as the open cast mining progresses and get expose to rainfall there by develops into deep cut on the earth crust as seen in Plate 1 and 3. Overburden also forms steep slope that in some cases wash back into the pits initiating rill erosion and subsequently develop into deep gullies.

Figure 5, Show the summary of land use and land cover changes between 2005 and 2015.



Source: Authors analysis, 2016

Figure 5 : Land cover features changes between 2005 and 2015

Figure 5, Clearly shows that natural vegetation decreases from [7126.30] acres in 2005 to [1391.54] acres, mining in general is associated with site clearance of all vegetation cover for mining operation, in which it exposes the bare soil to be more susceptible to wind, water erosion, the removal of the trees and plant root system which act as a binding mechanisms, which can also lead various types of erosion. Thus deforestation can lead to exposure of top soil venerable and susceptible to erosion.

Farmland has also reduces from [5771.23] acres in 2005 to [3344.65] acres in 2015, It is obvious from the result obtained that coal mining has affected both vegetation and farm lands, this is evident in the rate at which areas cover by vegetation and farm land were shrinking giving way to mining site and ponds due to expansion of mining activities. Thus deforestation can lead to lowering in general fertility of soil and consequently the productivity of the soil due to absence of humus and nutrient content (Fig.5).

Table 1, Show decreased in build up area from [713.23] acres in 2005 to [3291.71] acres in 2015. The decreases in build up area could be as a result of the resettlement of the resident done by the mining company which compel most the resident to relocate from their original settlement.

Table 1 : Land use classification analysis of the study area between 2005 and 2015

Category	2005	2015
	Area in Acres	Area in Acres
Mining Pond	172.58	1131.56
Build up area	713.23	3291.71
Vegetation	7126.30	1391.54
Farmland	5771.23	3344.65
Rock outcrops	2762.40	2278.25
Bare surfaces	3583.72	3838.59

Source: Authors analysis, 2016

On the other hand socio-economic data was collected from respondents using questionnaires administered to 98 household heads out of which, 51.0% of the respondents are male while 49.0% are female, their occupational status stood at, 53.3% Famers, 27.0% Traders and 20.0% engage in various business activities, the data obtained indicate that most of the respondents are famers.

Furthermore, 47.4% of the respondents did not attend any formal education, 28.9% attended primary and secondary education, this result indicate that most people of the community are illiterate, an elder in the community during field interview, stress the need for the mining industry to start up skill acquisition centre as they have promised. In other to assess the socioeconomic impacts of coal mining on the locals, respondent were asked if the mining company in the area provide you or any member of your household with employment, 78.5% of the respondents disagreed that the mining industry does not provide them with employment while 21.5% agreed. Since one of the importances of industry is to provide employment, the mining industry should take employment of the community members seriously as stated in their memorandum of understanding sign by the miners, according to community leader.

When asked if mining activities in the area increase your income, 86.9% disagreed that the mining activity has increase their income, as 13.1% agreed. During the field interview with the community members most of them lament that most of their compensation was not fully paid that was why they embark on street demonstration in July, 2014. On investment, the respondents were asked if they have any investment or share in the mining industry in the area, none of the respondent said that he or she has an investment in the industry. On migration 94.3% of the respondents agreed that mining activities in the area has effect on migration, 5.7% disagree, this large percentage is as a result of the community relocating from their original settlement where the mining is currently going on.

To test the respondent level of awareness on problem associated with coal mining, the respondents were asked if they agree that coal mining activities in the area can affect health, 76.4% agreed while 23.6% disagreed. Since coal mining is associated with health hazard the community need to be enlightened on such issue. From the land use and land feature analysis its clearly seen that the mining activities have taken over most of the community's farm lands and in line with this issue the respondents were asked if they notice the effects of coal mining activities on local community's farm land, 82.9 % agreed that mining in the area makes their farmland scarce and unproductive while 17.1% disagree.

On basic amenities provided for the community, respondents were asked if they are satisfied with the basic amenities provided by the mining industry, most of the respondents were not satisfied, as 87.6% satisfied and 12.4% not satisfied. During our field observation we have noticed that the industry has build houses, mosque, church, clinic and a primary school for the community. However, most of the structures are

substandard and has now become dilapidated as lamented by the community leader during their protest and the industry fail to build road, skill acquisition centre for community as the agreed before the mining start in 2007.

Finally on reclamation the respondent were asked if their satisfied with reclamation measure carried out by the mining industry, 79.6% are not satisfied with reclamation measure taken by the mining industry while 20.4% were satisfied, land reclamation involve restoring back mined lands to productive use after minerals have been extracted through mechanical and biological means. Base on the data collected during the field observation as seen in Plate 1,2,3 and 4 open cast method of mining is used in the study area which has resulted to large deep cut in to the soil to mine coal, observation reveals that most of the mining ponds were not reclaimed, further more mining in the area has not only changed the pattern of the land but have greatly contributed to degradation of the environment, the effect can be clearly seen in the study area which includes lost of arable land for agriculture as well as change in the land cover feature such as vegetation and farm lands which are converted into mining ponds.

IV. Conclusion

Many surface mines have removed acres of vegetation and altered topographic features, such as hills and valleys, leaving soil exposed for erosion resulting from ecological disturbance to pollution of air, land and water, instability of soil and rock masses, and radiation hazards. On the other hand coal mining has it positive impact on the society which includes creation of employment, provision of basic amenities by the mining industry to the affected community and the increase Gross Domestic Product (GDP) of a country through economic activities.

Since much of the damages are inevitable and if the minerals must be developed, both the government and the mineral industries must be involved in taking precautionary and remedial measures that can minimize the ill-effects of mineral exploration. For mining to be effective in the study area and the world at large the following measures needed to be taken with all sense of seriousness.

- Where ever possible, mining industry should be mandated to carry out and fully implement Environmental Impact Assessment [EIA] of the project before embarking on the project
- Coal mining industries should fund research and public action to ensure that the mining standards are applied.
- All arable land affected by mining operation in the area need to be regularly and urgently reclaimed.
- Government need to compel all operating companies to take their cooperate responsibility to provide standard houses and other needed amenities for the affected communities.
- The company need to give priority to all able locals in terms of employment.

Plates

Plate 1 : Hips of coal Mine

Plate 2 : Mining pond

Plate 3 : Excavation by heavy equipment

Plate 4 : Heavy Duty truck use in Mining

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Health Facilities Distribution Mapping in Addis Ababa, Ethiopia

By Abebaw Andarge
Debre Markos University

Abstract- Geographical Information Systems (GIS) have been used widely in many countries to map health-related events and the results are used for planning of health services and in assessing clusters of health facilities. This project demonstrates the application of GIS in the mapping of health facilities in Addis Ababa particularly Gulele sub-city; the ArcGIS 9.3 software was used to map and evaluate the spatial clustering of health facilities in the study area. The study was conducted using primary and secondary data collected from various areas with GPS technology. The results suggest that new health facilities should be built in the woredas of Gulele sub-city. The method of analysis employed point pattern analysis used to evaluate the physical distribution of point events and test whether there is a significant clustering of points in a particular area and also ratio. The project has been developed for all participating service agencies to give an overview 'map' of the health service sector. The project is designed to assist the participating health services in developing a good understanding of the community in the recovery context, enabling strategic planning and coordination of services to the increased need of the population of the subcity in the area of health facilities.

Keywords: *GIS; health facility; mapping.*

GJHSS-B Classification : *FOR Code: 040699*

Strictly as per the compliance and regulations of:

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I. Introduction

We live in an age of information, and spatial information is one of the most critical elements underpinning decision making for a range of disciplines (Rajabifard and Williamson, 2001). Health, wealth and population distributions are all examples of spatial information commonly attached to administrative polygons. In fact, there are few areas of the economy and environment that do not rely either directly or indirectly on the integration of data attached to administrative boundaries for planning, maintaining or rationalizing activities (Eagleson et al., 2001).

GIS has the ability to examine the complex behavior of geographically referenced data. Today, with increased spatial and network analysis capabilities, GIS are designed to predict and understand the interactions between entities and phenomena throughout space and over time (Tomlinson, 2002). Since the 1980s the benefits of geographic data and GIS for analysis and modeling have been realized. As a result, virtually all people, property and infrastructure have the ability to be referenced by location (Openshaw, 2000). With geographic data readily collected and GIS technology now available at a relatively low cost, it should be possible to build a digital representation of virtually any phenomena of interest. Related technical issues such as data exchange, differences in geographic boundary design and data integration present serious limitations, however, and must be addressed if geographic data is to be used to its full potential.

Health is vital for all of us and understanding the determinants of a disease, its spread from person to person and community to community has become increasingly global (ESRI, 1999). As expressed by (Scholten and De Lepper, 1991), ''health and ill-health are affected by a variety of life-style and environmental factors, including where people live". There are various factors such as climate, environment, water quality and management, education, air pollution, natural disasters, social and many others which are the reasons for the emergence of diseases. The characteristics of these locations (including socio-demographic and environmental exposure) offer a valuable source for epidemiological research studies on health and the environment. Epidemiological research ranges from outbreak investigation, data collection, design and analysis including the development of statistical models. Since health is a geographical phenomenon and various factors attributing to the health diagnostics and planning are geography dependent, as such, GIS (Geographic Information System) for health studies serves as an important tool. Therefore, this project focuses on mapping health facilities and to show their spatial distribution in Gulele sub-city and finds gaps on which woreda health service provision is needed.

Author: Department of Geography and Environmental Studies, College of Social Science and Humanities, Debre Markos University, Debre Markos, Amhara Regional State. e-mail: abeandargie@yahoo.com

a) Data Sources and Methodology of the Study

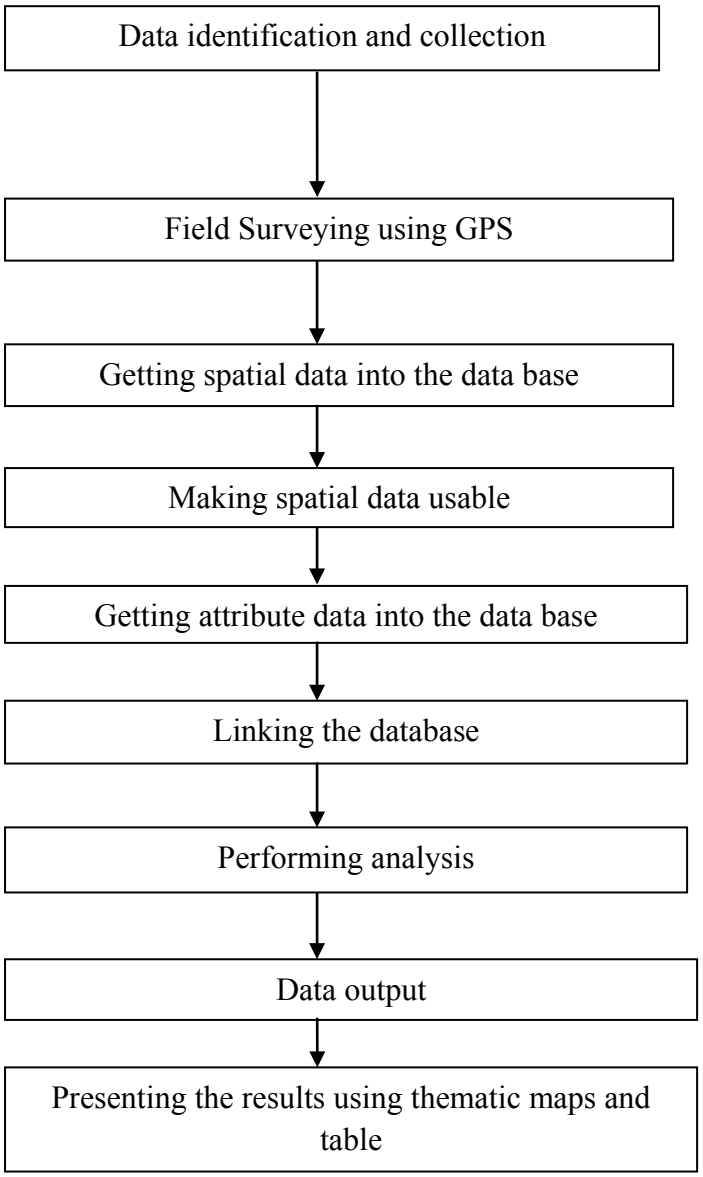

Figure 1 : Overview of the Methodology

b) Source and Nature of Data

This project utilizes different methods of data collection, and the sources of information were both primary and secondary data. The primary data collected through Garmin 76 GPS were, the spatial distribution of health facilities (pharmacies, hospitals, clinics and health posts). Secondary data were population data from the Central Statistical Agency (CSA), these data were combined to form a database for this project.

c) Data Collection

During the present study, both spatial and non spatial data were gathered, from primary and secondary sources. Primary data were generated from the analysis of field visits. A field survey was undertaken to record the geographic coordinates of all health facilities (government hospitals, private hospitals, government clinics, private clinics, government pharmacies, health centers, private pharmacies and government health centers) were recorded. The addresses of these facilities were obtained from the Ministry of Health and their spatial locations were gathered using GPS. In addition, the major primary data required for the study has been extracted from various road category net works were also generated from 1:50,000 scale topographic maps of Addis Ababa obtained from Ethiopian Mapping Agency through digitizing and the sub-city layer was obtained from Ethio- GIS.

❖ Field Visit

A field survey was undertaken to record the geographic coordinates of health facilities. As the

addresses of the health facilities were generalized to maintain the confidentiality, it was often difficult to record the precise location. Various approaches were used to identify the location as close as possible to the actual location. These included checking the addresses by using Google Earth software prior to undertaking the fieldwork, Field visits were the major data collection mechanisms. Preliminary field visit was carried out to get an overall overview of the study area, to identify health facilities and to collect using Garmin 76 GPS readings of the various health facilities readings of the study area.

d) Data Analysis

The data that was collected using Garmin 76 GPS, after recording these locations using GPS and data obtained from GPS were loaded into the ArcView 3.2 GIS software and later converted into the ArcGIS 9.3 format. All data were in ArcGIS 9.3 format.

The data entered with were provided in Microsoft Excel format, then export to SPSS version 20.0 to change DBF format, after changing to DBF format, ArcGIS capable with this format, then with this software changed to shapefile. Since the data handled is large and diverse i.e. from different sources, the database is organized in a series of tables so that it can be shared. Each table is called a relation and it consists of a number of rows and columns.

The method of analysis employed in this project was subjected to different softwares depending on the objective of analysis. For analysis, GIS data was vertically organized into layers or themes. Using database query, these basically involve basic retrieval of what is already in the database. In addition, point pattern analysis was conducted to evaluate the distribution of health facilities in the sub-city. Nearest neighbor statistics was calculated for the evaluation of the pattern of the distribution of the cases. Nearest neighbor ratio (R) calculates the distance between one point to its nearest points. It was calculated using equation (1) below (Robinson, 1998).

$$R = \frac{dobs}{dexp} \quad (1)$$

Where,

R = nearest neighbor ratio

$dobs$ = observed average distance between nearest neighbor

$dexp$ = expected average for a hypothetical random distribution

This index gives a systematic measure of the pattern within a specific region. R values range from 0 to 2.1491, where an R ratio value less than 1 indicates that the point pattern distribution is more clustered than random, the value of R is greater than 1 indicates that the point pattern distribution is more dispersed than random (Robinson, 1998). This analysis was undertaken with the ArcGIS9.3 software.

II. Results and Discussion

a) Physical and Socio-Economic Background of Addis Ababa

Addis Ababa, the capital of Ethiopia, which is by far the largest in the country located in the central part of Ethiopia and belongs to the Western highlands. All sides of the capital city is bordered by Oromiya Regional state, and covers an area of 530 square kilometers (53,000 ha) and a total population of 3,041,002 million persons (CSA, 2011). Addis Ababa has a history of 125 years. Thus, one can say with certainty that it had its earliest beginnings in the mid 1880s and had evolved to be the capital of Ethiopia around 1886/87 City Council of Addis Ababa, 1986 (Johnson, 1974). Then after that changed the name to Addis Ababa City Municipality and also in 2005 called as Addis Ababa City Administration.

Astronomically, Addis Ababa is located at $09^0 02'$ N Latitude and $38^0 44'$ E Longitude. It is situated on the foot of escarpment of Mt. Entoto in the North which rises to 2900 meters to the south with an average altitude of 2400 meters. This varying topography of the city has affected its spatial expansion favoring the relatively flat landscape in the south as a major factor contributing to the "unsafe housing" condition in the city, as cited in Hadgu (1988).

b) Gulele Sub-city Total Population: Woreda

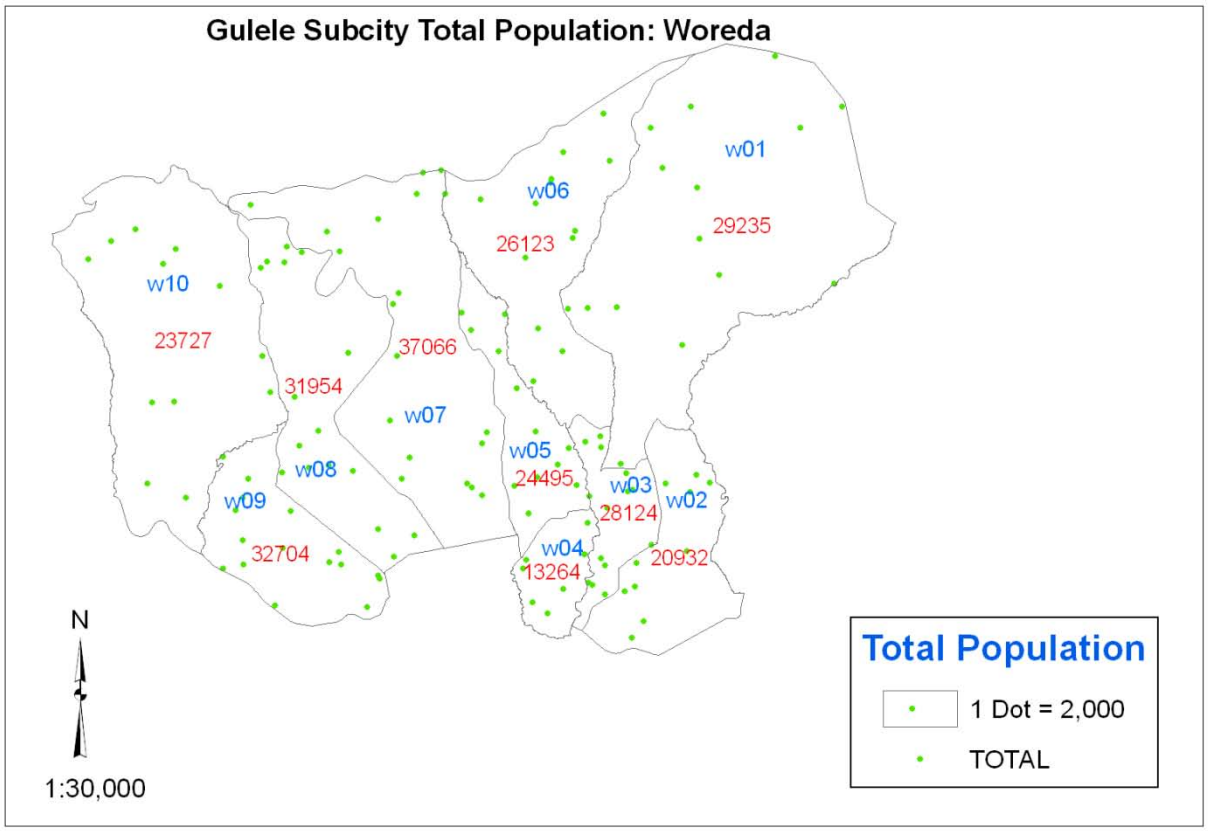

Figure 2 : Gulele sub-city total population

According to the 2011 statistical abstract, Gulele sub-city has a total population of 267,624. This map portrays the number of inhabitants of each woreda. According to cartographic standards, dot density symbol is used. Each dot represents 2,000 people. The average woreda population is 26762. Woreda 04 is the least populated with 13,264 inhabitants, whereas woreda 07 is the most populated with 37,066 inhabitants.

c) *Gulele sub-city sex ratio: Woreda*

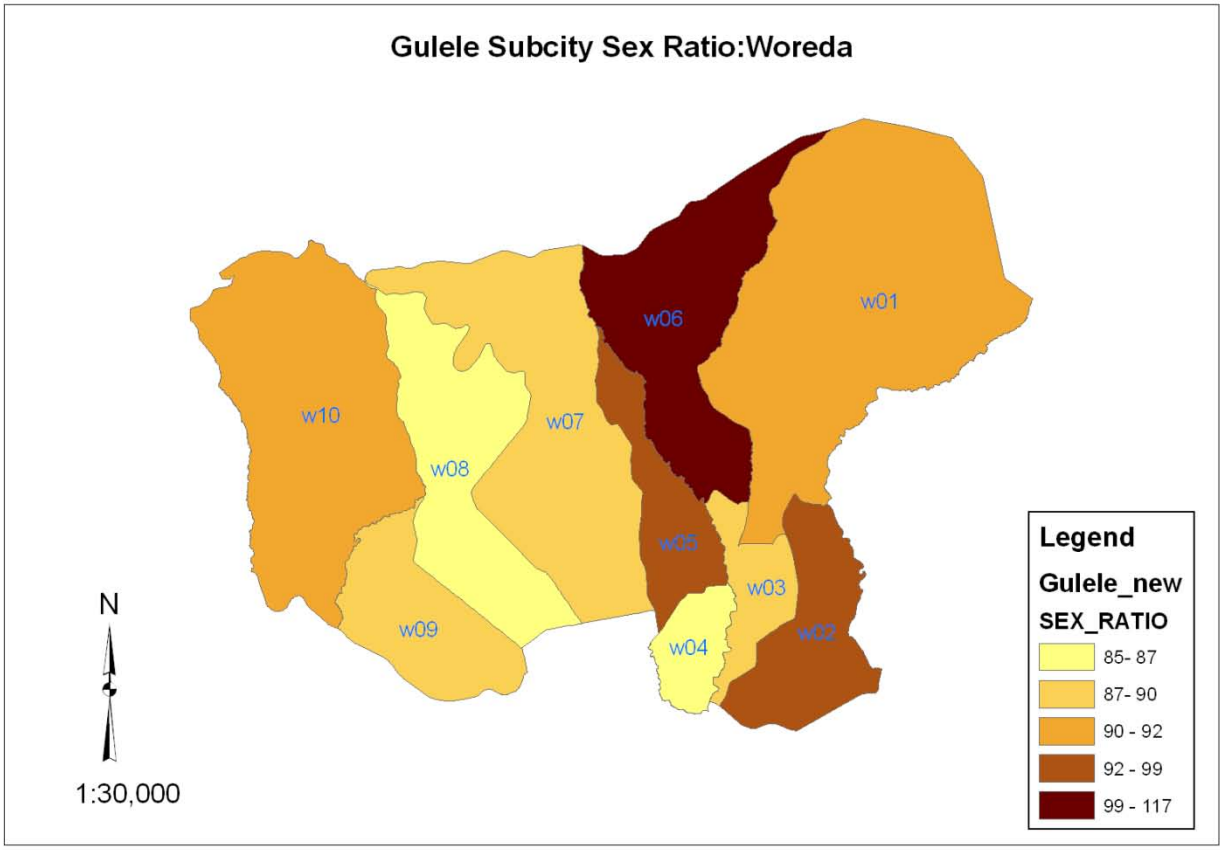

Figure 3 : Gulele sub-city sex ratio

According to the 2011 statistical abstract, Gulele sub-city has a total population of 267,624, from which 129,396 are males and 138,228 are females. Thus, males comprise 48 % and females 52 % of the total population of the sub-city. The sex ratio for Gulele sub-city equals 94 %. It is calculated as the number of males over the number of females. When the ratio is greater than hundred it indicates a higher number of males than females. Ratio closer or equal to hundred shows balanced number of males and females in a given woreda.

The female population exceeds the number of male population by 8832 persons on average at woreda level. Higher number of females are recorded at woreda 09. Sex ratios greater than hundred are observed in woreda 06. The highest sex ratio, that is, 118%, is recorded in woreda 06.

d) Gulele sub-city Population Density: Woreda

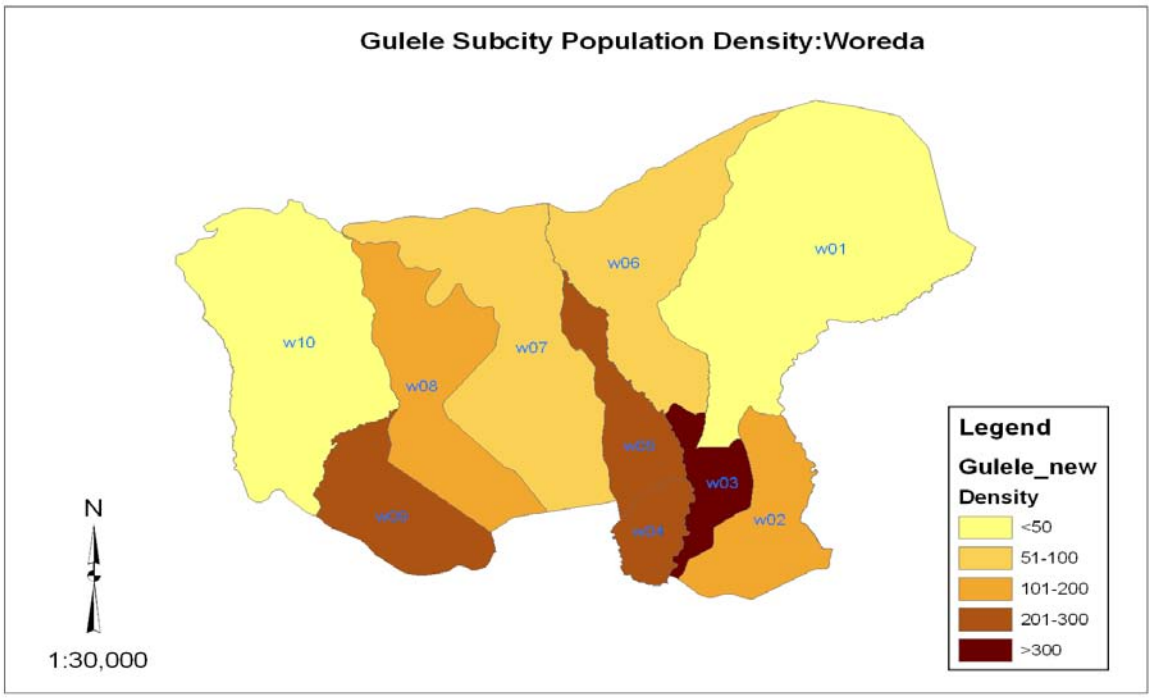

Figure 4 : Gulele sub-city population density

This map on Figure 4 shows the population density of Gulele sub-city. The average density of all woredas is 125 persons per hectare (ha). Woreda 01 and Woreda 10 of the sub city are less densely populated, whereas woreda 03, 04, 05 and 09 are densely populated.

e) Distribution of Health Facilities

i. *Gulele sub-city Health Facilities*

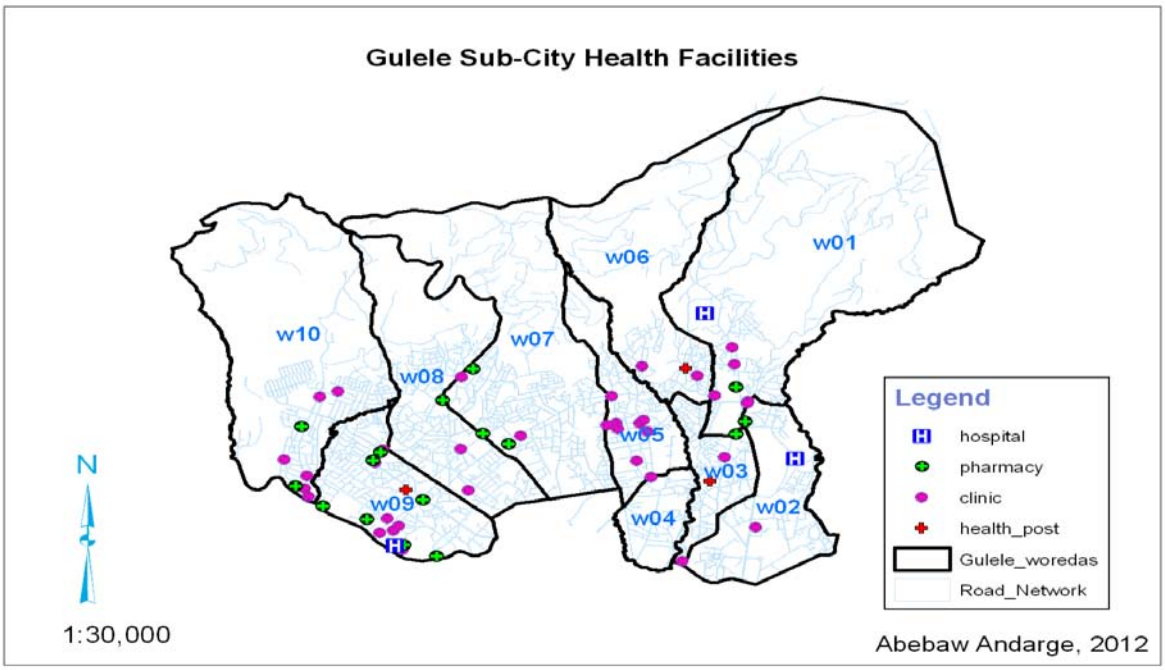

Figure 5 : Gulele sub-city health facilities

This map on Figure 5 shows the spatial location of all health facilities in the sub-city. Based on the spatial distribution of health facilities illustrated on the map, woreda 09 have consisted all health facilities (i.e., pharmacies, hospital, clinics and health center). But, woreda 04 have consisted only one clinic. The rest woredas of the sub-city health facilities have less sparsely distributed. The North West, north and north east part have outskirts of the sub-city have no health facilities, because these parts of the sub-city have steep slope and covered with forests.

ii. *Point pattern analysis of the Health Facilities*

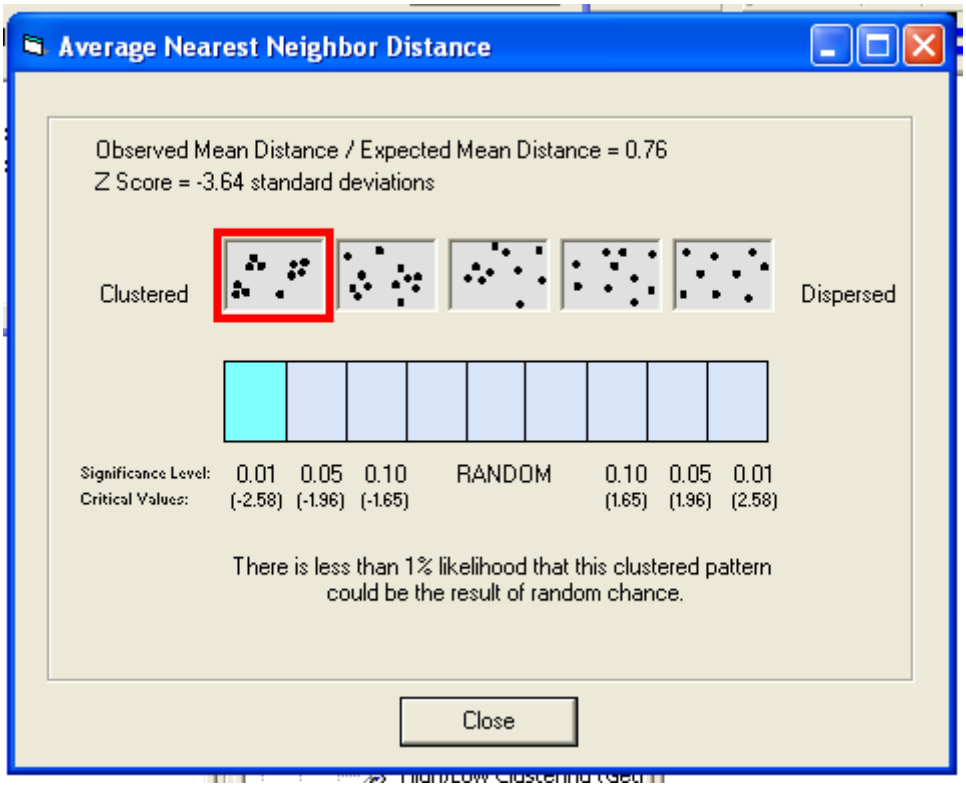

Figure 6 : Results of point pattern analysis

Point pattern analysis is used to evaluate the physical distribution of point events and test whether there is a significant clustering of points in a particular area. Health facilities distribution in Gulele sub-city were clustered, because, the ratio obtained was 0.76 (which is <1). Z score = -3.64 standard deviations; whereas the P-Value is 0.0000274. Thus, in Gulele sub-city health facilities were concentrated only in some woredas, for example, in woreda 09 all facilities are found. But, there were many cases have seen no built up of health facilities in the sub-city.

f) Gulele sub-city Pharmacies

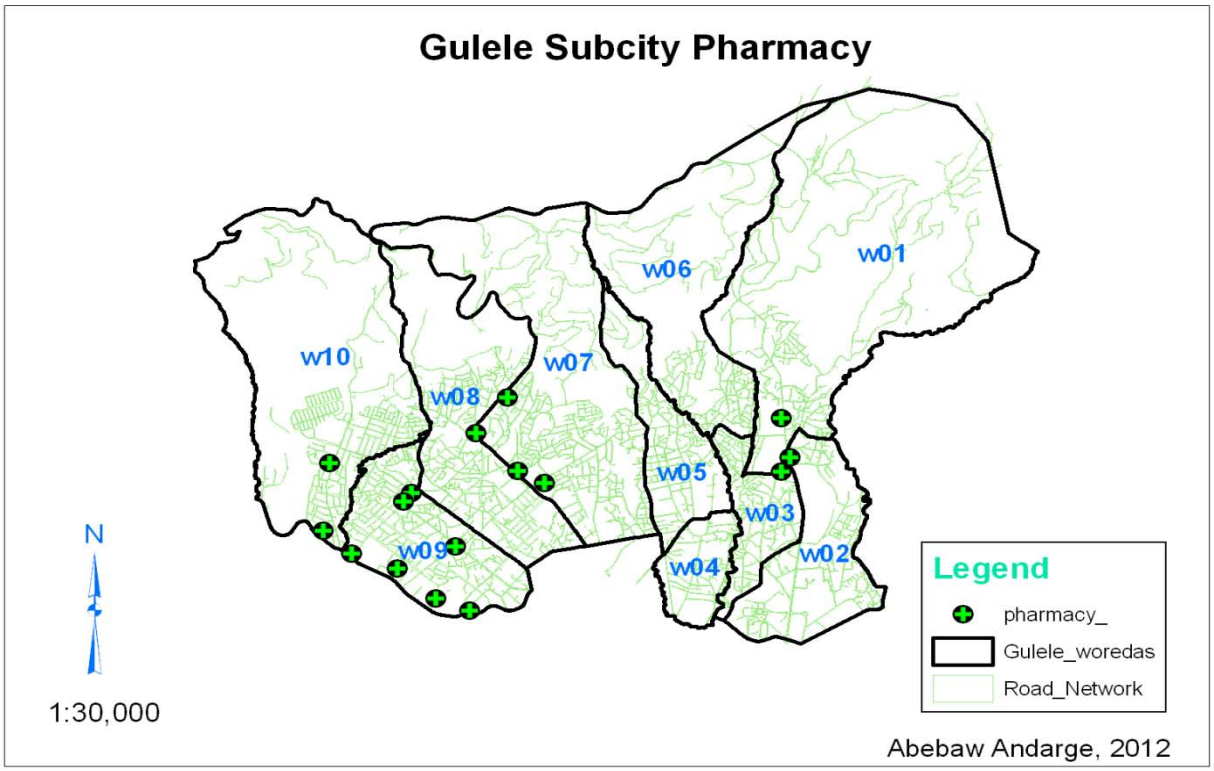

Figure 7 : Gulele sub-city pharmacies

Gulele sub-city has a total population of 267,624; this map on Figure 7 represents the spatial location of pharmacies in the sub-city. According to the spatial location of pharmacies, there are 16 pharmacies in the Sub-City. The distribution of pharmacies is not equitable because all of them except one are privately owned pharmacies and the owners opened the pharmacies on downtown where more market is available. The pharmacies mostly concentrated on woreda 09 but no pharmacies opened on woreda 04, 05 and 06.

Table 1 : Population sharing one pharmacy: Gulele sub-city

Gulele sub-city	Population	Pharmacy	Population sharing one pharmacy
Woreda 01	29235	1	29235
Woreda 02	20932	1	20932
Woreda 03	28124	1	28124
Woreda 04	13264	-	0
Woreda 05	24495	-	0
Woreda 06	26123	-	0
Woreda 07	37066	3	12355
Woreda 08	31954	1	31954
Woreda 09	32704	7	4672
Woreda 10	23727	2	11864

The above table 1 shows that, for each woreda the ratio shows how many people share a pharmacy on average. It is calculated as the number of people divided by the number of pharmacies. There is still a need for constructing new pharmacies for showing zero population sharing for the pharmacy.

The average population of the sub-city is 26762 whereas at sub-city level average number of pharmacies is 1.6 thus for on average for 16726 people needs nearly 2 pharmacies. But, the distribution of pharmacies in the sub-city is not on the above proportion. On woreda 09 there is more concentration of pharmacies, that is 7 pharmacies.

g) Gulele sub-city Hospitals

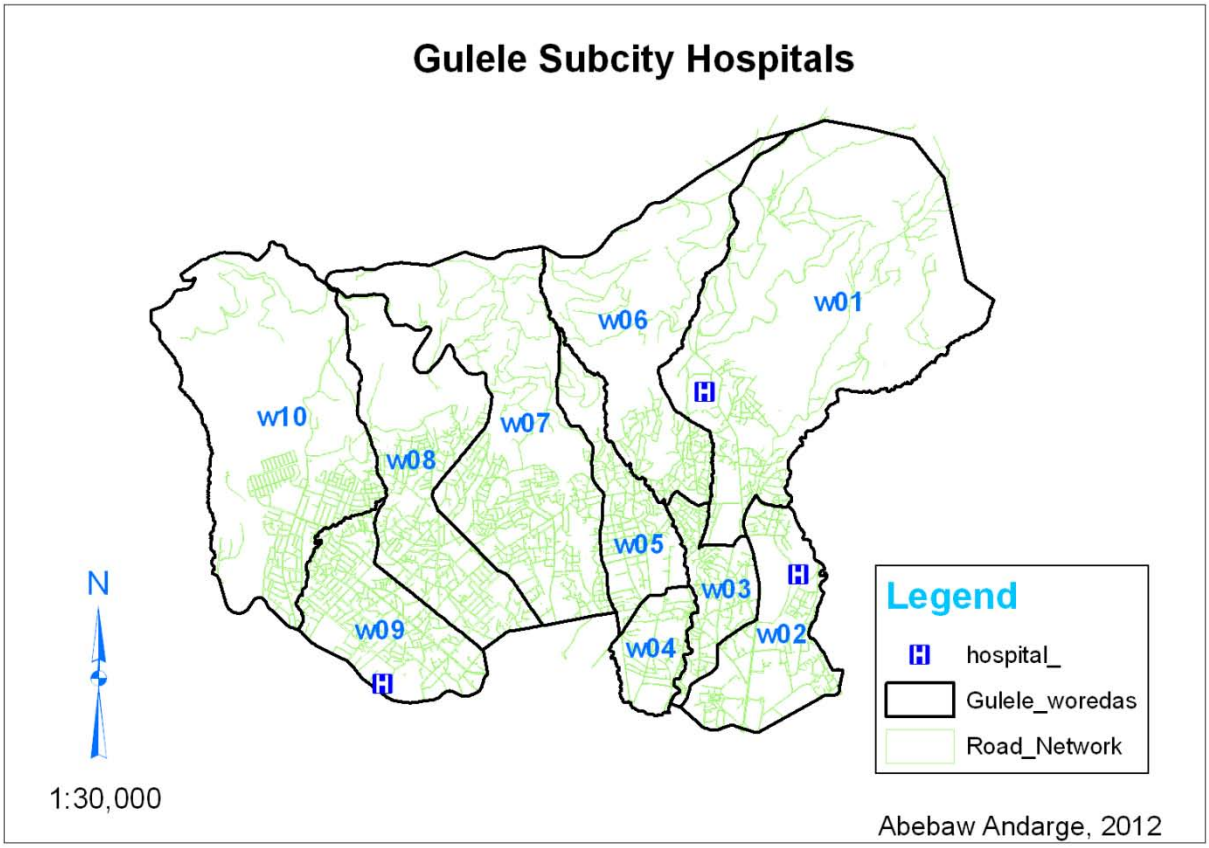

Figure 8 : Gulele sub-city hospitals

Gulele sub-city has a total population of 267,624; this map shows that the spatial location of hospitals in the sub-city. In this sub-city there are two specialized government hospitals and one general private hospital. The first specialized hospital (Kidus Petros TV Center) is found in woreda 01. In addition, the other specialized hospital (Poulos hospital) is found in woreda 09. The private general hospital (Cure hospital) is found in woreda 02. The hospitals found in Gulele sub-city serve not only to Gulele sub-city but also for the country as a whole.

Out of six specialized hospitals found in Addis Ababa city Administration two of them are found in Gulele sub-city. The proportion of population expected to serve in specialized hospital is 1:5,000,000 population means that 1 specialized hospital expected to serve for 5,000,000 people. Whereas, for general hospital is 1:1,000,000 population means that 1 general hospital expected to serve for 1,000,000 people. Thus, it is enough general and specialized hospitals found in Gulele sub-city according to population ratio. According to, Ministry of Health report on Health Sector Development Program IV for the next five years it will be increased the number of hospitals by 25 percent.

h) Gulele sub-city Clinics

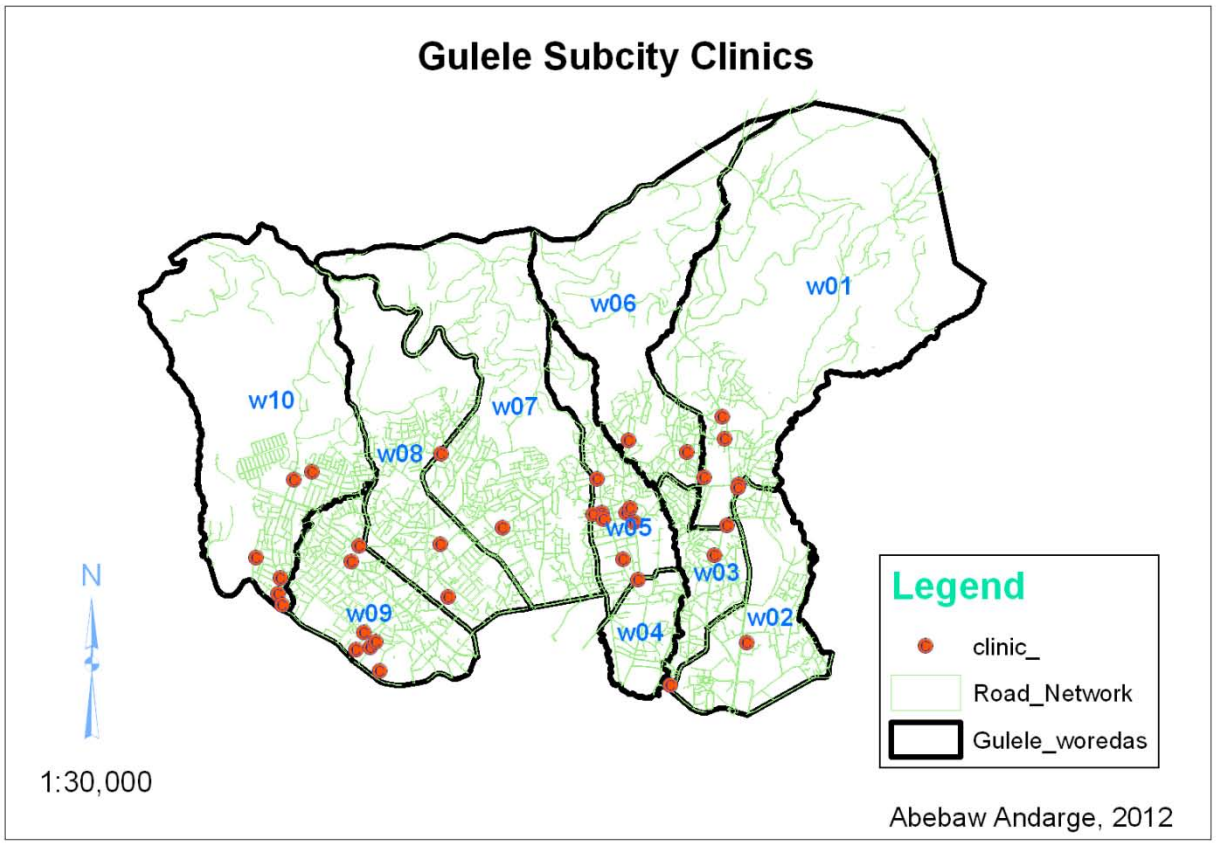

Figure 9 : Gulele sub-city clinics

The above map on Figure 9 represents the spatial location of clinics in the sub-city. According to the map distribution of clinics in the woredas are not equitable. Most of the clinics distributed in the woredas below average. The average numbers of clinics are 4. Woreda 01, 05, 09 and 10 are above average, but the rest woredas are below average. The probable reason for the distribution of clinics in most woredas are below average because all clinics are owned by privately, thus, owners opened clinics where better market is available and accessible to main road.

Table 2 : Population sharing one clinic: Gulele sub-city

Gulele Subcity	Population	Clinic	Population sharing one Clinic
Woreda 01	29235	5	5847
Woreda 02	20932	1	20932
Woreda 03	28124	3	9375
Woreda 04	13264	1	13264
Woreda 05	24495	8	3062
Woreda 06	26123	2	13062
Woreda 07	37066	2	18533
Woreda 08	31954	2	15977
Woreda 09	32704	7	4672
Woreda 10	23727	6	3955

The above table 2 shows distribution of clinics in the ten woredas and one clinic supposed gives services. Accordingly, the average population of the sub-city is 26762 and clinics are 4, thus, averagely 6690 people share 4 pharmacies. But the distribution is very sparse in woreda 02, 04, 06, 07 and 08.

i) Gulele Sub-city Health Centers

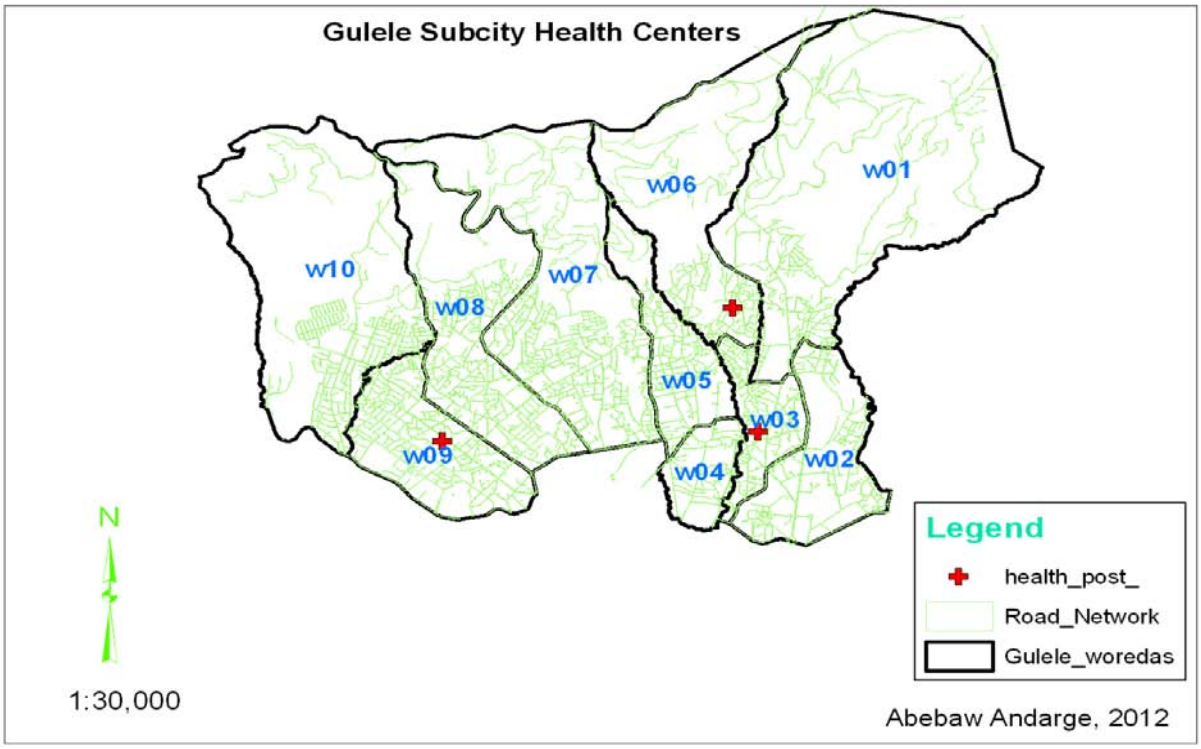

Figure 10 : Gulele sub-city health centers

This map shows the spatial allocation of health centers in the sub-city. Based on the spatial distribution of health centers illustrated on the map, in this sub-city there are three health centers namely shiro meda health center (woreda 03), woreda 6 Tena tabiya (woreda 06) and Selam Tena tabiya (woreda 09) all of them are governmental. The recent structure of Ministry of Health there is not private health centers all of them are owned by government. According to their spatial location, health centers are not equally distributed on the woredas of the sub-city.

Table 3 : Population sharing one health center: Gulele sub-city

Gulele Sub city	Population	Health Center	Population sharing one Health Center
Woreda 01	29235	-	0
Woreda 02	20932	-	0
Woreda 03	28124	1	28124
Woreda 04	13264	-	0
Woreda 05	24495	-	0
Woreda 06	26123	1	26123
Woreda 07	37066	-	0
Woreda 08	31954	-	0
Woreda 09	32704	1	32704
Woreda 10	23727	-	0

The above table 3 shows that, for each woreda how many people share a health center. According to Ministry of Health on Health Sector Development Program IV (2011-2015), the proportion of health center is 1:25,000 population means that 1 health center expected to serve 25,000 people. But, the reality seen on the sub-city is different. Based on the spatial distribution, woreda 03 is only 1 health center for 28,124 people, woreda 06 is 1 health center for 26,123 people and woreda 09 is also 1 health center for 32,704 people. On the rest woredas there is not a health center. From this we conclude that in woredas where no health center, there is a need for built additional health center.

III. Conclusions and Recommendations

GIS is designed to predict and understand the interactions between entities and phenomena throughout space and over time. This project mapped

the distribution of health facilities. A field survey was undertaken to record the geographic coordinates of all health facilities and their spatial locations were gathered using GPS. The results showed that health facilities are sparsely distributed in most of the woredas. Planners and concerned government officials should be built extra health facilities based on the population ratio in Gulele sub-city. The necessary extra pharmacies, clinics and health centers should be built timely in order to solve the health facility problem which prevails in the study area. Analyses provide essential information for health practitioners to understand the problem and help them plan for additional health facilities distributed equally in the sub-city.

IV. Acknowledgements

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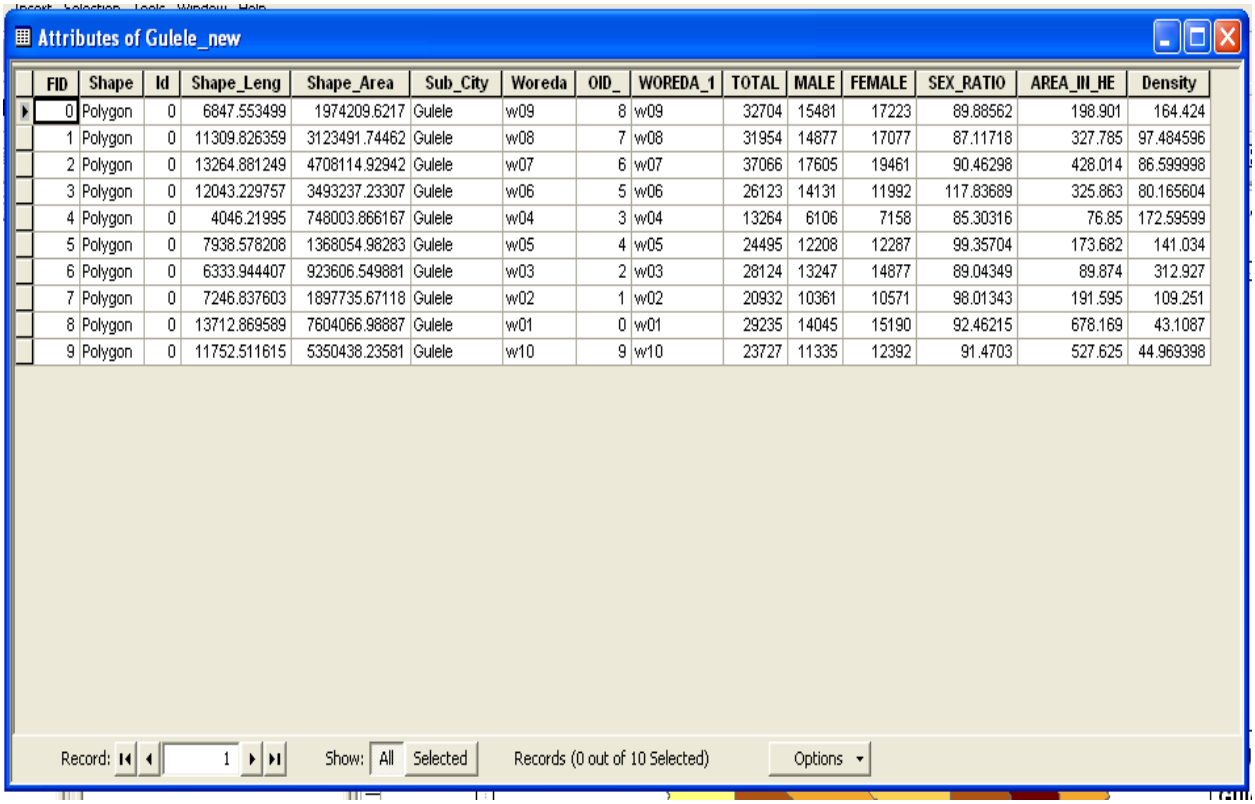
Annexes

Annex 1.1 : Attributes of total population, sex ratio and population density



Attributes of Gulele_new

FID	Shape	Id	Shape_Leng	Shape_Area	Sub_City	Woreda	OID_	WOREDA_1	TOTAL	MALE	FEMALE	SEX_RATIO	AREA_III_HE	Density
0	Polygon	0	6847.553499	1974209.6217	Gulele	w09	8	w09	32704	15481	17223	89.88562	198.901	164.424
1	Polygon	0	11309.826359	3123491.74462	Gulele	w08	7	w08	31954	14877	17077	87.11718	327.785	97.484596
2	Polygon	0	13264.881249	4708114.92942	Gulele	w07	6	w07	37066	17605	19461	90.46298	428.014	86.599998
3	Polygon	0	12043.229757	3493237.23307	Gulele	w06	5	w06	26123	14131	11992	117.83689	325.863	80.165604
4	Polygon	0	4046.21995	748003.866167	Gulele	w04	3	w04	13264	6106	7158	85.30316	76.85	172.59599
5	Polygon	0	7938.578208	1368054.98283	Gulele	w05	4	w05	24495	12208	12287	99.35704	173.682	141.034
6	Polygon	0	6333.944407	923606.549881	Gulele	w03	2	w03	28124	13247	14877	89.04349	89.874	312.927
7	Polygon	0	7246.837603	1897735.67118	Gulele	w02	1	w02	20932	10361	10571	98.01343	191.595	109.251
8	Polygon	0	13712.869589	7604066.98887	Gulele	w01	0	w01	29235	14045	15190	92.46215	678.169	43.1087
9	Polygon	0	11752.511615	5350438.23581	Gulele	w10	9	w10	23727	11335	12392	91.4703	527.625	44.969398

Record: 1 Show: All Selected Records (0 out of 10 Selected) Options

Annex 1.2 : Attributes of Health Facilities

Attributes of Gulele_Health

FID	Shape *	Sub_City	Kebele	Woreda	Facilty_Na	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
0	Point ZM	Gulele	19/20/21	1	YESSHAK CLINIC	Health Center	clinic	Private	147.75405	473737.345138	1001779.90585
1	Point ZM	Gulele	19/20/21	1	K/MEHERAT CLINIC	Health Center	clinic	Private	75.337388	473727.142479	1001753.34996
2	Point ZM	Gulele	19/20/21	1	BEMNET MEKAKELGNA CLINIC	Health Center	clinic	Private	136.69785	473386.011563	1001852.96327
3	Point ZM	Gulele	19/20/21	1	Govt. Health Center	Health Center	Hosepital	Govt	76.594828	473610.920814	1001967.73035
4	Point ZM	Gulele	19/20/21	1	Govt.Phamacy	Health Center	Pharmacy		9.340123	473610.682864	1001960.3133
5	Point ZM	Gulele	01/02	2	M.Clinic	Health Center	clinic		4284.455976	473815.586966	1000186.881
6	Point ZM	Gulele	01/02	2	Cure Hospital	Health Center	Hosepital		6768.863318	474229.402526	1001057.1312
7	Point ZM	Gulele	01/02	2	Dan. Pharmasy	Health Center	Pharmacy	private	151.558363	473701.271337	1001525.48718
8	Point ZM	Gulele	01/02	2	Cure Hospital	Health Center	Hosepital		6681.149158	474327.061484	1001042.12606
9	Point ZM	Gulele	03/04/05	3	G/S/C/A Shiro meda Health center	Health Center	Health Post		2861.77113	473335.435819	1000771.44437
10	Point ZM	Gulele	03/04/05	3	Miki drag store	Pharmacy	Drug Stor		68.027246	473387.301824	1000310.30396
11	Point ZM	Gulele	03/04/05	3	Rohobot middile clinic	Health Center	clinic		211.74615	473485.459659	1001071.76121
12	Point ZM	Gulele	03/04/05	3	M.D pharmacy	Pharmacy	Pharmacy		264.940988	473610.368706	1001365.207
13	Point ZM	Gulele	03/04/05	3	M.D middle clinic	Health Center	clinic		271.752808	473616.724267	1001374.2125
14	Point ZM	Gulele	03/04/05	3	Menen higer clinic	Health Center	clinic		613.974912	473045.240099	999758.108527
15	Point ZM	Gulele	06	4	MEDHANEALEM KEFTEGNA CLINIC	Health Center	clinic		340.125931	472720.730101	1000821.10141
16	Point ZM	Gulele	06	4	PROPOSED HEATH CENTER G+4	Health Center			1264.048	472454.050891	1000091.98394
17	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		488.127896	472681.294745	1001403.13411
18	Point ZM	Gulele	07/17	5	Fremetodist Clinic	Health Center	clinic		6438.927451	472569.419461	1001028.32395
19	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		618.396246	472597.769843	1001500.45513
20	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		209.562347	472640.841142	1001545.97703
21	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		195.657261	472306.676974	1001841.95553
22	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		556.061742	472349.772691	1001500.84933
23	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		551.81704	472260.803882	1001480.77634
24	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		195.961829	472368.65255	1001434.49382
25	Point ZM	Gulele	18	6	WW_6 TENA TABIYA	Health Center	Health Post		909	473079.778891	1002203.73597
26	Point ZM	Gulele	18	6	CLINIC	Health Center	clinic		469.102021	473205.88889	1002105.71757
27	Point ZM	Gulele	18	6	ZEQALA CLINIC	Health Center	clinic		962.786074	472620.328506	1002224.7806
28	Point ZM	Gulele	08/16	7	Mewdede melsetgna clink health institution	Health Center	clinic		890.522801	471355.00017	1001346.27831
29	Point ZM	Gulele	08/16	7	Kenema pharmacy health institution	Pharmacy	Pharmacy		284.895325	471226.571958	1001243.97696
30	Point ZM	Gulele	08/16	7	Golely pharmac.y h.inst	Pharmacy	Pharmacy		393.341153	470955.884116	1001377.22774
31	Point ZM	Gulele	08/16	7	Brhanbre Clinic	Health Center	clinic		317.00404	470735.106699	1002091.0798
32	Point ZM	Gulele	08/16	7	Loza Pharmacy	Pharmacy	Pharmacy		1310.772653	470847.475426	1002193.87201
33	Point ZM	Gulele	09/15	8	Enat clinic	Health Center	clinic		49.63074	470799.750448	1000651.36693
34	Point ZM	Gulele	09/15	8	GIOBAL CLINIC	Health Center	clinic		311.77545	470723.164657	1001178.18498
35	Point ZM	Gulele	09/15	8	WEDAJO PHARMACI	Pharmacy	Pharmacy		485.09139	470533.584563	1001797.95652

Con'd… (Attributes of Health Facilities)

Attributes of Gulele_Health

FID	Shape *	Sub_City	Kebele	Woreda	Facilty_Na	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
35	Point ZM	Gulele	09/15	8	WEDAJO PHARMACI	Pharmacy	Pharmacy		485.09139	470533.584563	1001797.95652
36	Point ZM	Gulele	10/11/12	9	maristops clinic	Health Center	clinic		550.882586	469955.735764	1000291.48809
37	Point ZM	Gulele	10/11/12	9	poulos Hospital	Health Center	Hosepital		18264.000592	470036.305996	999951.689764
38	Point ZM	Gulele	10/11/12	9	Wonchi Higher clinic	Health Center	clinic		1187.971199	469875.814781	1000113.72721
39	Point ZM	Gulele	10/11/12	9	Selam Tena Tabia	Health Center	Health Post		3168.417171	470151.562813	1000658.11533
40	Point ZM	Gulele	10/11/12	9	LILI PHARMACY	Pharmacy	Pharmacy		500.725538	470327.787045	1000531.8564
41	Point ZM	Gulele	10/11/12	9	S.T.RUFAEL MEKAKELEGNA CLINIC	Health Center	clinic		484.928615	469905.79545	1001164.80749
42	Point ZM	Gulele	10/11/12	9	SOLINA PHARMACY	Pharmacy	Pharmacy		132.173173	469884.18483	1001133.2172
43	Point ZM	Gulele	10/11/12	9	FIKRE MARIAM PHARMACY	Pharmacy	Pharmacy		32.350061	469802.035675	1001035.86041
44	Point ZM	Gulele	10/11/12	9	Prosthitics Orthotics Center	Health Center	clinic		6270.782956	470019.059033	1000139.9428
45	Point ZM	Gulele	10/11/12	9	Tiruworke Pharmacy	Pharmacy	Pharmacy		425.006744	469735.084503	1000287.77418
46	Point ZM	Gulele	10/11/12	9	Gefersa Poulos Clinic	Health Center	clinic		757.752337	470112.619059	999899.21153
47	Point ZM	Gulele	10/11/12	9	Worda 9 Heath Extention	Health Center			737.783067	469898.149582	1001253.04175
48	Point ZM	Gulele	10/11/12	9	D/r Melaku Mekakelegna clinic	Health Center	clinic		542.732871	469824.187236	1001003.79979
49	Point ZM	Gulele	10/11/12	9	Ethio-German Pharmacy	Pharmacy	Pharmacy		45.734184	469280.725151	1000454.68612
50	Point ZM	Gulele	10/11/12	9	Central Pharmacy	Pharmacy	Pharmacy		1146.341192	470465.994701	999821.461639
51	Point ZM	Gulele	10/11/12	9	Yeroam Pharmacy	Pharmacy	Pharmacy		196.257338	470126.922876	999958.441308
52	Point ZM	Gulele	10/11/12	9	p-R-D Medhantit Hekemena	Health Center	clinic		508.502	470074.884575	1000196.15419
53	Point ZM	Gulele	13/14	10	Haji Nure AdemYbahile Hekemena	Health Center	clinic		505.034663	469246.295109	1001834.90622
54	Point ZM	Gulele	13/14	10	Belese Higher Cilinc	Health Center	clinic		359.179492	469432.583812	1001910.94904
55	Point ZM	Gulele	13/14	10	Koseb Pharmacy	Pharmacy	Pharmacy		260.65332	469055.156894	1001463.59168
56	Point ZM	Gulele	13/14	10	Selam Higher Cilinic	Health Center	clinic		291.32185	468869.321337	1001042.4799
57	Point ZM	Gulele	13/14	10	Boni At Higher Cilinic	Health Center	clinic		417.538772	469108.914865	1000835.34791
58	Point ZM	Gulele	13/14	10	baroo Pharmatical p.l.c	Pharmacy	Pharmacy		930.977219	468990.242347	1000707.80673
59	Point ZM	Gulele	13/14	10	Mehiret Clinic	Health Center	clinic		487.481041	469085.308573	1000677.6788
60	Point ZM	Gulele	13/14	10	Unity Clinic	Health Center	clinic		478.347982	469127.734681	1000570.12454
61	Point ZM	Gulele	19/20/21	1	KIDUS PETROS TV CENTER	Health Center	Hosepital		48315.913317	473281.63192	1002897.25723
62	Point ZM	Gulele	19/20/21	1	NOAHE CLINIC	Health Center	clinic		76.69865	473570.308831	1002465.52066
63	Point ZM	Gulele	19/20/21	1	MD CLINIC	Health Center	clinic		463.823183	473590.179963	1002245.76258
64	Point ZM	Gulele	19/20/21	1	Sanba Nekersa	Health Center			312.567517	473414.000023	1002883.00004

Record: 1 Show: All Selected Records (0 out of 65 Selected) Options

Annex 1.3 : Attributes of Pharmacy

Attributes of pharmacy_

FID	Shape *	Sub_City	Kebele	Woreda	Facilty_Na	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
0	Point ZM	Gulele	19/20/21	1	Govt.Phamacy	Health Center	Pharmacy		9.340123	473610.682864	1001960.3133
1	Point ZM	Gulele	01/02	2	Dan. Pharmasy	Health Center	Pharmacy	private	151.558363	473701.271337	1001525.48718
2	Point ZM	Gulele	03/04/05	3	M.D pharmacy	Pharmacy	Pharmacy		264.940988	473610.368706	1001365.207
3	Point ZM	Gulele	08/16	7	Kenema pharmacy health institution	Pharmacy	Pharmacy		284.895325	471226.571958	1001243.97696
4	Point ZM	Gulele	08/16	7	Golely pharmac.y h.inst	Pharmacy	Pharmacy		393.341153	470955.884116	1001377.22774
5	Point ZM	Gulele	08/16	7	Loza Pharmacy	Pharmacy	Pharmacy		1310.772653	470847.475426	1002193.87201
6	Point ZM	Gulele	09/15	8	WEDAJO PHARMACI	Pharmacy	Pharmacy		485.09139	470533.584563	1001797.95652
7	Point ZM	Gulele	10/11/12	9	LILI PHARMACY	Pharmacy	Pharmacy		500.725538	470327.787045	1000531.8564
8	Point ZM	Gulele	10/11/12	9	SOLINA PHARMACY	Pharmacy	Pharmacy		132.173173	469884.18483	1001133.2172
9	Point ZM	Gulele	10/11/12	9	FIKRE MARIAM PHARMACY	Pharmacy	Pharmacy		32.350061	469802.035675	1001035.86041
10	Point ZM	Gulele	10/11/12	9	Tiruworke Pharmacy	Pharmacy	Pharmacy		425.006744	469735.084503	1000287.77418
11	Point ZM	Gulele	10/11/12	9	Ethio-German Pharmacy	Pharmacy	Pharmacy		45.734184	469280.725151	1000454.68612
12	Point ZM	Gulele	10/11/12	9	Central Pharmacy	Pharmacy	Pharmacy		1146.341192	470465.994701	999821.461639
13	Point ZM	Gulele	10/11/12	9	Yeroam Pharmacy	Pharmacy	Pharmacy		196.257338	470126.922876	999958.441308
14	Point ZM	Gulele	13/14	10	Koseb Pharmacy	Pharmacy	Pharmacy		260.65332	469055.156894	1001463.59168
15	Point ZM	Gulele	13/14	10	baroo Pharmatical p.l.c	Pharmacy	Pharmacy		930.977219	468990.242347	1000707.80673

Record: 1 Show: All Selected Records (0 out of 16 Selected) Options

Annex 1.4 : Attributes of Hospital

Attributes of hospital_

FID	Shape *	Sub_City	Kebele	Woreda	Facilty_Na	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
0	Point ZM	Gulele	01/02	2	Cure Hospital	Health Center	Hosepital		6768.863318	474229.402526	1001057.1312
1	Point ZM	Gulele	10/11/12	9	poulos Hospital	Health Center	Hosepital		18264.000592	470036.305996	999951.689764
2	Point ZM	Gulele	19/20/21	1	KIDUS PETROS TV CENTER	Health Center	Hosepital		48315.913317	473281.63192	1002897.25723

Record: 1 Show: All Selected Records (0 out of 3 Selected) Options

Annex 1.5 : Attributes of Clinic

Attributes of clinic_

FID	Shape *	Sub_City	Kebele	Woreda	Facilty_Na	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
0	Point ZM	Gulele	19/20/21	1	YESSHAK CLINIC	Health Center	clinic	Private	147.75405	473737.345138	1001779.90585
1	Point ZM	Gulele	19/20/21	1	K/MEHERAT CLINIC	Health Center	clinic	Private	75.337388	473727.142479	1001753.34996
2	Point ZM	Gulele	19/20/21	1	BEMNET MEKAKELGNA CLINIC	Health Center	clinic	Private	136.69785	473386.011563	1001852.96327
3	Point ZM	Gulele	01/02	2	M.Clinic	Health Center	clinic		4284.455976	473815.586966	1000186.881
4	Point ZM	Gulele	03/04/05	3	Rohobot middile clinic	Health Center	clinic		211.74615	473485.459659	1001071.76121
5	Point ZM	Gulele	03/04/05	3	M.D middle clinic	Health Center	clinic		271.752808	473616.724267	1001374.2125
6	Point ZM	Gulele	03/04/05	3	Menen higer clinic	Health Center	clinic		613.974912	473045.240099	999758.108527
7	Point ZM	Gulele	06	4	MEDHANEALEM KEFTEGNA CLINIC	Health Center	clinic		340.125931	472720.730101	1000821.10141
8	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		488.127896	472681.294745	1001403.13411
9	Point ZM	Gulele	07/17	5	Fremetodist Clinic	Health Center	clinic		6438.927451	472569.419461	1001028.32395
10	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		618.396246	472597.769843	1001500.45513
11	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		209.562347	472640.841142	1001545.97703
12	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		195.657261	472306.676974	1001841.95553
13	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		556.061742	472349.772691	1001500.84933
14	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		551.81704	472260.803882	1001480.77634
15	Point ZM	Gulele	07/17	5	Private Clinic	Health Center	clinic		195.961829	472368.65255	1001434.49382
16	Point ZM	Gulele	18	6	CLINIC	Health Center	clinic		469.102021	473205.88889	1002105.71757
17	Point ZM	Gulele	18	6	ZEQALA CLINIC	Health Center	clinic		962.786074	472620.328506	1002224.7806
18	Point ZM	Gulele	08/16	7	Mewdede melsetgna clink health institution	Health Center	clinic		890.522801	471355.00017	1001346.27831
19	Point ZM	Gulele	08/16	7	Brhanbre Cilinic	Health Center	clinic		317.00404	470735.106699	1002091.0798
20	Point ZM	Gulele	09/15	8	Enat clinic	Health Center	clinic		49.63074	470799.750448	1000651.36693
21	Point ZM	Gulele	09/15	8	GIOBAL CLINIC	Health Center	clinic		311.77545	470723.164657	1001178.18498
22	Point ZM	Gulele	10/11/12	9	maristops clinic	Health Center	clinic		550.882586	469955.735764	1000291.48809
23	Point ZM	Gulele	10/11/12	9	Wonchi Higher clinic	Health Center	clinic		1187.971199	469875.814781	1000113.72721
24	Point ZM	Gulele	10/11/12	9	S.T.RUFAEL MEKAKELEGNA CLINIC	Health Center	clinic		484.928615	469905.79545	1001164.80749
25	Point ZM	Gulele	10/11/12	9	Prosthitics Orthotics Center	Health Center	clinic		6270.782956	470019.059033	1000139.9428
26	Point ZM	Gulele	10/11/12	9	Gefersa Poulos Clinic	Health Center	clinic		757.752337	470112.619059	999899.21153
27	Point ZM	Gulele	10/11/12	9	D/r Melaku Mekakelegna clinic	Health Center	clinic		542.732871	469824.187236	1001003.79979
28	Point ZM	Gulele	10/11/12	9	p-R-D Medhantit Hekemena	Health Center	clinic		508.502	470074.884575	1000196.15419
29	Point ZM	Gulele	13/14	10	Haji Nure AdemYbahile Hekemena	Health Center	clinic		505.034663	469246.295109	1001834.90622
30	Point ZM	Gulele	13/14	10	Belese Higher Cilinc	Health Center	clinic		359.179492	469432.583812	1001910.94904
31	Point ZM	Gulele	13/14	10	Selam Higher Cilinic	Health Center	clinic		291.32185	468869.321337	1001042.4799
32	Point ZM	Gulele	13/14	10	Boni At Higher Cilinic	Health Center	clinic		417.538772	469108.914865	1000835.34791
33	Point ZM	Gulele	13/14	10	Mehiret Clinic	Health Center	clinic		487.481041	469085.308573	1000677.6788
34	Point ZM	Gulele	13/14	10	Unity Clinic	Health Center	clinic		478.347982	469127.734681	1000570.12454
35	Point ZM	Gulele	19/20/21	1	NOAHE CLINIC	Health Center	clinic		76.69865	473570.308831	1002465.52066
36	Point ZM	Gulele	19/20/21	1	MD CLINIC	Health Center	clinic		463.823183	473590.179963	1002245.76258

Annex 1.6 : Attributes of Health Center

Attributes of health_post_

FID	Shape *	Sub_City	Kebele	Woreda	Facilty_Na	Facility_T	Category	Owner	Area	X_Coord	Y_Coord
0	Point ZM	Gulele	03/04/05	3	G/S/C/A Shiro meda Health center	Health Center	Health Post		2861.77113	473335.435819	1000771.44437
1	Point ZM	Gulele	18	6	WW_6 TENA TABIYA	Health Center	Health Post		909	473079.778891	1002203.73597
2	Point ZM	Gulele	10/11/12	9	Selam Tena Tabia	Health Center	Health Post		3168.417171	470151.562813	1000658.11533

Record: 1 Show: All Selected Records (0 out of 3 Selected) Options

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An Assessment of Road Network Quality in Jos City, Nigeria: Using Geographic Information System (GIS)

By Daful, Mwanret Gideon & Oluwole, Olumide Akinwumi
Nigerian Defence Academy

Abstract- Given the significance of spatial data in planning, management and utilization of a road network in any society, the current study provides empirical spatial data on the road network of Jos city Centre, examine its quality, create a spatial and attribute database and analyzes its bearing on traffic flow situation. On-field data acquisition through measurement, observation and counting were used to collect information on the road network quality variables, Geographic Information Systems (GIS) technique was used to digitize and in combination with the road network quality attributes used to produce a spatial and attribute database for the road network of the study area. The data were analyzed in Arc GIS 10.3 software environment. This provides an avenue for spatial querying of the various attributes of the streets. The result of the finding reveal that 3.91% of the road network are in good condition, 19.55% are fairly good, 51.40% are at an average condition, 23.44% are below average and 1.68% are under repairs. These have shown that the quality of roads in the study area can be termed to be at an average, this is fair, but not good enough to facilitate an excellent accessibility to the various socio economic activities within and around Jos City Centre and its environs.

Keywords: *road network, quality, accessibility, spatial analysis.*

GJHSS-B Classification : *FOR Code: 040699*

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I. Introduction

Transportation represents one of the most important human activities worldwide. It is an indispensable component of the economy and plays a major role in spatial relations between locations. Transportation creates valuable links between regions and economic activities, between people and the rest of the world. Transport according to Rodrigue (2013) is a multidimensional activity whose importance is historical, social, political, economic and environmental. In the field of geography, a network is generally defined as "a set of geographic locations interconnected in a system by a number of routes" (Campbell, 2001). A transport network is defined as a number of links connecting the nodes all having their own characteristics (Steenbrink, 1974).

Transportation, if well planned contributes greatly to the economic development of a place, the standard of living, the level of economic growth as well as the standard of productivity of the people. These are no doubt determined by the efficiency of movement in the given area. This movement is facilitated by the availability of a good transport network (Hoyle, 1973). Interactions among and between people is promoted by the facilities involved in the movement of people, materials, goods and services. For interaction to really take place between cities there must be accessibility which has become a major area of concern for transportation geographer (Rodrigue, 2013). Transportation is a requirement for every nation, regardless of its industrial capacity, population size or technological development. Moving of goods and people from one place to another is critical to maintaining strong economic and political ties between regions in the same state; roads came into being to facilitate the movement of wheeled vehicles which in turn, fostered the development of regions (Obafemi. *et al.* 2011). This research defines road quality as the general condition of the total road length and its facilities.

One of the most special tools for solving spatial problem is the Geographic Information System (GIS), its capability in spatial planning and management has been widely acknowledged. GIS is a robust suite of technical software designed to accept, analyze, store and presents geo-database. Presently, the GIS technology is gradually but steadily marking inroads into transportation planning, development and management. It is becoming quite fashionable to use GIS to heuristically study transportation issues such as those relating to traffic congestion, optimum location of transportation facilities, network analysis, transport system modeling, analysis of transport-induce environmental problems, and so on (Uluocha, 2007).

The effective implementation of any project lies on proper planning and design of the spatial database which forms the heart of GIS. The process of designing such database is referred to as data modeling. It is the process in which real world entities and their inter-relationships are analyzed and modeled in sucha way that maximum benefits are derived while utilizing a maximum amount of data (Kufoniyi, 1998). It has been noted that improper design often leads to implementation problems and low cost recovery. Database Models are being used to describe the subset

Author α σ: Department of Geography, Nigerian Defence Academy, Kaduna. e-mail: daful5mg@gmail.com

of an entity at different levels of abstraction. The architecture of a database can be classified into: Conceptual Data Model, and Logical Data Model Architecture. The conceptual, understanding the nature and structure of data at the user level independently of how the data is processed. The logical, transforming of the conceptual view into one or a combination of the following logical model: Relational Modeling, Object Relational and object oriented. This study however adopts the relational database modeling architecture.

The relational database architecture represents combination of related data values. These values can be interpreted as facts describing a real world entity or relationship, with the table name and column names used in interpreting the meaning of the values in each row of the table (Chang, 2010; Fazal, 2008 and Nyerge 1988).

An efficient road network promotes a high level of socio-economic activity and industrial production in any urban area. Inadequate supply of raw materials to industries as well as inadequate supply of industrial products to the markets may emerge as a result of inefficient or poor road network. Road transportation is the heart of the concept of accessibility in a region, and serves as a medium by which demand and supply, where they do not coincide in space are linked.

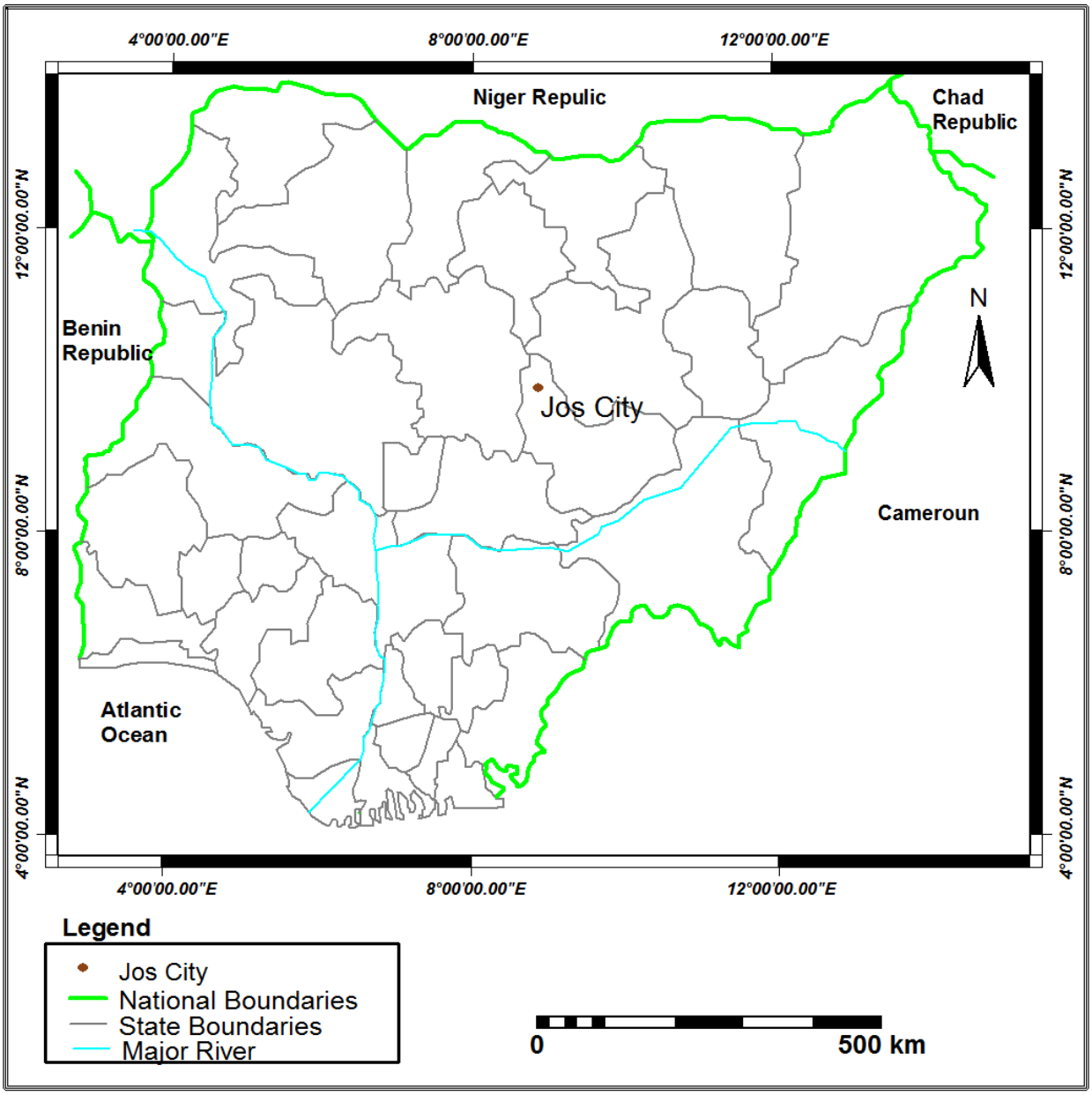
It therefore becomes imperative for a study on road network quality to be carried out in Jos city so as to examine the road network situation with reference to the conditions of road surfaces, the road type, width and thickness of the tarred, number of street light, pot holes, paint lines, drainage type, side walkway width and condition, availability of parking space, and the width of the road covered by traders as well as traffic problem. To this end therefore, this study examines the quality of the road network, create a spatial and attribute database and analyzes its bearing on traffic flow situation.

a) Study Area

Jos City (figure 1) is the capital of Plateau State Nigeria, Jos is located almost in the geographical center of Nigeria; it is about 1,000 Km north east of Lagos, 400 Km south of Kano, 900 Km north of Port-Harcourt, 600 km south west of Maiduguri, 1000 km south-east of Sokoto and 300 km away from Abuja. The state occupies an approximate total land area of about 39,934 square kilometers. The coordinates of the study area, "Jos Central" are given between latitude 9° 53"N and latitude 9° 56"N of the equatorial plane and longitude 8° 54"E and longitude 8° 52"E of the Greenwich Meridian, and have an elevation which rise between 1,276 M and 1,160 M above mean sea level. It is located at the northern point of the plateau, which bears its name at an elevation of about 1,200 M above mean sea level. As a town it is the most asymmetrically placed state capital in the whole of Nigeria, located at the extreme northern end of the State. Except on its northern part, the town is almost surrounded by hills. To the east are Dogon Dutse and Shere Hills which rise to over 1,400 M and 1,777 M respectively, on the west side are the Jentar Hills which also rise to over 1,280M above mean sea level. To the south are many other small and large inselbergs and rock out crops. In the north the topography is worsened by many un-reclaimed old mining paddocks (Morgan, 1979).

The city of Jos is synonymous with mining and commerce; it is mainly a colonial creation and one of the earliest and busiest cosmopolitan centers in Nigeria. Most inhabitants of this bustling city are immigrants attracted by the numerous commercial prospects available there in. Jos is indeed an attractive place to live in because of the unique physical features, favorable climate, variety and scenic beauty and pleasurable social atmosphere.

Jos city being the administrative capital, and the commercial nerve Centre of plateau state, is the most densely populated area in the state. According to the 2006 Nigerian census result, the city has a population of 836,910 people, and with a present projected population of about 1.1 million people. The city normally witnesses great influx of people from within and outside the state, for various socio economic activities, such as education, health services, and tourism and administrative purposes. Jos city will continue to attract and absorb more people and diverse forms of human activities from the already overloaded city center.



Source : National Centre for Remote Sensing Jos, Nigeria.

Figure 1 : Map of Nigeria Showing Jos City

II. Methodology

Needed information were obtained through direct field survey of the study area, the exercise of measurements and observation of the road quality attributes (in terms of width of the road, nature and numbers of pot holes, drainage system types, nature of edges of the entire road network, the width of the road covered by traders, availability of parking space, paint lines, thickness of tarred and number of street lights,) was carried out for each street. A structured observation chart was design and used as a guide in the field, to assemble data on each road and nodes in the field.

Information on road width, width of road covered by traders, and width of sidewalk ways were obtained through direct field measurements and recordings, all measurement was made in meters. Measurements were taken at 3 main points of the road (at the beginning, middle and end nodes of each street), an averaged was taken to ascertain the road width, while the road length was obtained from the digitized map of the study area. On the other hand, information on the nature of the surface of the road, drainage type and the nature of the edges of the road were obtained through observation. Observations on road surface condition, considering the incidences and frequencies

of pot holes on roads. Information on the number of street lights and number of painted lines was through counting in the field.

a) Data Processing

i. *Basic Procedure/Operations*

The following operations were carried out in this research;

- Geo-reference Quick-bird satellite image of the study area "captured in 2013" and the greater Jos road network map were acquired.
- The Quick-bird satellite image was imported in to the Arc GIS 10.3 software, in which the desire portion of the image was subset using the clip (extract) operation function of the software.
- Since the image has already been geo-referenced, polyline shape file was created for the digitization of the roads (streets). In the digitization, all routes were digitized as an arc. The digitization was done in such a way that a street was digitized from the beginning to the end without stopping before starting another street (so each street has its own unique identity number), this was to have an easy and efficient way of measuring the length and integrating the network map (spatial database) with the attribute database.
- The greater Jos Street map was used to abstract the names of the Street, which was used in naming the digitized streets in the attribute table of the database.
- The road network quality data obtained from the field completion, was used in building the attribute table, for the formation of the database of the network, by using the Add-field function of the attribute table, to create a column for each of the street attribute quality, in which the various quality attribute were input into the table.
- From the road network map produce and link with the quality attribute data (database of the network), both spatial and attribute data queering of each street and each attribute can now be carried out.

The create report tool, of the attribute table in Arc GIS 10.3 environment was used in analyzing the results of the findings.

III. Results and Discussion

The quality measure of a road network is one of the important measures of road network development. In assessing road quality in Jos City the study considers its attributes as regards the road width, road type, road lane, length, thickness of road tarred, pedestrian work way, drainage type, street lights, painted lines, width of the road covered by traders and the general surface condition of the roads.

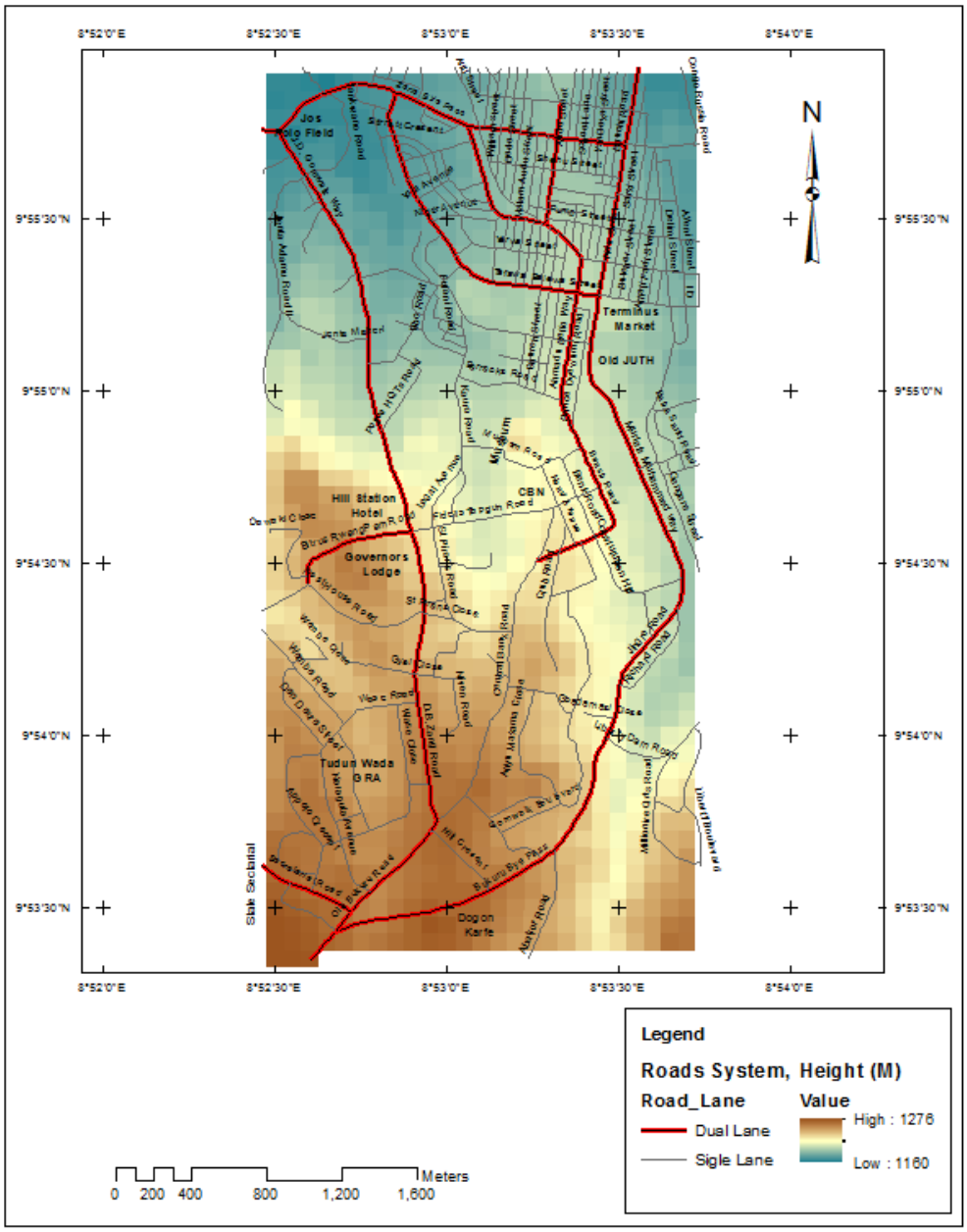
The road type is an important index of assessing the network quality; this is because it helps examine the various functions each street or road way performs. The study categorizes the roads into 3 classes of expressway, major arterial and collector roads, an attribute query of the network database in table 1 reveals that Jos City Centre has 8.38% streets as expressways, 48.6% of the streets as major arterial and 43.02% of the street as collector's road. The value of the streets as expressway is low and that of the arterial roads is not sufficient for a city Centre, which is a state capital and the commercial nerve Centre of a state. This can be associated with the various circulation (accessibility) delays experienced on the road network of the study area, thus the need for the construction and upgrading of roads as expressway and arterial roads, so as to improve the speed of accessibility into the various goods and services provided by the city.

Table 1 : Roads Types Distribution

S/N	Road Type	Frequency	Percentage
1,	Expressway	15	8.38%
2,	Major Arterial	87	48.60%
3,	Collector	77	43.02%
	Total	179	100%

Source: Author's Fieldwork (2013)

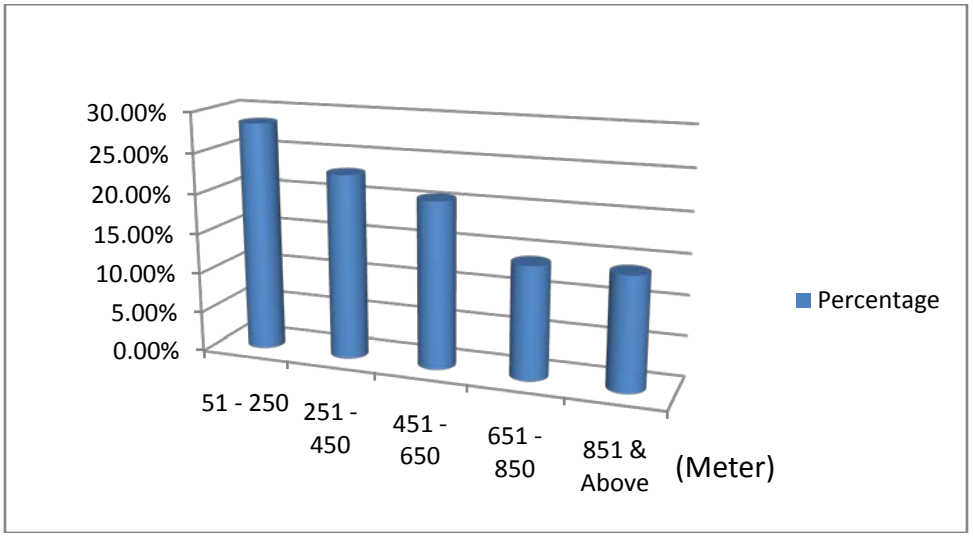
The lane of the road is an important attribute index of assessing the road quality, this is because it aids in coordinating the flow of traffic on the road. The study area is an urban area and a city Centre with the status of a state capital, commercial Centre with a population of over one million inhabitants. The need for multiple lanes of roads is imperative, the study reveals that the study area has 10.06% of dual lane roads and 89.94% of single lane roads, the percentage of dual lane roads is low for a city Centre such as Jos city circulation of goods and services hence, the need for network development in terms of upgrading some of the single lane routes to dual lane, so as to enhance the level of accessibility into the city services. Figure 2, shows a spatial analysis of the dual and single lane routes from the database of the road network, in the study area.



Source; GIS Analysis (2013)

Figure 2 : Spatial Analysis, of Dual and Single Lane Routes in the Study area

The length of the roads is an important index in assessing the quality and level of connectivity of the road network. An attribute analysis of the road network database reveals that the study area has a total sum of 93,407.09 meters of road length, with an average length of 521.83 meters, a standard deviation of 398.80 meters, with 2293.04 meters being the longest street length and 51.58 meters being the shortest street length. The lengths of the roads in this study are categorized into the following classes; 51 – 250 meters are termed short length roads, 251 - 450 meters are termed fairly short lengths, 451 - 650 meters are termed average length roads, 651 - 850 meters are termed fairly long length and 851 & above are termed long length. From figure 3, it can be seen that the study area is dominated by short length and fairly short length roads. 28.48% of the streets are short, 22.91% are fairly short, 20.67% have an average length, and 13.97% have fairly long length and also13.97% of the streets have long length. This is important because it would aid planners, policy makers and individuals in making decision in terms of network development, e.g. which street should be reconstructed? What is the length of the street, what will be the cost implication? Can the street be transformed? And so aid in planning for an excellent accessibility on the road network.



Source : Fieldwork and Analysis (2013)

Figure 3 : Variations in Street lengths

The width of a road is also one of the most important attributes used in assessing the quality of a street, how wide or narrow the road width is, helps in assessing its accessibility. An attribute analysis of the road network database reveals that, the study area has an average width of 7.04 meter, with a standard deviation of 1.51 meter, and 13.8 meter as its widest width and 4.1 meter as its narrowest width. Table 2 analysis of the roads width attribute reveals that 3.91% of the roads have narrow width, 21.78% have a fairly narrow width, 41.34% have an average width, 25.14% have wide width and 7.82% have a very wide width. The width of the road, if not adequate for an area will affect the level of flow of goods and services, this also aids when making decisions about network development, e.g. should the width of the road be expanded or the number of lanes be increased?

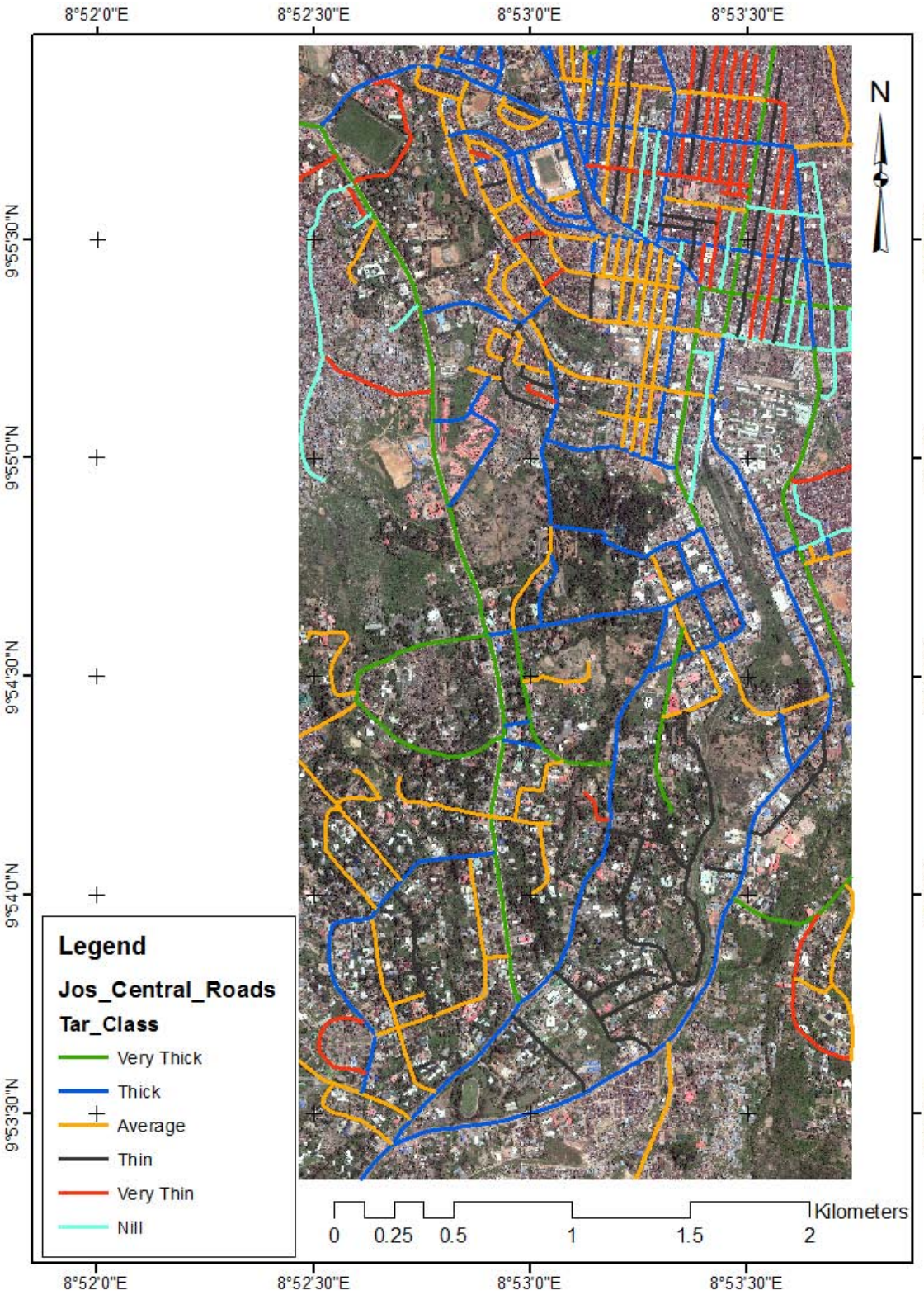
Table 2 : Road width Categories

S/N	Road Width (M)	Frequency	Percentage
1	3 – 4.4	7	3.91%
2	4.5 – 5.9	39	21.79%
3	6 – 7.4	74	41.34%
4	7.5 – 8.9	45	25.14%
5	9 & above	14	7.82%
	Total	179	100%

Source: Fieldwork (2013)

The qualities of the roads were also assessed by its physical condition as it relates to the thickness of tar. A spatial and attribute data analysis of the road network thickness of tar from the study database reveals that 8.94% of the streets have no tar, 12.85% of the Streets have tar of between 0.5 – 1.4 cm thicknesses which were tagged very thin tar, 13.97% have tar of between 1.5 – 2.4 cm and tagged thin tar, 31.28% have 2.5 – 3.4 cm which were tagged averagely thick tar, 25.70% have 3.5 – 4.4 cm thickness and tagged thick tar and 7.26% have tar of thicknesses 4.5 cm and above which were tagged very thick tar, a spatial distribution of the thickness tar, from the study area database is presented in figure 4. It was observed from the study that streets with very thin and thin tar have more frequent potholes; this implies that those streets get easily deteriorated, does affect the free flow of goods and services.

The quality of the road network was also assessed using the pedestrian facilities and their condition; this is a function of the side walkway width and its condition. An attribute data analysis of the roads pedestrian facility condition from the database shows that 3.91% are in good condition, 15.64% are in fair conditions and 17.88% are in a deteriorating condition while 62.57% of the roads do not have any existing pedestrian facilities? This implies that most of the roads in Jos City are in need of pedestrian facilities and streets with deteriorated pedestrian facilities need to be repaired, so as to improve the level of circulation on those roads.



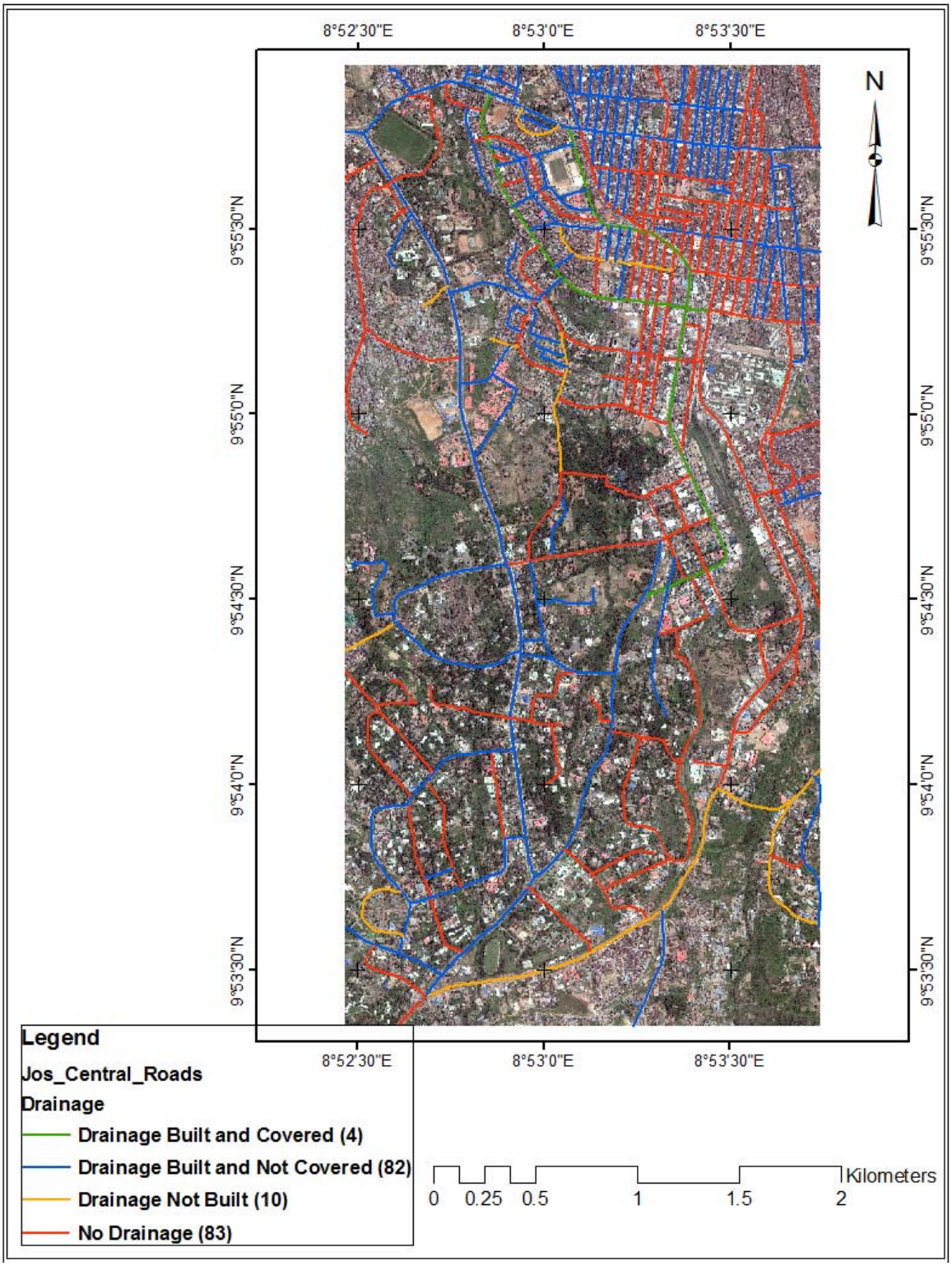
Source: Author's Fieldwork and GIS Analysis (2013)

Figure 4 : Spatial Distribution of Tar Thickness

Drainage types are important index of road network quality assessment, as thus helps in defining the flow of water on a street; this is because most roads not well drained seem to be swampy on a rainy day, such affects the ease of accessibility on such roads, it is also of negative effect to the tar of the roads in the area, as it causes the tar to deteriorate easily, which results in frequent potholes, thus, affects the free flow of goods

and services. The study reveals that 2.74% of the streets have drainages built and covered, 45.25% have drainages built but not covered, 5.64% have drainages that have not been built and 46.37% have no drainages, figure 5 shows the spatial distribution of the drainage types in the study area. The spatial analysis shows that only the northern part of the city has drainages built and covered, while the other drainage types are distributed all over the study area. These implies that there is the need for the construction of drainages in streets without drainages and those not constructed, so as to aid control the movement of water, which will prevent flooding and protect the road tar from easy deteriorating, this will give room for free movement of goods and services within the road network of the city.

The study was able to identify the streets that have street lights and how many street lights are there in a street. An attribute data analysis of the street light, from the study database reveals a total of 987 street lights in the study area, distributed over 22 streets, this also shows that only 12% of the roads have street lights and 88% don't have street lights, and of the streets having street lights none seem to be properly functional as at the time of this study. The study also reveals that only Ahmadu Bello way have a defined parking space which is not adequate, hence, vehicles are mostly parked by the road shoulder in which part of the vehicles block part of the road, which results in some form of traffic holdups and affects the free flow of goods and services, and is of a negative influence to the socio economic development of Jos City.



Source: Author's Fieldwork and GIS Analysis (2013)

Figure 5 : Spatial Distribution of Drainage Types

The width of the road covered by traders is also an important attribute used in assessing the quality of accessibility in a street, this is because traders seems to block through traffic on a street, as their activities on the road seems to hinder the free flow of traffic on the roads, hence slows accessibility to the various goods and services in the city. An attribute analysis of the width of the road covered by traders from the database of the study in table 3 reveals that 19.55% of the streets have traders blocking the free flow of traffic on the roads and

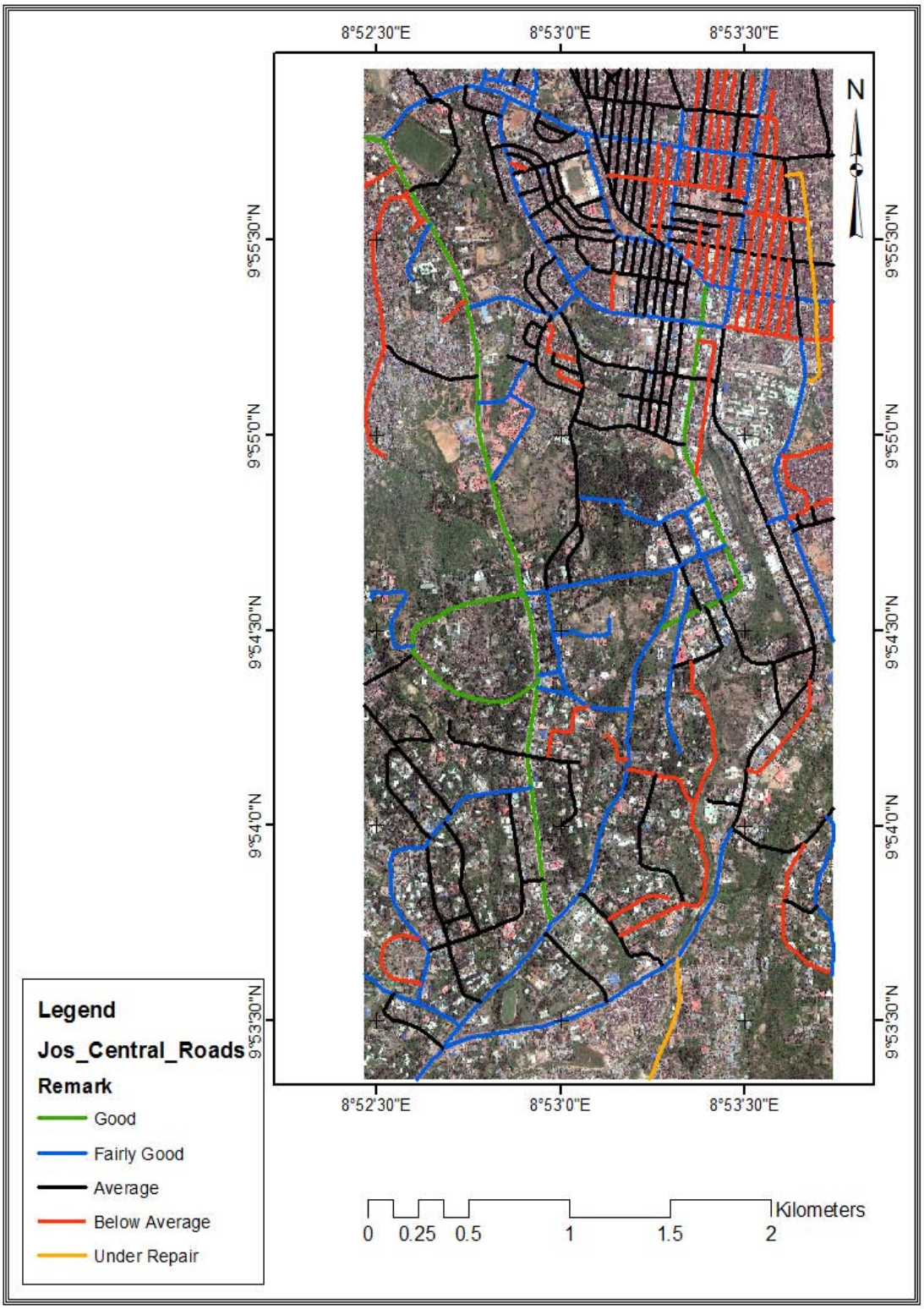
80.45% of the streets have no traders blocking the road. The study also reveals that the flow of traffic on streets like Prince Oyewumi Road and market road seems to be impossible due to the activities of traders on those streets. Thus, there is no doubt that the activity of traders is affecting the easy of accessibility within the road network.

Table 3 : Percentage of Streets with Traders covering part of the Road

S/N	Street Traders Availability	Frequency	Percentage
1	Streets with Traders	35	19.55%
2	Streets Without Traders	144	80.45%
		179	100%

Source: Fieldwork (2013)

The general surface condition of the roads is a function of the number of potholes on a road and how rough or smooth the surface of the road is, it is an important attribute of the road quality, connectivity and accessibility. The surface condition of the roads is categorized into the following classes; very smooth surface with no potholes are termed good, very smooth surface with less potholes are termed fairly good, smooth surface with less potholes are termed averaged, un-tarred and rough surface condition with frequent potholes area termed below average and streets under reconstruction are termed under repair. A spatial and attribute data analysis of the database reveals that 3.91% of the roads have good surface condition, 19.55% have fairly good surface condition, 51.40% surface condition is said to be at an average, and 23.46% have surface condition below average and 1.68% were under repair, the spatial analysis of the roads as shown in figure 6 reveals that most of the roads whose surface condition is below average and average are in the northern part of the city with just few in the southern part of the city, the remaining classes are fairly well distributed in the city. These have shown that the quality of the roads can be termed to be at an average, which is not good enough for an efficient circulation of goods and services within a city Centre.



Source: Author's Fieldwork and GIS Analysis (2013)

Figure 6 : Spatial Distribution of the Road Network General Surface Condition

IV. Conclusion and Recommendation

Planning being an act of preparation for future action, availability of background information, such as this, constitutes a major preliminary exercise in the planning process, for the development of the road network of Jos City. It is also pertinent to note that one essential pre-requisite of any planning exercise is a clear understanding of the existing conditions in a given area, the enviable capacity of GIS to solve spatial problems

as it relates to road network planning and database management have been utilized in this study. The quality of the roads in Jos City Centre can be termed to be at an average. A general assessment of the roads shows that the dual carriage ways are considered the best in the town since they have smooth surfaces, less or no pot holes with good pedestrian's facilities, street lights and wide width for easy flow of traffic. These implies that the quality of roads in the study area is affecting the speed of accessibility to the various goods and services provided by the city, most especially on the major arterial and collector's routes. Thus to improve the level of accessibility, there is the need for the provision of adequate transport facilities around the study area, through the upgrading of the existing facilities e.g. Street lights, Paint lines, Car parks, Bus stops etc.; this will instill some form of orderliness on the various road users who flock these roads. Furthermore, it is obvious that pedestrian's lanes around the City Centre have not been clearly demarcated, thus, there is the need for the provision and clear demarcation of pedestrian lanes.

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Land use and Land Cover Change Detection of Ganakbari Mauja in Savar Upozila

By Mehjabin Elahi, Dr. Shahedur Rashid & Dr. Prosannajid Sarkar
Jahangirnagar University

Abstract- The aim of this work is to study the changes in land use in the study area in manner that can aid quick and useful decisions for the purpose of land development, administration and planning for a sustainable environment. The main objective of the study is to analyze the land use changes in Ganakbari Mouza. This study has used mainly primary and secondary data. Stratified random sampling was used for primary data, and secondary information (data) was collected from various secondary sources. Findings revealed that in liner pattern of growth which is taking in haphazard manner. Irresponsibility of RAJUK and other related development authority is the main cause of this haphazard growth. Lack of land use policy, zoning regulation and other controlling rules and laws are also responsible for this uncontrolled and unplanned development. But as a potential area of development, Ganakbari may play an important role in whole region. It may also the role of an efficient and suitable satellite city for the megacity Dhaka. It is concluded that remote sensing and GIS tools provide an outstanding platform from which accurate information on Land use changes and patterns can be obtained and that Ganakbari area of Dhamsona union has experienced tremendous changes in land use, so efforts should be made to regularly update available data in order to control further development.

Keywords: land cover change, ganakbari mouja, land use.

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Keywords: land cover change, ganakbari mouja, land use.

I. Introduction

Land use referred to as man's activities and the various uses which are carried on land. Land cover is referred to as natural vegetation, water bodies, rock/soil, artificial cover and others resulting due to land transformation. And digital change detection is the process that helps in determining the changes associated with land use and land cover properties with reference to geo-registered multi temporal remote sensing data. The use of remotely sensed data (satellite and aerial) to detect changes in Land use as well as precise and accurate analysis using GIS is widely preferred over other conventional survey techniques because the method is very efficient for assessing the change or degrading trends of a region, from a small city of about 200,000 in 1947. Dhaka has grown into a crowded metropolis of over 4 million people by 1987. During the 1960's and the city's annual rate of population growth was nearly 10 percent, being, one of the highest for any city in the world (Fouzder, 2005). The acceleration rate of population growth in and around the DMA makes a tremendous pressure on land and on urban infrastructural services. Dhaka city is growing very rapidly towards its west and north-west direction. The fringe areas are being changed due to numerous causes and land use is changing. The causes responsible for such change is like rapid population growth, diminution of interesting agricultural sector, there is strong tendency of urban expansion in the suburban Ashulia, just lying outside the DMA. Ashulia union, as a developing peripheral area has a great potentiality and efficiency to be established as a well-designed industrial town. Its influences and linkages are speeded over a broader scale because of its good communication network. With the inclusion of study area is into the jurisdiction of the RAJUK in 1989. It has received further impetus to growing a rapid manner. The transformation of land use and its potentialities in the northwest and west fringe of the city of Dhaka will be identified. As an agro-based country, this region also not poles apart from any other region, but after construction of "Asian Highway" in 1996, a tremendous change has been transpired here and modified the aspect of this region. This road provides multi dimensional advantages and promotes interactional trade and socio-economic development of this region. Moreover in 1985, Savar was included into the greater Dhaka city and declared as an industrial area by the RAJUK. Since, savar had located close to Dhaka and Asian Highway passes through hit. The area becomes an important place of urbanization. In one hand a number of industries are being established here. Due to the impact of advanced transportation network and communication systems rapid land use changes, reduction of agricultural land, development of local economy, increase of employment opportunity, increase of demand for land can be seen. This area is located within the jurisdiction of greater Dhaka but RAJUK is not condemned about it. That's why most of the housing projects are constructed in this area along the highway without following any rules and regulations. In this connection we conducted research on land use and land cover change detection of Ganakbari Mauja in Savar Upozila.

Author α: Department of Geography and Environment, Jahangirnagar University, Savar. e-mail: mehjabinelahi@yahoo.com
Author σ: Professor, Department of Geography and Environment, Jahangirnagar University, Savar. e-mail: m.s.rashid@gmail.com
Author ρ: Researcher, Dr. Wazed Research Institute, Begum Rokeya University, Rangpur. e-mail: drpsarkarbrur@yahoo.com

II. Objectives of the Study

To analyze the land use changes in Ganakbari Mouza and prepare a land use map of the study area.

III. Methodolgy

Ganakbari Mouza is at Dhamsona Union in Savar Upzilla of Dhaka District is our study area. In this study the necessary data and information were collected from the primary and secondary sources. For primary data, stratified random sampling was used to draw respondent interviewed. Stratified Random Sampling was selected for this study because it reduces the chances of having an unrepresentative sampling. Stratification is based on certain stratums. The secondary data and information were collected from various sources like published materials in the form of books, conference proceedings, journal, and thesis. Studies and office work of both government and semi government office and few unpublished reports will be reviewed to prepare a conceptual frame work for the study. The satellite data was enhanced using histogram equalization in ERDAS Imagine 9.3 to improve the image quality and to achieve better classification accuracy. During the survey period various land use will be observed and ground truth of this union. Local people opinion will be collected from a questionnaire survey about the land use changes of the Ganakbari Union.

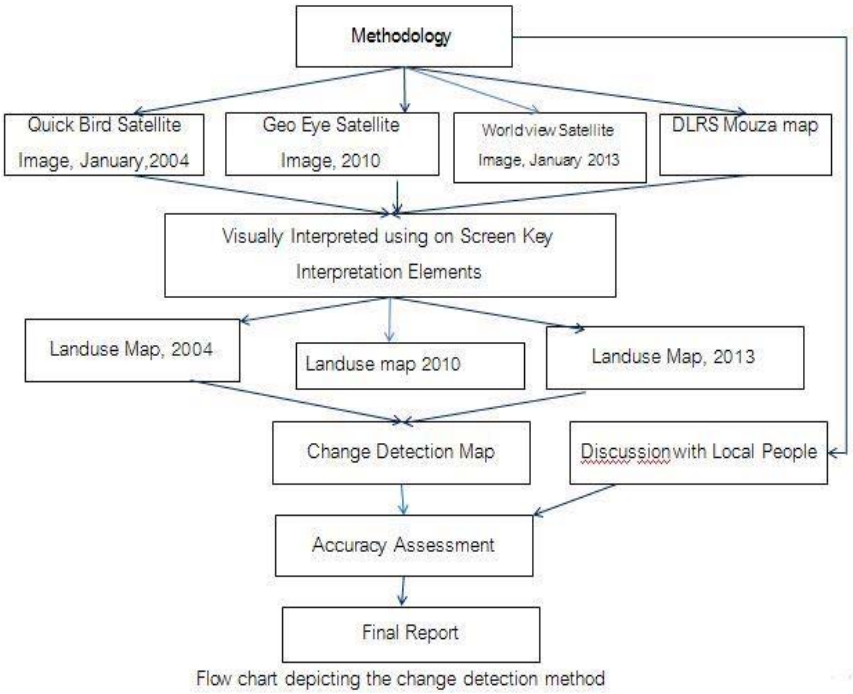

Figure 1 : Flow chart of the methodology

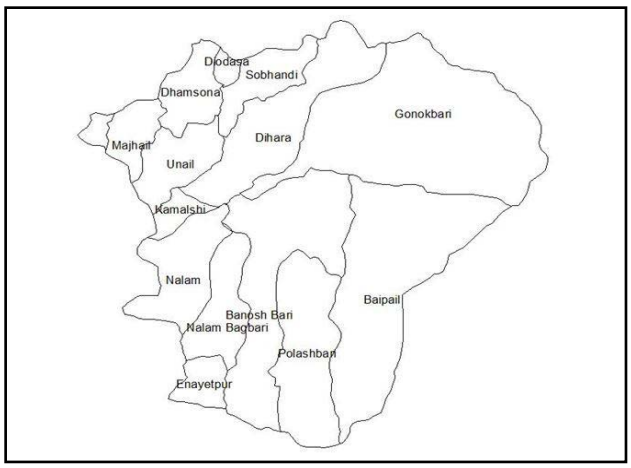

Figure 2 : In a map Ganakbari Mouza

Figure 2 illustrated that in a map details scenery of Ganakbari Mouza and one of the 14 mouza of Dhamsona union as well as Ganakbari.

Table 1 : At a glance Ganakbari Mouza

Content of Ganakbari Mouza	Details	Content of Ganakbari Mouza	Details
Area	2096 acre	Number of educational institution	10
Total population	12500	Number of Religious institution	10
Literacy rate	42 %	Number of industry	47
Public health care	3	Super market	2

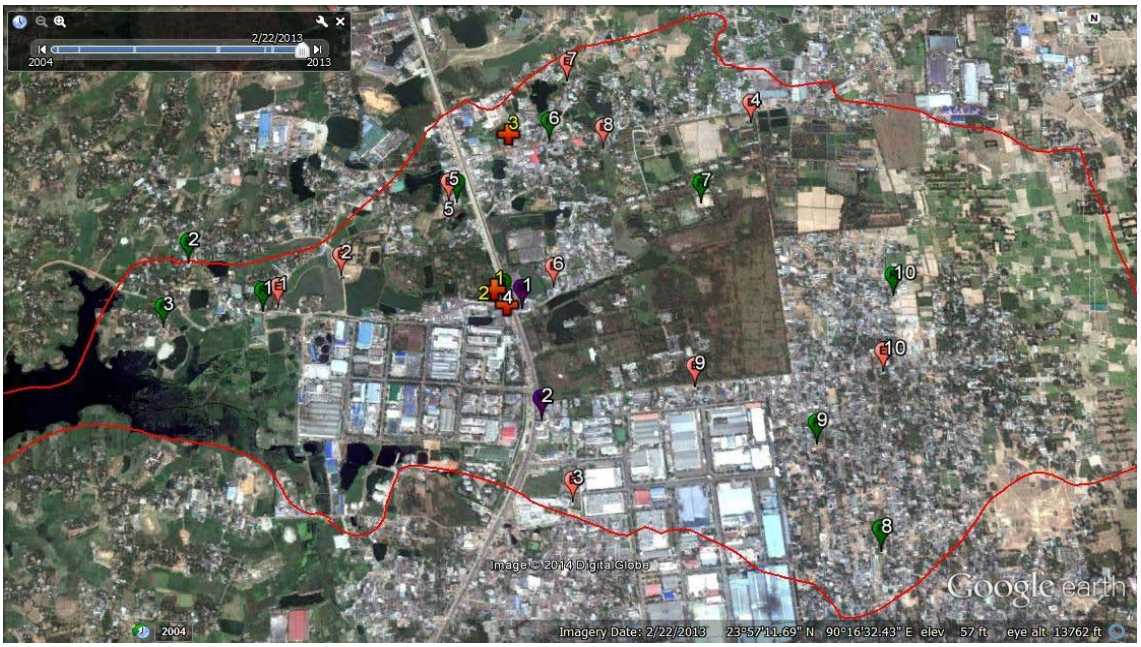

Figure 3 : The satellite image of Ganakbari Mouza

Figure 3 showed in satellite image, the position of 10 educational institution as red 'E', 10 religious institution as green 'R', 2 super market as violet 'M', 3 public health care as red '+'.

IV. Results and Discussions

a) Land use and Land Cover Change Detection

Land use in Ganakbari mouza: Ganakbari area is connected with several important roads which influence other areas. Baipail-Tangail highway plays a very significant role on the changing characteristics of the land use pattern in this area.

Comparison on land use among 2004, 2010 and 2013: Land use in Ganakbari drastically changes in last ten years. In 2004 most of the land of Ganakbari was being used for agricultural as well as industrial purposes. There were vast vacant land and water bodies. But at 2013 it was observed that vacant land and water bodies have been reduced. Vast area under agricultural use has been transformed to residential ones which have been aggravated by rapid population growth. The demand for more space arising out of rapid growth of housing, food production, market expansion, communication, commerce, industries etc. is going to exert even more competing pressure on land; and this will play significant roles in land use change of Ganakbari in future.

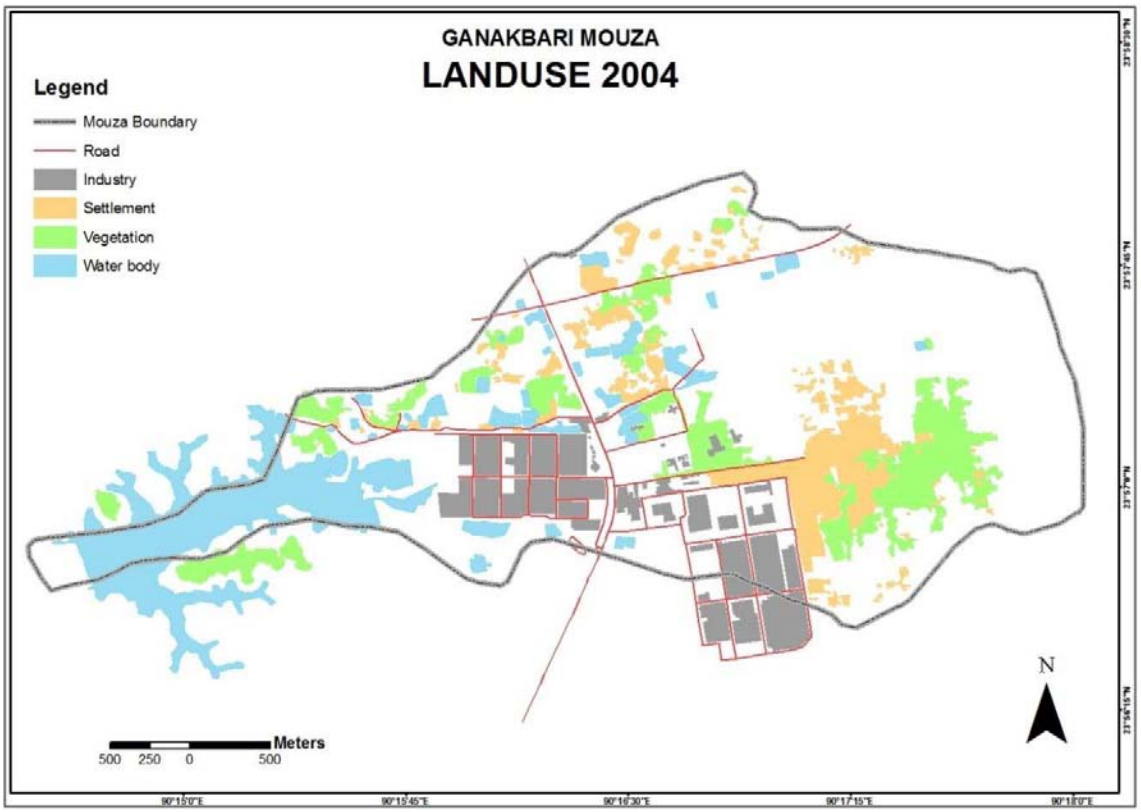

Figure 4 : Land Use Pattern in 2004

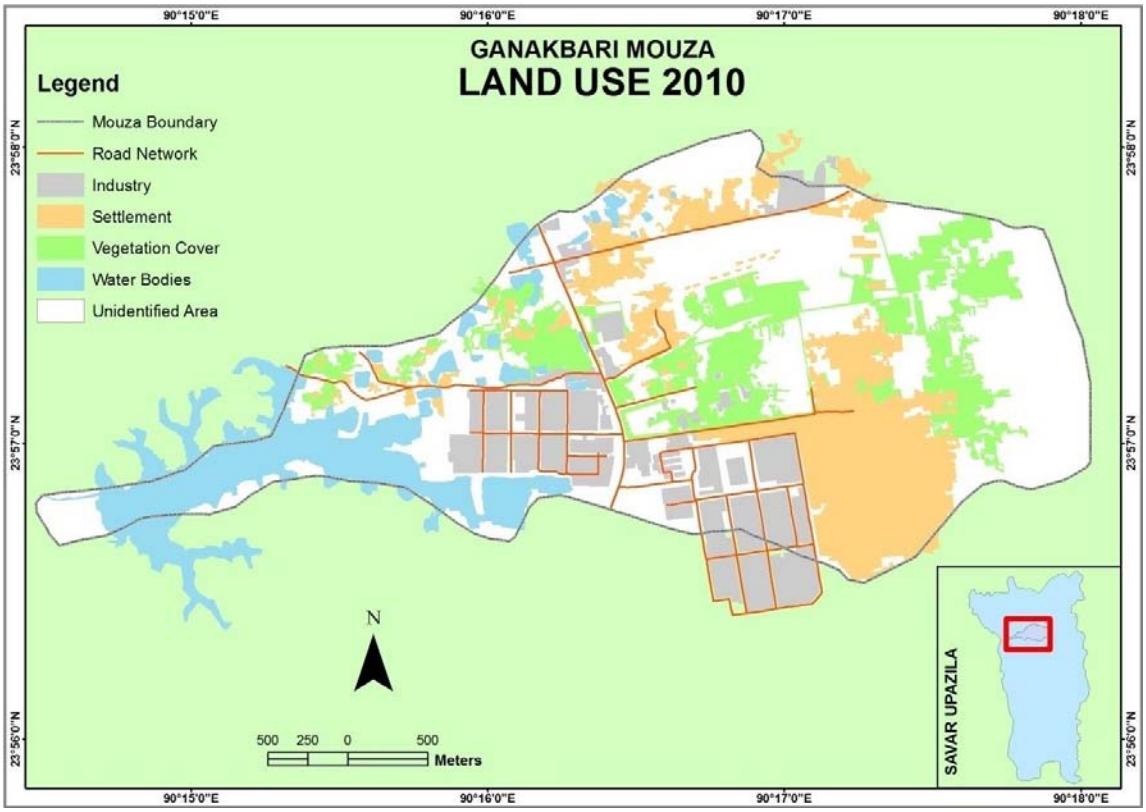

Figure 5 : Land Use Pattern in 2010

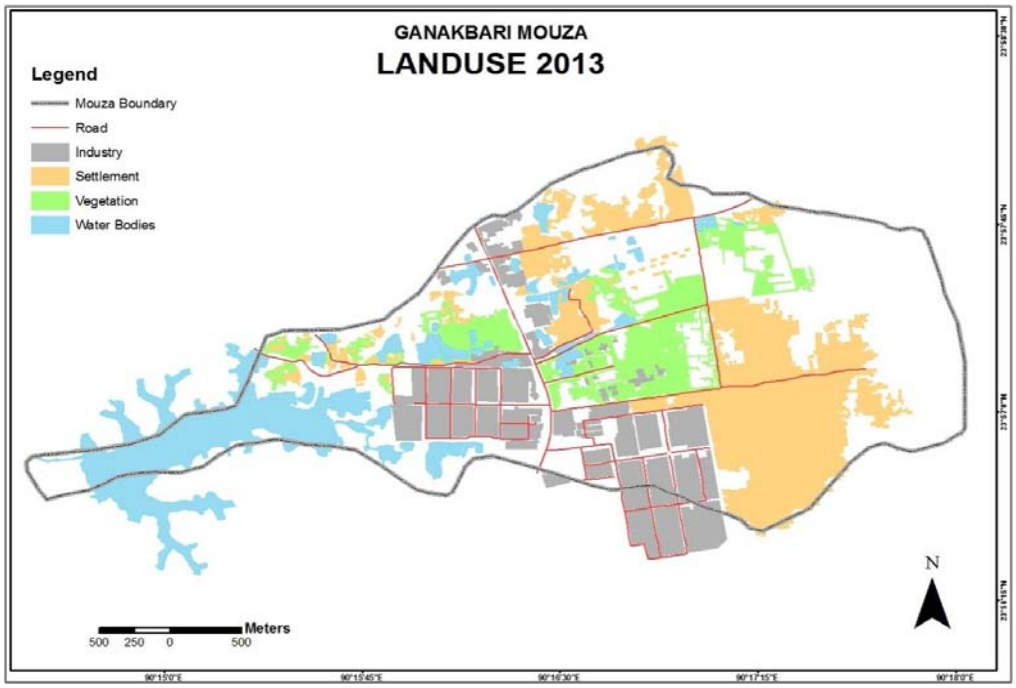

Figure 6 : Land Use Pattern in 2013

From the above figures (4-6), confirm that the land use has been changed mainly for settlement, industry and commercial sites, water bodies and vegetation areas.

Land use Change in Vegetation or Agricultural Lands: The agricultural land is gradually deceased because to 1) continuation of urbanization process and its impact upon the agricultural land 2) location and distance from the edge of the city 3) distance from the Dhaka–Tangail high way which is national arterial road and 4) the physical quality of the land in the study area.

Table 2 : Changing pattern of agricultural land area 2004 -2013

Feature	2004	2010	2013
Vegetation	213 acre	201.20 acre	184 acre

Land use Change in Settlement: In Ganakbari highland are associated with human settlement and the lowlands are used in agriculture purposes. In the floodplains of northern and western side of Ganakbari, many settlements are existence. The present settlement in Ganakbari is randomly distributed, with few buildup concentrations in high terrains. But on the basis of topography characteristics water supply situation and transport system has led to highly scattered population distribution with a distinctly dispersed pattern of settlement and due to scarcity of raised lands along with the increase pressure of population, the compact patterns of settlement throughout the area has been created. The flood free highland in Ganakbari has been focus point for organized housing in the manner of cooperative housing societies for the migrated workers of DEPZ. Major concentration housing society has been observed along the Dhaka-Tangail highway. Some of these residential districts have been established around the DEPZ area. Actually the maximum area of Ganakbari mouza is under DEPZ and atomic energy research institute. Many bare lands are found inside AERI area. The eastern and western side of Ganakbari is very populated area. Maximum people of there are migrated and garment workers changing pattern of settlement area 2004 -2013.

Land use change in industry and commercial sites: Industrial development pattern has in influence over the whole system of an urban area. Due to centrifugal migration of industry and commerce, more and more industries quit from the core city and get themselves placed in the sub urban township like Dhamsona union, more specifically in Ganakbari mouza. Even two decades ago, Ganakbari was rural areas which serve only the agricultural product but the scenario has drastically changed. Commercial land use in Ganakbari mainly consists of market and some sort of shopping center, which includes small shop, retail and wholesale trading. The major concentrations are located mainly in DEPZ area and have expanded in a liner from beside the Nabinagar-Tangail highway.

Land use change in water bodies: There is no river in the study area. There are some ponds. The ponds were cut at 1992-94 to take the soil from here, and make the DEPZ area in higher position. Due to population increasing, the ponds and low lands are filled up and new infrastructures are being built. At 2004, the water

bodies of the study area were 322 acres, which has been decreased to 317.51 acre at 2010. This process is ongoing and became 289 acres at 2013. As it is an industrial area, many people is migrating themselves daily to work in these industries. So the water bodies of this area are being filled up and new rooms are built up. So the water bodies are being reduced.

b) Findings

Having completed the stage of database implementation, user friendly analysis is made possible in the GIS environment. The program presents an interface, which enables the user to make a choice based on the user's aims and objectives. The real strength of GIS comes in when a relational database in linked with the graphics in real time. A good GIS allows the user to select attributes in the database and to view the results on an interface displayed which can be printed as hard copy. These operations are carried out in this work and some of the results are as displayed and discussed below.

c) To Analyze the Land use Changes in Ganakbari Mouza

The main features of the study area Ganakbari are industry and commercial sites, vegetation area, water bodies and settlement. Here are given the change detection for these features individually-

Change Detection for Industry and Commercial Sites: In the study area there is being built high infrastructures, which are used for factories and commercial building like market, cinema hall, bazaar, showroom, pharmacy, grocery shops etc. At 2004 the total area used for industry and commercial work was 186 acres. Again that rose at 2010 with the area of 265.57 acre. At 2013 it has been increased to 284 acres. So it is clear that the areas which were bare or low land or agricultural land became exchange with factories and commercial infrastructures. With the help of GIS application the change detection for industries and commercial sites have been found out. To analyze the Land use change detection of Ganakbari mouza it has been individually worked for the features. Here the industrial areas change detection is given-

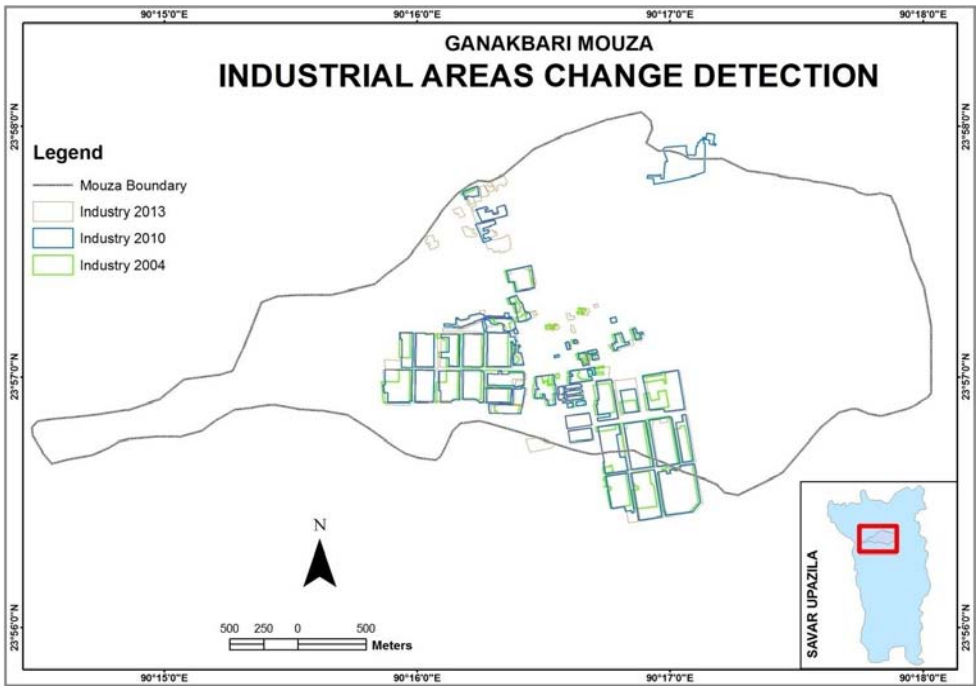

Figure 7 : Change detection for industry and commercial sites

Change Detection for Vegetation Areas: Ganakbari mouza was a green vegetation area two decades ago. At 1993 the DEPZ industrial area was starting to build up the factories. As a result the vegetation areas were cut down to make the space. As the research is worked with the time period between 2004 and 2013, so, it is described about the deforestation for this time interval. At 2004 the total area under vegetation cover was 213 acres, which was reduced to 201.20 acre at 2010, and at 2013 it became to 184 acres. So it is clear that the vegetation cover areas are being decreased for making the space for new migrated people. With the help of Google Earth and ArcGis the change detection for Vegetation areas have been found out. To analyze the land use change detection of Ganakbari mouza it has been individually worked for the features. Here the vegetation areas change detection is given-

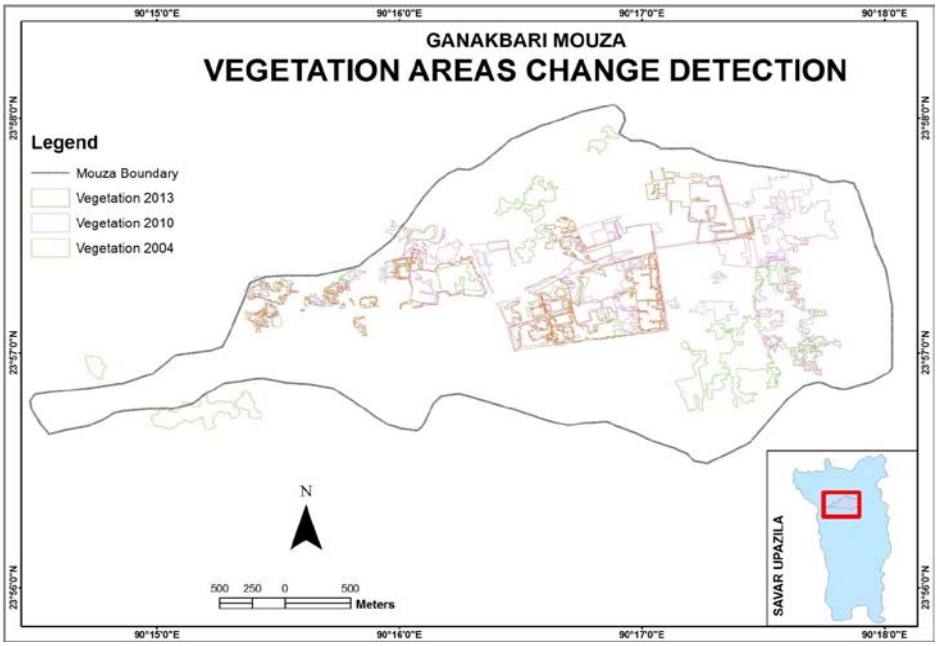

Figure 8 : Change detection for the vegetation areas

Change Detection for Water body's area: There is no river in the study area. There are some ponds. The ponds were cut at 1992-94 to take the soil from here, and make the DEPZ area in higher position. By the passing of time the position of Ganakbari area has increased. As a result these ponds are being filled to make over place for the extended people as well as for the newly migrated peoples. At 2004, the water bodies of the study area were 322 acres, which has been decreased to 317.51 acre at 2010. This process is ongoing and became 289 acres at 2013. As it is an industrial areas, many people is migrating themselves daily to work in these industries. So the water bodies of this area are being filled up and new rooms are built up. So the water bodies are being reduced. Here the water bodies areas change detection is given below in figure-

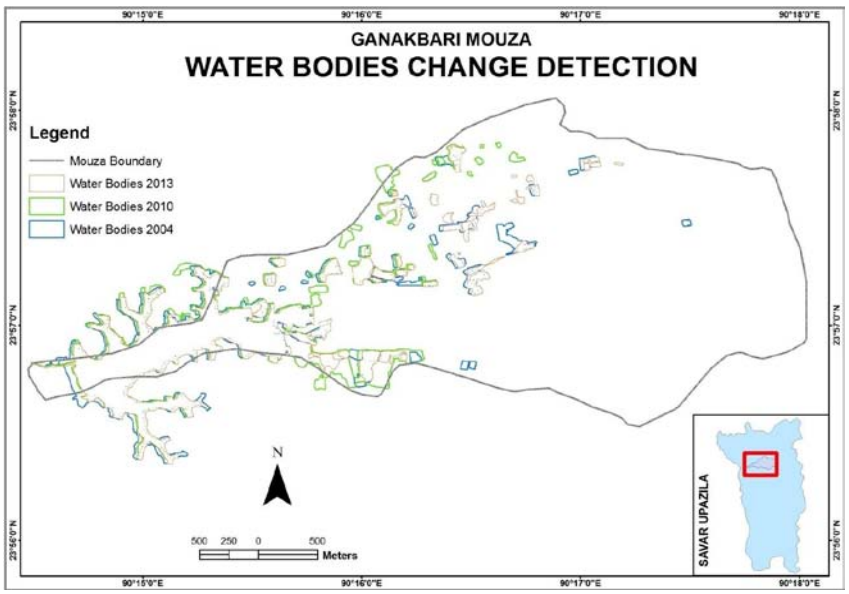

Figure 9 : Change detection for the water bodies

Change Detection for Settlement area: Maximum area of Ganakbari mouza is under DEPZ and Atomic Energy Research Institute. Many bare lands are found inside AERI area. Settlement is the feature that changed most. At 2004 the settlement area in Ganakbari mouza was 174 acres. It became double at 2010 within 6 years. That means it was 380 acre at 2010. Again at 2013 it raised up to 441 acres. So it is clear that the population of Ganakbari mouza is increased in alarming rate. To make space for the people of this area, the bare and low lands

are filled up. New houses are built up. Here the settlement areas change detection is given below in figure-

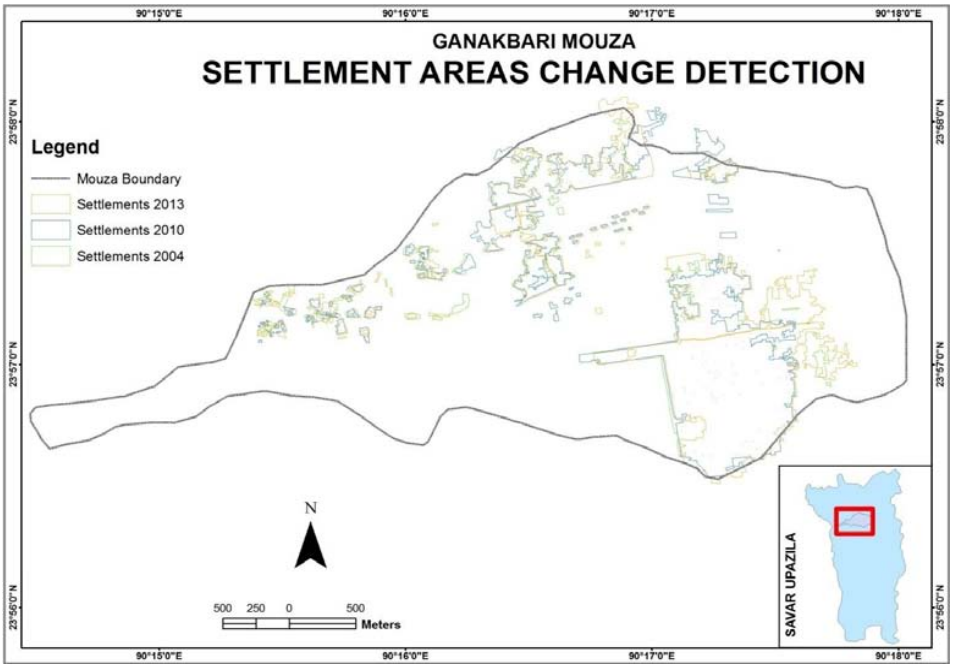

Figure 10 : Change detection for the settlement areas

d) To Prepare a Land use Map of the Study Area

I have prepared the map where the main features water bodies, vegetation areas, industrial areas, settlement areas as well as the educational institutions, religious institutions, medical centers, super market, roads have been shown. In this land use map, the vegetation areas are shown in green colour, industries and commercial areas are shown in ash colour, water bodies are shown in blue and settlements are shown in orange colour. Again the educational institutions are shown as yellow point, religious institutions are shown in blue stars, medical centers are in red+sign and super markets are shown in green points.

The land use map of the study area is given below:

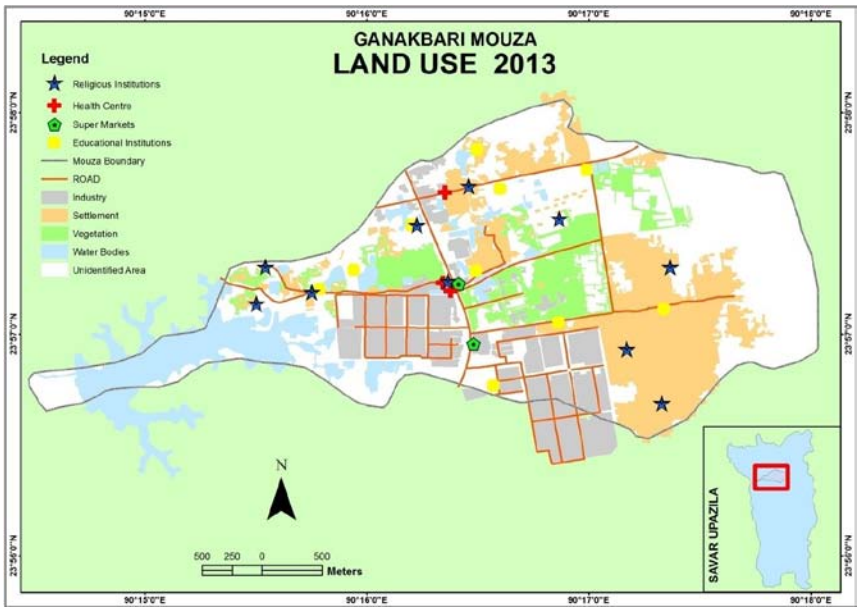

Figure 11 : Land use map of the common features of Ganakbari mouza

V. Recommendation for the Future Land use

Policy to control further commercialization: Taxation policy is recommended aiming at controlling commercial use of building is four times then that for residential use. This difference of taxes for residential and commercial use of buildings should be mire widened in order to discourage expansion of commercial land use. Through the low land is of agriculturally high value thus this type of land has to be saved. In recent year this kind of land is being used for industrial purpose mainly for super market. On the other hand this type of land is also being engulfed by land filling. Of the low land is converted into the residential or commercial uses the agricultural intensity will be decreased. So, necessary steps have to be taken for saving the high agricultural value land. In the study area sporadic land uses are found. There should be provision for land use zoning. Agricultural, industrial, residential and commercial area should be zoned for better utilization of land and escaping from the noxious environment condition.

Guidelines to regulate the residential growth: Though the population of the study area is increasing day by day and housing facilities are very essential for the over population, the agricultural land is being used for the residential uses. So, some following steps should be taken-

- The Municipality should prepare a plan for housing for the newly built up areas as soon as stated in DMDP;
- Existing build up areas should be restricted for further development by enacting strict rules and regulation;
- The housing in the too much congested areas should be relocated in the newly built up areas by providing them incentives and necessary compensations;
- After relocate some housing in the planned areas the remaining housing states should be serviced with necessary civics facilities and the internal roads should be widened or constructed where necessary by the concerned authority;
- Zoning should be introduced in the newly built up areas and should follow strictly by the developers;
- The person who seeks the pitfall and take the advantage of the rules by illegal persuasion should be punished firmly by the concerned authority;
- Needed to coordination of plot distribution between the high medium and low income group;
- Construction of buildings must follow the modern technologies. More emphasis should be given on height density thus constructing the high rise buildings up to 10 storied for the middle class people to accommodate more and more people and reducing the pressure of population growth in the area;
- People will be discouraged to construct buildings in a close proximity of Baipail-DEPZ Highway. They should maintain the rules of 50 meters distance from the highway while taking any initiative of construction of residential buildings.

a) *Summary*

Ganakbari is the top most important area under Savar Upzilla. Dhaka EPZ is situated here. Many people work in the factories here. Information on land use/land cover in the form of maps and statistical data is very vital for spatial planning, management and utilization of land. Remote sensing data and analysis techniques are now providing detailed information for detecting and monitoring changes in land cover and land use. This research work showed that the land use change of Ganakbari Mouza within 2004 to 2013. Agricultural land has been decreased because of making settlement for the garment workers. To conserve our environment, we should take sustainable development planning.

The urbanization process of an area is directly related to the population change in a given time. The size of population may due to annual growth rate of increase of migration rate. The population change in Ganakbari plays a significant role in transformation of large scale land use, in response to the increased modification of rural land for urban use.

Sporadic residential land use is increasing in the study area by engulfing high value agricultural land, population growth, flood free high land, transport facilities, infrastructures development and industrial establishment. Those are the main factor for this fringe area development.

Agro based settlement pattern was the main character of the study area. But now residential areas occupy 48% of land. This area is practicing the growth of mixed land use. Agro land fallow land are gradually shifting to mainly commercial, industrial and residential exercise and result a colossal pressure on the society economy environment in this area. The study also examined that the growth pattern of Ganakbari over the past decades using maps and spatial analytical capabilities of GIS. Survey research will used to identify the socio economic characteristics of the population found in these areas. An analysis on how population change affects the land use pattern, socio economic condition and infrastructural development of Savar using the data of past periods.

Thus the study reveals with the major findings of trend of population changing, socio economic changing, development trend on Ganakbari (from 2004-2013), its existing land use pattern, land use changing

pattern and impact of such type of changes on the area and some consequent recommendations.

The land use transformation process in Ganakbari has been started after 1993; basically it took place along the Baipail-Tangail highway. This study has tried to find out the changing land use trend of the site, the factor responsible for such type of changes, the problems arises for land use changes and its impact on physical, social, and living environment. Some recommendation to overcome the problem resulting from huge land transformation has been presented here existing trend to development and existing policy measure.

Due to unplanned growth and expansion of settlement, industrial and commercial establishment the community is facing numerous problems, which are influencing present physical, socio-economic and environmental condition. Some steps should be taken to overcome all of the short coming related to deviation of agro land, environmental degradation, hortage of utility facilities, lack of monitoring system, lack of active supervision of regulation for industries, lack of public open space and health care centers etc.

It can be say that there has been a rapid growth of spontaneous sub-urban settlements in Ganakbari between the last few decades due to high demand for housing. Rural to urban migration and urban to sub-urban migration are responsible for the increasing land-housing demand in this area. Infrastructure like road network, gas, and electricity influence the location of these spontaneous haphazard settlements. It is also show that the unplanned development and growth of these settlements is not sustainable in the long term.

For controlling large scale land use trans-formation and develop a planned sub urban township in Ganakbari. Government agencies have to play a vital role in term of policy formulation and proper implementation. Beside this monitoring cell and annual auditing system should be directly exercised by RAJUK. NGOS also have a significant importance to participate such type of sustainable development activities such as, enhance environment and public awareness building. Through this way a sustainable sub urban development is possible in Ganakbari.

VI. Conclusion

A gradual and almost imbalanced pattern of growth took place in the suburban township. In first two decades the growth was proportionately slow; but in last two decades the growth, flood free high land, transport facilities, infrastructures development and industrial establishments. This growth has caused great impact on inhabitant's socioeconomic status. The growth also affects the land value and increase the life expectancy. Here it is found that in liner pattern of growth which is taking in haphazard manner. Irresponsibility of RAJUK and other related development authority is the main cause of this haphazard growth. Lack of land use policy, zoning regulation and other controlling rules and laws are also responsible for this uncontrolled and unplanned development. But as a potential area of development, Ganakbari may play an important role in whole region. It may also the role of an efficient and suitable satellite city for the megacity Dhaka. If this rapidly unplanned and haphazard growth cannot be controlled as possible as soon, it will be threaten for the sustainable development of the area in near future. A national body on suburban land use planning policy formulation, effective coordination and guidance. A local level land use planning and implementation body is also needed to be set up in this area. It is required to determine the land use change in this area on a continuous basis and control the unplanned use of land by strong regulation like "ZONING". The GIS technology has been employed to assist decision-makers by indicating various alternatives in development and conservation planning and by modeling the potential outcomes of a series of scenarios. It should be noted that any task begins and ends with the real world. Data are collected about the real world. After the data are analyzed, information is compiled for decision makers. Based on this information, actions are taken and plans implemented in the real world. It is concluded that remote sensing and GIS tools provide an outstanding platform from which accurate information on Land use changes and patterns can be obtained and that Ganakbari area of Dhamsona union has experienced tremendous changes in land use in between 2004 and 2013, so, efforts should be made to regularly update available data in order to control further development.

a) Limitations

To conducting this research work on land use transformation, there are shortcomings have been faced like time limitation, man power limitation, financial limitation, spatial limitation, unavailable secondary and primary data, Lack in covering all the aspect relating the study, Lack of co-operation during survey etc.

b) Conflict of Interests

The authors declare that there is no conflict of interests regarding the publication of this paper.

VII. Acknowledgment

I wish to deeply indebted to my beloved brother Late Khondokar Masud Elahi for their heartfelt supports and encouragement throughout the study and express deep appreciation to my parents and parents in law and all other family members for their inspiration and encouragement accomplish my research work is gratefully acknowledged.

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b) List of Abbreviation

AERI: Atomic Energy Research Institute

DMA: Dhaka Metropolitan Area

DEPZ: Dhaka Export Processing Zone

DMDP: Dhaka Metropolitan Development Plan

ERDAS: Earth Resources Data Analysis System

GIS: Geographical Information System

RAJUK: Rajdhani Unnayan Kartripakkha

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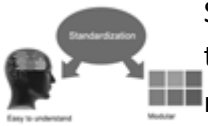

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The MARSHS member can apply for approval, grading and certification of standards of their educational and Institutional Degrees to Open Association of Research, Society U.S.A.

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Institutional Fellow of Open Association of Research Society (USA) - OARS (USA)

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The author fees of such paper may be waived off up to 40%.

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After nomination of your institution as "Institutional Fellow" and constantly functioning successfully for one year, we can consider giving recognition to your institute to function as Regional/Zonal office on our behalf.
The board can also take up the additional allied activities for betterment after our consultation.

The following entitlements are applicable to individual Fellows:

Open Association of Research Society, U.S.A (OARS) By-laws states that an individual Fellow may use the designations as applicable, or the corresponding initials. The Credentials of individual Fellow and Associate designations signify that the individual has gained knowledge of the fundamental concepts. One is magnanimous and proficient in an expertise course covering the professional code of conduct, and follows recognized standards of practice.

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- The Fellow can become member of Editorial Board Member after completing 3yrs.
- The Fellow can earn 60% of sales proceeds from the sale of reference/review books/literature/publishing of research paper.
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- • This individual has learned the basic methods of applying those concepts and techniques to common challenging situations. This individual has further demonstrated an in–depth understanding of the application of suitable techniques to a particular area of research practice.

Note :

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- In future, if the board feels the necessity to change any board member, the same can be done with the consent of the chairperson along with anyone board member without our approval.
- In case, the chairperson needs to be replaced then consent of 2/3rd board members are required and they are also required to jointly pass the resolution copy of which should be sent to us. In such case, it will be compulsory to obtain our approval before replacement.
- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

"

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The paper should be in proper format. The format can be downloaded from first page of 'Author Guideline' Menu. The Author is expected to follow the general rules as mentioned in this menu. The paper should be written in MS-Word Format (*.DOC,*.DOCX).

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(III) Click 'Submit Manuscript'. Fill required information and Upload the paper.

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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript's Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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Complete support for both authors and co-author is provided.

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Based on potential and nature, the manuscript can be categorized under the following heads:

Original research paper: Such papers are reports of high-level significant original research work.

Review papers: These are concise, significant but helpful and decisive topics for young researchers.

Research articles: These are handled with small investigation and applications

Research letters: The letters are small and concise comments on previously published matters.

5.STRUCTURE AND FORMAT OF MANUSCRIPT

The recommended size of original research paper is less than seven thousand words, review papers fewer than seven thousands words also.Preparation of research paper or how to write research paper, are major hurdle, while writing manuscript. The research articles and research letters should be fewer than three thousand words, the structure original research paper; sometime review paper should be as follows:

Papers: These are reports of significant research (typically less than 7000 words equivalent, including tables, figures, references), and comprise:

(a)Title should be relevant and commensurate with the theme of the paper.

(b) A brief Summary, "Abstract" (less than 150 words) containing the major results and conclusions.

(c) Up to ten keywords, that precisely identifies the paper's subject, purpose, and focus.

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(e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition; sources of information must be given and numerical methods must be specified by reference, unless non-standard.

(f) Results should be presented concisely, by well-designed tables and/or figures; the same data may not be used in both; suitable statistical data should be given. All data must be obtained with attention to numerical detail in the planning stage. As reproduced design has been recognized to be important to experiments for a considerable time, the Editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned un-refereed;

(g) Discussion should cover the implications and consequences, not just recapitulating the results; conclusions should be summarizing.

(h) Brief Acknowledgements.

(i) References in the proper form.

Authors should very cautiously consider the preparation of papers to ensure that they communicate efficiently. Papers are much more likely to be accepted, if they are cautiously designed and laid out, contain few or no errors, are summarizing, and be conventional to the approach and instructions. They will in addition, be published with much less delays than those that require much technical and editorial correction.

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Language: The language of publication is UK English. Authors, for whom English is a second language, must have their manuscript efficiently edited by an English-speaking person before submission to make sure that, the English is of high excellence. It is preferable, that manuscripts should be professionally edited.

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Abbreviations supposed to be used carefully. The abbreviated name or expression is supposed to be cited in full at first usage, followed by the conventional abbreviation in parentheses.

Metric SI units are supposed to generally be used excluding where they conflict with current practice or are confusing. For illustration, 1.4 l rather than 1.4 × 10-3 m3, or 4 mm somewhat than 4 × 10-3 m. Chemical formula and solutions must identify the form used, e.g. anhydrous or hydrated, and the concentration must be in clearly defined units. Common species names should be followed by underlines at the first mention. For following use the generic name should be constricted to a single letter, if it is clear.

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A major linchpin in research work for the writing research paper is the keyword search, which one will employ to find both library and Internet resources.

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- One should start brainstorming lists of possible keywords before even begin searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in research paper?" Then consider synonyms for the important words.
- It may take the discovery of only one relevant paper to let steer in the right keyword direction because in most databases, the keywords under which a research paper is abstracted are listed with the paper.
- One should avoid outdated words.

Keywords are the key that opens a door to research work sources. Keyword searching is an art in which researcher's skills are bound to improve with experience and time.

Numerical Methods: Numerical methods used should be clear and, where appropriate, supported by references.

Acknowledgements: Please make these as concise as possible.

References

References follow the Harvard scheme of referencing. References in the text should cite the authors' names followed by the time of their publication, unless there are three or more authors when simply the first author's name is quoted followed by et al. unpublished work has to only be cited where necessary, and only in the text. Copies of references in press in other journals have to be supplied with submitted typescripts. It is necessary that all citations and references be carefully checked before submission, as mistakes or omissions will cause delays.

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Figures: Figures are supposed to be submitted as separate files. Always take in a citation in the text for each figure using Arabic numbers, e.g. Fig. 4. Artwork must be submitted online in electronic form by e-mailing them.

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TECHNIQUES FOR WRITING A GOOD QUALITY RESEARCH PAPER:

1. Choosing the topic: In most cases, the topic is searched by the interest of author but it can be also suggested by the guides. You can have several topics and then you can judge that in which topic or subject you are finding yourself most comfortable. This can be done by asking several questions to yourself, like Will I be able to carry our search in this area? Will I find all necessary recourses to accomplish the search? Will I be able to find all information in this field area? If the answer of these types of questions will be "Yes" then you can choose that topic. In most of the cases, you may have to conduct the surveys and have to visit several places because this field is related to Computer Science and Information Technology. Also, you may have to do a lot of work to find all rise and falls regarding the various data of that subject. Sometimes, detailed information plays a vital role, instead of short information.

2. Evaluators are human: First thing to remember that evaluators are also human being. They are not only meant for rejecting a paper. They are here to evaluate your paper. So, present your Best.

3. Think Like Evaluators: If you are in a confusion or getting demotivated that your paper will be accepted by evaluators or not, then think and try to evaluate your paper like an Evaluator. Try to understand that what an evaluator wants in your research paper and automatically you will have your answer.

4. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

5. Ask your Guides: If you are having any difficulty in your research, then do not hesitate to share your difficulty to your guide (if you have any). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work then ask the supervisor to help you with the alternative. He might also provide you the list of essential readings.

6. Use of computer is recommended: As you are doing research in the field of Computer Science, then this point is quite obvious.

7. Use right software: Always use good quality software packages. If you are not capable to judge good software then you can lose quality of your paper unknowingly. There are various software programs available to help you, which you can get through Internet.

8. Use the Internet for help: An excellent start for your paper can be by using the Google. It is an excellent search engine, where you can have your doubts resolved. You may also read some answers for the frequent question how to write my research paper or find model research paper. From the internet library you can download books. If you have all required books make important reading selecting and analyzing the specified information. Then put together research paper sketch out.

9. Use and get big pictures: Always use encyclopedias, Wikipedia to get pictures so that you can go into the depth.

10. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right! It is a good habit, which helps to not to lose your continuity. You should always use bookmarks while searching on Internet also, which will make your search easier.

11. Revise what you wrote: When you write anything, always read it, summarize it and then finalize it.

12. Make all efforts: Make all efforts to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in introduction, that what is the need of a particular research paper. Polish your work by good skill of writing and always give an evaluator, what he wants.

13. Have backups: When you are going to do any important thing like making research paper, you should always have backup copies of it either in your computer or in paper. This will help you to not to lose any of your important.

14. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several and unnecessary diagrams will degrade the quality of your paper by creating "hotchpotch." So always, try to make and include those diagrams, which are made by your own to improve readability and understandability of your paper.

15. Use of direct quotes: When you do research relevant to literature, history or current affairs then use of quotes become essential but if study is relevant to science then use of quotes is not preferable.

16. Use proper verb tense: Use proper verb tenses in your paper. Use past tense, to present those events that happened. Use present tense to indicate events that are going on. Use future tense to indicate future happening events. Use of improper and wrong tenses will confuse the evaluator. Avoid the sentences that are incomplete.

17. Never use online paper: If you are getting any paper on Internet, then never use it as your research paper because it might be possible that evaluator has already seen it or maybe it is outdated version.

18. Pick a good study spot: To do your research studies always try to pick a spot, which is quiet. Every spot is not for studies. Spot that suits you choose it and proceed further.

19. Know what you know: Always try to know, what you know by making objectives. Else, you will be confused and cannot achieve your target.

20. Use good quality grammar: Always use a good quality grammar and use words that will throw positive impact on evaluator. Use of good quality grammar does not mean to use tough words, that for each word the evaluator has to go through dictionary. Do not start sentence with a conjunction. Do not fragment sentences. Eliminate one-word sentences. Ignore passive voice. Do not ever use a big word when a diminutive one would suffice. Verbs have to be in agreement with their subjects. Prepositions are not expressions to finish sentences with. It is incorrect to ever divide an infinitive. Avoid clichés like the disease. Also, always shun irritating alliteration. Use language that is simple and straight forward. put together a neat summary.

21. Arrangement of information: Each section of the main body should start with an opening sentence and there should be a changeover at the end of the section. Give only valid and powerful arguments to your topic. You may also maintain your arguments with records.

22. Never start in last minute: Always start at right time and give enough time to research work. Leaving everything to the last minute will degrade your paper and spoil your work.

23. Multitasking in research is not good: Doing several things at the same time proves bad habit in case of research activity. Research is an area, where everything has a particular time slot. Divide your research work in parts and do particular part in particular time slot.

24. Never copy others' work: Never copy others' work and give it your name because if evaluator has seen it anywhere you will be in trouble.

25. Take proper rest and food: No matter how many hours you spend for your research activity, if you are not taking care of your health then all your efforts will be in vain. For a quality research, study is must, and this can be done by taking proper rest and food.

26. Go for seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

27. Refresh your mind after intervals: Try to give rest to your mind by listening to soft music or by sleeping in intervals. This will also improve your memory.

28. Make colleagues: Always try to make colleagues. No matter how sharper or intelligent you are, if you make colleagues you can have several ideas, which will be helpful for your research.

29. Think technically: Always think technically. If anything happens, then search its reasons, its benefits, and demerits.

30. Think and then print: When you will go to print your paper, notice that tables are not be split, headings are not detached from their descriptions, and page sequence is maintained.

31. Adding unnecessary information: Do not add unnecessary information, like, I have used MS Excel to draw graph. Do not add irrelevant and inappropriate material. These all will create superfluous. Foreign terminology and phrases are not apropos. One should NEVER take a broad view. Analogy in script is like feathers on a snake. Not at all use a large word when a very small one would be sufficient. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Amplification is a billion times of inferior quality than sarcasm.

32. Never oversimplify everything: To add material in your research paper, never go for oversimplification. This will definitely irritate the evaluator. Be more or less specific. Also too, by no means, ever use rhythmic redundancies. Contractions aren't essential and shouldn't be there used. Comparisons are as terrible as clichés. Give up ampersands and abbreviations, and so on. Remove commas, that are, not necessary. Parenthetical words however should be together with this in commas. Understatement is all the time the complete best way to put onward earth-shaking thoughts. Give a detailed literary review.

33. Report concluded results: Use concluded results. From raw data, filter the results and then conclude your studies based on measurements and observations taken. Significant figures and appropriate number of decimal places should be used. Parenthetical remarks are prohibitive. Proofread carefully at final stage. In the end give outline to your arguments. Spot out perspectives of further study of this subject. Justify your conclusion by at the bottom of them with sufficient justifications and examples.

34. After conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print to the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects in your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form, which is presented in the guidelines using the template.
- Please note the criterion for grading the final paper by peer-reviewers.

Final Points:

A purpose of organizing a research paper is to let people to interpret your effort selectively. The journal requires the following sections, submitted in the order listed, each section to start on a new page.

The introduction will be compiled from reference matter and will reflect the design processes or outline of basis that direct you to make study. As you will carry out the process of study, the method and process section will be constructed as like that. The result segment will show related statistics in nearly sequential order and will direct the reviewers next to the similar intellectual paths throughout the data that you took to carry out your study. The discussion section will provide understanding of the data and projections as to the implication of the results. The use of good quality references all through the paper will give the effort trustworthiness by representing an alertness of prior workings.

Writing a research paper is not an easy job no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record keeping are the only means to make straightforward the progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear

· Adhere to recommended page limits

Mistakes to evade

- Insertion a title at the foot of a page with the subsequent text on the next page
- Separating a table/chart or figure - impound each figure/table to a single page
- Submitting a manuscript with pages out of sequence

In every sections of your document

· Use standard writing style including articles ("a", "the," etc.)

· Keep on paying attention on the research topic of the paper

· Use paragraphs to split each significant point (excluding for the abstract)

· Align the primary line of each section

· Present your points in sound order

· Use present tense to report well accepted

· Use past tense to describe specific results

· Shun familiar wording, don't address the reviewer directly, and don't use slang, slang language, or superlatives

· Shun use of extra pictures - include only those figures essential to presenting results

Title Page:

Choose a revealing title. It should be short. It should not have non-standard acronyms or abbreviations. It should not exceed two printed lines. It should include the name(s) and address (es) of all authors.

Abstract:

The summary should be two hundred words or less. It should briefly and clearly explain the key findings reported in the manuscript--must have precise statistics. It should not have abnormal acronyms or abbreviations. It should be logical in itself. Shun citing references at this point.

An abstract is a brief distinct paragraph summary of finished work or work in development. In a minute or less a reviewer can be taught the foundation behind the study, common approach to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Yet, use comprehensive sentences and do not let go readability for briefness. You can maintain it succinct by phrasing sentences so that they provide more than lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study, with the subsequent elements in any summary. Try to maintain the initial two items to no more than one ruling each.

- Reason of the study - theory, overall issue, purpose
- Fundamental goal
- To the point depiction of the research
- Consequences, including definite statistics - if the consequences are quantitative in nature, account quantitative data; results of any numerical analysis should be reported
- Significant conclusions or questions that track from the research(es)

Approach:

- Single section, and succinct
- As a outline of job done, it is always written in past tense
- A conceptual should situate on its own, and not submit to any other part of the paper such as a form or table
- Center on shortening results - bound background information to a verdict or two, if completely necessary
- What you account in an conceptual must be regular with what you reported in the manuscript
- Exact spelling, clearness of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else

Introduction:

The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
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The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

INDEX

A

Ancillary · 24
Aqueous · 59

C

Calorific · 50, 55, 60
Canyons · 4
Credence · 38

F

Furnaces · 52

I

Infiltration · 1
Insulation · 47, 49, 61, 64
Inundation · 25, 26, 29, 40

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