Research Article

Estimation of the relative spatial proximity of human population of Ethiopia to the roads of Ethiopia

Muhammed Hamid
College of Veterinary Medicine, Samara University, Semera, Ethiopia. P.O.Box 132
E-mail: *Muhammedhamid8@gmail.com*

Abstract

This research project was conducted from February to April 2010 E.C with the objective of to estimate the spatial proximity of human population to line string roads (which includes both secondary routes and primary routes) of Ethiopia. The study materials were collected from different websites like Ethiopian roads vector data was downloaded from DIVA GIS and Ethiopian population density (2000) vector data was downloaded from ILRI GIS. Before the proximity analysis was computed, the vector population density data is changed to raster data. The analysis tried to show the spatial relationship of Human population with roads in a country by creating three buffer zones (within 10km radius, 10-30km radius and greater than 30km radius from roads). The proximity of human population to roads was computed using Zonal Statistics. The QGIS software was used as operating software for performing this proximity analysis project work. The study result showed that from the total population of the country a population of 64.7% (49,649,222), 32.4% (24,881,804) and 2.9% (2,198,678) are situated within 0-10km, between 10-30 km and greater than 30km distance from roads of Ethiopia respectively. The study also showed that from the total 1,145,983km^2 area of a country an area of 57.98% (664,448.88km^2), 35.99% (412,403.6 km^2) and 6.03% (69,130.7 km^2) is located within 0-10km, between 10-30 km and greater than 30 km distance from roads of Ethiopia respectively.

Keywords: Ethiopia, Human population, Proximity, Roads

1. Introduction

Ethiopia is one of the Sub-Saharan African Countries known for their fast population growth. The current population of Ethiopia is 106,896,880 as of Thursday, April 5, 2018, based on the latest United Nations estimates. Ethiopia population is equivalent to 1.41% of the total world population. Ethiopia ranks number 12 in the list of countries (and independencies) by population. The population density in Ethiopia is 108 per km^2. The total land area is 1000,000 km^2. 20.6% of the Ethiopia population is urban and the median age in Ethiopia is 18.8 years (1).

The road transport sector is essential for developing countries for the reason that provision of other advanced means of transportation is expensive. For instance, Fan and Rao (2003), citing numerous studies, indicated that public spending in rural infrastructure is one of the most powerful instruments that governments can use to promote economic growth and poverty reduction and among these services road transport sector is considered as the crucial one (2).

According to World Bank (2010), only 10 percent of the rural population lives within two kilometers of all weather roads. Thus, the remaining 90 percent of rural people live at a distance of more than two km from all weather roads. The under development of the road network has its implication for the development of the agricultural sector which is the main stay of the rural people and the country in general. Visual inspection

indicates that a lot has to be done to put a sufficient network in the country (3).

A well-developed road transport sector in developing countries is assumed to fuel up the growth process through a variety of activities of the development endeavors of a nation. Among these, creation of market access opportunities for agricultural products is the major one. The issue of market access is more relevant for a country like Ethiopia where rural population accounts for about 85% of the national population who are engaged in production for both the domestic and international market.Therefore the objective of this project/study was:

➢ To estimate the spatial proximity of Ethiopia human populations from line string roads of Ethiopia.

2. Materials and Methods

2.1 Study Area

The study was carried out in Ethiopia (formerly called Abyssinia), Situated in eastern Africa, which has an area of approximately 1,127,127 sq km (435,186 sq mi), with a length of 1,639 km (1,018 mi) East to West and a width of 1,577 km (980 mi) North to South . Comparatively, the area occupied by Ethiopia is slightly less than twice the size of the state of Texas. It is bounded on the North by Eritrea, on the North East by Djibouti, on the East and South East by Somalia, on the South by Kenya, and on the West by Sudan, with a total boundary length of 5,328 km (3,311mi) (4).

Ethiopia is in the Tropical zone laying between the Equator and the Tropic of cancer. It has three different climate zones according to elevation which are kola (Tropical zone), Woina dega (Sub tropical zone) and Dega (Cool zone), which have elevation below 1830 meters, 1830 to 2440 meters, and above 2440 meters respectively. Also Ethiopia has four seasons, which are Kiremt or Meher (Summer), Belg (Autumn), Bega (Winter) and Tseday (Spring) (5).

Since 1995, Ethiopia has been divided into 9 administrative regions and two self-governing administrations (Addis Ababa and Dire Dawa) based on ethnic lines. These are Tigray, Afar, Amhara, Oromia, Somali, Benishangul, Southern Peoples' State, Gambella and Harar. The regions of Ethiopia are administratively divided into 68 or more zones.

2.2. Study Materials

To study the relative proximity of Ethiopia human population to Ethiopia roads using proximity analysis, the data collected were Ethiopian population density (2000) vector data downloaded from ILRI GIS and Ethiopian line string roads shape file (include the primary and secondary route) were downloaded from DIVA GIS. The QGIS software was used as operating software for performing this proximity analysis project work.
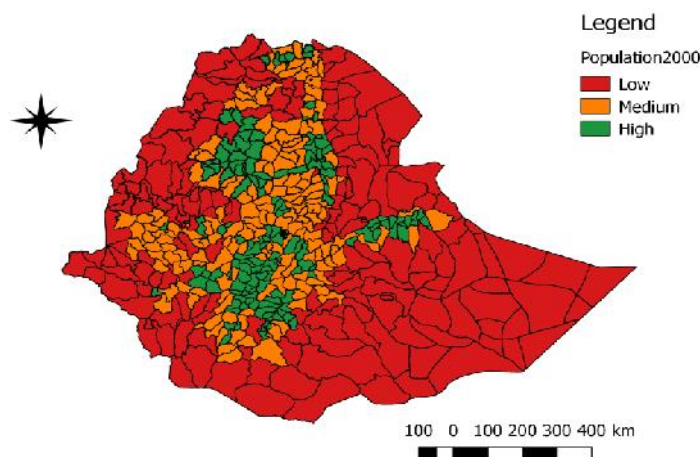

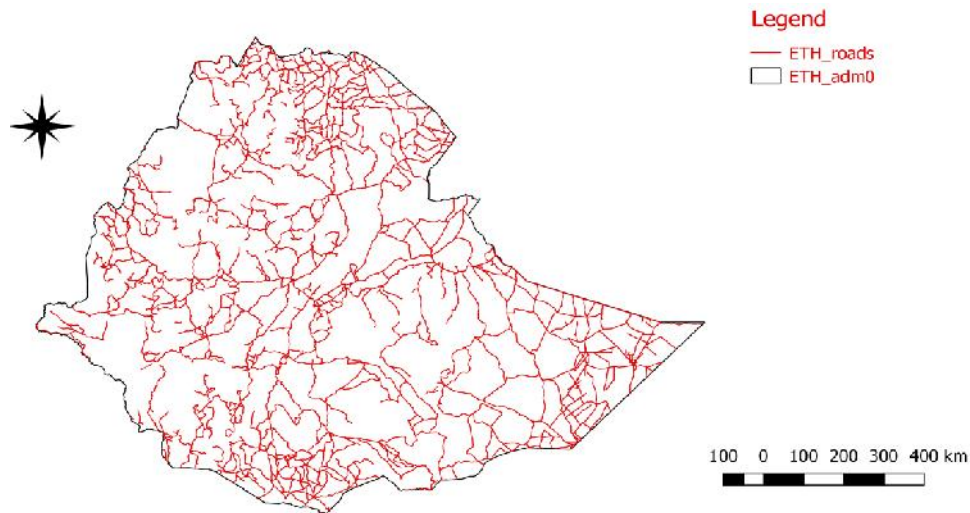Figure 1. Spatial Distribution of Ethiopia Human population

Figure 2. Line string Roads Distribution in Ethiopia

2.3. Study Methods and Procedures of Data Analysis

The study estimates the distance or proximity of human populations of Ethiopia to line string roads of the country using proximity analysis method. The proximity of human population to roads was computed using Zonal Statistics. Before the proximity analysis was computed, the spatial distribution of population was created in raster layer (pixel size x = 1 km and y = 1km). The country's total land mass was classified into three zones. Zone one (areas within 10km radius), zone two (areas between 11 to 30km radius) and zone three (areas greater than 30km radius) from all line string roads in the country. The proximity analysis was conducted after collecting all the necessary data by using the following procedures.

1.   Firstly Open QGIS and Load the two layers (the Ethiopian line string road shape file and the Ethiopian human population grid layers)
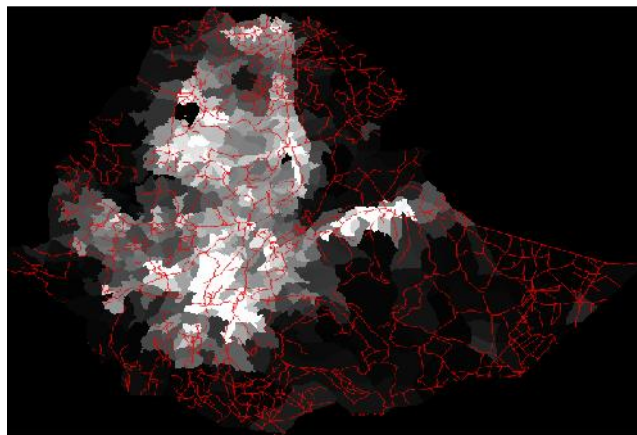

2. Then classify Ethiopia land mass into three zones, which are areas within 10 km radius, areas between 10 to 30 km radius and areas greater than 30 km radius from line string roads. By clicking on Vector >> Geoprocessing Tools>> fixed distance buffer (fill the required information in the coming dialog box for each zone).

3. Create a buffer for the first zone (0-10kms from line string roads). To do this, click on "Vector >> Geoprocessing Tools>> fixed distance buffer" then select "Eth_Roads line string" shape file in the "input layer" box. For the "Distance" provide 0.09009 since my projection is in degrees, and then tick the "Dissolve results" dialog box to dissolve overlapping polygons.
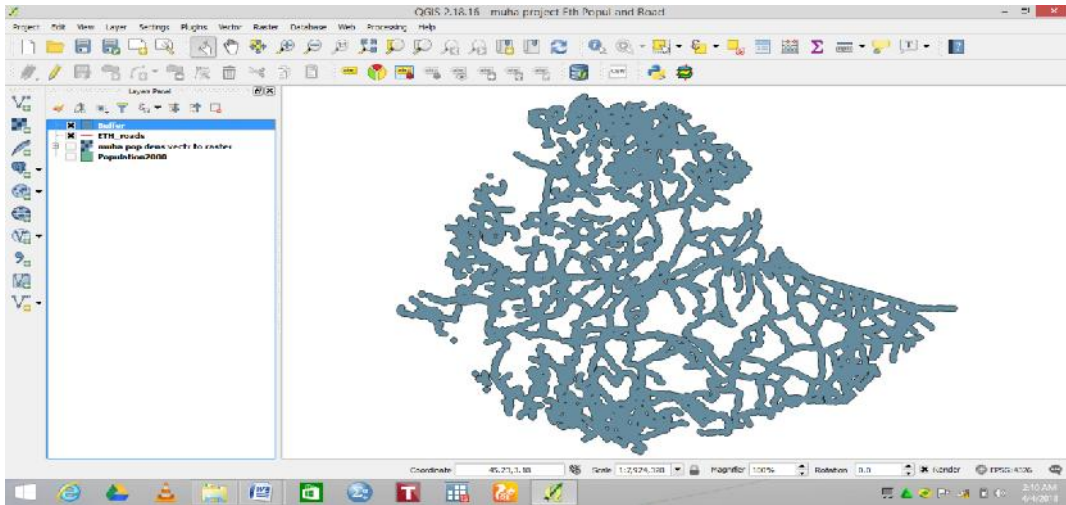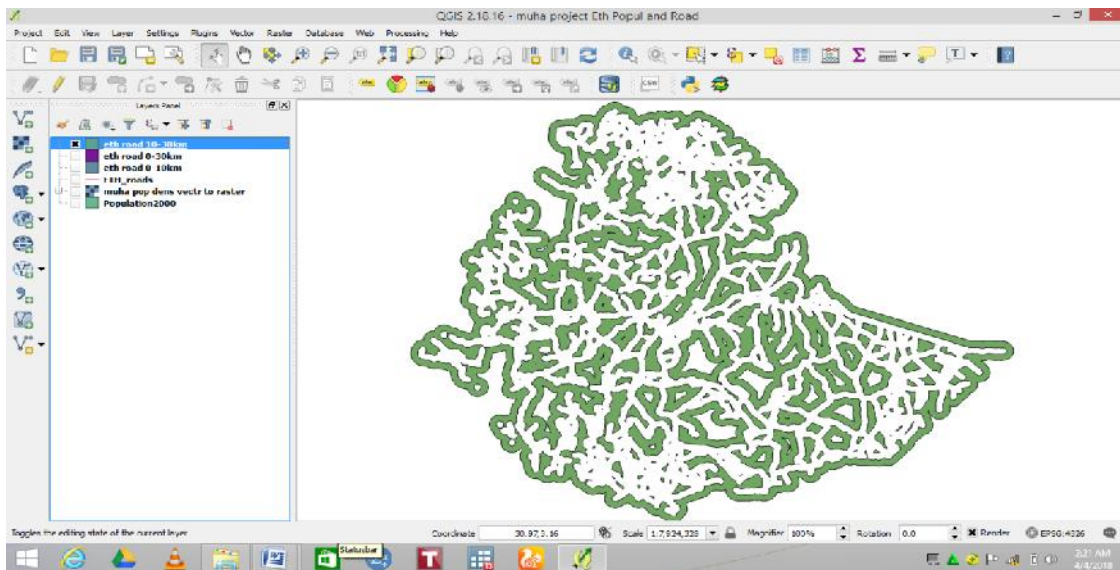
4. Create a buffer for the second zone (10-30kms from line string roads) by the same procedure with the first zone creation, but here for "Distance" provide 0.27027, then obtain shape files which look like this.
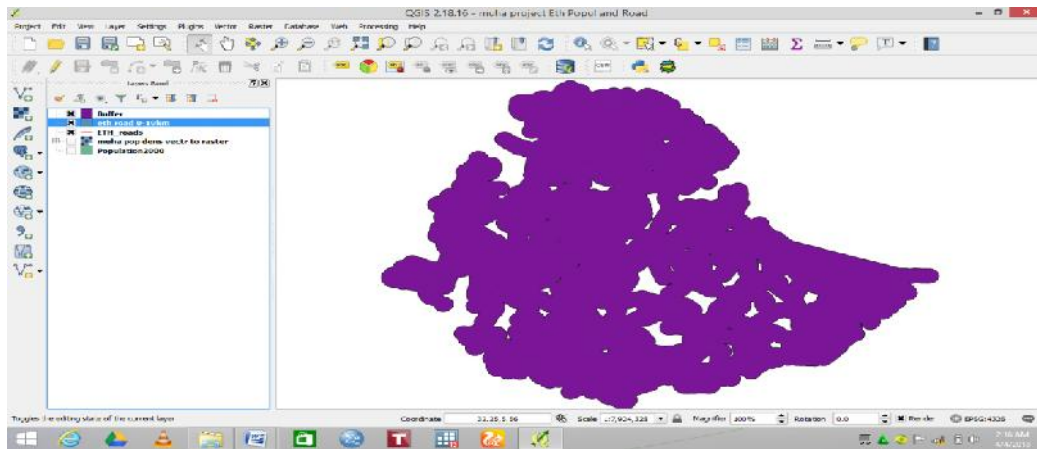

5. This (above) shape file contains buffer areas ranging from 0 to 30kms from the line string roads but the target is to get 10-30kms. Thus, need to clip the up to 10 kms from this layer. To do this, go to Vector >> Geoprocessing Tools>> Difference. Provide "Eth_Roads_0-30km_buffer" as in put layer and "Eth Roads_10km_buffer" as the difference layer. After this deactivate the other layers and obtain the following:

6. Create a buffer for the third zone (greater than 30kms from line string roads). First import Ethiopian level zero admin boundary shape file and then the Ethiopian national boundary will used as input layer and Eth_Roads_0-30km_buffer will be used as a difference layer. Then deactivate the other layers, and obtain shape files which look like this.
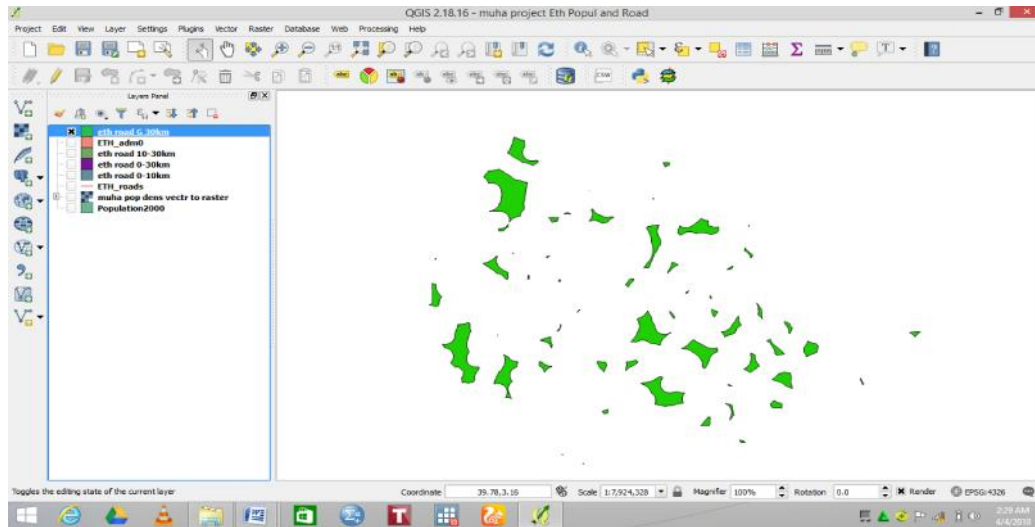

7. Now let's activate the three layers (zone 1, zone 2 and zone 3). I obtain shape files which look like the following. The red line shape files are Ethiopian roads. The yellow color is area within 10km radius from line string roads. The purple color is area between 10 - 30km radius from the line string roads and the green color is areas greater than 30km radius from the line string roads.
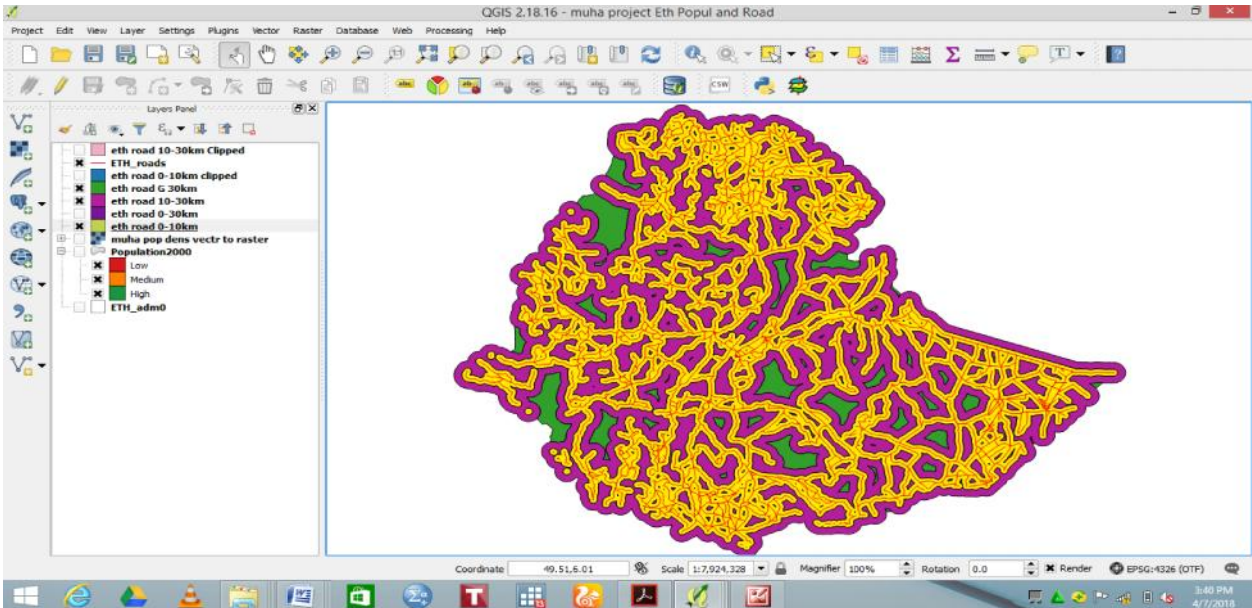
8. As you can visualize below some areas in zone 1 and zone 2 are out of the Ethiopian national border.
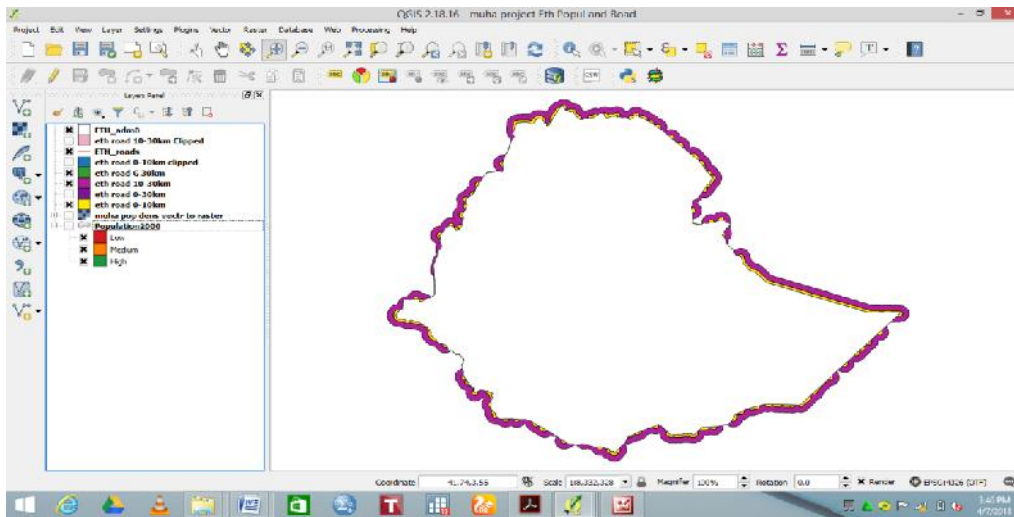
So I clip these two layers to fill into Ethiopian extent.
After clipping to Ethiopian extent I can obtain the
following
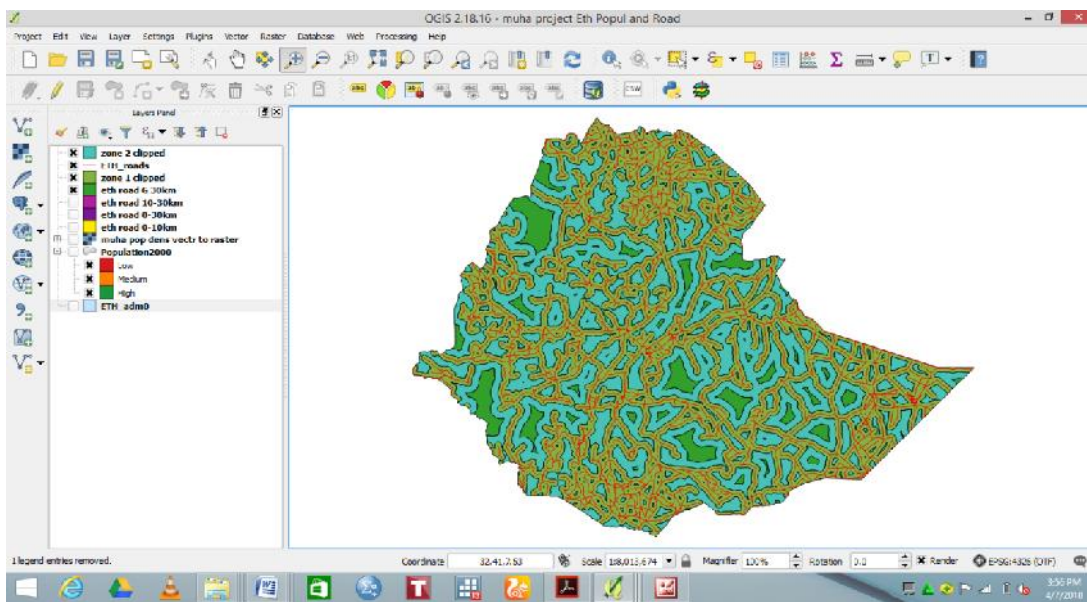
9. Now let's calculate the human population of
Ethiopia in each zone by Clicking on raster >>Zonal
statistics >> Zonal statistics, then fill human
population as raster layer and zone 1 clipped as
polygon layer, then tick Sum, Mean and Median on
statistics to calculate option. First lets calculate the
livestock population of zone one (within 10km radius).

10. The result is store in "zone 1 clipped" shape file.
When I Open the attribute of the "Eth_line string
Roads zone 1 clipped" shape file I can notice the
calculations made which are indicated below.
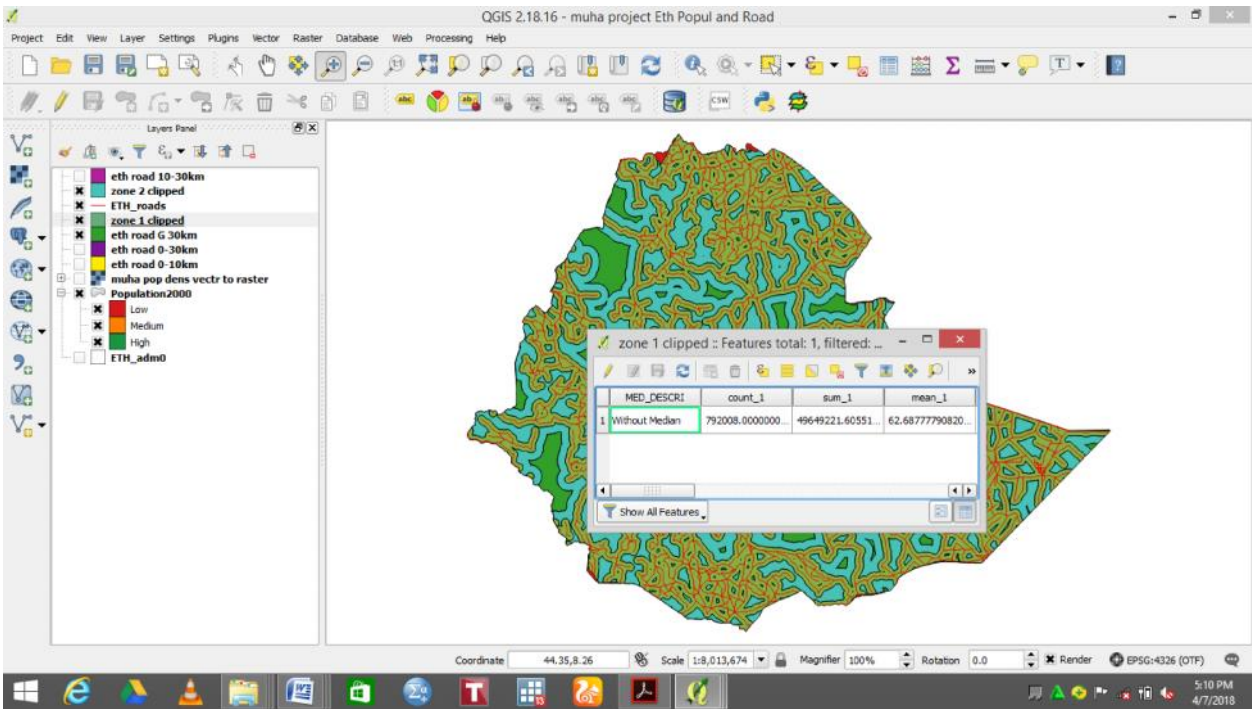
11. Calculate the human population of zone two (within 10km-30km radius) by same process with the first calculation but here zone 2 clipped used as polygon layer. The result is store in "zone 2 clipped"

shape file). When Open the attribute of the "Eth line string Roads zone 2 clipped" shape file, we can notice the statistical calculations made which are indicated below.
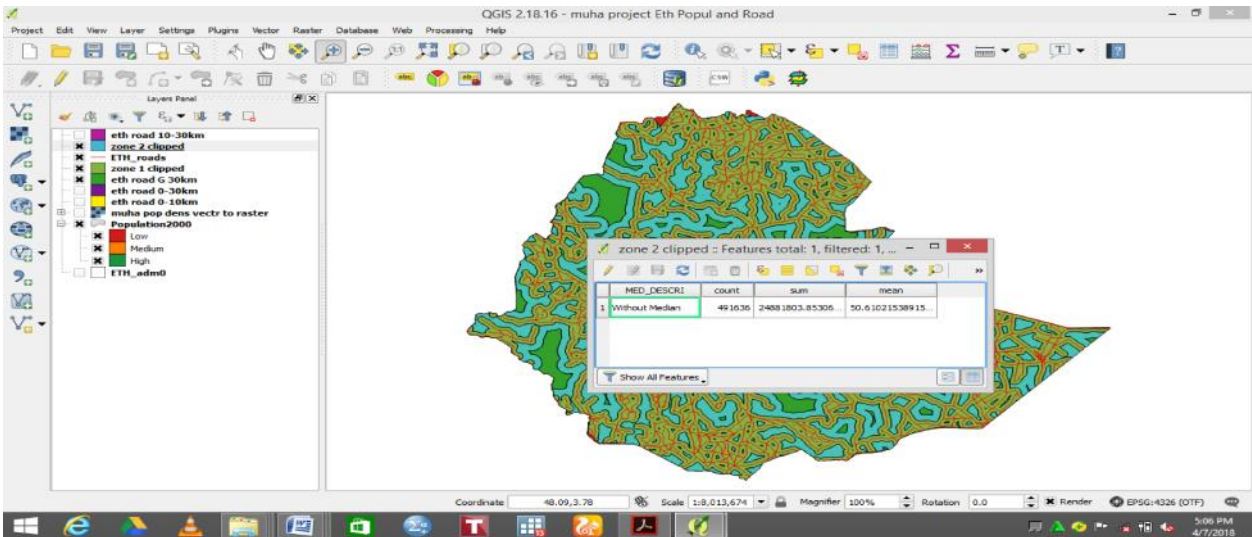
12. Calculate the human population of zone Three (greater than 30km radius from roads)
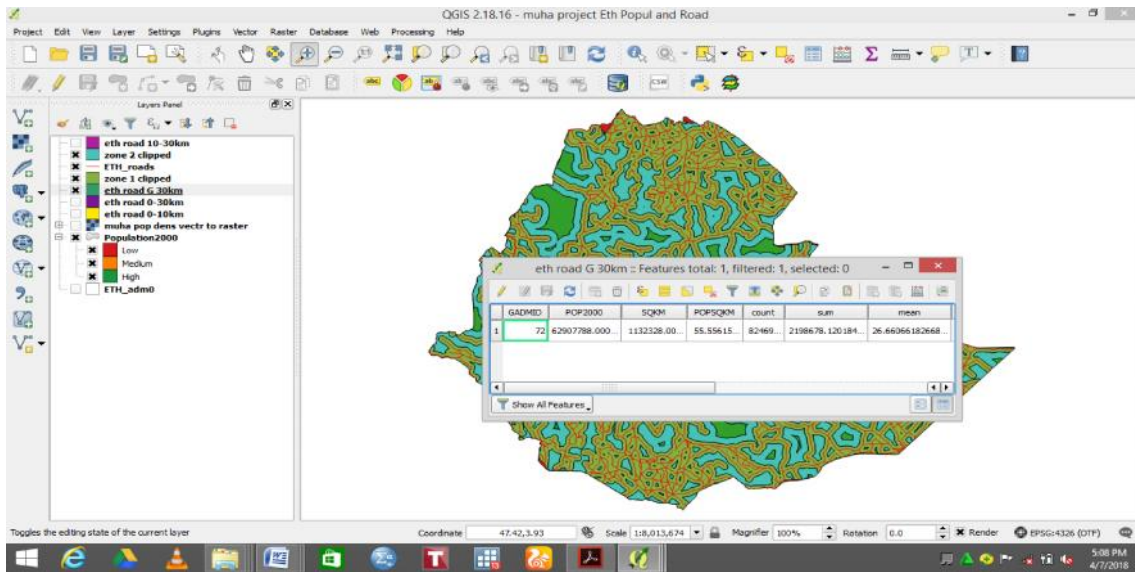
13. We can observe the result of zonal statistics (human population in each zone) in the attribute table of each zone, but here the values are estimated human population density per square kilometer, so the values should be multiplied by the estimated area of each of the polygon zone to get the estimated human population in that polygon.

14. Open the attribute table of each zone and calculates the estimated area for each zone (by opening the field calculator and filling required information) and save the value as CSV excel file to calculate the total human population size and over all area covered by each zone.

3. Results and Discussion

This project/study is carried out to estimate the human population distance from roads with the aim of providing information about the closeness of the human population to line string roads of Ethiopia. The analysis tried to show the spatial relationship of Human population with roads in a country by creating three buffer zones (within 10km radius, 10-30km radius and greater than 30km radius from roads).The results are shown on three buffer zone in figure 3, 5 and 6. The area and human population of each zone are summarized in table1.
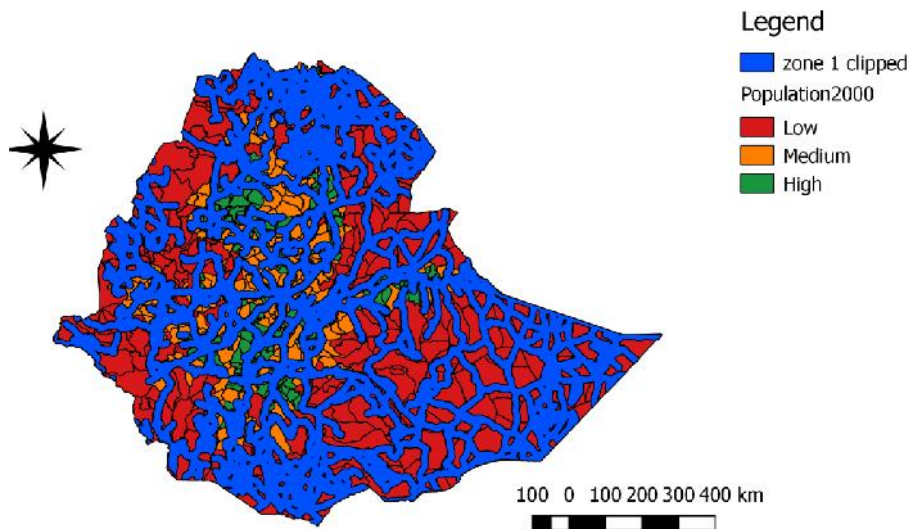

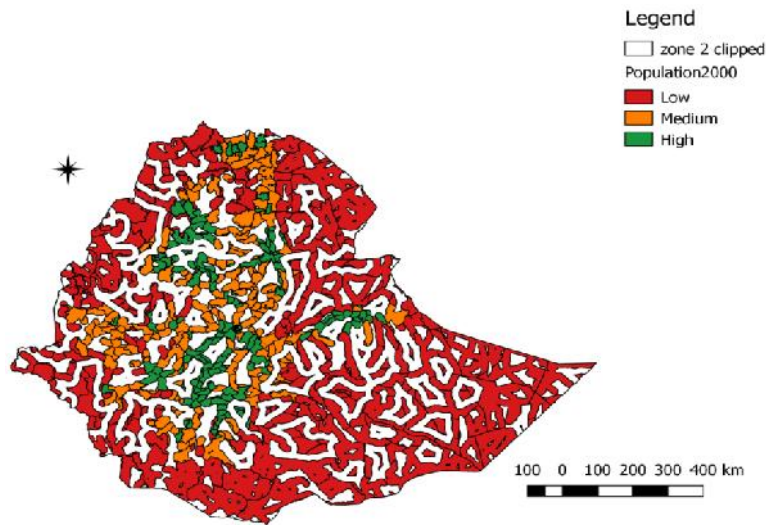Figure 3. Population distribution with in 10km radius from roads

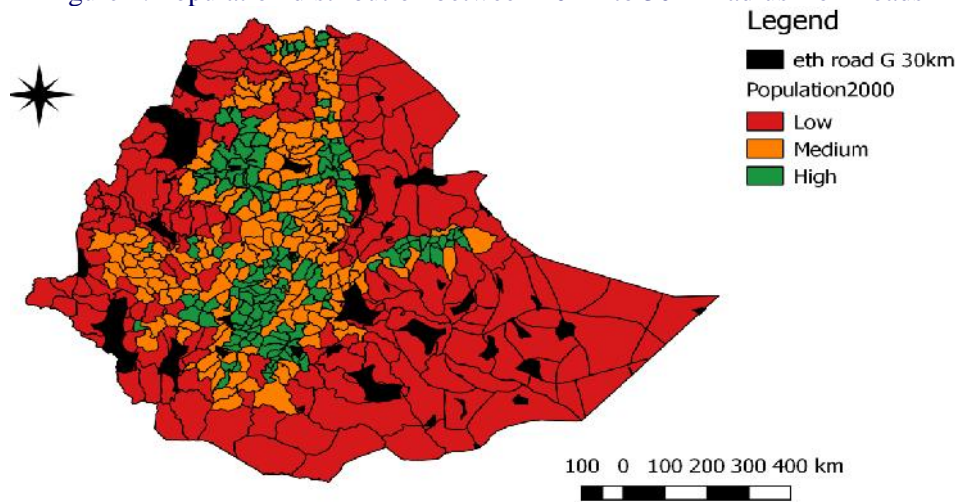Figure 4. Population distribution between 10km to 30km radius from roads

Figure 5. Population distribution with in areas greater than 30km radius from roads

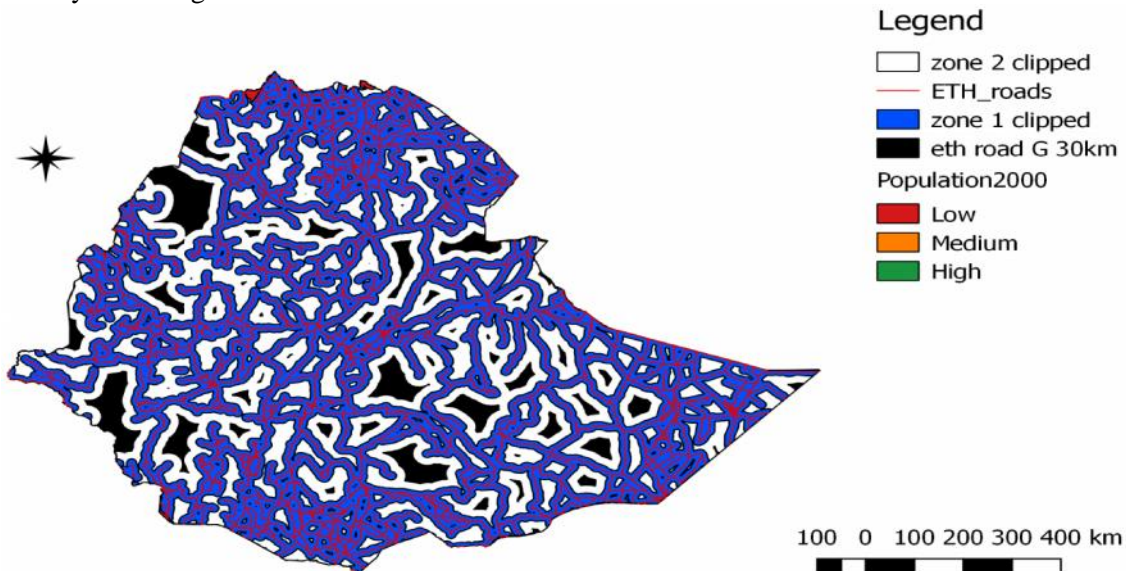The result (map) revealed that there is Low population density in areas greater than 30km.

Figure 6. Population distribution in each of the three zones.

47

In this picture or figure 6, we can appreciate the three zones easily in which red color lines are line string roads of Ethiopia, Blue colors are areas with in10km radius from roads, White colors are areas far from roads by 10km to 30km and black colors are areas which have more than 30 km distance from roads.

Table 1: Estimated area and population distribution in each buffer zone.

Buffer zone	Estimated area (km^2)	Areas covered by each zone from total area of the country (%)	Estimated human population	Population distributed in each zone from total population of the country (%)
0-10 km	664,448.88	57.98	49,649,222	64.7
10-30 km	412,403.6	35.99	24,881,804	32.4
>30 km	69,130.7	6.03	2,198,678	2.9
Total	1,145,983	100	76,729,704	100

Total area=1,127,127km^2 (Source, Elaboration of data by united nations, the 2017 Revision*). Total population=107.5 million (2018) (Source, www.Worldometers.info)*

4. Conclusion and Recommendations

Based on the result of the project/study only 64.7% (49,649,222) of the total populations were lived within 10km radius close to the line string roads and these populations can get immediate access to the roads or transportation. The result also showed that 32.4% (24,881,804) of population of Ethiopia settle in an area between 10 to 30km away from roads. This may lead a risk on the life of a population specially if there is no basic public services like health centers and schools around their area of settlement and so they will go a long distance without transportation to get these services. In addition 2.9% (2,198,678) of population of Ethiopia settle in an area greater than 30km away from roads. These populations are at a greater risk to get health centers like clinics and hospitals when there are health problems (especially on pregnant women's delivery problem). Also they suffer to get schools to teach their children's.

Based on the above conclusion the following recommendations are forwarded:

➢ Roads must be constructed in areas where populations are dense and lived far from roads (especially for populations lived in zone 2).

➢ Public services especially health centers and schools should also be constructed in dense populations who are lived far from roads.
➢ Further research should be conducted to know the human population accessibility to roads, health centers and schools.

References

1. http://www.nationsencyclopedia.com/Africa/Ethiopia-LOCATION-SIZE-AND-EXTENT.
2. Fan, S., and N. Rao. (2003) Public Spending in Developing Countries: Trend, Determination and impact. EPTD Discussion Paper 99. Washington, D.C.: International Food Policy Research Institute.
3. Elaboration of data by United Nations (2017) Department of Economic and social affairs, population division, World population prospects.

4. Philip Briggs, Ethiopia, The Bradt Travel Guide (2002) Third Edition, Published By Bradt Travel Guides Ltd, England, Uk.
5. ILRI-GIS/192.156.137.110/Ethiopia population density/zipped shape file.
6. WWW.diva-gis.org/Ethiopia/Roads.