

## PREPARATION OF TOPOGRAPHIC MAP USING APPLICATIONS OF GPS AND GIS TECHNIQUES: THE CASE OF TEPI CAMPUS

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### ABSTRACT

*Topographic maps have proved to be effective, legitimate, and convincing media to demonstrate to external agencies how the community value, understands interacts with its traditional lands and immediate space. From cave/wall paintings, ancient maps of Babylon and Greek philosophers, through the Age of Exploration, and on into the 21st century, people have created and used maps as the essential tools to help them define, explain and navigate their way through the world. Topographic maps represent features on the earth's surface through symbols and labels; separate colors distinguish the main classes of map features. But at the Tepi campus the main problem; there is no clear topographic map prepared to explain land features and slopes of up and down of land. So, this makes that information gap on a topographic map scale, the purpose of the map. The main objective of this study was to describe the preparation of a topographic map using the application of GIS and GPS techniques.*

*This study specifically focuses on the preparation of a topographic map; identify the information of contour and the triangulation irregular network of the enclosed area. The method used for this study was to collect field data of each feature of Tepi campus using GPS instrument and downloading in the office the collected data. Some of the surveying instruments and software used to prepare this topographic map was GPS instrument (Trimble R8 receiver), GPS, GIS, and AutoCAD. After the field*

*data was downloaded; the researcher was given a scientific name for each feature and digitizes the features using GIS software.*

*The result of this study where including a prepared topographic map of Tepi campus, the slope analyzed by surfer 32 software, and triangulation irregular network prepared by GIS software. The prepared topographic map of Tepi campus was shows both the natural and manmade features. Such as; forests, rivers, roads, fences, buildings, and vehicle parks.*

*Finally, prepared a topographic map of Tepi campus, triangulation irregular network, surface analysis, and the slope that identify elevations all features of the study area.*

**Keywords:** *Topographic Map Preparation, GIS, GPS, Triangular Irregular Network*

## **1. INTRODUCTION**

### **1.1 Background**

The map is described as documents showing a structure on the world or another celestial body, which is made with abstract characteristics, with a particular scale on a flat surface in a graphical and photogrammetric way. These strategic information sources have usually been preserved in palaces and military bases because of the value of the information they contain. Maps are one of the oldest written information resources. Maps are usually seen as being used in military operations and wars. For this reason, when the map is named, firstly wars come to mind. However, maps are used in many fields except this field and they can be prepared differently according to these fields. This shows that it is necessary to control the maps, produce them according to particular rules and apply different rules in access and organization of them. Cartography, which knows as mapping or surveying map, had not seen as a science and application field at first. Considering the historical process, it is known that the first maps were drawn in the shape of plans and included narrower lands. These map drawings have been seen in Mesopotamia, where the civilization occurred, for the first time. However, the first remnant resembling a map (in fact a city plan) was found in the excavations of Çatalhöyük and this is dated 6200 B.C. This plan is in the Museum of Anatolian Civilizations in Ankara (Bagrow, 1964:2-3; Brock, 2001). Another important map is the first world map drawn on a clay tablet by the Babylonians (Bagrow, 1964:31; Bricker, 1968:11; Brown, 1949:33, 37).

Maps are now everywhere, from the Web to smartphones, and are no longer limited to paper maps for hiking or routing. But most of the maps provided to the general public are not good maps, so they are

not as effective as they could be. Whether they are static or dynamic (i.e. pan and zoom allowed), on paper or screens of variable sizes, good maps are maps where every feature is legible, and where the user can easily understand the geography behind the map and the message of the map (Production of Topographic Maps with VGI: Quality Management and Automation Guillaume Touya\*, Vyron Antoniou\*\*, Sidonie Christophe\*, Andriani Skopeliti\*\*).

Topographic mapping to describe any features found on the earth's surface by its symbol. For this project, it is possible to identify (describe) the objects on a map or topographic mapping. The feature that found in MizanTepi university Tepi campus such as building, different of road, pole, river, different types of trees, a reservoir of water electric pole and describes the parking of the road on the map. To prepare the topographic mapping of the Tepi campus by using different types of surveying instruments such as global position system (GPS), total station and using surveying software geographical information system (GIS), softdesk8, and other software.

## **1.2 Statement of the problem**

National Mapping Agency (NMA) is a national organization of which main objective is to produce topographic maps for the governmental and private sectors. The normal standard products are used by several different organizations for different purposes. The users require information either in analog or digital forms according to their applications. As digital technology is introduced, NMA is expanding its products to some extent. But the whole system of NMA is remaining in a traditional way that is fit to produce analog topographic maps (Redesign of Topographic Mapping System using Unified Modeling Language (UML) by Kwon, Tae – Sub March 2020).

Topographic mapping data must collect for any project of engineering work. In Tepi campus to construct any design work used the oldest topographic mapping. So for this construction design, we must prepare the modern topographic map of the Tepicampus. Because the previous or old topographic map of Tepi campus does not include the new building, new road, waste disposal storage, or biogas building. So, this problem is the main factor to know the information feature of a topographic map of Tepi campus. But the new one is describing all features found on the topographic map of Tepi campus with a clear symbol for a person who can get more information about the project area of the map. The topographic map of the Tepi cannot prepare in modern form because the construction of the building does not complete, road networks are complex, temporary construction of building, temporary types of the electric pole and pipelines.

The topographic map of Tepi campus has no practical purpose full for the current usage of the activity of the university, as it is understood by the research members for current planning of the campus infrastructure like electric line distributions, temporary construction like student and teacher lunch temporary house store of material, temporary toilet, uncompleted building construction, current land deformation analysis, the foundation of geo-spatial products, information concerning landscape elements and selecting new pipeline routes demands a new updated topographic map of the campus. Because of the listed reasons developing an updated and proper topographic map is necessary.

### **1.3 Objectives of the study**

#### **1.3.1 General objective**

The main objective of this study was the preparation of topographic mapping of Tepi campus using the application of GIS and GPS.

#### **1.3.2 Specific objectives**

To achieve the main objective, several sub-objectives have to be achieved. These are listed below.

- ✓ To identify the position of natural and manmade features of the study area using a coordinate system (X, Y, and Z).
- ✓ To identify land features of Tepi campus by using the contour and elevation.
- ✓ To generating triangulation irregular network and surface analysis of Tepi campus.
- ✓ To prepare topographic map by using GPS application and GIS software.

### **1.4 Research question study**

To achieve the research objective, the following questions need to be addressed.

1. How to identify the position of the features?
2. How to describe the land feature of Tepi campus on a map?
3. How to generate a triangulation irregular network and analyze the surface of Tepi campus?
4. How to prepare a topographic map of Tepi campus?

### **1.5 Scope of the study**

The scope of this study was the preparation of a Topographic Map of the Tepi Campus. The Topographic Map was showed all-natural and man-made features of the Tepi Campus which should be

enclosed under the study area. All the on-going improvements and construction in the Campus should be shown as well as the future land expansion and development areas.

### **1.6 Significance of the study**

The Topographic Map of the Tepi Campus was used for different activities and might prove beneficial to the whole Campus Community specifically for the Civil Engineering, Planning and surveying Engineering Department. It would help the University's Planners to prepare comprehensive land use and land cover map of the Campus as well as for the preparation map of a Campus development plan for the next 20 years. Generally, this study helped to established vertical accuracy, horizontal control, boundary determination of the deformation, and selection of new planning pipelines.

### **1.7 Limitation of the study**

The study area was limited to the Tepi Campus and its immediate surroundings. The data gathering tool for the location of points is the Global Positioning System. The accuracy of the collection of point coordinates was highly dependent on the availability of satellites. Insufficient satellite during data collection period the result was the poor or erroneous location of points.

Lack of an old topographic map of the Tepi Campus and some data are missing and unreliable to use as reference materials. The conduct of the study was only one semester but the preparation of a topographic map by manual or conventional topographic mapping survey is for 6 months or more. The final map might not be as accurate as to how I wanted it to be. The following are the different limitations: Lack of time, Lack of reference materials (old maps, etc.) for the preparation of the Topographic Map, and an insufficient number of satellites during the GPS topographic survey.

## **2. LITERATURE REVIEW**

The map is described as documents showing a structure on the world or another celestial body, which is made with abstract characteristics, with a particular scale on a flat surface in a graphical and photogrammetric way. These map drawings have been seen in Mesopotamia, where the civilization occurred, for the first time. However, the first remnant resembling a map (in fact a city plan) was found in the excavations of Çatalhöyük and this is dated 6200 B.C. This plan is in the Museum of Anatolian Civilizations in Ankara (Bagrow, 1964:2-3; Brock, 2001). Another important map is the first world

map drawn on a clay tablet by the Babylonians (Bagrow, 1964:31; Bricker, 1968:11; Brown, 1949:33, 37).

Topographic maps produced and published by government agencies usually include both physical and cultural features, making the maps useful in municipal planning, civil engineering, watershed, and other environmental studies, design of communication systems, and outdoor recreation, among others. The influence of topography is important because it controls the water subsurface contact time (Beven and Kirkby, 1979; Wolock et al., 1990; Dillon and Molot, 1997; McGuire et al., 2005). and tan is the local slope (Beven and Kirkby, 1979; Quinn et al., 1995). The TWI represents the wetness distribution in a catchment, and it has frequently been used in modeling. This process can help identify key areas of conflict and help narrow the tension to identifiable, and subsequently manageable, units(<http://www.ga.gov.au/topographic-mapping/basics/what-is-a-topographic-map.html>).

A comprehensive physical survey of the planning area can be carried out using total station survey equipment. Several details are surveyed ranging from all built features, roads, natural elements, levels, etc(Application ofremotesensing, GIS, andGPSforefficient urban managementplan–Acasestudyofpartof Hyderabad city AdeyinkaK.Akanbi,Santosh Kumar,UwayaFidelis).

GPS is the only system today able to show the exact position of features above or on the earth. 24GPS satellites are continuously monitored by ground stations located worldwide. The satellites transmit the signals that can be detected by anyone with a GPS receiver. Using a GPS receiver, the surveyor can determine the designated location with great precision (Redesign of Topographic Mapping System using Unified Modeling Language (UML) by Kwon, Tae – Sub, March 2020).

GISs have been developed since the mid 1980s. These systems consist of a series of physical elements (hardware), logical elements (software), and personnel, targeted at the acquisition, storage, processing, and representation of geographic information for a given purpose (Improving the Use of GPS, GIS, and Remote Sensing in Setting up Master Sampling Frames, January 2015).

GPS relative positioning, on the other hand, employs two GPS receivers simultaneously tracking the same satellites. If both receivers track at least four common satellites, a positioning accuracy level on the order of a few meters to millimeters can be obtained. GPS relative positioning is used for high-accuracy applications such as surveying and mapping, GIS, and precise navigation (Shaw, M., K. Sandhu, and D. Turner, "Modernization of the Global Positioning System," GPS World, Vol. 11, No. 9, September 2000, pp. 36–44.).

### **3. DESCRIPTION STUDY OF THE AREA**

#### **3.1 Location of the area**

The location of the project area is in the Southern Nation Nationalities and People's Region part of Ethiopia in State, Sheka- Zone, YekiWereda at a Distance of 611 km from Addis Ababa. The astronomical location of the Tepi town has a latitude and longitude of  $7^{\circ}12'N$  &  $35^{\circ}27'E$  and  $7.20^{\circ}N35.45^{\circ}E$ , respectively, with a mean elevation of 1,097 meters above sea

level([http://en.wikipedia.org/wiki/Tepi#Overview.en.wikipedia.org/.../Southern Nations, Nationalities, and Peoples' Regi](http://en.wikipedia.org/wiki/Tepi#Overview.en.wikipedia.org/.../Southern_Nations,_Nationalities,_and_Peoples'_Regi)).

The Mizan Tepi University has two campuses Mizan Campus. At the Tepi Campus, some different features or objects can be found such as buildings, different types of roads, streams, green areas, and biogas building or storage. These buildings are divided into different parts depending on their location and service. The first one is the building found around the office and lab class with a different design. The second one is the building around the female dormitories and male dormitories. The shape of these buildings is similar. The third building of the Engineering and Technology Library & Computer Technology Library has the same shape. The figure below is the location of the Tepi Town on the map of Ethiopia. The town is located in the southern part of the country with coordinates  $7^{\circ}12'N35^{\circ}27'E$  and the elevation is 1,097 m. The location of the project area, which is the Tepi Campus, is at coordinates  $796870N$  Latitude and  $766022E$  Longitude with an elevation of 1262m and comprising an area of approximately 52 hectares ([http://en.wikipedia.org/wiki/Mizan - Tepi University, National Geographic: Round Earth, Flat Maps](http://en.wikipedia.org/wiki/Mizan_-_Tepi_University,National_Geographic:_Round_Earth,_Flat_Maps)). This location can be seen on the satellite images taken from the world earth Google.

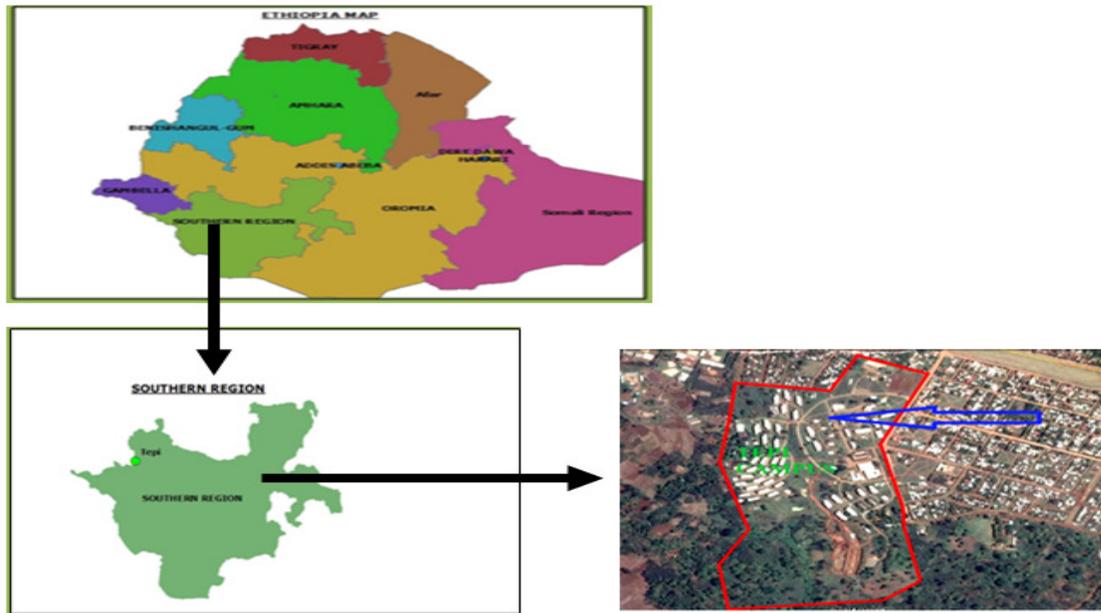


Figure: 3.1 Location of the Tepi Campus (source: GIS and Google Earth map)

### 3.1 The weather condition of the study area

#### 3.1.1 Rainfall

The rainfall was important for the different fruits such as mango, coffee, bananas, papaya, and different kinds of fruits. The mean annual rainfall varies from 1000 to 1800 mm. But the estimated rainfall to be well over 2200mm. the highest rainfall season between June and September. The monthly minimum rainfall is 70 mm and the monthly maximum rainfall is 200mm. The mean annual precipitation is around 2100mm.

Table: 3.1 Mean monthly rainfalls (mm)

Months	Jan	Feb	Mar	Apr	May	June	July	Aug
Rainfall(mm)	9	24	48	57	114	144	180	189

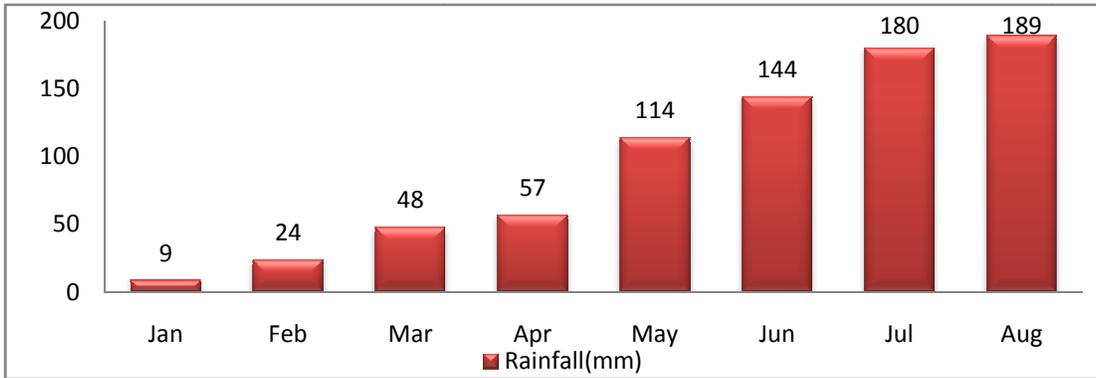


Figure: 3.2 Rainfall graph

### 3.1.2 Temperature

The temperature is very hot and changes in different weeks, months. This hot temperature is important for plantations of coffee and other fruits. There are displays as the following according to the metrological description. The maximum mean annual temperature of the location area is 25 degrees Celsius up to 35 degrees Celsius. The minimum mean annual temperature of the location area is 10 degrees Celsius up to 15 degrees Celsius. The average warmest month is 28 degree Celsius and the average coldest month is 12 degrees Celsius.

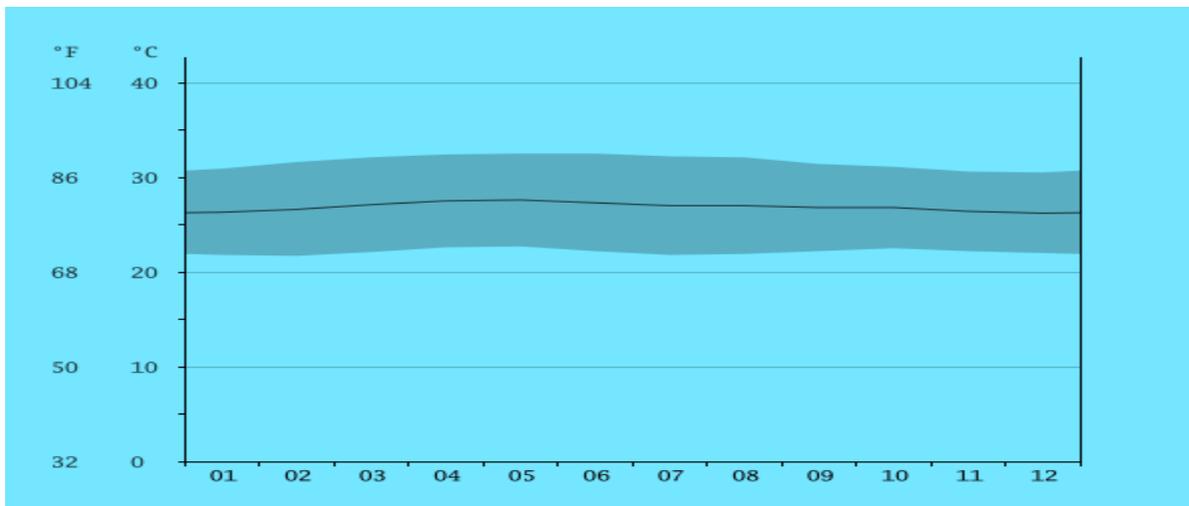


Figure: 3.3 Temperature graph

The temperatures are highest on average in May, at around 27.6 °C. At 26.2 °C on average, December is the coldest month of the year.

### 3.1.3 Climate of the study area

This city has a tropical climate. The rainfall in Tepi Air is significant, with precipitation even during the driest month. The temperature here averages 26.9 °C. Precipitation here averages 2943 mm.

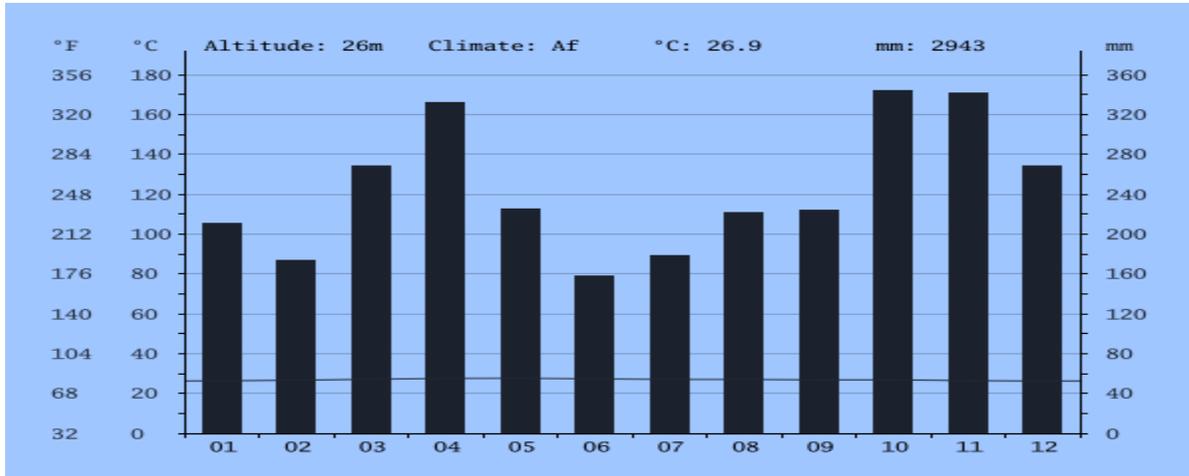


Figure: 3.4 Graph of Tepi climates

Table: 3.2 Temperatures – precipitation

Months	Jan	Feb	Mar	Apr	May	June
Average high in °C	30	29	30	29	30	29
Average low in °C	14	14	14	14	14	14
Av. precipitation - mm	11	30	53	46	187	175
Months	July	Aug	Sep	Oct	Nov	Dec
Average high in °C	29	28	28	28	28	29
Average low in °C	13	14	14	13	13	14
Av. precipitation - mm	259	259	199	45	22	6

The least amount of rainfall occurs in June. The average in this month is 158 mm. In October, the precipitation reaches its peak, with an average of 344 mm.

### 3.1.4 The soil type of Tepi campus

The most soil type of Tepi campus the red color. This soil type does not store rainfall for a long period. Because of the particle of this soil is poor water storage behavior for a long time.

## 4. METHODOLOGY

### 4.1 Fieldwork

The first method of study is reconnaissance the study area or visiting the area, to draw the freehand sketch for doing the next steps. Reconnaissance has visited the area before collecting the data from the site location area. In this part they can get further information gained through site investigation by asking the local inhabitants, different passengers from the study area and also topographic views of the area, soil types of the area, natural and manmade features of the area, and weather condition of the area such as rainfall temperature of studying moments as the Site Engineer. Data collection is the gathering of information from a particular source for various purposes. This data collection is used different techniques:

- Interview, Observation, and From written documents

Interview:-is the primary data collection type includes: - asking the person to know about the location of the study area deeply.

### 4.2 Material used in fieldwork

They are different surveying instrument used for the collection of data from the field location. Now a day the accuracy of this instrument is very high to save time and also put the full information about the study area in the modern form.

Global position system (GPS):-is the space-based global navigational satellite system that provides reliable location and time information in all weather and at all times. It can measure the distance; coordinate points to the required minimum of three trilateration range points.



Figure: 4.1 GPS controller and Receiver

#### **4.2.1 Selection of Receiver Type**

Receiver selection can be a complex process due to the large number of GPS receivers available and their range of capabilities and intended applications are widely varied.

It is suggested that all GPS receivers used together for relative positioning be of the same make to avoid problems that often result from mixing receiver types such as biases and complexities in data processing and data rate incompatibilities.

The receiver used must be capable of collecting the measurements needed for the desired positioning techniques, e.g., for both single point positioning and relative positioning. For Kinematic, Rapid Static, and Conventional Static GPS surveys, code and carrier measurement receivers are required. For a short baseline using a conventional technique, a single frequency receiver is sufficient.

For this research, a dual-frequency GPS receiver was used together with relative positioning to accurately locate the different manmade and natural features of interest within the Tepi Campus.

#### **4.2.2 Rover receiver**

The rover receiver should have been turned on at the same time the base receiver was powered up; this allows the rover receiver to collect satellite data. After the receiver collects satellites make sure that the rover receiver chosen to connect with the GPS receiver uses the down arrow to toggle between receivers. Make sure you have a radio icon on the screen then go to Survey, pick your Survey Style, and pick start Survey from the menu.

#### **4.3 Office work**

There are different types of office work that were done during the preparation of the topographic map. These are starting from downloading field data into the computer using different software. Then connect the controller with the computer by the cable of the controller. After connects the controller with the computer they select folder name from the controller and right-click on the folder name and export it into the computer. Then the data downloaded is transferring into Trimble business center that can put in excel forms. General different material or software is used in the preparation of the topographic map. These are GPS (Controller, GPS receiver, pointer, and antenna).

- Arc GIS, AutoCAD, Google Map, Map Source, and Excel are also main software to process the collected. For example, the excel data is the main objective to start the future work to prepare a topographic map of MizanTepi University Tepi campus.

The data that can be transferring into excel is describing as the following:

Table 4.1 Excel data

A	B	C	D	E					
POINT	EASTING	NORTHING	ELEVATION	DESCR					
					1449	765955.8	796817	1271.347	pole
					1450	765923.8	796829.9	1271.135	pole
1	765944.4	796992.8	1266.745	fence c1	1451	765883	796842.4	1270.916	pole
2	765944.6	796993.5	1266.579	fence c2	1452	765873.9	796827.8	1273.642	contour
3	765930.3	796973.9	1266.398	trees	1453	765850.2	796848.4	1269.971	pole
4	765952.7	796961	1266.739	basket bc1	1454	765814	796849.5	1268.559	pole
5	765964.2	796971.4	1266.446	basket bc2	1455	765780	796844.4	1264.13	pole
6	766007.3	796930.8	1265.538	basket bc3	1456	765748.9	796828.5	1261.094	pole
7	766001.1	796924	1265.082	basket bc4	1457	765715.7	796805.8	1259.233	pole
8	765990.8	796933.9	1265.361	basket bc5	1458	765647.5	796782.7	1256.302	pole
9	765986.5	796929.5	1264.911	basket bc6	1459	765651.5	796763.9	1256.908	pole
10	765957.5	796938	1265.976	volley bc1	1460	765720	796748.9	1261.77	pole
11	765949.5	796932.7	1265.859	volley bc2	1461	765713.6	796728.3	1259.823	pole
12	765943.7	796939.4	1266.066	volley bcenter1	1462	765712.4	796694.9	1261.61	pole
13	765952.6	796945.5	1266.836	volley bcenter2	1463	765709.9	796663.6	1259.847	pole
14	765939.2	796947.2	1266.467	volley bc3	1464	765707.8	796629	1260.063	pole
15	765946.7	796952.4	1266.743	volley bc4	1465	765729.6	796623.2	1262.386	pole
16	766001.2	796908.2	1267.24	resorviorp1	1466	765743.2	796606.5	1262.588	tree
17	765998.9	796908.7	1267.172	resorviorp2	1467	765880.2	796723.1	1267.447	pole
18	765996	796908.7	1268.005	resorviorp3	1468	765905.1	796727.8	1269.57	pole
19	765994.8	796904.6	1265.025	resorviorp4	1469	765903.8	796729.9	1269.349	pole
20	765994.4	796901.1	1262.915	resorviorp5	1470	765904.4	796729.6	1267.679	pole
21	765995	796901.6	1262.743	resorviorp6					
22	765993.2	796899.1	1264.537	resorviorp7					

The above excel data was the basis for any work research activities like to draw (connect points) using polylines by Auto CAD software and imported into GIS. The above data contained X, Y, and Z values of natural and manmade features of the enclosed study area start to point 1 to 1470.

#### 4.4 Methodology design process

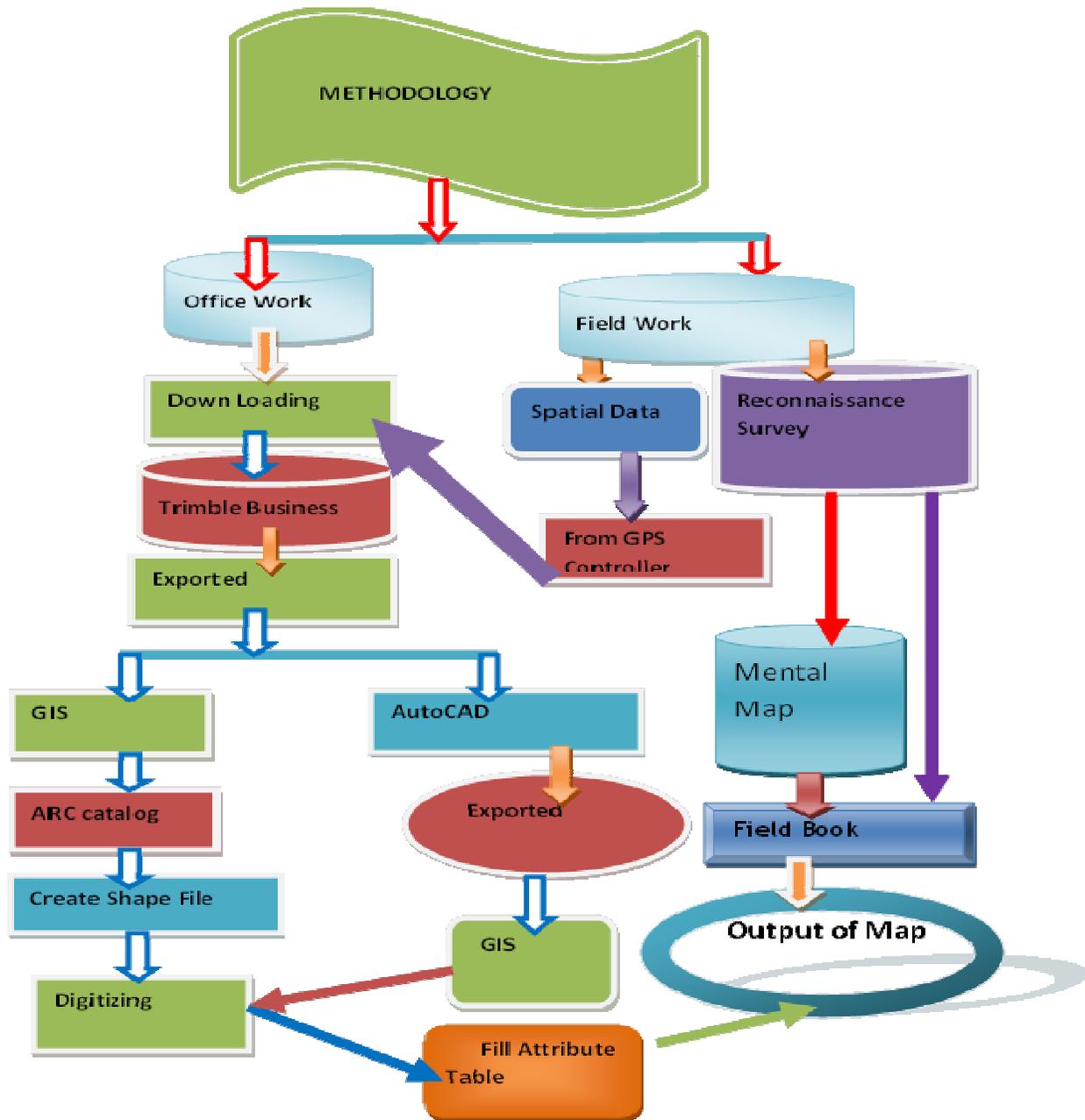


Figure: 4.2 Methodology process

The general methodology supported by fieldwork like reconnaissance data collection and office work of computer applications soft wares like AutoCAD, GIS, and Microsoft office excel, Microsoft office word, Microsoft office Microsoft PowerPoint, etc, based on mapping system preparation; data

interpretation, and data generation has occurred. This thesis is highly dependent on the collection of spatial data.

## **5. RESULTS AND DISCUSSIONS**

### **5.1 Data analysis and features generating**

Analysis of data was a process of inspecting, cleansing, transforming, and modeling data to discover useful information, suggesting conclusions, and supporting decision making. Data analysis has multiple facets and approaches, encompassing diverse techniques under a variety of names, in different business, sciences, and social science domains. Data analysis was the process of systematically applying statistical and or logical techniques to describe and illustrate and data analysis was the organization of raw data to extract useful information.

The collected basic data, information of field data contained such as field survey, control point data, coordinates of each building corner, fences, road curves, trees, poles, and stream data by using GPS instrument, data conversion can follow before these data can be analyzed.

The raw GPS data was converted to its useable format using software which in turn is transferred to AutoCAD software for the plotting of the points and digitization of the line features.

The process of data collection, processing, and analysis is done as follows: Downloading, Exporting, Plotting, Importing, Connecting the point on the AutoCAD software, and Transferring into GIS software

#### **5.1.1 Downloading Data**

Downloading means a process of transferring field data into the computer by using different software. Such processing where explains as following:

- I. Open Trimble GeomaticsOffice and open the project. There is a triangle in the middle of the screen which is a base position imported from work.
- II. Then go to “Files” “Import” “SurveyDevice” study data and pick Survey Controller on ActiveSync Connect the TSC2 to the computer and choose the correct data collector file to import. Make sure the “convert to data collector file definition” is checked, hit OK
- III. To import files doubleclick on the triangle and see the updated Latitude, Longitude, and ellipsoid height along with the Northing easting and elevation

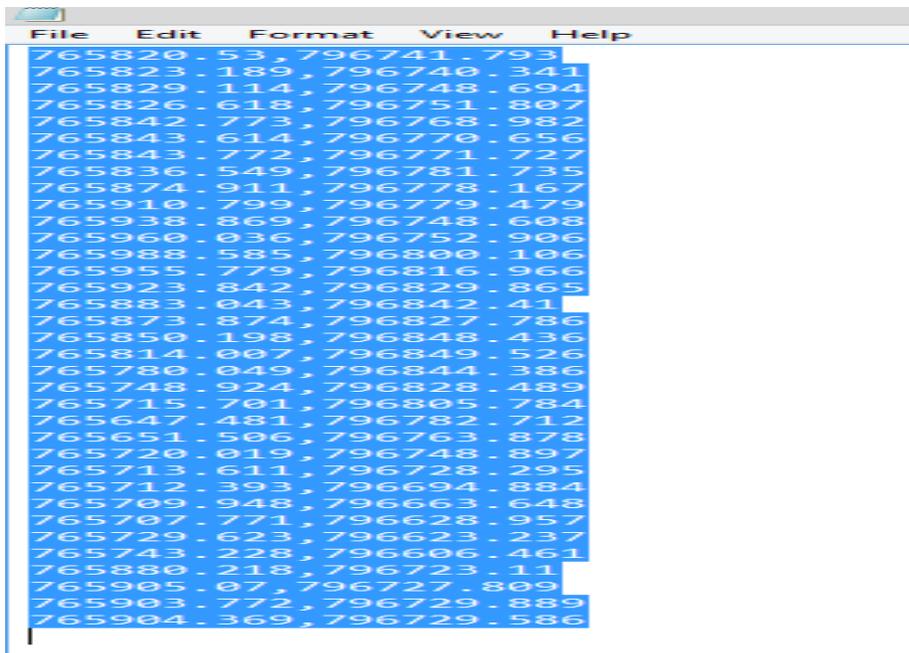
The files from the data collector are in the Trimble Data file. Copy the \*.csv (the file named above) and \*.job (the name of the project) and click the OK button on the Transfer Complete message. The \*.csv file can be TSC2 files and saved to the desired directory. Note that saving the \*.job file to the computer is a backup of the survey if the data were to be lost in the TSC2. If a message pops up on the computer regarding an error in copying, go to the data collector and make sure that the file is in Excel. After data is downloaded and the data is saved in CSV format, open in notepad and transfer into Auto CAD.

### 5.1.2 Exporting data

The exporting data was the data that can save on excel is transferring into AutoCAD. This step was as following:

- ✓ To select only easting and northing the data from excel then drag the data to transfer into excel and save the data on the desktop by using the common delimited method.
- ✓ The other one is to Right-click on the folder and transferring the data into AutoCAD software by using a notepad.

Table: 5.1 Data in notepad form



File	Edit	Format	View	Help
765820	.53	,796741	.793	
765823	.189	,796740	.341	
765829	.114	,796748	.694	
765826	.618	,796751	.807	
765842	.773	,796768	.982	
765843	.614	,796770	.656	
765843	.772	,796771	.727	
765836	.549	,796781	.735	
765874	.911	,796778	.167	
765910	.799	,796779	.479	
765938	.869	,796748	.608	
765960	.036	,796752	.906	
765988	.585	,796800	.106	
765955	.779	,796816	.966	
765923	.842	,796829	.865	
765883	.043	,796842	.41	
765873	.874	,796827	.786	
765850	.198	,796848	.436	
765814	.007	,796849	.526	
765780	.049	,796844	.386	
765748	.924	,796828	.489	
765715	.701	,796805	.784	
765647	.481	,796782	.712	
765651	.506	,796763	.878	
765720	.019	,796748	.897	
765713	.611	,796728	.295	
765712	.393	,796694	.884	
765709	.948	,796663	.648	
765707	.771	,796628	.957	
765729	.623	,796603	.237	
765743	.228	,796606	.461	
765880	.218	,796723	.11	
765905	.07	,796727	.809	
765903	.772	,796729	.889	
765904	.369	,796729	.586	

### 5.1.3 Plotting the exported data

Plotting means in this study they are connecting the exported data by using GIS and AutoCAD software. But Export data from the current field book to AutoCAD and connect similar features with each other's by polyline and make object's layer current.

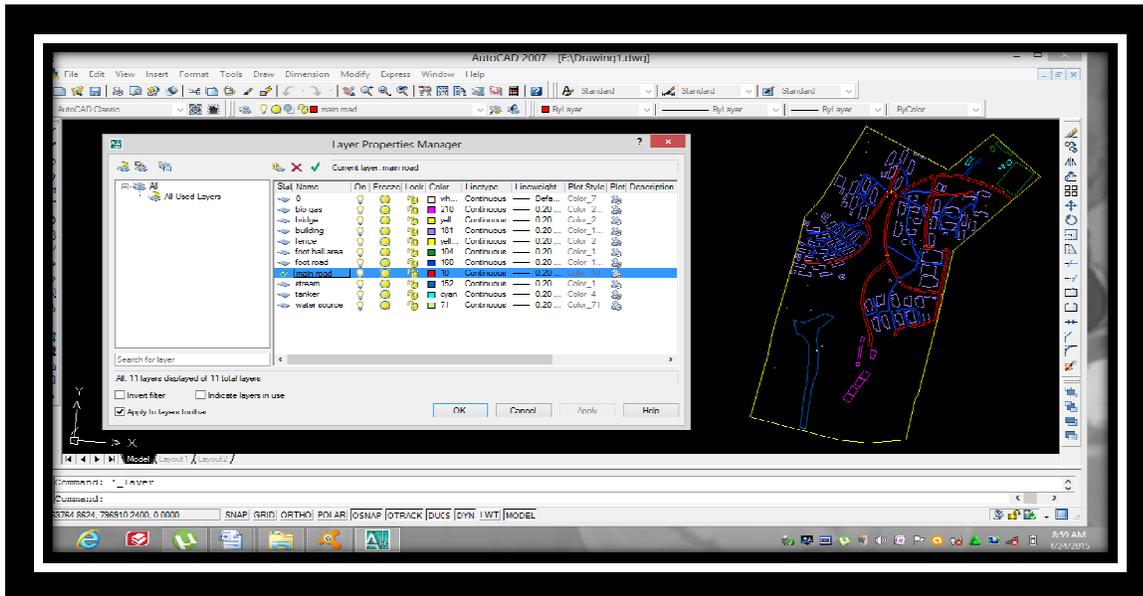


Figure: 5.1 Topographic maps drawn by AutoCAD

The above figures described that each feature was connected by AutoCAD. The analyses of this were used polyline and points according to the standards of AutoCAD software.

### 5.1.4 Importing the data

The importing data was transferring the drawing data into GIS software by using different steps or techniques. The importing of this drawing data was used to prepare a map by GIS software. The importing data passes through many procedures such as: (i) Open ArcGIS to use Arc Map to get Toolbox conversion tool for creating geo-database and(ii) Import from CAD Under input select where the file is found. After the drawing was imported, (iii) create the shape file on the Arc catalog with the coordinate system and other useful information.

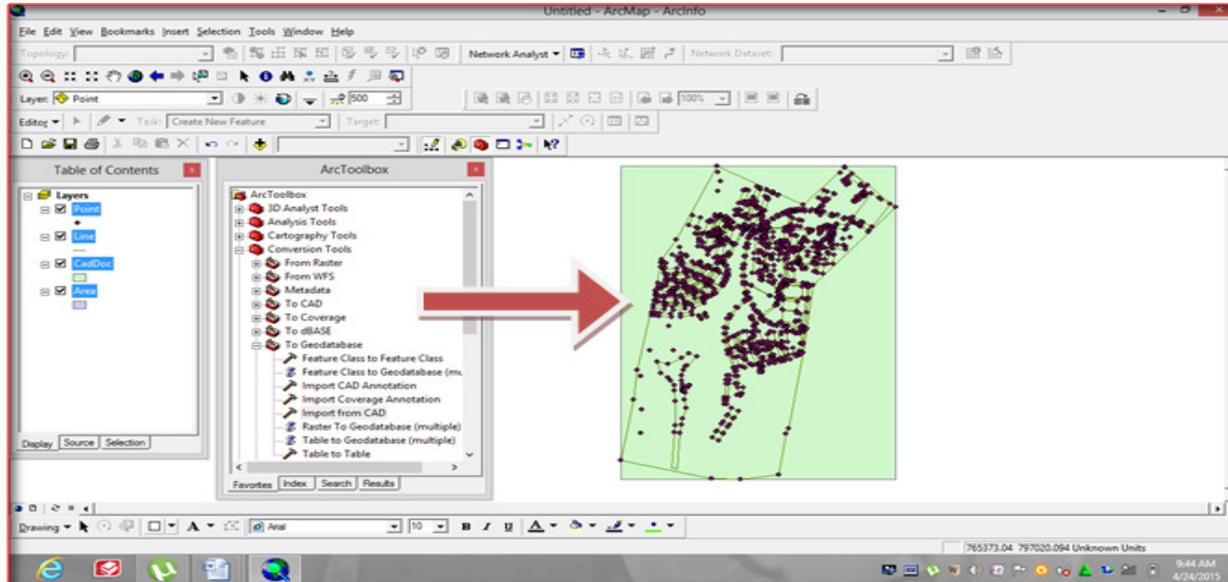


Figure: 5.2 AutoCAD data imported into GIS

## 5.2 Data interpretation

### 5.2.1 The process of map design

The map was a graphical representation, at an established scale, of a part of the earth's surface, showing important natural and manmade features in their correct positions relative to a coordinate reference system and each other.

In this study, the map design was dependent on the raw data that can be collected from the field using different GPS instruments, and the data transferred into a computer using AutoCAD and GIS software. So, topographic map design was started from this raw data. However, data collection was only the first step. The map design was very important because a map is a form of communication. The map reader sees the geographic image on the map and to know the feature that is found on the map with full description reader person is easily understand. Unlike verbal communication in which the speaker or writer can control the sequence in which information is transmitted and received, the map maker has little control over how the map user will view and interpret the map. So, the map user can understand the information of the map that can be included in the map description. The map includes the following points: Clarity, Order, and Balance.

### **5.2.2 Features analyzing on topographic map**

To make maps more readable, contours are classified and the classes are distinguished by different weights and styles of lines. Index contours every fourth or fifth contour, depending on the basic interval- -are accentuated by making the line wider than the other contours. Supplementary contours, used on the flatter areas of some maps, are shown as dashed or dotted lines. Elevation figures are shown on the contour line at frequent intervals to facilitate their identification, as well as to assist in determining the value of adjacent contours. The two main reasons for showing relief information on maps are to furnish coordinated data for engineering calculations or other scientific measurements and to present a graphic picture of the ground surface. The two objectives are related but distinct, and sometimes they may be conflicting.

**Measurement:**-For engineers or scientists who are interested in exact measurement, topographic maps furnish dimensional information about elevations, areas, grades, and volumes. The approximate elevation of any point can be read directly or interpolated from contours. A series of elevations on a line determines the grade or profile of the line, and areas and volumes can be computed by combining line profiles in various ways. The relief information shown by contours is sufficient for calculating the storage capacity of a reservoir, the area of a watershed, or the volume of earth to be moved in a large road cut or fills.

**Interpretation:**-On the other hand, many persons who use maps are not concerned with exact ground elevations but are more interested in the general appearance and shape of the land. For them, contours are the graphic means of visualizing the terrain and aid in locating positions on the map.

### **5.2.3 Selection in mapping relief features**

The amount of relief information that can be shown on a map depends largely upon the scale of the map and the contour interval used to portray the relief. If a great amount of relief detail is required, the scale must be enlarged and the contour interval made smaller; but regardless of the scale and contour interval, all information concerning the ground surface cannot be shown on maps. The mapmaker must always make a judicious selection of the features that it is desirable to portray.

**Choosing a contour interval:** - A topographic map shows the varying shapes, heights, and slopes of a landscape using contour lines. That's why they are so useful for bushwalking, property mapping, and even town planning. Contour Lines are curves that connect points of equal elevation. Contours are lines

that connect points at the same height above sea level and are plotted using vertical aerial photographs. The closer these contours are the steeper the gradient. However, the height difference between one line and the next is always the same throughout the map. This is called the contour interval.

### Contour generating by the surfer software

In this study Surfer software was generating the contour in different shapes that describe the interval of contour with the different shapes. The field data that collected was transferring into the surfer then the software puts the contour in different shapes like in three dimensions (3d) and other shapes.

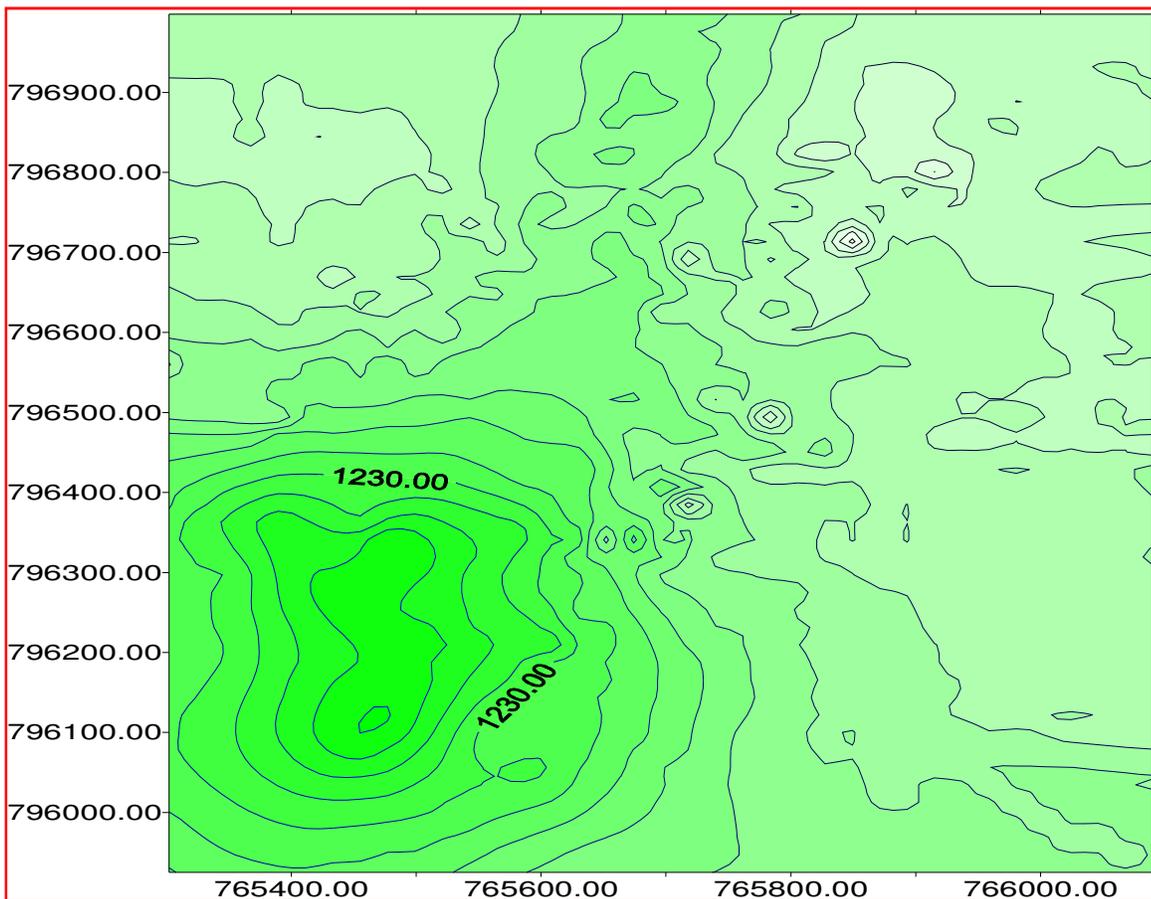


Figure: 5.3 Contour of Tepi campus analyzed by Surfer 32

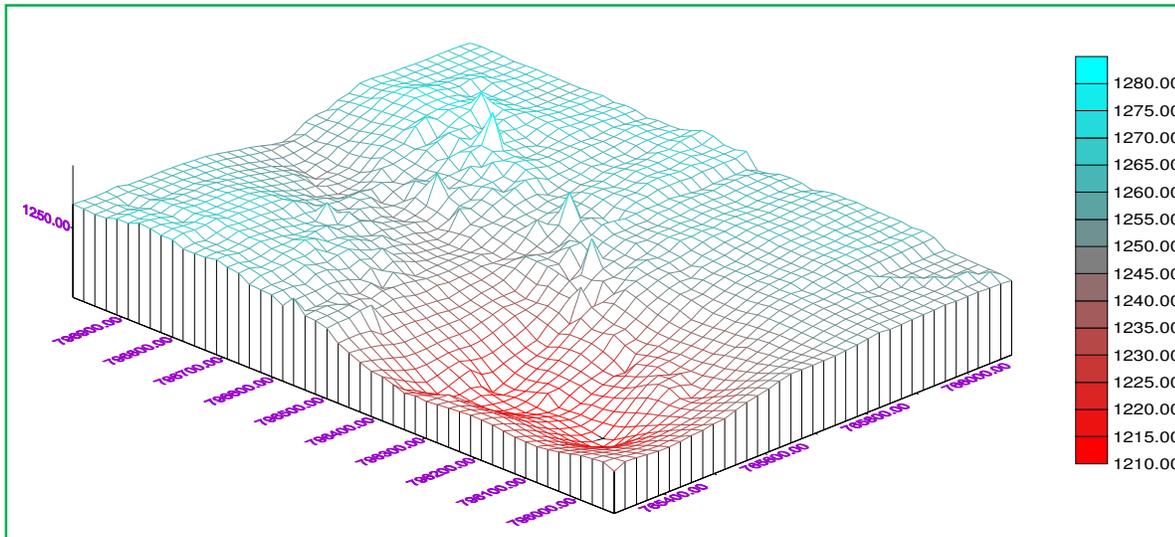


Figure: 5.4 Three dimension of the contour of Tepi campus analyzed by Surfer 32

### 5.3 Prepare Topographic map

In this study elements that are found generally on a map, specifically on topographic maps include the distance or scale, direction, legend, sources of information and how the map was processed, orientation, and location.

### 5.4 Spatial analysis of the study

The process of examining the data and analyzed the relationships of features in spatial data through overlay and other analytical techniques to address a question or gain useful knowledge. Spatial analysis extracts or creates new information from spatial data.

### 5.5 Triangulation Irregular network (TIN)

Triangulations are a form of vector-based digital geographic data and are constructed by triangulating a set of vertices points. A vector data structure that partitions geographic space into contiguous, no overlapping triangles. The vertices of each triangle are sample data points with x, y, and z values. These sample points are connected by lines to form Delaunay triangles. TINs are used to store and display surface models.

#### 5.5.1 The storing of TIN

In this study, the coverage of TIN is stored as a directory of files. Note, however, that a TIN is not covered and has no associated information files. A TIN directory contains seven files containing

information about the TIN surface. These files are encoded in binary format and are not readable by standard text display or editing programs. So, the triangulation irregular network of this study was stored as the following using GIS software.

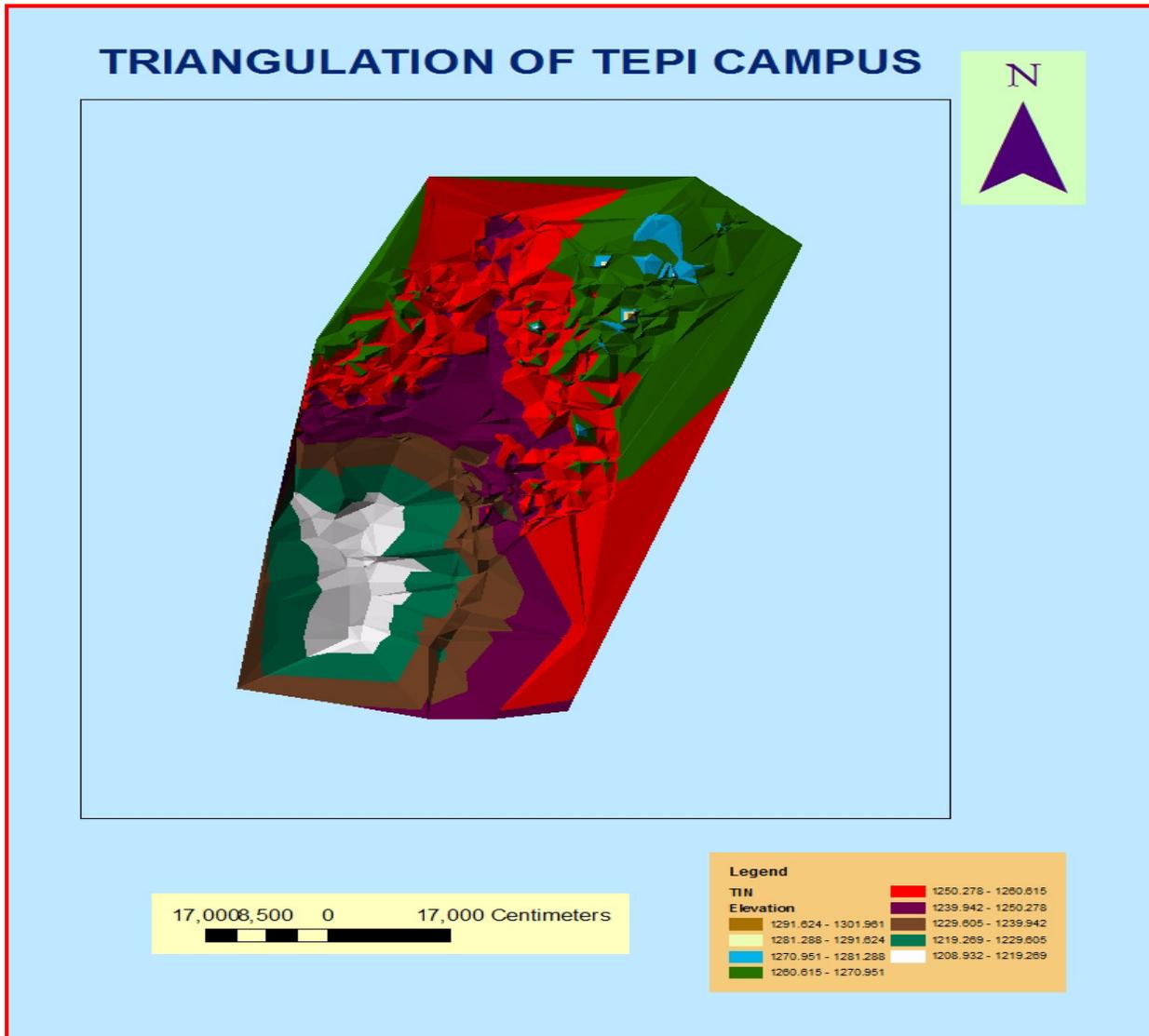


Figure: 5.5 Triangulation of Tepi campuses analyzed by GIS

In the above figure, the elevation of each triangular irregular network shape was described in a different color. So each elevation had minimum and maximum values.

### 5.6 Surface analysis by Slope

The slope is the incline, or steepness, of a surface. The slope can be measured in degrees from horizontal (0–90), or percent slope (which is the rise divided by the run, multiplied by 100). A slope of

45 degrees equals 100 percent slope. As slope angle approaches vertical (90 degrees), the percent slope approaches infinity. The slope of a TIN face is the steepest downhill slope of a plane defined by the face. In this study, the slope for a cell in a raster was the steepest slope of a plane defined by the cell and its eight surrounding neighbors. The slope of the Tepi campus was described as following:

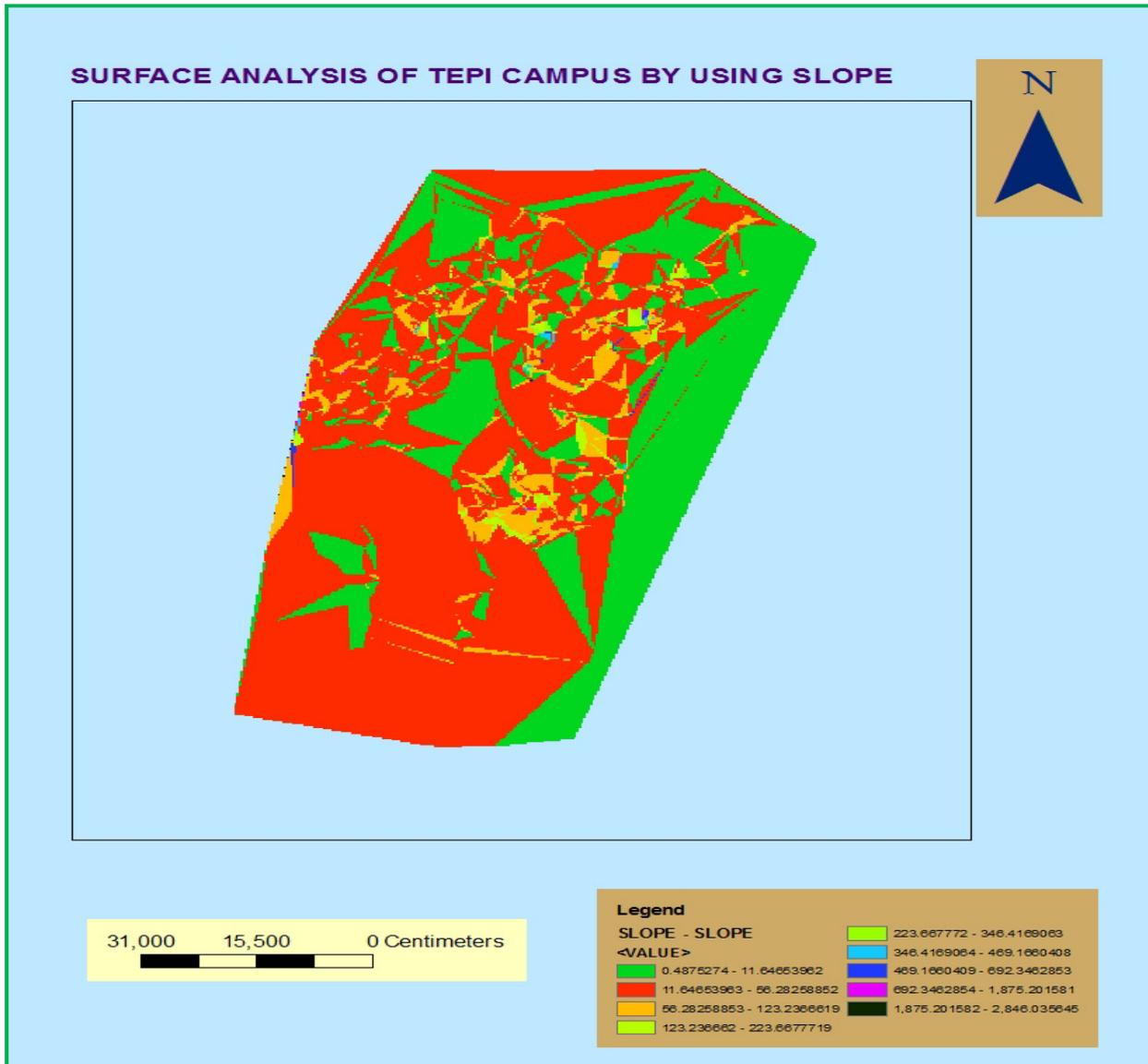


Figure: 5.6 The Slope of Tepi campus analyzed by GIS

### 5.7 Analysis of Aspect triangulation

The compass direction that a topographic slope faces, usually measured in degrees from north. In this study, aspects can be generated from continuous elevation surfaces. For example, the aspect recorded

for a TIN face was the steepest downslope direction of the face, and the aspect of a cell in a raster is the steepest downslope direction of a plane defined by the cell and its eight surrounding neighbors. So, in this result analysis, the aspect of Tepi campus was described by direction.

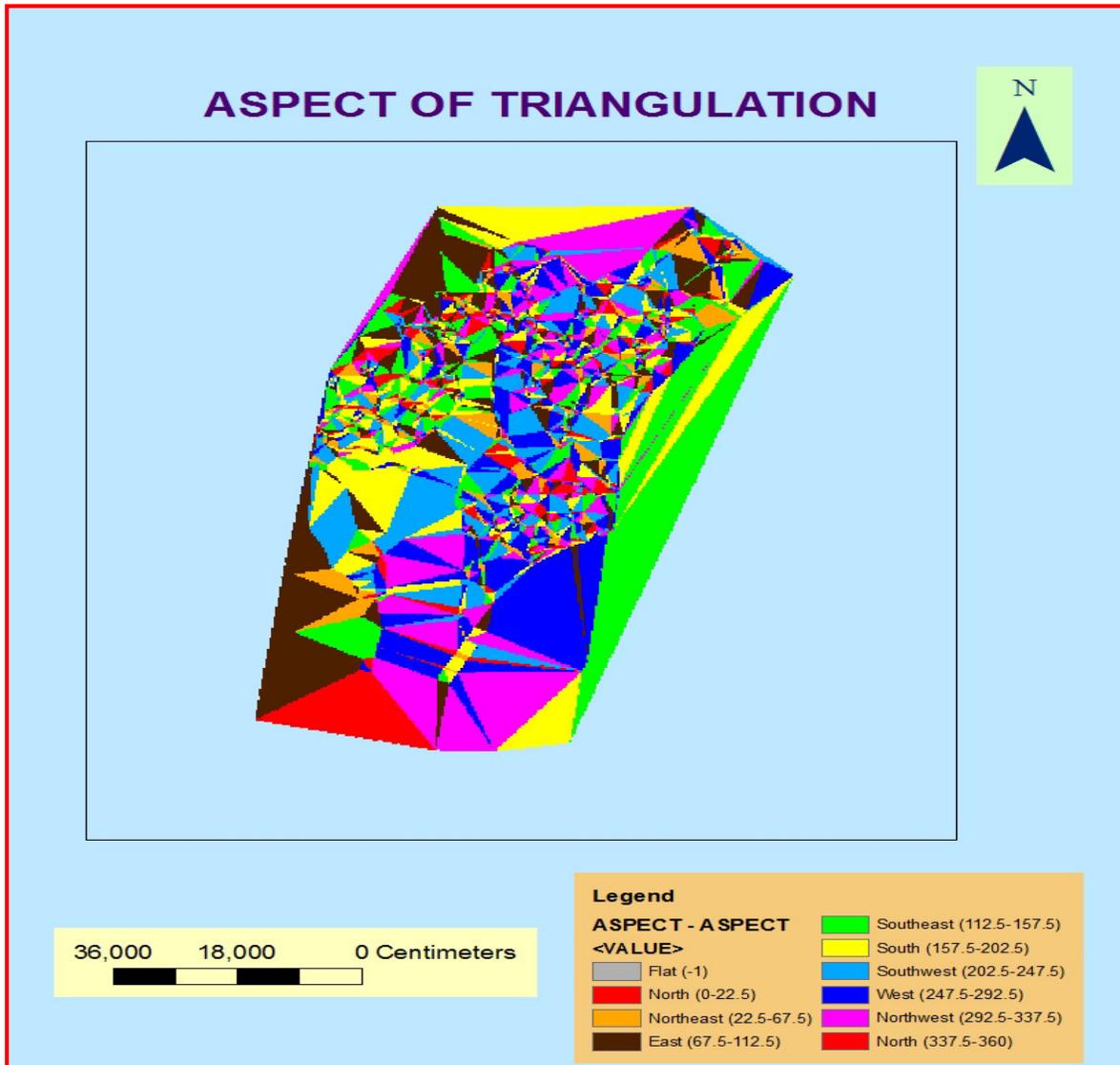


Figure: 5.7 The Aspect of Tepi campus analyzed by GIS

### 5.8 Final prepared topographic of Study area

The final result of this study was to prepare the map of Tepi campus from the collected field data by using GIS software. By considering all the map design elements discussed above the topographic map of the study area was prepared with each natural and manmade feature. The features were put on this prepared map by using standard name all users as easily communicate with a map. This prepared map

was containing each building type, road type, river, trees, pole, and other natural and manmade features. Each feature was prepared by using different colors to easily understand. The prepared topographic map of the Tepi campus based on existing features was detail explained as following Figure.

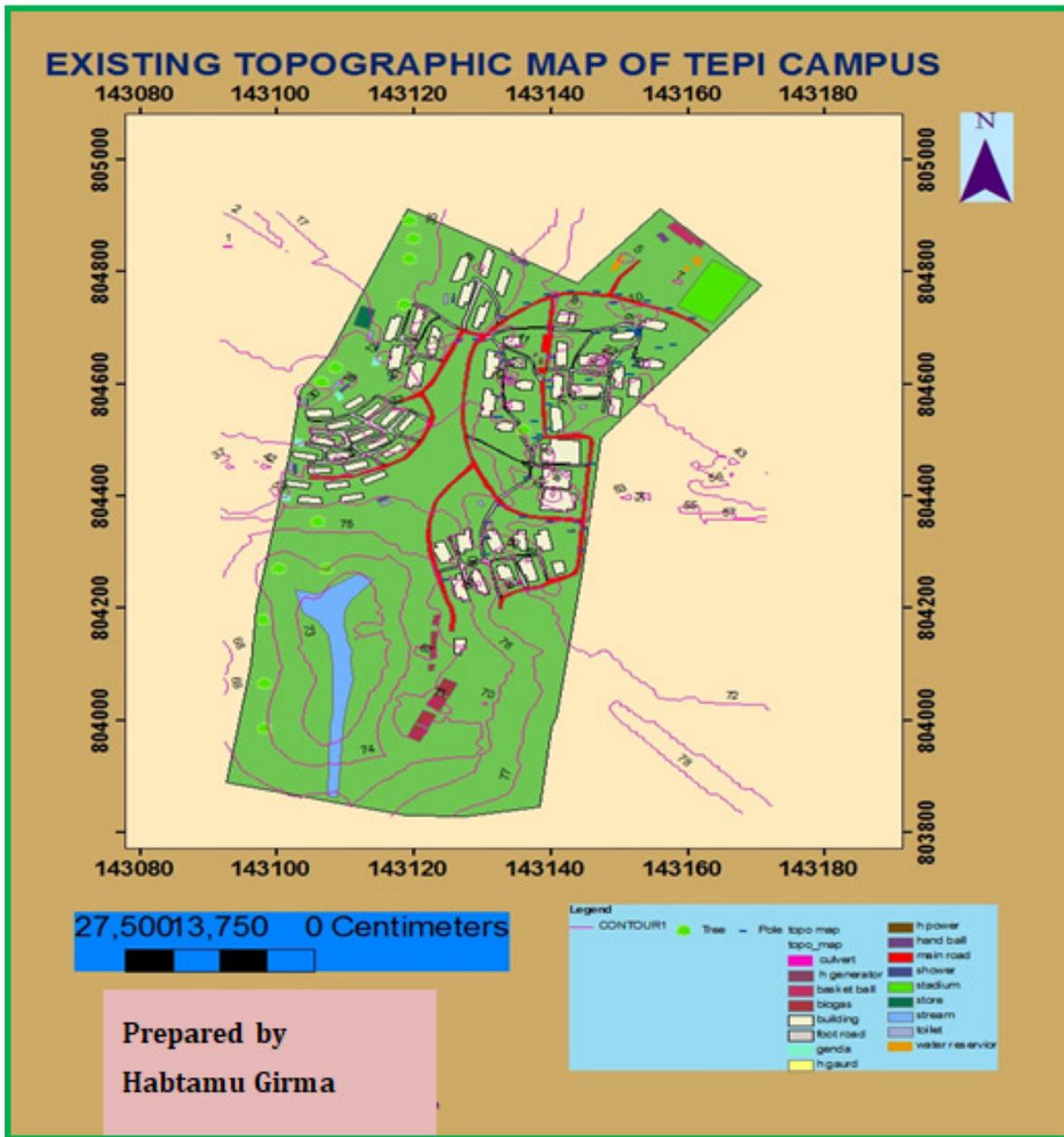


Figure: 5.8. Prepared Topographic map of Tepi campus analyzed by GIS

## **6. CONCLUSION AND RECCOMANDATION**

### **6.1 Conclusions**

The preparation of a topographic map was very necessary for any work activities to run their job in any country and different area of work that can be done for existences and the future. Now a day's the topographic map are very essential in diverse fields of work, which are very common in the day-to-day activity of human beings such as the design of the road, study of the contour interval, and knowledge building construction area. As abroad use of the topographic map in a diverse field after expanding a lot of skill and effort on this study, helps to increase the capacity of producing a well-organized topographic map. While undergoing GPS (R8 Rover) selected for data collection in connection with Controller, preferred using soft desk civil survey, GPS, and GIS software to process the field data into the computer. The topographic map of the Tepi campus includes different features (objects) that can be found in nature and artificial (manmade). This study was used for the following purposes. Such as to exercise or explore skills in making a map, has a great role on behalves of upgrading potential to produce a map (topographic map).

The preparing of topographic map is the detail work because the feature that can be found in that area is representing in their symbol to describe full information about the feature. So, a topographic map is used for the university to study the slopes, elevation, maximum contour interval, minimum contour interval, the location of infrastructure, and different types of construction.

Generally, the prepared topographic map showed the all features of the ground surface on the paper by using their symbol, color, size, and different shapes. After expending a lot of effort on the thesis and producing well organized and qualified topographic map which serves as an internationally accepted topographical map.

### **6.2 Recommendations**

The preparation of a topographic map is highly used fully for a different purpose if the data was collected carefully by a modern instrument like a GPS satellite receiver. So, the recommendation was lists as following:

- ✦ In this study, the data collection was done only by GPS instrument due to resource (budget) limitations. So it is recommended that for the data collection using the different modern instruments to minimize the error.

- ⊕ Enough the chance of using different software during the preparation of the topographic map.
- ⊕ The map designer and all engineer was getting the chance of know all features that found in the enclosed study area with the full information.
- ⊕ A student and department which they will do the different project related with the map were used as a reference.
- ⊕ In this study, the map was prepared by GIS and AutoCAD software. If the map designer wanted that in three dimensions I recommended that using sketch-up software.

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