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Case Report

Preparing Topographic Map of Wallaga University Around College of Natural Science by Using GIS Software, West Wallaga, Oromia, Ethiopia

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Abstract: A topographic map serves as a two-dimensional depiction of the three-dimensional terrain. Unlike other maps, topographic maps uniquely capture both the horizontal and vertical dimensions of the landscape. Employing a combination of contour lines, colors, symbols, labels, and various graphical elements, they effectively illustrate the forms and positions of natural and manmade features such as mountains, forests, rivers, lakes, cities, roads, bridges, and more. By utilizing contour lines, a topographic map represents the diverse shapes, elevations, and slopes of the land. These lines connect points at identical heights above sea level, derived from vertical aerial photographs. The proximity of these contour lines indicates the steepness of the terrain, while the consistent height difference between adjacent lines remains uniform across the entire map. For the construction of any infrastructures or facilities in the area, an accurate and updated topographic map should be used in order to maintain the quality and accuracy of any activity using the topographic map. The topographic map was prepared using the different modern surveying instruments and techniques like Total station and GIS particularly in the college of natural science Area of Wallaga University. The Spatial data (Excel point data) of the area was collected using Total station and it was processed using the different software like AutoCAD, Eagle point, and ArcGIS to come up with the new updated and accurate topographic map. The contour map, built-up area, and Green area maps were also prepared in different layers for more information to be used as a reference in the construction of any new infrastructure in the area.

Keywords: Topographic Map, Contour, Feature, Information

1. Introduction

The historical significance of maps, particularly topographic maps, has been profound [1]. From ancient cave paintings to the comprehensive topographic maps produced by Cassini and his descendants, maps have served as essential tools for defining, explaining, and navigating the world. Topographic maps, in particular, have proven to be effective in demonstrating how communities value and interact with their traditional lands and immediate surroundings [2].

Topographic maps, commonly referred to as topo maps, hold significant value for both governmental agencies and the general public. Distinguishing themselves from many other maps that solely portray two-dimensional positions, topographic maps integrate the third dimension by employing contour lines to illustrate changes in elevation across the Earth's surface [3].

The concept of a topographic map is relatively straightforward. Contour lines on the map represent lines of equal elevation above or below a reference datum. These lines provide a visual representation of the elevation changes on the Earth's surface [4].

In the context of Wallaga University, topographic mapping involves the identification and description of various features found on the university grounds, such as buildings, roads, rivers, trees, and other objects. This mapping process often involves the use of surveying instruments like GPS and total stations, as well as software such as GIS and Softdesk8 [5].

The preparation of a contour map around the Natural Science Area of Wallaga University includes depicting elevation levels and topographic features such as buildings and road curves. Additionally, adding text to the map enhances communication and understanding of geographic information. Topographic maps are essential for engineering projects, as they provide crucial data for landforms, elevations, and gradients. They are also instrumental in the planning and design of major civil engineering projects [6].

In summary, maps, particularly topographic maps, serve as vital documents that represent the structure of the Earth's surface. They provide an economic and practical method for mapping large areas and projects, offering valuable insights for a wide range of disciplines, including engineering, economics, and geology.

2. Statement of the Problem

Using an outdated topographic map for construction projects can indeed lead to inaccuracies and potential issues. It's crucial to have an updated and accurate representation of the project area, especially when considering new infrastructures and facilities [7].

In the case of Wallaga University's Natural Science area, the use of modern surveying techniques and tools, such as GPS, total stations, and GIS software, can greatly benefit the creation of an updated topographic map. These techniques can ensure that all new features, including buildings, roads, waste disposal storage, and other facilities, are accurately represented on the map.

Having an updated topographic map will provide essential information for future construction and expansion projects in the area. It will enable engineers, architects, and planners to make informed decisions based on the current layout and features of the land, ultimately leading to more accurate and successful construction projects.

By investing in the creation of an updated topographic map, Wallaga University can ensure that its engineering design work is based on reliable and precise data, leading to better outcomes for the university and its surrounding environment.

3. Objective of the Study

3.1. General Objective

The general objective of this project is to prepare Topographic map of Wallaga University around natural science area by using GIS Software

3.2. Specific Objectives

1) To show the relief of the area as a basis for the construction of new facilities.
2) To identify the position of all features in the area using their coordinates.
3) To conduct the collected data.

4. Materials and Methods

4.1. Location and Description of the Study Area

The project area is situated in the East Wallaga Zone of the Oromia Region, specifically in Nekemte. Nekemte is geographically positioned at latitude of 9°5′N and a longitude of 36°33′E, with an elevation of 2,088 meters. Positioned at the heart of the road network for southwestern Ethiopia, Nekemte is approximately 331 kilometers away from Addis Ababa and the project area is Natural Science Area. Figure 1 shows the location of the project area.

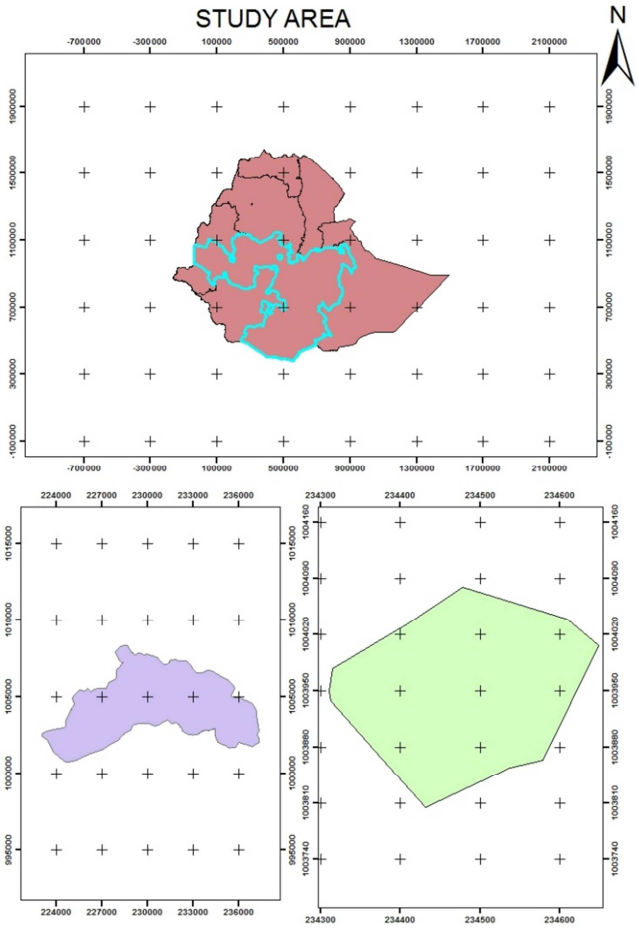

Figure 1. *Location map of the study area.*

4.2. Data Collection and Analysis

Collecting both primary and secondary data is essential for a comprehensive study of the efficiency and productivity of an area, such as the Natural Science area of Wallaga University. Utilizing a variety of instruments and data collection methods ensures a robust and well-rounded understanding of the area.

Literature surveys provide valuable insights into existing research and findings related to the area in question [8]. They can offer historical context, established theories, and prior assessments, which can be crucial for understanding the evolution of the area's productivity and efficiency.

Field surveys are essential for gathering firsthand information about the area. This involves physically visiting

the location to observe and document specific details, features, and conditions that may not be captured in existing literature or secondary sources.

Formal group discussions with participants and informal group discussions can provide different perspectives from individuals who have direct experience with the area. These discussions can yield qualitative data, insights, and opinions that are valuable for understanding the human and social aspects of the area's productivity and efficiency.

Questionnaire surveys are effective for gathering real-time data and feedback from a broader audience. They can provide quantitative data and opinions from a larger sample size, offering a more comprehensive understanding of the area's dynamics over the study period [9].

By employing a combination of these data collection methods, researchers can ensure that they have a well-rounded and comprehensive dataset to analyze and draw conclusions about the efficiency and productivity of the study area.

4.3. Data Collection Method and Materials

The timeframe of the research study you conducted, spanning from January 2022 to December 2023, indicates a comprehensive and in-depth investigation into the efficiency and productivity of the Natural Science area at Wallaga University. The utilization of both primary and secondary data, as well as a range of surveying instruments such as Total Station, theodolite, tape meter, staff, and GPS, reflects a rigorous and meticulous approach to data collection and measurement.

The use of modern surveying instruments such as Total Station and GPS demonstrates a commitment to accuracy and precision in the collection of field data [10]. These instruments are essential for capturing detailed spatial information, which is crucial for creating an updated and accurate topographic map of the area.

By employing a diverse array of surveying instruments over the course of the study, you have ensured that the data collected is comprehensive and reliable, allowing for a thorough analysis of the area's characteristics and features. This approach will contribute to the development of a robust understanding of the Natural Science area and will provide valuable insights for future construction and expansion projects at Wallaga University.

Overall, the combination of an extensive timeframe, varied data sources, and advanced surveying instruments underscores the thoroughness and depth of the research study conducted in the Natural Science area of Wallaga University.

4.4. Primary Data Collection

Collecting both planimetric and altimetric measurements as part of the primary data collection process demonstrates a comprehensive approach to understanding the topography and features of the Natural Science area at Wallaga University. Planimetric measurements, which focus on the horizontal positions of features, and altimetric measurements, which pertain to elevations and vertical positions, provide a well-rounded dataset for creating an accurate topographic map.

Field observations are essential for gaining firsthand insights into the methods of topo map preparations. By directly observing and investigating the process, researchers can better understand the specific techniques and considerations involved in creating a topographic map for the area. This hands-on approach allows for a deeper understanding of the terrain, natural features, and man-made structures that need to be accurately represented on the map.

The inclusion of both planimetric and altimetric measurements, along with field observations, ensures that the primary data collection process captures a wide range of spatial information, enabling the creation of a detailed and accurate representation of the Natural Science area. This comprehensive approach will be invaluable for future construction and expansion projects, as it provides a solid foundation for informed decision-making based on a thorough understanding of the area's topography and features [11].

Table 1. *Material used.*

No	Soft wares	specification	Purpose
1	Arc GIS	10.2	For analyzing both spatial and non-spatial data.
2	Computer	Lap top	To analyze, store and process data
3	Total station	Trimble	To collect data from field work

4.5. Field Work and Data Collection Methods

Field work is of primary importance in all types of surveys. Absolutely, becoming a skilled surveyor requires a combination of theoretical understanding and practical experience [12]. The study of a comprehensive training manual can provide the necessary theoretical foundation, covering topics such as surveying principles, instruments, methods, and data analysis. This theoretical understanding serves as the basis for practical fieldwork, where the knowledge gained from the manual can be applied in real-world scenarios.

The activities you mentioned, such as gathering information from existing features, conducting reconnaissance surveys, establishing control points, and performing planimetric and altimetric measurements, are all essential components of fieldwork for a surveyor [13]. These activities are crucial for accurately capturing the characteristics of the surveyed area, ensuring that the resulting data is reliable and comprehensive.

Engaging in these field activities allows aspiring surveyors to develop practical skills, gain familiarity with surveying instruments, and understand the intricacies of different surveying methods. It also provides valuable hands-on experience in applying theoretical knowledge to real-world surveying tasks.

By combining theoretical study with practical fieldwork, individuals can develop the expertise necessary to become proficient surveyors, capable of effectively and accurately capturing spatial data and creating detailed representations of the surveyed areas.

4.6. Office Work and Data Processing

The office work involved in the preparation of a topographic map following field data collection involves several crucial steps. Here are some key activities that are typically carried out in the office:

Data Download: The first step involves downloading the field data collected using surveying instruments such as Total Station, theodolite, and GPS into a computer [14]. This data may include planimetric and altimetric measurements, control point coordinates, and other relevant information.

Software Setup: Prior to downloading the data, it's essential to ensure that the necessary software for processing and analyzing the survey data is set up on the computer. This may involve installing and configuring specific software packages tailored for survey data processing and mapping.

Data Processing: Once the data is downloaded, it needs to be processed using specialized software. This may include adjusting and refining the measurements, correcting for errors, and integrating the different types of data collected during fieldwork.

Map Preparation: After processing the data, the actual preparation of the topographic map begins. This involves using Geographic Information System (GIS) software, Computer-Aided Design (CAD) software, or specialized mapping software to create an accurate and detailed representation of the surveyed area.

The process of converting the analog information into digital information on map can be captured by digitizing each feature thus the process of digitization converts the spatial features on a map into digital format [15]. Therefore, point, line and area features that compose a map are converted into X & Y co-ordinates represent a point and a string of co-ordinates represent a line. Therefore, points, lines, and area features that compose a map are converted in to (x, y) coordinates.

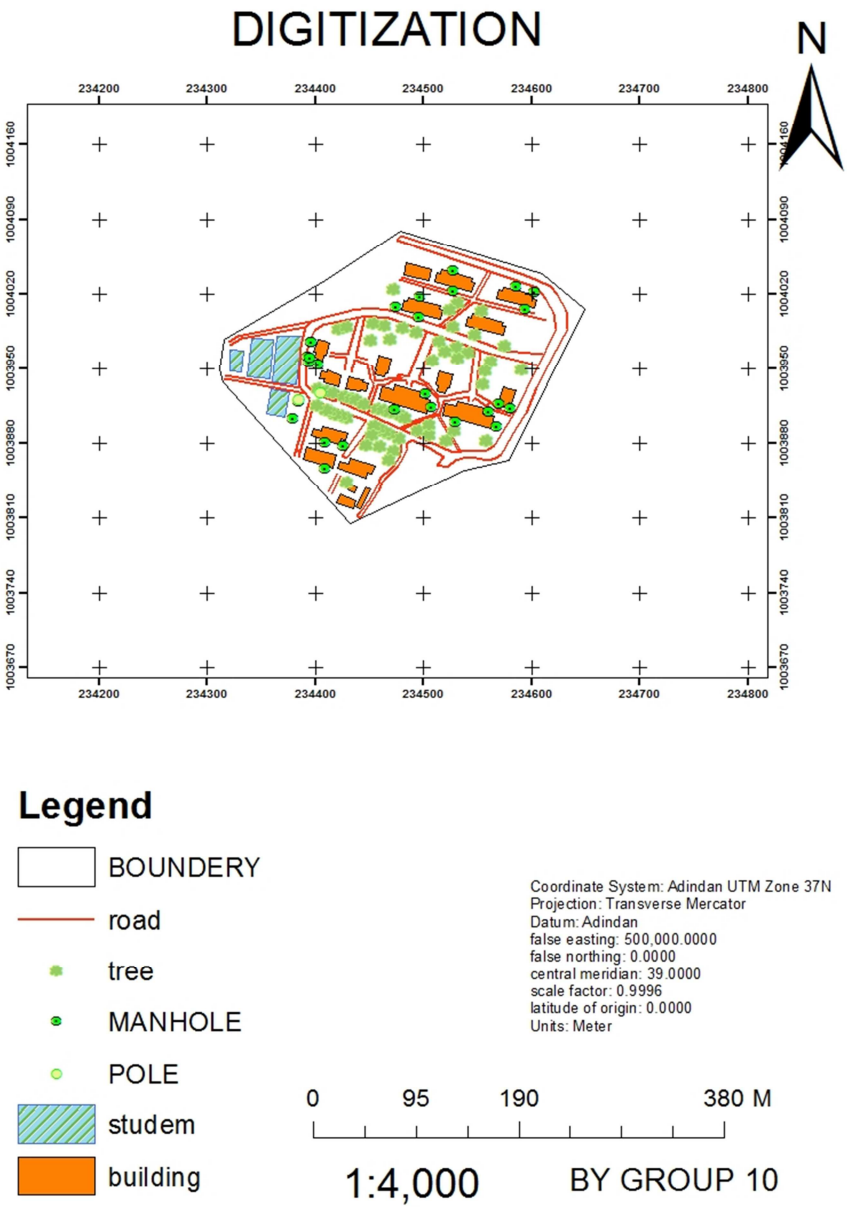

Figure 2. *Shows digitizing of the features.*

5. Features Shown on Topographic Maps

The relief is commonly depicted by contour lines. Instead of referring to level of measurement, some authors distinguish between qualitative and quantitative features or attributes. Qualitative corresponds to nominal measurement and quantitative corresponds to ordinal, interval, and ratio measurements [11]. There are different forms of features in topographic maps.

5.1. Point Features

A dimensionless abstraction of an object is denoted by a singular X, Y coordinate. Within this area, point features such as electric poles and trees are represented. These features are intricately linked with their corresponding attributes, providing a clear description on the map. The figure below illustrates the locations of existing electric poles and trees in the area.

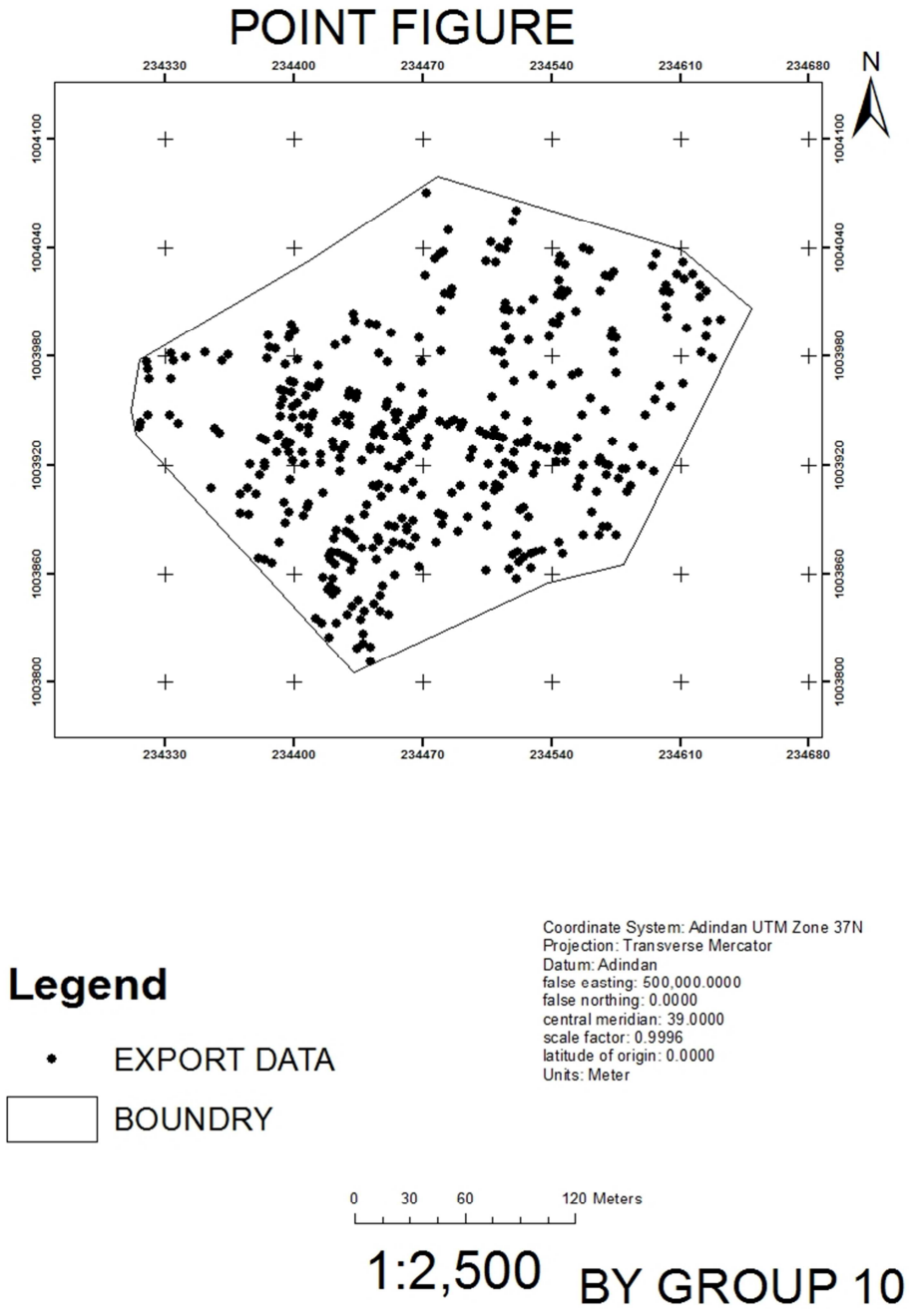

Figure 3. *Point feature map of the area.*

5.2. Line Features

A collection of ordered coordinates represents the configuration of geographic features that are too slender to be portrayed as an area at the current scale, or linear features characterized by length without width. Typically, within the

context of our geographic understanding, street features are prevalent in this area within the realm of natural sciences.

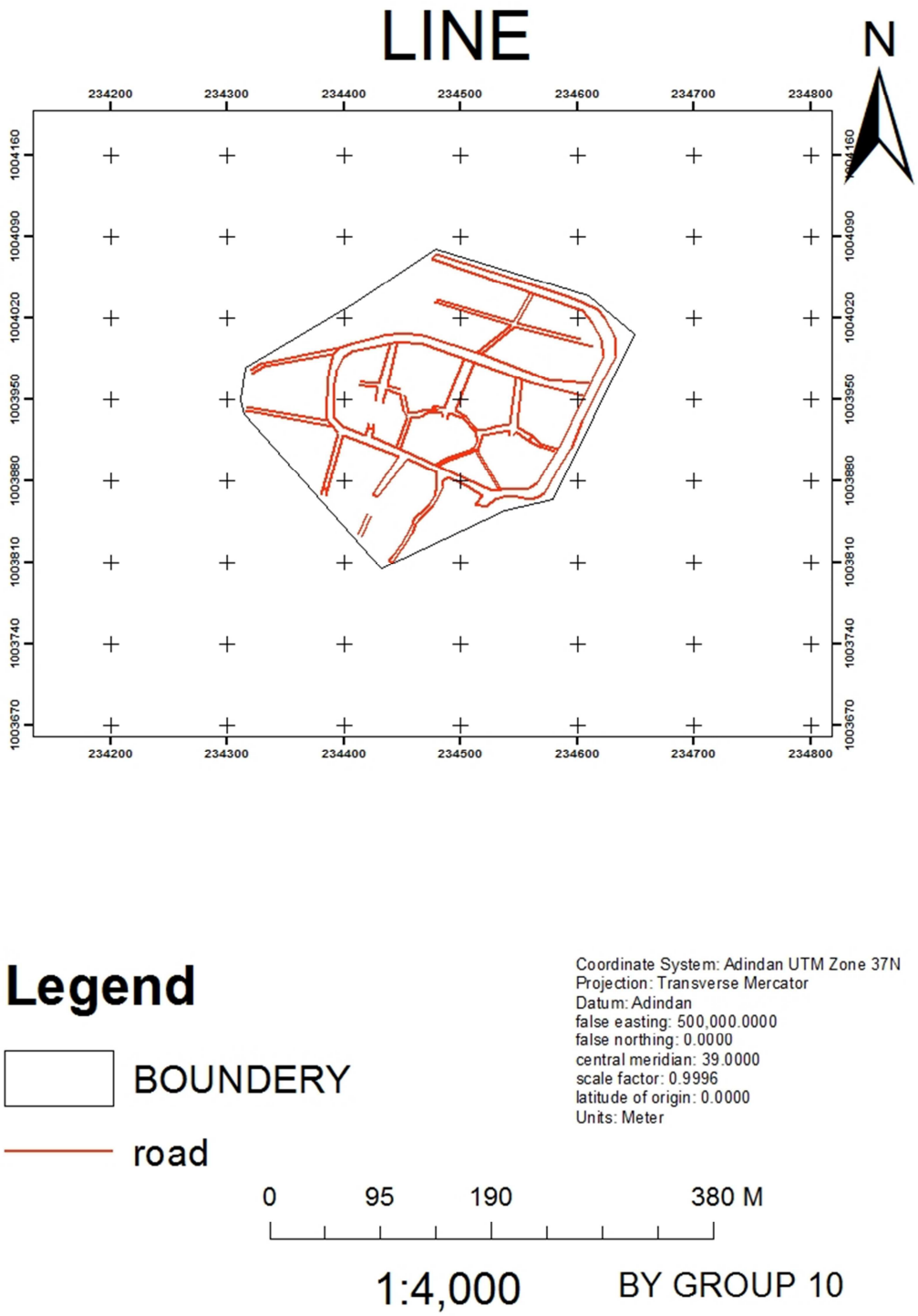

Figure 4. *Road feature map of the area.*

5.3. Polygon (Area) Features

A polygon is defined by the lines that make up its boundary and a point inside its boundary for identification. It is used to represent areas. Polygons have attributes that describe the geographic feature they represent. In the project area forms of polygon features are buildings and green areas were represented under these features. They are described in the map below.

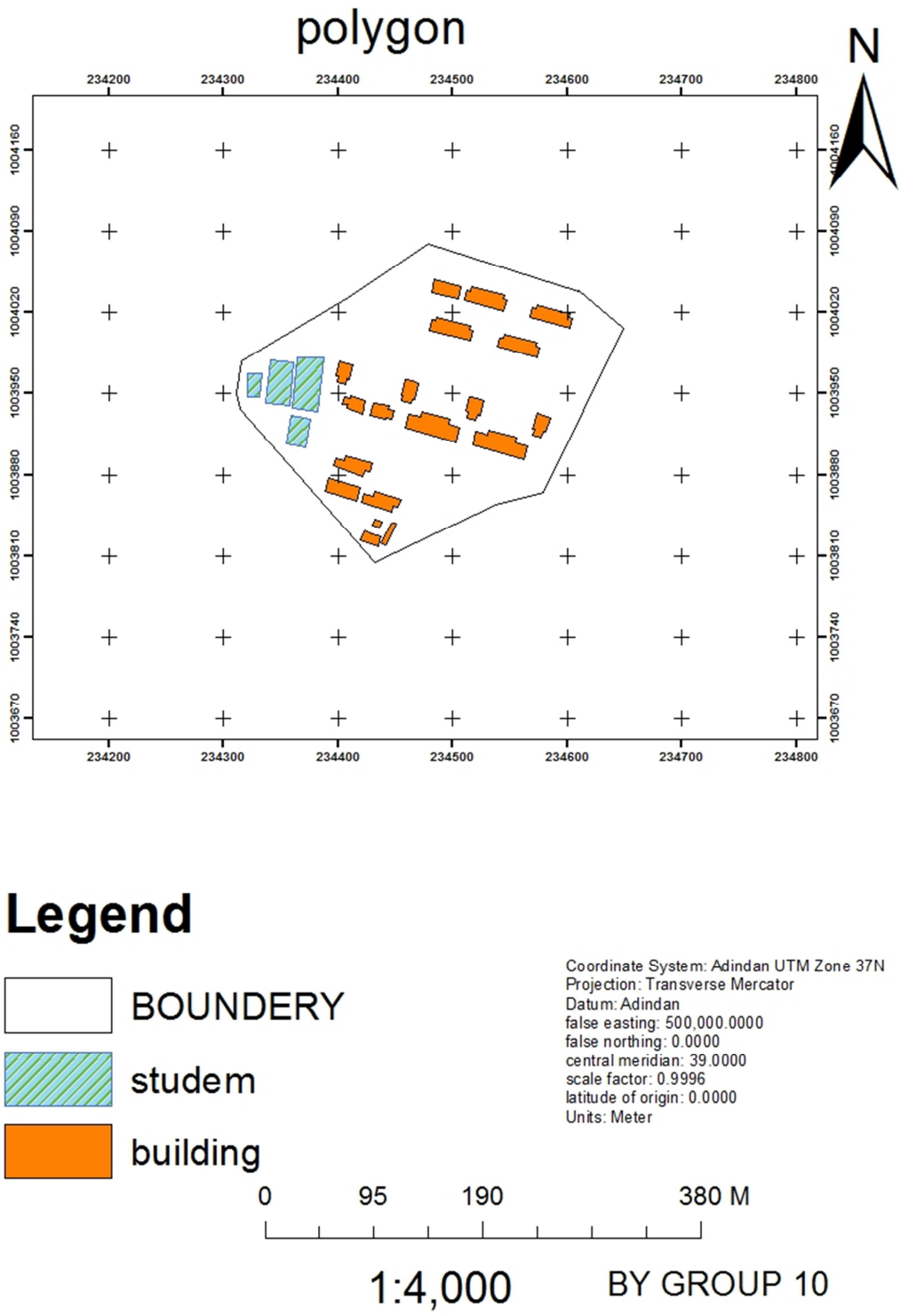

Figure 5. *Polygon feature map of the area.*

5.4. Interpreting Contour Lines

Contour lines depicted on a map serve to illustrate topography and variations in elevation. These lines disclose the presence of slopes, depressions, ridges, cliffs, mountain and hill heights, and various other topographic characteristics. Each contour line, usually brown, connects points of identical elevation, running parallel to one another with shapes roughly mirroring those above and below. Key attributes of contour lines include their representation of places at equal heights, conveying the height, slope, or gradient of the landform. Dense clustering of contours indicates steep slopes, while wider spacing suggests a more gradual incline. The convergence of two or more contour lines signifies features of vertical slopes like cliffs or waterfalls, and contours of different elevations typically do not intersect. The process of generating contour maps involves using GIS arc toolbox tools

to prepare configurations of features, revealing the layout of slopes, depressions, ridges, cliffs, and other topographical aspects. The resulting contour lines on the map, distinguished by their brown color, connect points sharing the same elevation.

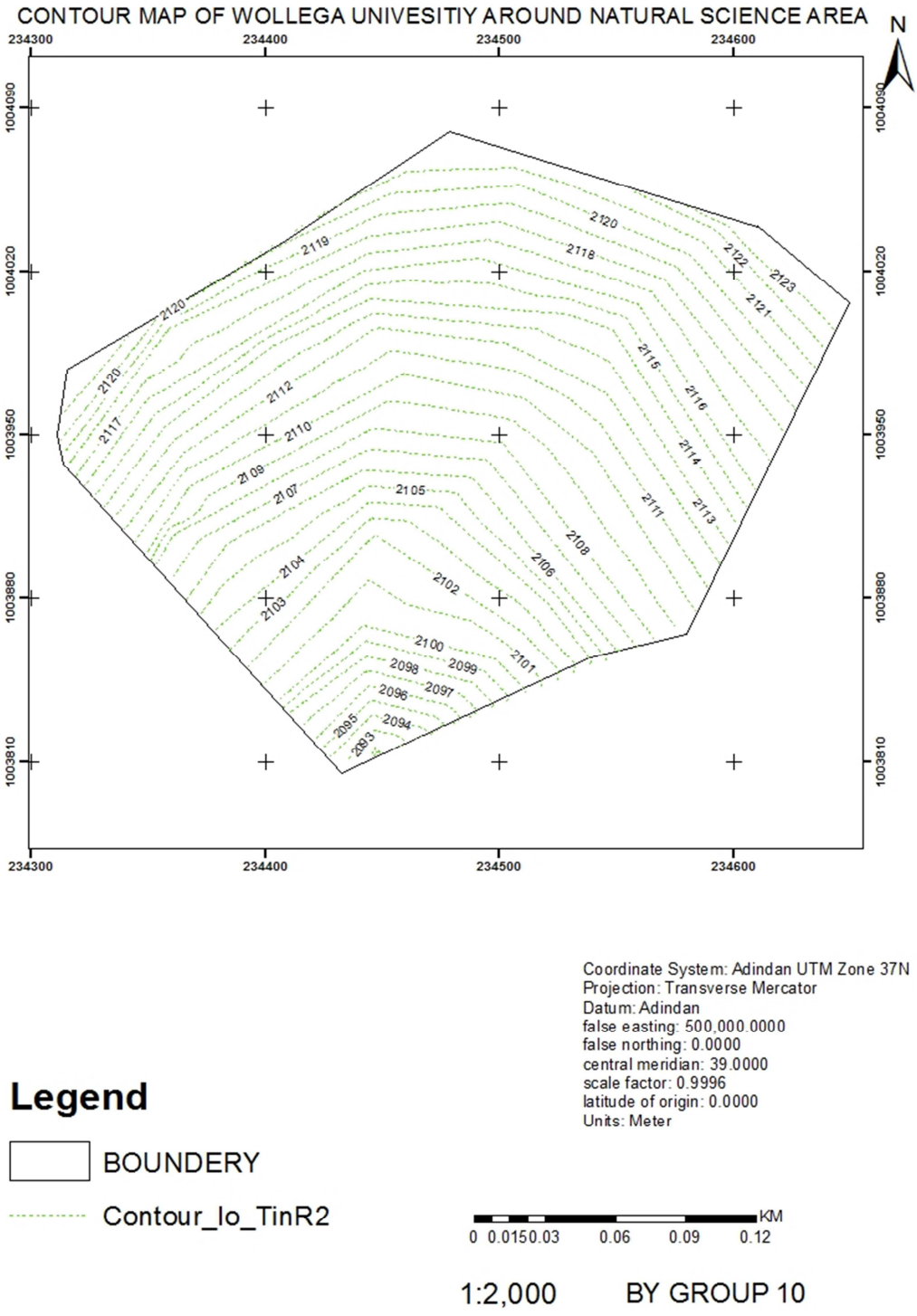

Figure 6. *Contour line map of the area.*

6. Results of Project (Output of the Project)

The output of the project is to prepared the topographic map of Walaga University, around Natural science area for the user (for identifying configuration of the area and also for educational purpose) and identifying land use land cover (percentage) of the area by using GIS from the collected field data by using ArcGIS software. By using all the map requirements, map elements for the prepared topographic map

of the project area which is parts of Wallaga University around natural science area. Land use land covers identifies area coverage in features presented in the areas This is the final topographic map of Wallaga university around natural science area is which contains all marginal information of map and all existed manmade natural features in the area is enumerated.

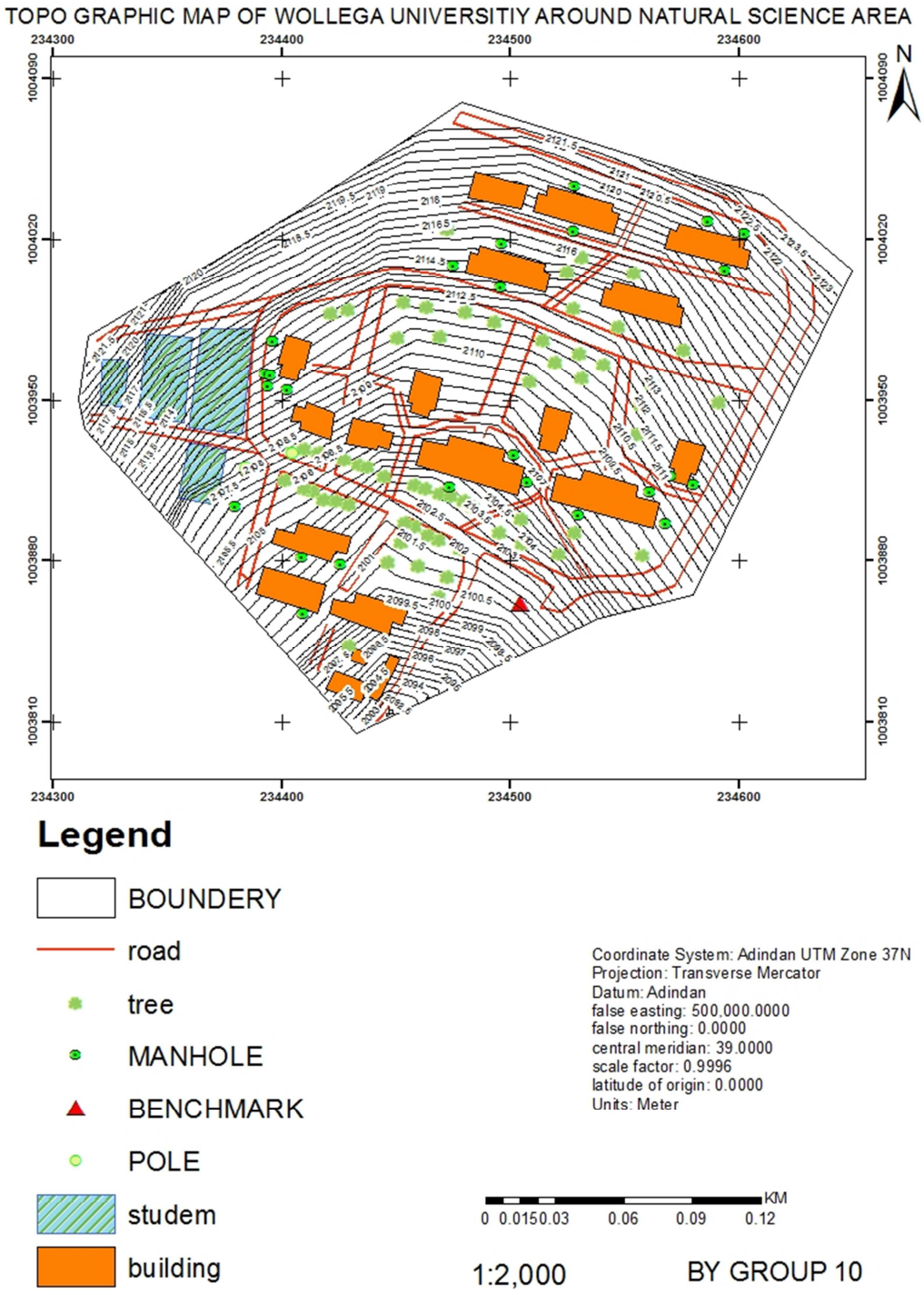

Figure 7. *Final topographic map of the area.*

7. Conclusion and Recommendation

7.1. Conclusions

To prepare topographic map is very important for any effort activities to run their occupation in any different area the work that can be done for existences and for the future. The topographic map should be correct and modernized and include all the features found in the area whether a natural or artificial features. To prepare a perfect and well-run topographic map, the use of different modern surveying instruments and techniques like Total Station and GIS Software in an advantage.

The topographic map of Wallaga University, specifically around the natural science area, encompasses a diverse range of features, both natural and manmade. The primary objective of this project, and the resultant map, serves multiple purposes. Firstly, it serves as a practical exercise to enhance skills in map-making, contributing significantly to the improvement of capabilities in producing topographic maps.

The meticulous effort involved in preparing a topographic map is crucial. Each feature in the area is represented with specific symbols to convey comprehensive information about its nature. The topographic map proves invaluable for the university's endeavors in studying various aspects such as slopes, elevation, maximum and minimum contour intervals, as well as the precise locations of infrastructure and different types of constructions.

In essence, our project involves the representation of Earth's surface features on paper through the utilization of symbols, colors, sizes, and diverse shapes. The extensive effort invested in the project results in the creation of a well-organized and qualified topographic map, designed to meet international standards for topographical mapping.

7.2. Recommendation

The preparation of topographic map is extremely useful for different purposes, so it is needed to have a modernized and precise map using the modern instrument like Total Station. So, we recommend the as follows: -

1) Surveying Engineering department would have to give attention on practical, software and laboratory works.
2) This Departments would have to give attention on Computer Lab for surveying student students to practical software as well as decided about lab safety and Radio during Data gathering.
3) The university also prepares more GCP for more reduce error which is used for a mini project or for trainees /the students and for facilitating any relating during data collection for prepare topographic maps.
4) The university should have to prepare all spatial and non-spatial data as a source for the growth of the university by doing a project or an input for a research on the university.
5) Public and new coming getting the chance for knowing all feature that found in WU, Nekemte Campus around natural science area with the easily full information from topographic map.
6) Lastly we would recommend regarding to accomplishment of this project, lab is crucial to this project but, there no access connection to facilitate our work in good manner. Generally; this University must solve such like problems as quick as possible for junior students.

Conflicts of Interests

The authors declare no conflicts of interest.

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