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ACCURACY ASSESMENT OF GOOGLE EARTH IN VOLUME COMPUTATIONS OF EARTHWORK MATERIALS AND ITS RELIABILIY WITH CONVENTIONAL DATA

A Case Study of Tanga, Pongwe ward

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BSc Geomatics

Dissertation

Ardhi University, Dar es Salaam

July, 2023

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A Dissertation Submitted to the Department of Geospatial Sciences and Technology in Partially Fulfilment of the Requirements for the Award of Bachelor Science in Geomatics (BSc. GM) of Ardhi University, July 2023

CERTIFICATION

The undersigned certify that they have read and hereby recommend for acceptance by the Ardhi University dissertation titled **"Accuracy assessment of google earth in volume computations of earthwork materials and its reliability with conventional data, Case Study of Tanga, Pongwe ward"** in partial fulfillment of the requirements for the award of degree of Bachelor of Science in Geomatics at Ardhi University.

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Mr. BAKARI MCHILA **Mr. TIMOTHEO JOSEPH**

Date ……………………… Date ………………………

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MOHAMED, HAMISI H.

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ACKNOWLEDGMENT

First and foremost, I sincerely thank the Almighty God the author of knowledge and wisdom for giving me strength and health to complete this study.

I extend my kind appreciations to Mr Bakari Mchila and Mr. Timotheo Joseph my supervisors, for their exceptional and endless support, kind and understanding spirit throughout my research. Their challenges, criticism and constant supervision has made this research successful.

Special thanks and appreciation to Ms. Valerie Ayubu from Ardhi University for her support, time and encouragement to this productive work.

I extend my gratitude to the staff members of Department of Geospatial Sciences and Technology (DGST) of Ardhi University, for their contributions during intermediate presentation sessions which helped me in one way or another to successfully accomplish my goals in this research.

Lastly, to my parents, close friends, relatives, colleagues, classmates and others who in one way or another gave their support and encouragement, either morally, financially or physically, thank you all.

DEDICATION

I dedicate this work to my mother Mrs. Zainab Salum Kambangwa, my relatives together with all my friends for their support for the completion of my Bachelor degree.

ABSTRACT

Google earth is the powerful geospatial tool that offers satellite imagery data for generation of digital elevation models and mapping capabilities for various applications in engineering activities. This research assessed the viability of google earth for volume computation of earthwork materials at ±3% percentage error.

The accuracy was checked by comparing with the volume obtained from data collected through convectional technique. The route was designed to both two type of data by considering the same differences between the existing and formation level at some selected chainages. The route designed is of class II, which is paved with roadway width 11.5m, comprises two lane each 3.75 m, with shoulder width 2 m in each lane. The process involved the use of computer software which is AutoCAD civil 3D.

The process of route design comprised several stages which started by creating the surface then from the surface the longitudinal profile was created to show the vertical view of the nature of the existing road. From the longitudinal profile the new road profile was designed. From there the assembly of road was created which comprised lanes, shoulder and day lights. From there, the volume of earthwork materials was calculated between the designed routes to existing surfaces. The net volume obtained from conventional data is 102297.80 m^3, and the volume obtained from the data extracted from the google earth was 93848.92 m^3. Based on the results obtained in this research between google earth and the convectional method the absolute error was 8.25% which is above ±3%.

Therefore, google earth technology is not feasible in data collection for computations of volume of earthwork materials. Thus, have to conduct additional studies to explore the accuracy and reliability of google earth in different geographic regions, terrain types instead of gentle slope of this study. Explore other remote sensing methods in data collection for volume computations of earthwork materials like that of using Landsat and sentinels images.

Keyword: Conventional technique, Google earth, Volumetric analysis, Road design

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATIONS

UAV	Unmanned Aerial Vehicle
CIA	Central Interagency Agency
FAA	Federal Aviation Administration
GPS	Geographical Positioning System
SRTM	Shurter Radar Topographic Mission.
EDM	Electronic Distance Measurements
GPR	Ground Penetrate Radar
DTM	Digital Terrain Model
CSV	Comma Separated Value
QGIS	Quantum Geographical Information System

CHAPTER ONE

INTRODUCTION

1.1 Overview

This chapter explain the background of the topic, statement of the research problem, main and specific objectives of the research, significance of the research and beneficiary.

1.2 BACKGROUND

Historically the most common method of collecting data for earthwork material volume calculations was manual surveying using traditional instruments such as theodolites, levels, and chains. This method involved measuring distances and elevations at various points on the site, and then using these measurements to create cross-sections or profiles of the site. Manual surveying was time-consuming and prone to errors, but was the only method available for many years (smith, 2021). In the 20th century, the development of new technologies such as electronic distance measurement (EDM) instruments and total stations made surveying more accurate and efficient. These instruments allowed surveyors to measure distances and elevations more quickly and with greater precision to compare with that of previous technology. The use of total stations and EDM instruments revolutionized the field of surveying, making it possible to obtain highly accurate measurements in a fraction of the time required by manual methods (Thomson, 2023).

In recent years, advances in technology have led to the development of new methods of data collection for calculations of volume of earthwork material. These include aerial photogrammetry, LiDAR (Light Detection and Ranging), and GPR (Ground Penetrating Radar). These methods allow for the collection of highly accurate data from a distance, without the need for direct contact with the site. New technologies such as aerial photogrammetry and LiDAR have made it possible to collect data on large sites quickly and efficiently, while GPR is useful for identifying subsurface features that may impact earthwork calculations (Anderson, 2022). But all those methods still be having some obstacles which is cost fully.

Previous studies have investigated the accuracy and reliability of google earth for various applications, including land cover classification, urban planning, and environmental monitoring. However, limited research has focused specifically on its performance in earthwork volume computation. Understanding the accuracy of google earth in this context is crucial to assess its suitability as a cost-effective alternative to conventional surveying methods. By comparing the results obtained from google earth with those derived from conventional survey data, researchers can evaluate its reliability and identify any limitations or discrepancies that may exist.

This research aims to address this gap in knowledge by conducting an accuracy assessment of google earth in volume computation of earthwork materials and evaluating its reliability compared to conventional survey data. The study will involve designing a road and then volume computed between the level of existing road to the level of designed road through a data extracted from the google earth with the data collected through conventional technique. These datasets will then be analyzed and compared using appropriate statistical methods to determine the level of agreement between the two approaches.

1.3 PROBLEM STATEMENT

In route design, convectional technique is the most used in data collection. But this technique is associated with challenges like time consuming, large number of man power also it is tiresome and sometime it is limited to collect data to the un accessible areas. The advancement of technologies like that of google earth can be used in data collection for surveying activities, however up to now no research has been conducted to check whether google earth is feasible for data collection for volume computations of earthwork materials. Therefore, the study intends to assess the accuracy of data extracted from google earth in volume computations of earthwork materials by comparing with data obtained from conventional technique.

1.4 OBJECTIVE OF THE RESEARCH

1.4.1 Main objective

To assess the accuracy of data extracted from google earth in volume computation of earthwork materials and its reliability with convectional data

1.4.2 Specific objectives

- Volume computation through data extracted from google earth.
- Volume computation through convectional data
- Comparison of results of volume obtained from the data extracted from Google earth with that of convectional method.

1.5 RESEARCH QUESTIONS

- How closely can google earth image volume estimates match those derived from convectional techniques?
- How well does google earth represent real world dimensions n both horizontal plane as well as the vertical?

1.6 DESCRIPTION OF STUDY AREA

The selected study area, is Pongwe ward in Tanga region. The central geographical location of pongwe is 5.125S 38.97E. The site was of gentle slope, comprises with manmade features like buildings.

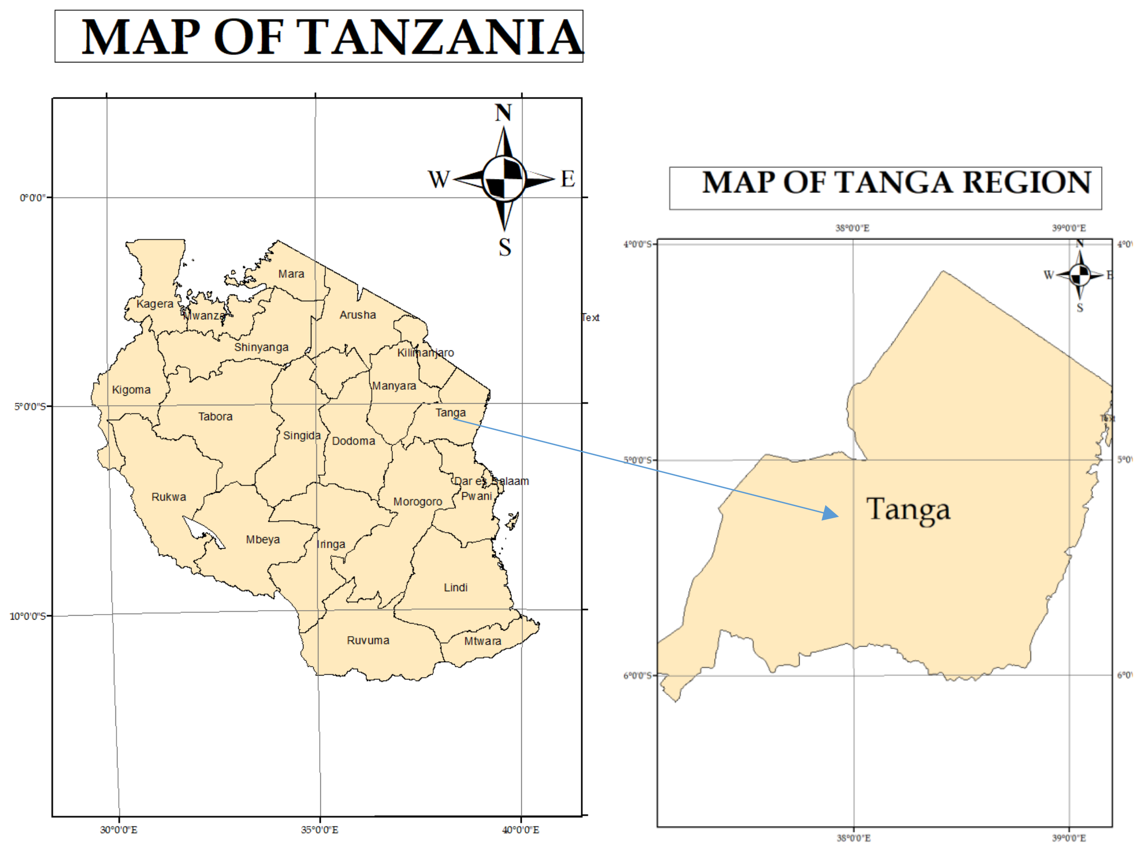

Figure 1.1: Map showing study area

1.7 SIGNIFICANCE OF THE RESEARCH

The research will be useful for professionals in fields such as surveying, engineering, construction, and environmental management, as it may help them determine the suitability of these new technologies for their own project and make more informed decisions about data collection methods. If applicable road design can be done without going to the field.

1.8 BENEFICIERS OF THE RESEARCH

- Professionals.

Surveyors and engineers as the major professionals involved in engineering work are one of the beneficiaries since they will have an alternative method, which is fast and accurate in volume computation in construction sites as it, saves time and costs.

- Contractors and Consultants in engineering projects.

The project owners and the project assessor also benefit from the results of this research as the addition of using a new method which is fast and cost effective other than conventional survey, will help to shorten the duration of project and start new projects.

- Miner in determination of Ore and waste amount.

Is one of the areas where volume computation is a day-to-day activity. Hence a new method and technology will help to reduce the risk in mine areas in measurement for volume determination.

1.10 EXPECTED OUTCOME

The result of the research could have implications for the use of Google Earth as a technique in data collection for volume computations of earthwork materials.

CHAPTER TWO

LITERATURE REVIEW

2.1 Overview

This section describes some of what others done in related work in order to give brief idea about the overall concept of precision and accuracy of total station and google earth pro in volumetric analysis.

2.2. Earthwork material

2.2.1 Definition of earthwork material

Earthwork materials are an essential component of civil engineering projects, particularly in the construction of highways, railways, and embankments. Earthwork materials are defined as materials that are excavated from one area and used to fill another area, typically to create a level surface for construction. These materials may include soil, rock, sand, gravel, and other aggregate (Khanna, 2005).

Proper selection and management of earthwork materials are critical to the success of any construction project. The properties of the soil and other materials used for earthworks can affect the stability and strength of the final construction, as well as its durability over time. It is therefore essential to conduct soil tests and other assessments to determine the quality and suitability of earthwork materials before beginning construction.

Figure2.1: Earthwork materials (Google)

2.2.2 Volume computations of earthwork materials

Volume computation of earthwork materials refers to the process of estimating the amount of earth, rock, or other materials that need to be moved or excavated from a construction site. This is an important aspect of construction planning and management, as it allows engineers and contractors to estimate the cost and time required for site preparation, grading, and excavation.

There are several methods for volume computation, ranging from simple manual calculations to advanced software applications. One common approach is to use topographic maps, survey data, and other geospatial information to create a digital terrain model (DTM) of the site. A DTM is a 3D representation of the terrain that can be used to calculate the volume of earthwork materials required to bring the site to a desired elevation.

In recent years, geospatial software such as google Earth Pro has become increasingly popular for volume computation of earthwork materials. This software provides high-resolution satellite imagery, 3D modeling, and measurement tools that allow users to estimate the volume of earthwork materials in a given area. The accuracy of the volume estimation depends on the quality of the input data and the precision of the measurement tools used.

2.2.3 Methods of volume computations

2.2.3.1 Section Method

This method involves taking cross-sections of the terrain at regular intervals and calculating the volume of earthwork materials between each cross-section. The formula used for calculation varies depending on the shape of the cross-section.

2.2.3.2 Prismoid Method

This method involves dividing the site into a series of prismoids, which are 3D shapes with a trapezoidal cross-section. The volume of each prismoid is calculated using a formula that takes into account the area of the two end faces and the area of the mid-section (Liu et al., 2020).

2.2.3.3 Grid Method

This method involves dividing the site into a grid of equally spaced points and taking elevation readings at each point. The elevation data is then used to create a digital terrain model (DTM), which can be used to calculate the volume of earthwork materials required.

2.2.3.4 Software Applications

In recent years, geospatial software such as Google Earth Pro, AutoCAD Civil 3D, and Trimble Business Center have become increasingly popular for volume computation of earthwork materials. These software applications provide advanced 3D modeling and measurement tools that allow users to estimate the volume of earthwork materials in a given area with high accuracy (Chen, 2020).

2.3. 3d modeling

3D modeling refers to the process of creating a three-dimensional representation of an object or environment using specialized software. The goal of 3D modeling is to create a virtual model that accurately represents the physical object or environment in terms of its shape, texture, color, and other properties (Gardiner, 2020).

2.4. Convectional survey technique

Convectional surveying techniques refer to the traditional methods of land surveying that have been used for centuries. These methods involve the use of instruments such as theodolites, total stations, levels, and chains, among others, to measure distances, angles, and elevations (Kavanagh, 2012).

One of the most common techniques in conventional surveying is triangulation, which involves the use of triangles to calculate the distances and positions of points on the ground (Kavanagh, 2012). This method is based on the principles of trigonometry and involves measuring the angles between the points and using them to calculate the distances.

Another technique used in conventional surveying is traversing, which involves measuring the angles and distances between a series of points along a path (Kavanagh, 2012). This method is commonly used for surveying roads, pipelines, and other linear features.

Convectional surveying techniques also involve the use of leveling instruments, which are used to measure the elevations of points on the ground relative to a benchmark (Kavanagh, 2012). This method is commonly used in construction and engineering projects to ensure that structures are level and properly aligned.

Despite the emergence of new technologies such as GPS (Global Positioning System) and laser scanning, conventional surveying techniques are still widely used today. These methods are often preferred for smaller-scale projects, where the high cost and complexity of new technologies may not be justified (Kavanagh, 2012).

2.5 Overview of google earth pro

Google Earth Pro is a powerful geospatial software that allows users to explore the world through high-resolution satellite imagery, 3D modeling, and other geographic data (Mishra, 2021). With Google Earth Pro, users can visualize and analyze spatial data, measure distances and areas, create custom maps and overlays, and even perform virtual tours of real-world locations. The software is widely used in a variety of fields, including geography, geology, urban planning, environmental science, and education (Mishra, 2021).

2.5.1 Google earth in volume computations

Google Earth as a geospatial software can be used for a wide range of applications, including volume computation of earthwork materials (Chung, 2021). This software provides high-resolution satellite imagery, 3D modeling, and measurement tools that allow users to estimate the volume of earthwork materials in a given area. In addition to volume computation, Google Earth Pro can also be used for site analysis, project planning, and visualization of spatial data (Chung, 2021).

There are several methods to obtain the volume of earthwork materials using Google Earth Pro. One approach is to use the software's built-in measuring tool, which allows users to draw polygons around an area and calculate its area and perimeter (Brown, 2022). Once the area of interest is defined, users can create a digital terrain model (DTM) of the site by importing elevation data from sources such as USGS (U.S. Geological Survey) or SRTM (Shuttle Radar Topography Mission). The DTM can then be used to calculate the volume of the material to be excavated or added using the cut-and-fill method.

Another approach is to use third-party software that integrates with Google Earth Pro, such as Civil 3D, AutoCAD, or Carlson Software. These programs can import the terrain data from Google Earth Pro and provide advanced tools for analyzing and designing earthworks, including volume calculations. For example, Civil 3D has a feature called "Volume Dashboard" that can calculate cut and fill volumes based on different design scenarios and generate report (Park, 2019).

2.6. Overview of previous studies concerned with Volume computations of Earthwork materials

Oluibukum, John designed a test concerned with calculation of earthwork materials, they are based on volume of stockpiles. Assessed the accuracy of Unmanned aerial vehicle (UAV) compared with ground GPS. Finally in comparing the volume from UAV with that of Ground data it seems that UAV is feasible for volume computation it was deviated only 0.9% at a height of 60m and 0.8% at a height of 100m.

(Lee, 2019), performed the test to check the accuracy of Images acquired by Unmanned Aerial vehicles at a different eight cases, case 1-4 the image acquired from a height of 50 m, and case 5-8 images are acquired from a height of 100 m and at a different angle in each case. Table below show those eight cases and their results.

Table 2.1: Accuracy acquired by Unmanned Aerial vehicles

Cases	Angle (°)	Results (%)
Case 1	90°	98.71
Case 2	90° + 45°	99.73
Case 3	90° + 60°	98.21
Case 4	90° + 75°	97.58
Case 5	90°	97.90
Case 6	90° + 45°	98.96
Case 7	90° + 60°	95.77
Case 8	90° + 75°	96.50

From the studies done it is clearly shows that the UAV can be used as a method of data collection for volume computations of earthwork materials, but the problem still comes in the costs of operating those machines. This research it come to check the possibility of using google earth which is costless, as a method of data collection for volume computations of earthwork materials in order to minimize those costs from using UAV and other techniques.

2.7. Error analysis in calculation of earthwork materials

According to the American Society of Civil Engineers (ASCE, 2020), error analysis in the calculation of earthwork material involves identifying and quantifying the different sources of error that can impact the accuracy of the calculations. These errors can arise due to a range of factors, including measurement errors, errors in data entry or recording, and errors in the assumptions or methods used in the calculation.

One of the main sources of error in earthwork calculations is the accuracy of the measurements used to determine the volume of material to be moved. This can be affected by a variety of factors, such as the precision of the surveying equipment and the skill and experience of the surveyor. Additionally, errors can arise due to discrepancies between the actual topography of the site and the assumed topography used in the calculation. Another source of error in earthwork calculations is errors in data entry or recording. These can occur during the measurement process or during the transfer of data to the calculation software or spreadsheet. Such errors can be minimized through the use of electronic data capture and automated data processing. To minimize errors in earthwork calculations, it is important to use accurate and reliable measurement techniques, carefully review and verify data, and use appropriate methods and assumptions in the calculation process. Additionally, it is important to conduct sensitivity analyses to assess the impact of errors and uncertainties on the calculated results.

2.7.1 Methods of error analysis

According to (Taylor, 1997), the methods of error analysis involve a variety of mathematical techniques used to quantify and characterize the different types of errors that can occur in measurements and calculations. These methods can be broadly categorized into two main types, statistical and systematic error analysis.

Statistical error analysis involves using statistical methods to analyze the variation in a set of measurements or data points. This includes techniques such as calculating the mean and standard deviation of a set of measurements, as well as conducting hypothesis tests to determine whether the variation is due to random error or some other factor.

Systematic error analysis, on the other hand, involves identifying and characterizing the sources of systematic error that can affect the accuracy and precision of measurements and calculations. This can be done through a variety of methods, such as analyzing the calibration of instruments, identifying and quantifying biases in measurement techniques, or conducting sensitivity analyses to assess the impact of different factors on the final result.

(Taylor, 1997) also notes that error analysis often involves the use of error propagation techniques. These techniques involve using mathematical formulas to propagate the errors in individual measurements or data points through to the final result. This allows researchers to quantify the overall uncertainty in the result and identify the most significant sources of error.

CHAPTER THREE

METHODOLOGY

3.1 Overview

This chapter describes methods, procedures that have been used to achieve the study objectives.

3.2 Data collection

3.2.1. Convectional technique

Data that collected through convectional technique are collected from site, involve detail picking of a road edge, cross section and other significance features which are within in 60m. The data collected in Tanga region Pungwe ward, which cover 4km with a span of 30m each side from the center of the road.

3.2.2. Data collection through google earth

The data from the google earth are extracted through the following process: _

1. Profile was created along the area of an interest from the google earth.
   This created in term of paths across the center of the existing road within a span of 30m to each side of the existing road.

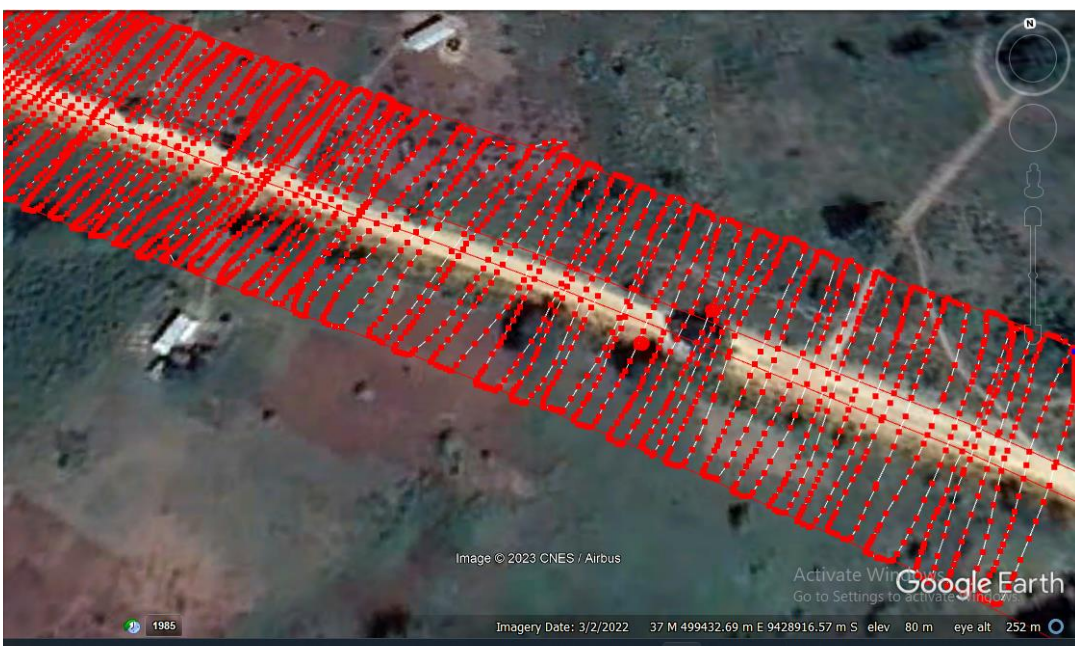

Figure3.1: Extraction of data from google earth

2. Obtain the elevations from the profile. In this, the profile is imported to the browser (*GPS visualizer .com*) to obtain those elevations.
3. The file that obtained from the GPS Visualizer imported into TCX convertor to get data in CSV format.
4. Creation of Digital Terrain model through the data extracted from the google earth.

   The Digital Terrain Model created through the data extracted from the google earth by using the Golden Surfer software.

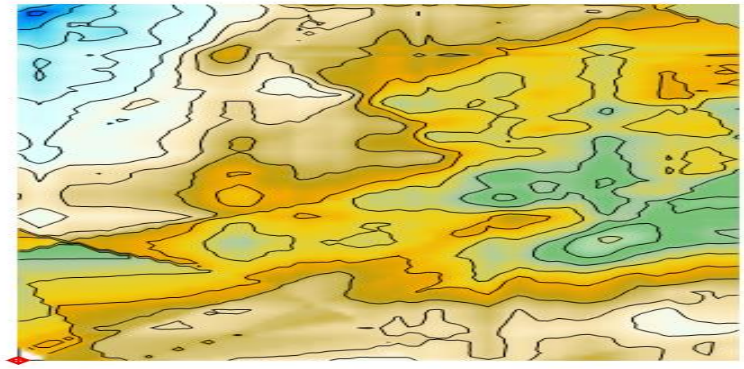

Figure3.2: 2D view of Digital Terrain Model

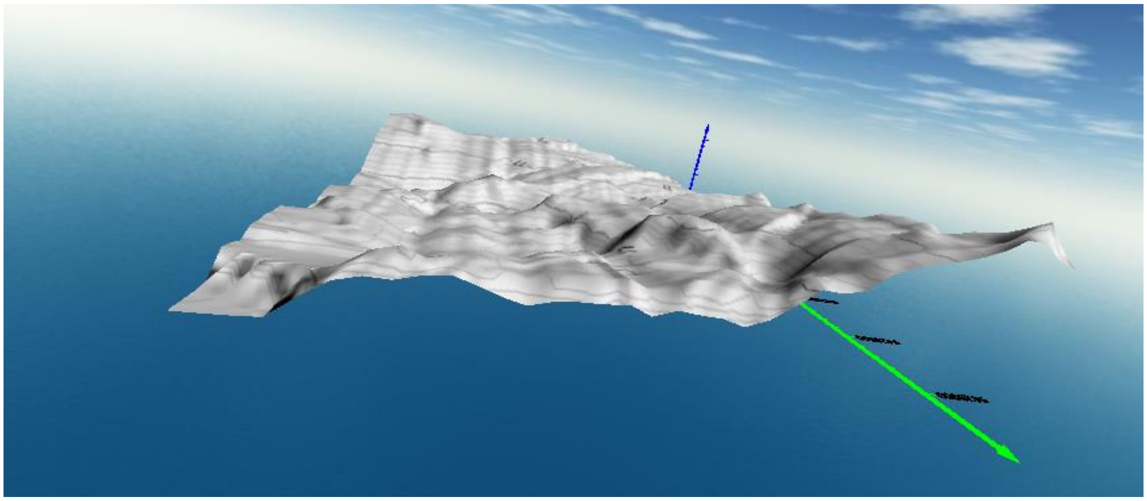

Figure3.3: 3D view of Digital Terrain Model.

5. Data extraction from the Digital Elevation Model.

   This process was done by taking the position data which collected through the conventional technique imported to the golden sulpha softeare associated with Digital terrain model generated with data extracted from google earth for the aim of explore the elevations according the position of conventional data.

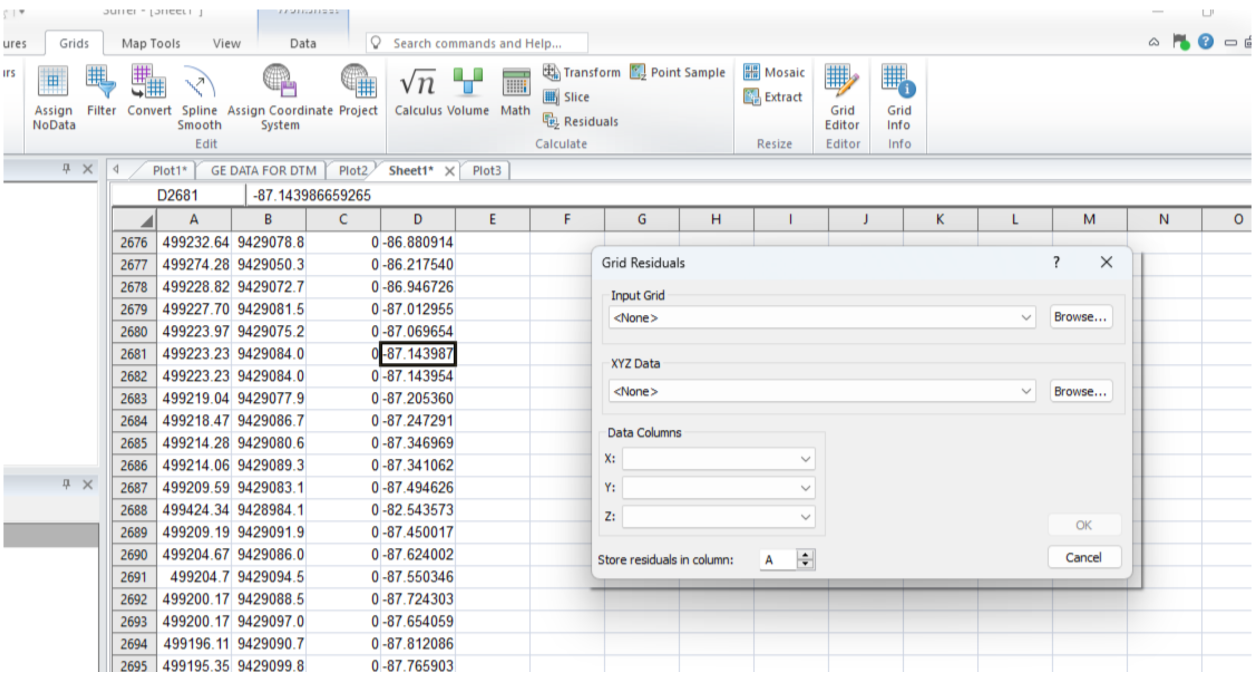

Figure3.4: Extracted elevations

3.3 Data processing

The data collected from field and the data extracted from google earth was processed to get the desired outputs. The processing involved cleaning, coding and sorting. The data was processed to deliver the best and quality output such as alignments, longitudinal profile and topographic maps along the routes. The process involves the use of computer software such as AutoCAD civil 3D, QGIS 3.6 and ArcGIS. All those processes were done to both two type of data that are those from google earth and those survey ground data.

3.4 Route design and volume computation

Route designed without considering the criteria design like foresight distances, design speed, traffic volume, this because the area was not conducted the geotechnical and geophysical survey. The only thing considered was the changes of elevations from the existing to the formation level in order to get the synchronization of formation levels of conventional technique with that of google earth. Also assumed that the material excavated can compensated to fill.

The route designed is of class II, which is paved with road reserve width 60 m, roadway width 11.5m, comprises two lane each 3.75 m, with shoulder width 2 m in each lane. The process involved the use of computer software which is AutoCAD civil 3D.

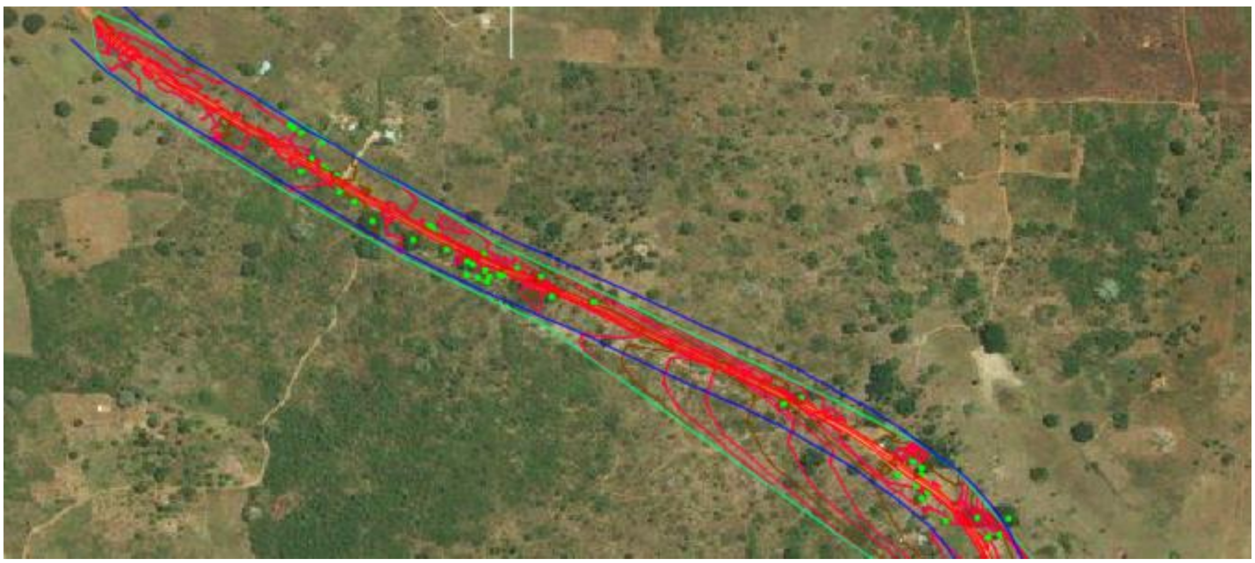

Figure3.5: Route design

The process of route design comprised several stages which are, start by creating the surface then from the surface the longitudinal profile was created to show the vertical view of the nature of the existing road.

3.4.1 Longitudinal profile creation

Longitudinal profile this refer to the diagram that show the verticality nature of the ground. The longitudinal profiles were created by starting creating the contour of the surface, then from the contour the horizontal alignment along the center of the existing road was created, so the longitudinal profiles were created along the center of the existing road.

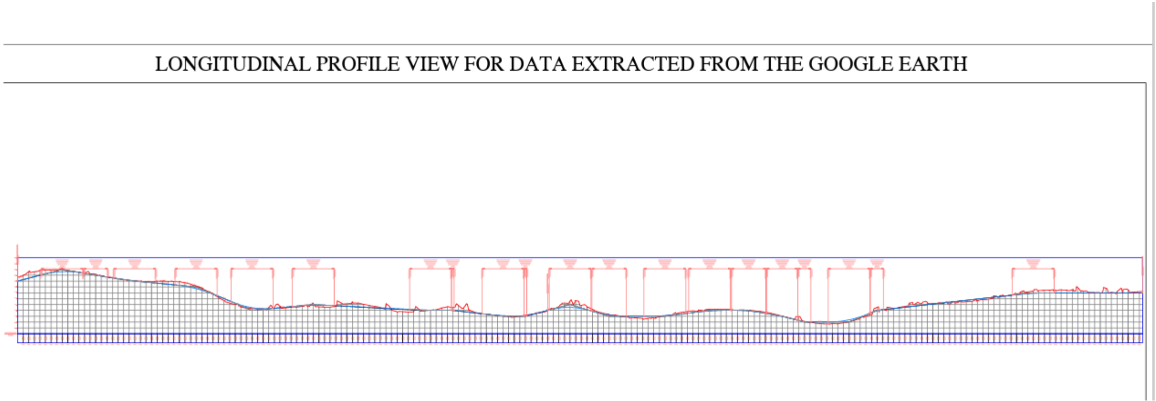

Figure3.6: Longitudinal profile

3.4.2 New Road design

The new road designed in all two types of data sources, the same designing was followed by considering the same changes of elevation from the existing road with formation level at the some of the selected chainages. Below is the table that show the chainage where have same changes from the formation level to the existing level.

Table3.1: Changes of levels

S/N	Chainage (m)	Difference in Elevations from existing (m)
1	0+ 00	0
2	0+ 150	0
3	0+ 225	-0.92535
4	0 +525	-1.1035
5	0 + 875	-0.37055
6	1 + 175	-0.18610
7	1 + 600	-0.41669
7	1 + 825	-0.42631

8	1 + 975	-0.21585
9	2 + 300	-1.78013
10	2 + 475	-0.33462
11	3 + 000	-0.63609
12	3 + 225	-0.03592
13	3 + 500	-0.13327
14	3 + 650	-1.9361
15	4 + 025	-0.42909

From the longitudinal profile the new road profile designed. From there the assembly of road created which comprise Lanes, shoulder and Day lights. Finally the new design and assembly combined to create a road corridor.

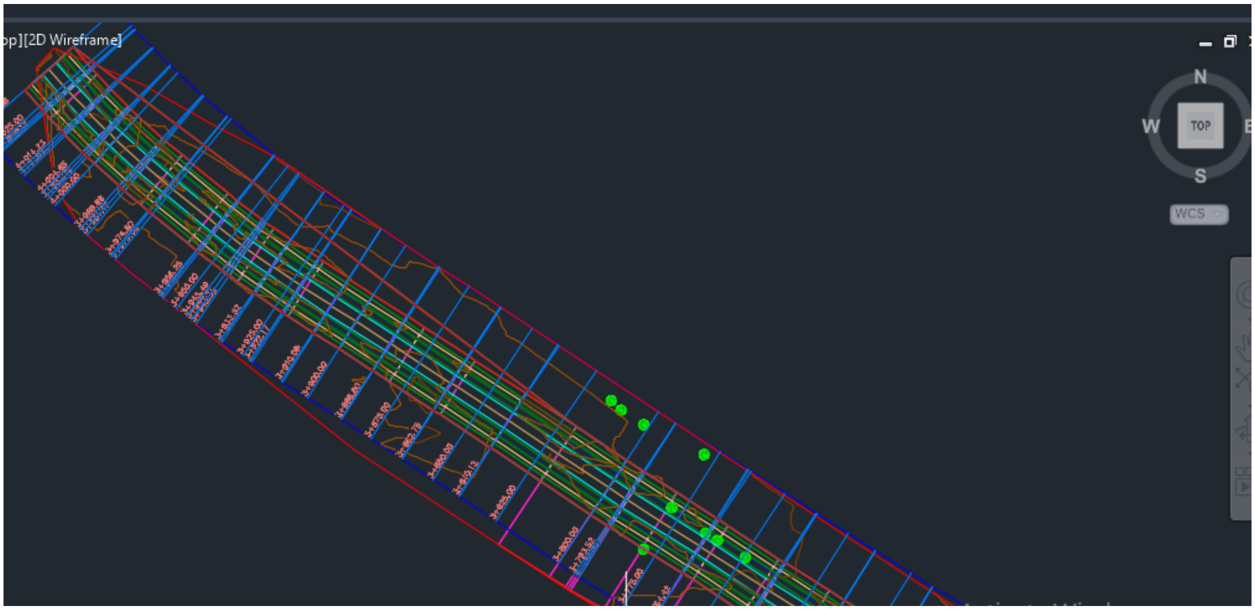

Figure 3.7: Road corridor

From there, the volume of earthwork materials calculated between the designed routes to existing surfaces.

CHAPTER FOUR

RESULTS AND ANALYSIS

4.1 Overview

This chapter includes the analysis and discussion of the findings gathered from this research by checking the percentage relative error between the result obtained from convectional and that of google earth.

4.2. Road design

The road designed was paved road of class II with width of 11.5m, road reserve of 60m. In road design start by creating topographic maps of the study area. Longitudinal profiles that show the nature of the center of the existing road also created. From the longitudinal profiles the new roads designed by ensuring the differences between the formation level to the existing level. All designing are presented in APPENDICES.

4.3. Volume computation

By start with conventional data, From the volume computation report which is presented in appendices the volume was found to be 51711.56 m^3 cumulative fill, and 154009.36 m^3 cumulative cut volume, thus the net Volume is 102297.80 m^3. From the google earth 76791.88 m^3 cumulative fill volume and 170640.81 m^3 cumulative cut volume, thus the net volume is 93848.92 m^3.

From the results obtained the accuracy checked by looking on relative errors between the true volume which is that of convectional with assumed volume which is that of google earth data.

$$RELATIVE\ ERROR = \frac{\text{VOLUME 1} - \text{VOLUME 2}}{\text{VOLUME 1}} \text{ X } 100\%$$

Where

VOLUME 1 Volume obtained through convectional data

VOLUME 2 Volume obtained from data extracted from google earth.

$$RELATIVE\ ERROR = \frac{102297.80 - 93848.92}{102297.80} \text{ X } 100\%$$

$$RELATIVE\ ERROR = \frac{8448.88}{102297.80} \text{ X } 100\%$$

RELATIVE ERROR = ± 8.26%

4.4. Discussion

Based on the results obtained, a number of decisions can be made, expecting the same volume is not realistic at all, the table below show the comparison based on measurements and ability in volume estimation.

Table 4.1: Volume comparison

Quantity	Com. Cut (m^3)	Com. Fill (m^3)	Net volume (m^3)	Diff. in volume (m^3)	Percentage error
Volume 1	154009.36	51711.56	102297.80	8448.88	±8.25%
Volume 2	170640.81	76791.88	93848.92		

4.5. Measurement comparison

Based on the results of the measurements performed between data extracted from google earth and conventional measurement (in situ measurement), the majority of relative percentage error were more than ±3%.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

This research is basically assessing accuracy of the google earth technology in data collection for computation of earthwork materials by comparing it with convectional technique.

Research aimed at assessing the accuracy of google earth in volume computation of earthwork material and evaluate its reliability in conjunction with conventional data. However, the analysis of the results has revealed that google earth may not be a viable option for estimating earthwork material volumes, and its reliability when compared to conventional survey methods is questionable.

The findings indicate significant discrepancies between the volume measurements derived from google earth imagery and those obtained through traditional survey techniques. The inaccuracies observed can be attributed to several factors. The resolution and quality of the satellite imagery provided by google earth may not be sufficient to capture the intricacies of the topography accurately. This can result in distorted elevation data, leading to erroneous volume calculations.

Moreover, the limitations inherent in satellite imagery, such as cloud cover, image distortion, and temporal variations, further contribute to the unreliability of google earth for volume computation. These factors introduce uncertainties that can significantly impact the accuracy of the measurements, making it challenging to rely solely on google earth data for earthwork material volume estimations.

Based on the analysis of the results, it can be concluded that google earth is not a viable option for accurate volume computation of earthwork material. Instead, the google earth may be used in preliminary stages like in visibility studies. Further research and advancements in satellite imagery and data processing techniques are necessary to address the limitations and improve the reliability of google earth for such applications.

5.2. RECOMMENDATIONS

Conduct additional studies to explore the accuracy and reliability of google earth in different geographic regions, terrain types, different of that of pongwe ward which is located at Tanga. This will help to validate the findings and understand the generalizability of the results.

Explore other remote sensing methods in data collection for volume computations of earthwork materials like that of using Landsat images.

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APPENDIX 1

VOLUME REPORT FOR CONVECTIONAL DATA

Cut/Fill Report

Generated:	2023-07-16 08:41:38
By user:	Mohamed Hamisi
Drawing:	D:\DATA PROCESSING\ROAD DESIGN CONV\D:\DATA PROCESSING\ROAD DESIGN CONV\ROAD DESIGN CONV.dwg

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (sq.m)	Cut (Cu. M.)	Fill (Cu. M.)	Net (Cu. M.)
VOLUME CONV (2)	full	1.000	1.000	216740.67	154009.36	51711.56	102297.80<Cut>

Totals

	2d Area (sq.m)	Cut (Cu. M.)	Fill (Cu. M.)	Net (Cu. M.)
Total	216740.67	154009.36	51711.56	107936.92<Cut>

* Value adjusted by cut or fill factor other than 1.0

APPENDIX II

VOLUME REPORT FOR DATA EXTRACTED FROM GOOGLE EARTH

Cut/Fill Report

Generated:	2023-07-16 08:52:41
By user:	Mohamed Hamisi
Drawing:	D:\DATA PROCESSING\ROAD DESIGN GE\D:\DATA PROCESSING\ROAD DESIGN GE\ROAD DESIGN GE.dwg

Volume Summary

Name	Type	Cut Factor	Fill Factor	2d Area (sq.m)	Cut (Cu. M.)	Fill (Cu. M.)	Net (Cu. M.)
VOLUME GE	full	1.000	1.000	226721.10	170640.81	76791.88	93848.92<Cut>

Totals

	2d Area (sq.m)	Cut (Cu. M.)	Fill (Cu. M.)	Net (Cu. M.)
Total	226721.10	170640.81	76791.88	93848.92<Cut>

* Value adjusted by cut or fill factor other than 1.0

7/16/2023