KATHMANDU UNIVERSITY

SCHOOL OF ENGINEERING

DEPARTMENT OF GEOMATICS ENGINEERING

DHULIKHEL, KAVRE

A MINI PROJECT REPORT ON

TOPOGRAPHIC MAP PREPARATION

USING UAV GENERATED ORTHOMOSAIC

PREPARED BY:

Rajesh Rokaya (63)

Level: UNG/ III Year/ I Semester

SUPERVISOR

Er. Sujan Sapkota

27 June, 2024

ABSTRACT

Although the goal of this mini project is exploration of the Pix4D software and the process of creating orthophotos has been significantly changed by unmanned aerial vehicles (UAVs), which offer a practical and affordable substitute for mapping and surveying tasks. The process and findings for generating an orthophoto of the kritipur ward no. 8 panga bus-park area using UAV technology are presented in this technical study. 106 photos were taken, with a front overlap of 80% and a side overlap of 70%. Pix4D mapper was used to process the photos in order to create an orthomosaic, DTM, Contour and orthorectified image while accounting for terrain displacement and ArcGIS was used to prepare topographic map. This study offers a through analysis of the steps involved in creating the orthophoto as well as the outcomes and constraints of the UAV-based orthophoto of kritipur area. The topographic map obtained from orthophoto provides a detailed picture of the topography, making it an invaluable tool for future mapping and surveying operations. The keywords using in this project was Image processing, UAV, DSM, 3D points Orthophoto, DTM, Contour, topographic map, GIS.

LIST OF FIGURES

LIST OF TABLES

TABLE OF CONTENTS

1.INTRODUCTION

Photogrammetry, also known as photogrammetric surveying, involves precise measurements derived from photographs or digital images. Its purpose is to locate features on or above the Earth's surface. When extensive area mapping is required, photogrammetry serves as a reliable alternative to traditional ground surveying methods. Albrecht Meydenbauer, a Prussian architect, first used the term "photogrammetry" in his 1867 paper "Die Photometrographie." The name itself combines the terms "photo," which describes an image, and "meter," which denotes a measurement. Essentially, photogrammetry is a combination of science and art. covering the technological tools required to obtain precise data on tangible items and their environments.

1.1 Background

The mapping and measurement method known as photogrammetry is one that uses aerial photography as a middleman rather than direct mapping. For many years, this method has been employed for many different tasks, one of them being the creation of extensive base maps. (SADIKIN, Hendriatiningsih, 2019) Unmanned aerial vehicles, or UAVs, are one of the technologies that are commonly employed in photogrammetric mapping techniques these days. Numerous advantages come with using UAVs, such as cost effectiveness, adaptability, high-resolution imaging, and quick data collecting. The position and orientation of the camera during image collection are determined by the IMU and airborne GPS units, and this information is employed in the image orientation process. (Alkhalil, 2022) DSM (Digital Surface Model)/DTM and an orthophoto to depict two-dimensional features are required to generate a topographic map. Drone surveying, also known as UAV (unmanned aerial vehicle) surveying, provides several benefits for various applications like Time and Cost Efficiency, Accurate and Exhaustive Data, Access to Inaccessible Areas, Quality Aerial Imaging, and Safety and Risk Reduction. In conclusion, drone surveying provides a useful and efficient way for jobs like cadastral surveys, mapping of land, and evaluation of infrastructure. Because of its benefits, it is a necessary instrument in contemporary surveying procedures.

1.2 Problem Statement

UAVs equipped with advanced sensors and high-resolution cameras capture detailed imagery of the terrain, providing a level of detail that may be challenging to achieve through traditional mapping methods. Advances in data processing software enable efficient handling of large datasets generated by UAVs. This accelerates the production of accurate topographic maps, making the entire process more streamlined.

1.3 Objectives

The primary goal of this project is to utilize a DJI drone to capture aerial images of a designated area and subsequently employ Pix4D, a UAV image processing software, to generate a digital Ortho-mosaic, Digital Surface Model (DSM), and Digital Terrain Model (DTM) and made a topographical map.

1.3.1 Main Objective

To produce or prepared detailed and accurate topographic maps by capturing high-resolution imagery using UAVs.

1.3.2 Sub-Objective

To learn about UAV flight planning and execution and to understand the procedure of image processing and map preparation in GIS environment.

1.3.3 Significance of Study

The study encourages interdisciplinary learning by combining aspects of geography, and technology. The findings of the study might be helpful for enthusiasts willing to plan flight and capture UAV image to prepare products such as orthomosaic, DSM, DTM, contours, topographic map, etc.

2 .METHODOLOGY

2.1 Study Area

The work was carried on the western region of Kritipur municipality and the study area is lies in ward no. 5, ward no. 8, and some area lies in the core area of panga, located about 9.7 km west of Kathmandu, the capital of Nepal. The figure is shown in given below:

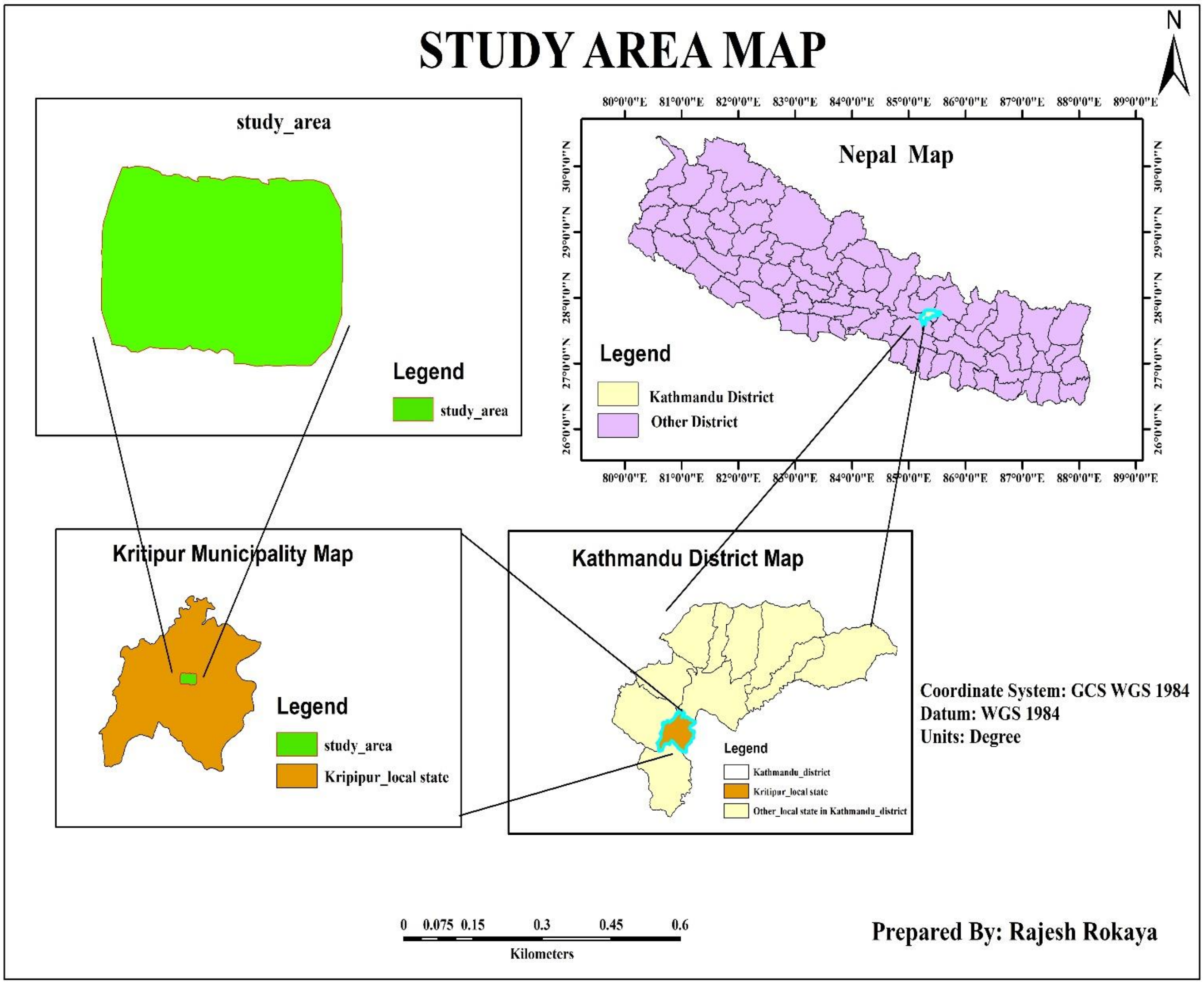

Figure 1: Map of Study Area

2.2 Specification Used

The specification used are given below in the table:

Table 1: Specification use:-

S.N	PARTICULARS	SPECIFICATION
1	Overlap	80% , 70%
2	Flight Planning	DJI Drone
3	Processing Software	Pix 4D Mapper
4	UAV	DJI Phantom 3
5	Type of File	JPG file (.jpg)
6	Altitude	70m
7	Image Dimensions	4000 x3000 Width: 4000 pixels Height:3000 pixels
8	Camera Model	FC300S
9	F-stop	f/2.8
10	Exposure Time	1/263 sec

2.3 Working procedure

The working procedure is shown in given below:

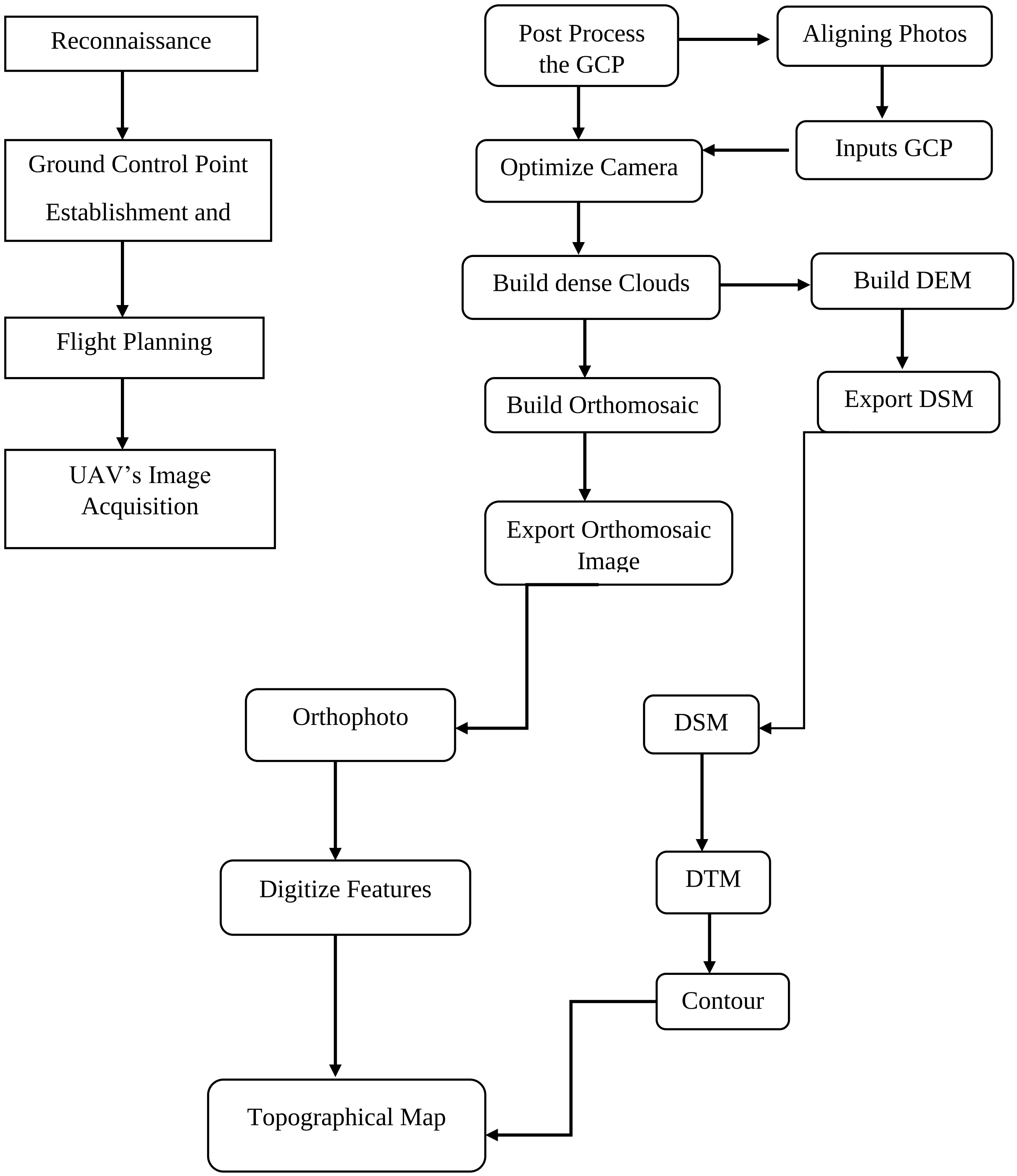

Figure 2: Work Flow

2.3.1 Planning

Reconnaissance for determining number and location of GCPs (Ground Control Points) was done. Flight planning was done for covering the entire area.

2.3.2 Image Capture and Flight planning

The flight plan was made using the single grid method in the DJI Pilot android application. An orthomosaic is defined as having a forward overlap of greater than 60% and a side overlap of at least 20%. However, it is suggested that UAVs utilize a wider overlap value of 80%–85% to lessen the possibility of gaps in the orthomosaic. (Tziavou, 2018). For this project, a Phantom 4 Pro drone was used to capture 106 orthogonal JPG images at a height of 70 feet, with 80% and 70% overlap on the front and side, respectively.

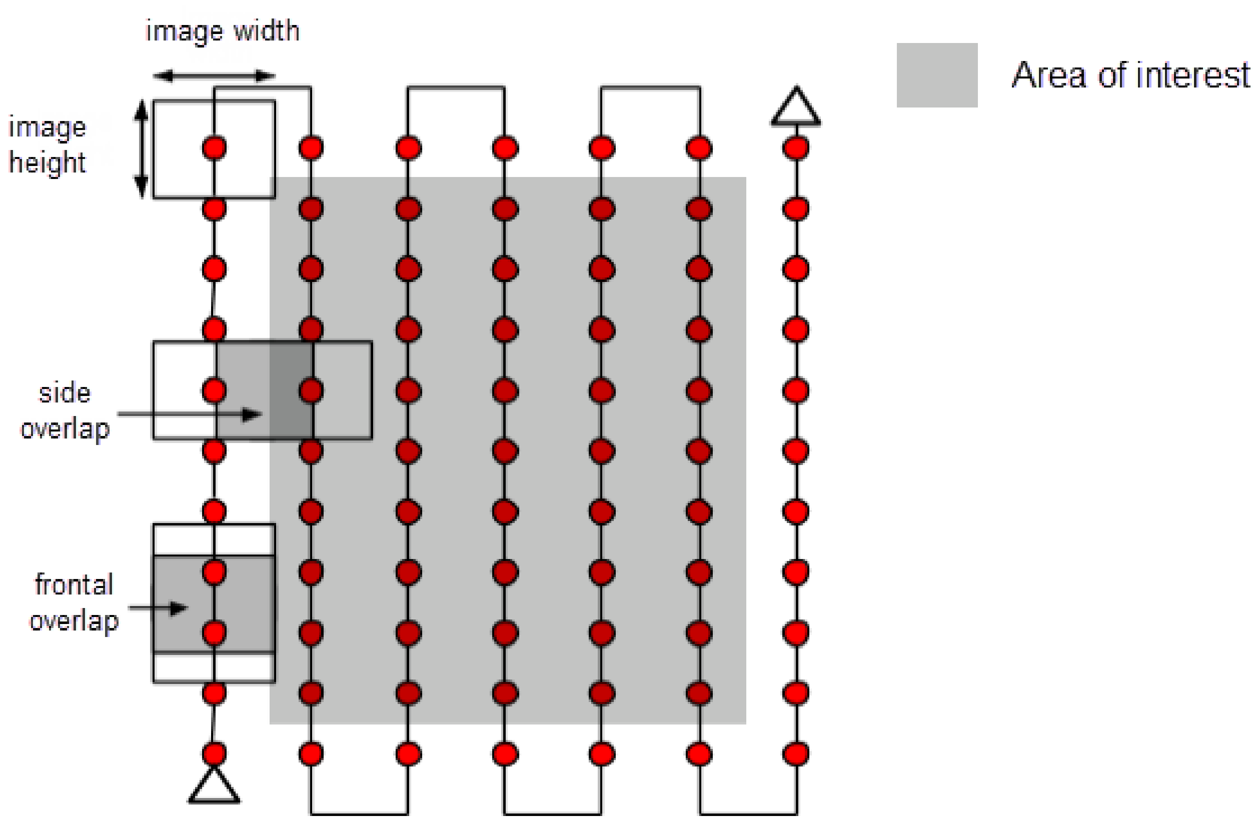

Figure 3: Flight Path

2.3.3 Image Processing

A dense cloud that was precise and detailed was produced by using higher quality settings. Rematching and reoptimizing were done to eliminate outliers brought on by noisy or inadequately focused photos. Using geographic projection and dense clouds as source data, the DSM, DTM, and orthophoto were produced. While just ground point classes were used for DTM, all point classes were employed for DSM in order to incorporate all ground features.

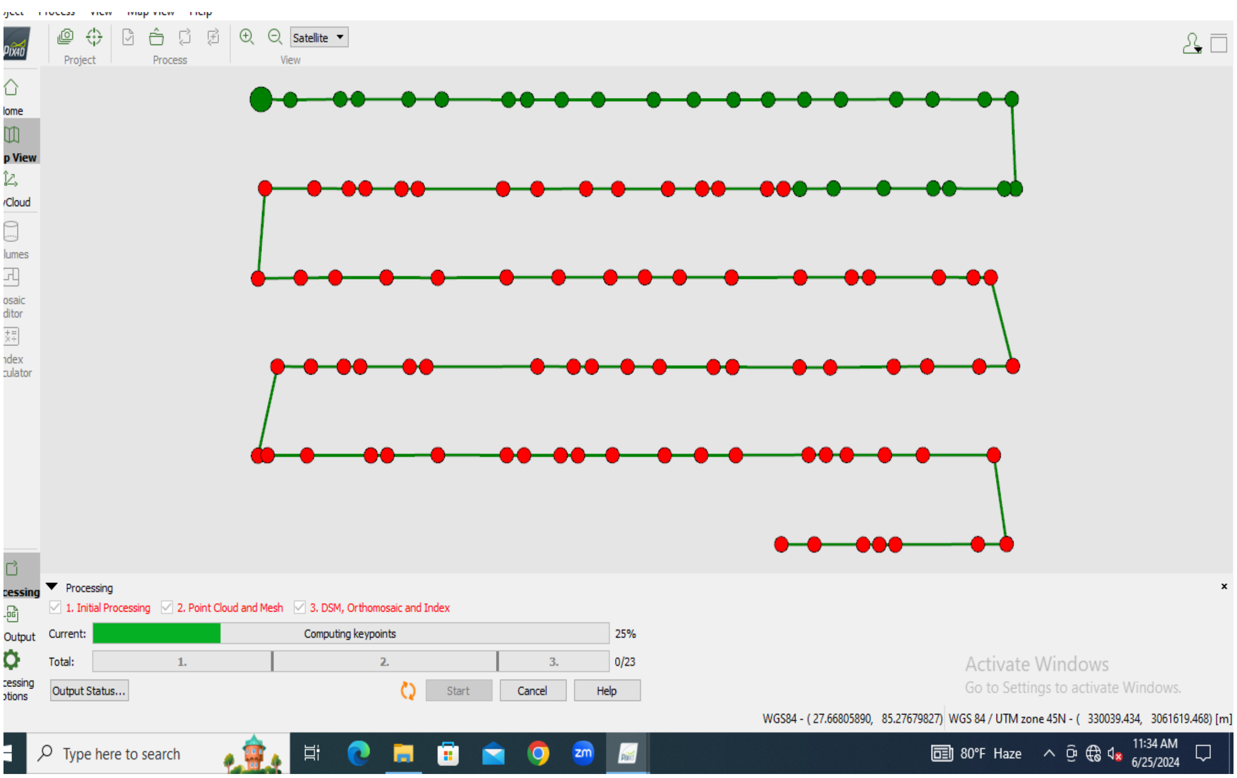

Figure 4: Image Processing of Study Area

2.3.4 Orientation and Geolocation

Pix4Dmapper can process images with or without geolocation. We haven't taken GCPs for orientation and manual georeferencing hence, images are not geolocated and ready for further processing to produce accurate UAV digital products.

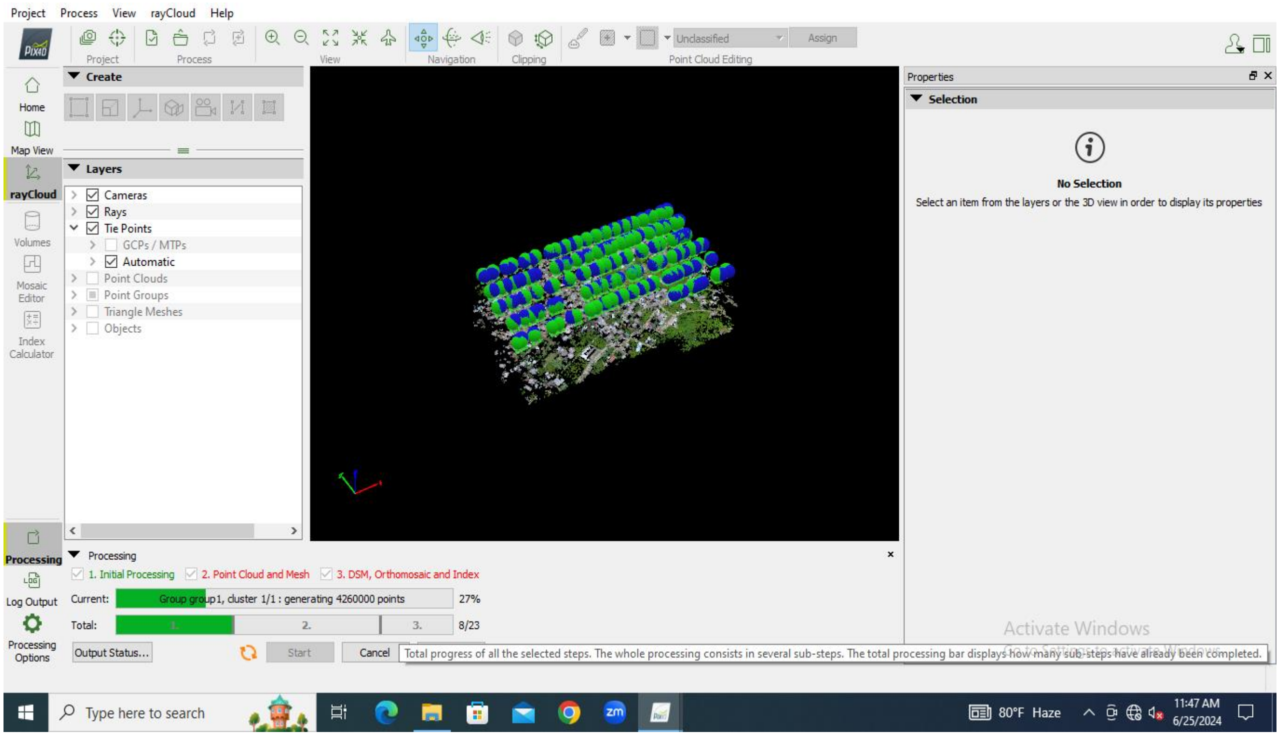

Figure 5: Cloud Ray View of Study Area

2.3.5 Generation of Orthomosaic, DSM and DTM

The goal of the project is to produce a high-accuracy topographical map of the study area by utilizing a DJI drone to take aerial photos and Pix4D software to produce an orthophoto, digital surface model (DSM), and digital terrain model (DTM). While a DTM usually enhances a DEM by adding vector elements of the natural terrain, including rivers and ridges, a DSM records both natural and built/artificial features of the environment. A geometrically corrected aerial image that is consistent from edge to edge is called an orthophoto. Drones are useful for surveying and GIS specialists because they are economical, effective tools for gathering data and may be utilized to produce precise, comprehensive elevation models. The resultant goods are necessary. The layout of the DSM, DTM and orthomosaic are shown in given below:

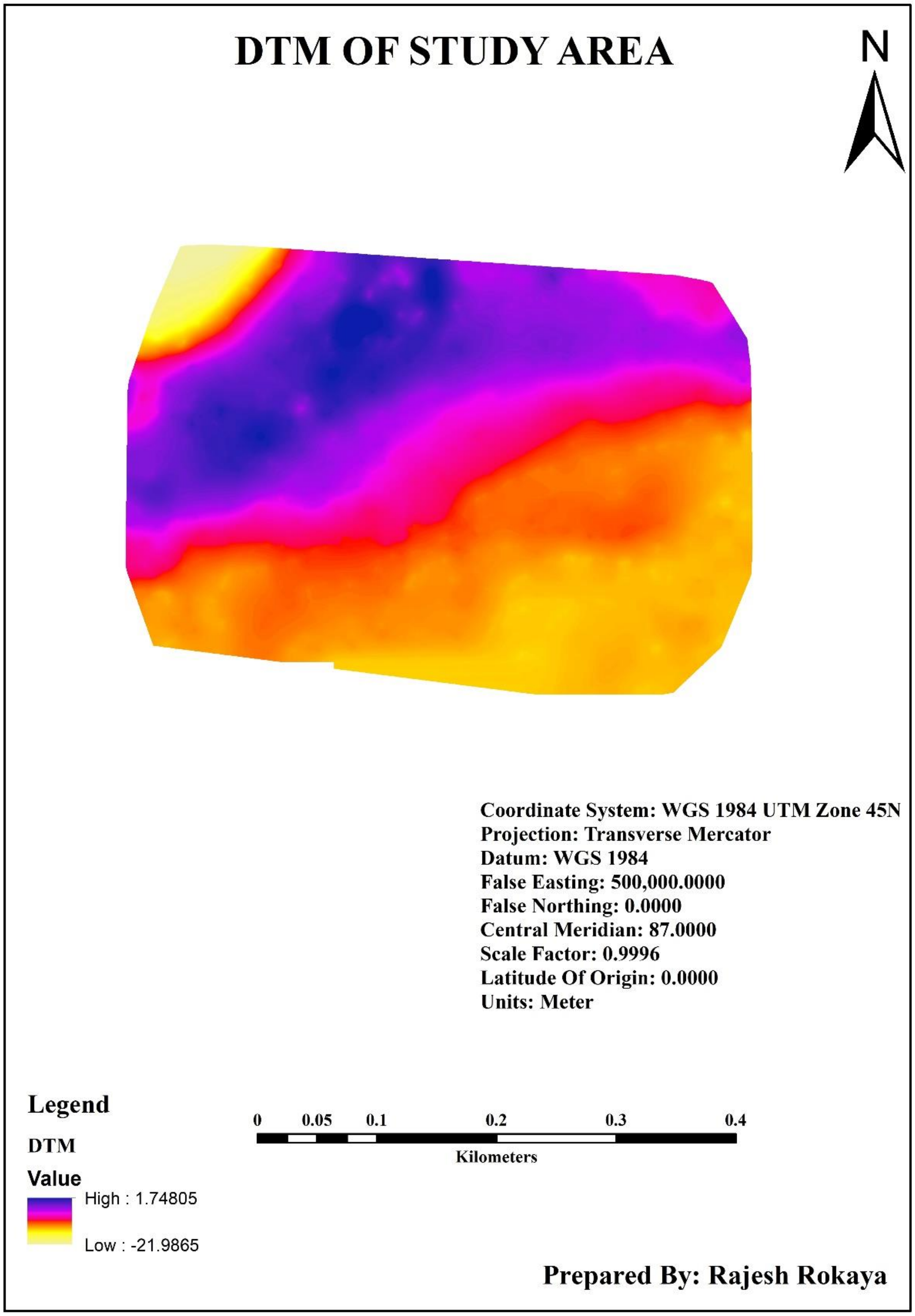

Figure 6: DTM of Study Area

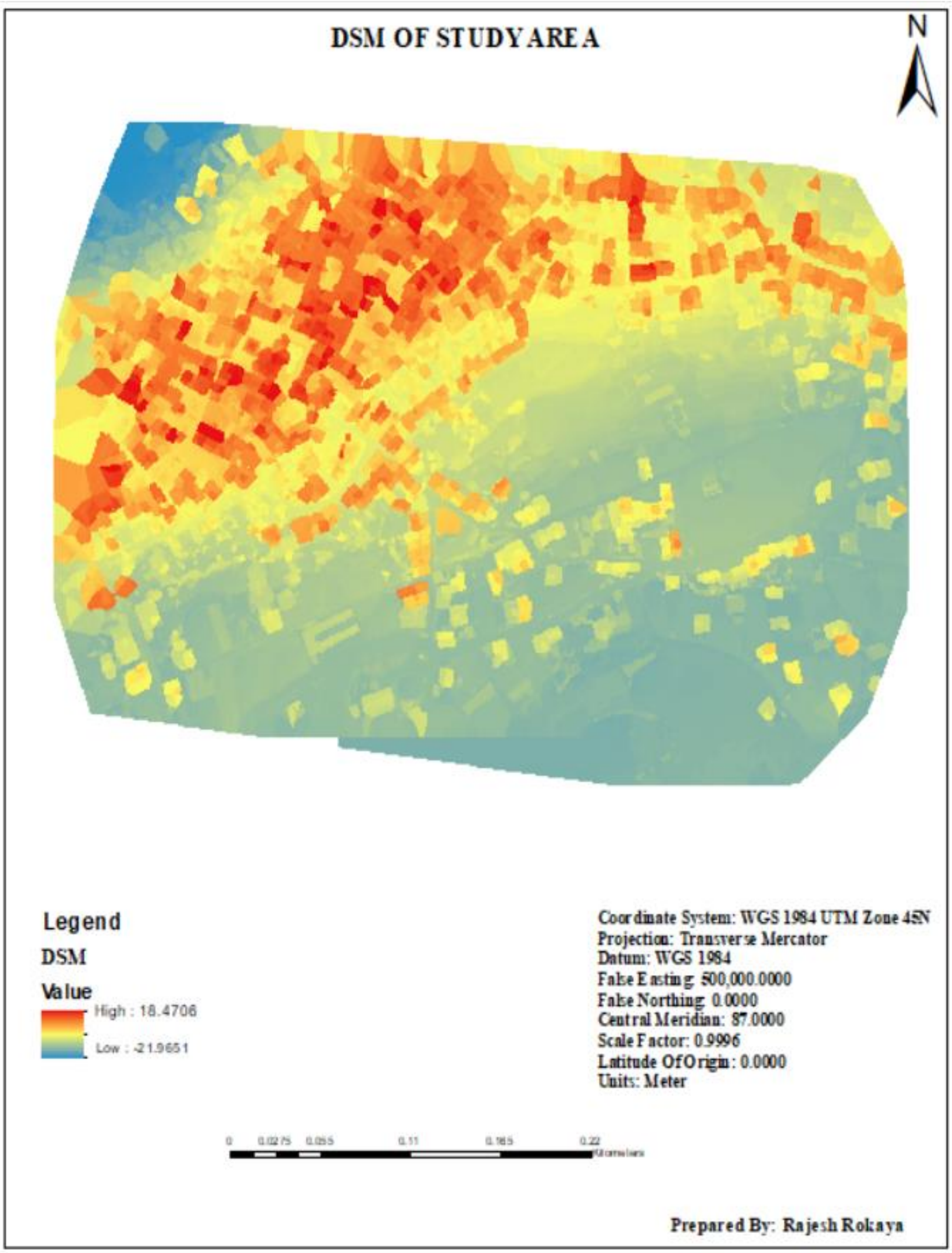

Figure 7: DSM of Study Area

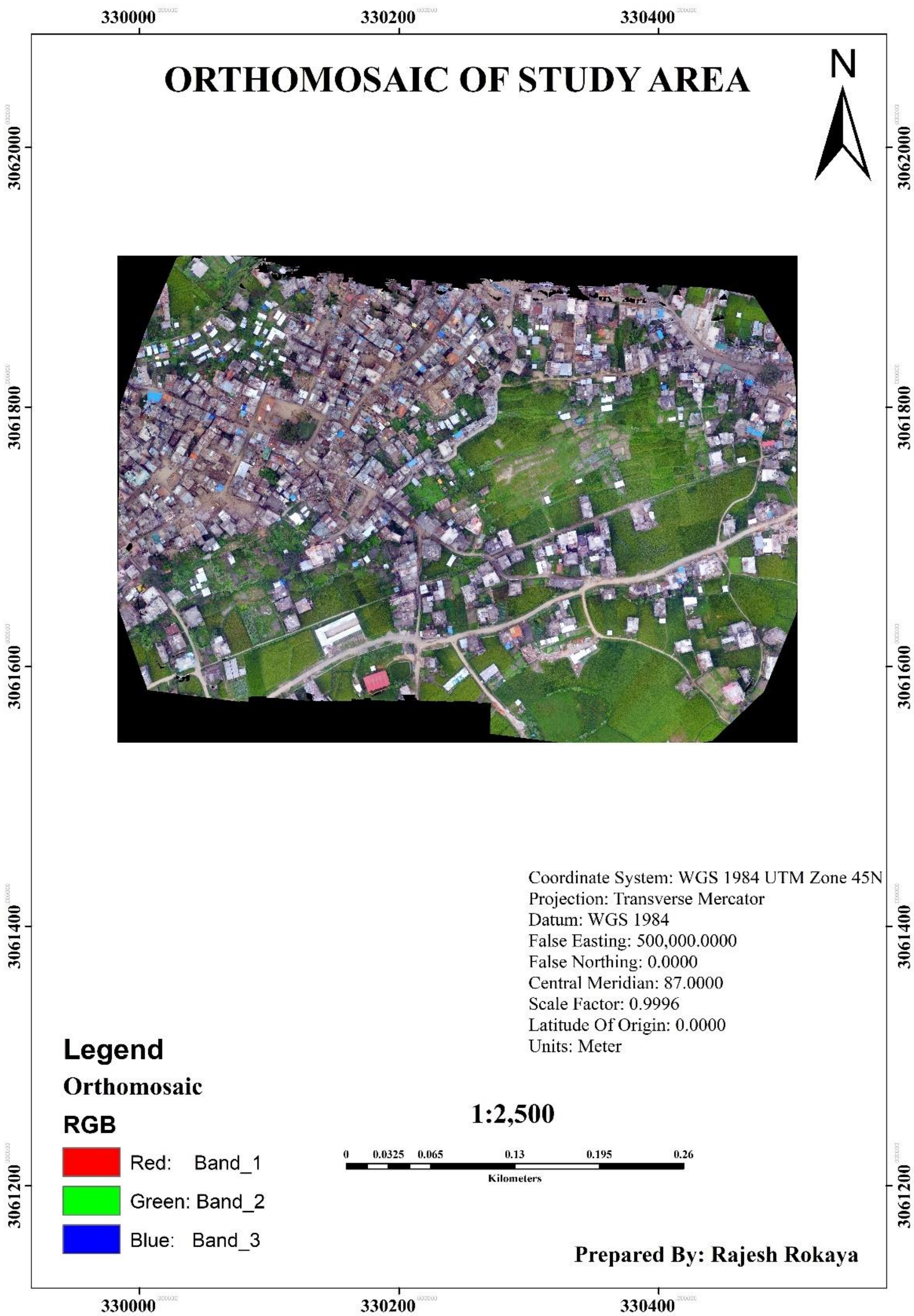

Figure 8: Orthomosaic of Study Area

2.3.6 GIS Analysis and Preparation of Topographical Map

Our project's primary goal is to develop a final digital topographic map in a specific study area. To conduct thorough analyses of photogrammetric products, we utilize GIS as the platform of choice. In this process, orthophotos are manually digitized to produce feature components for the Topographic map. Moreover, the Digital Terrain Model (DTM) undergoes additional processing to generate contours essential for crafting a detailed 3D topographic map of the area.

We imported orthomosaic image in ArcGIS and digitized boundary in polygon shapefile, road in polyline, electric poles in point and pond in polygon. We added contour in map and removed it from road, building, tree and temple location on a map as contour do not pass through artificial features and contour into index and intermediate. We labeled index contour. We prepared the layout of map by inserting elements scale, north arrow, legend, title, graticule and coordinate system. The figure is shown in given below:

3. RESULT AND DISCUSSION

DJI drones were used to take a total of 106 aerial pictures. Ultimately, Pix4d software was used to process aerial photos in order to create an orthophoto, a DSM, a DTM, and a contour. The elevation range was found to be between 1484 and 1508 meters based on the DSM data.

Finally, an orthophoto was obtained after around one and half hours of image processing for best results. Final orthophoto digitized and DTM processed topographic map of the study area is as shown below:

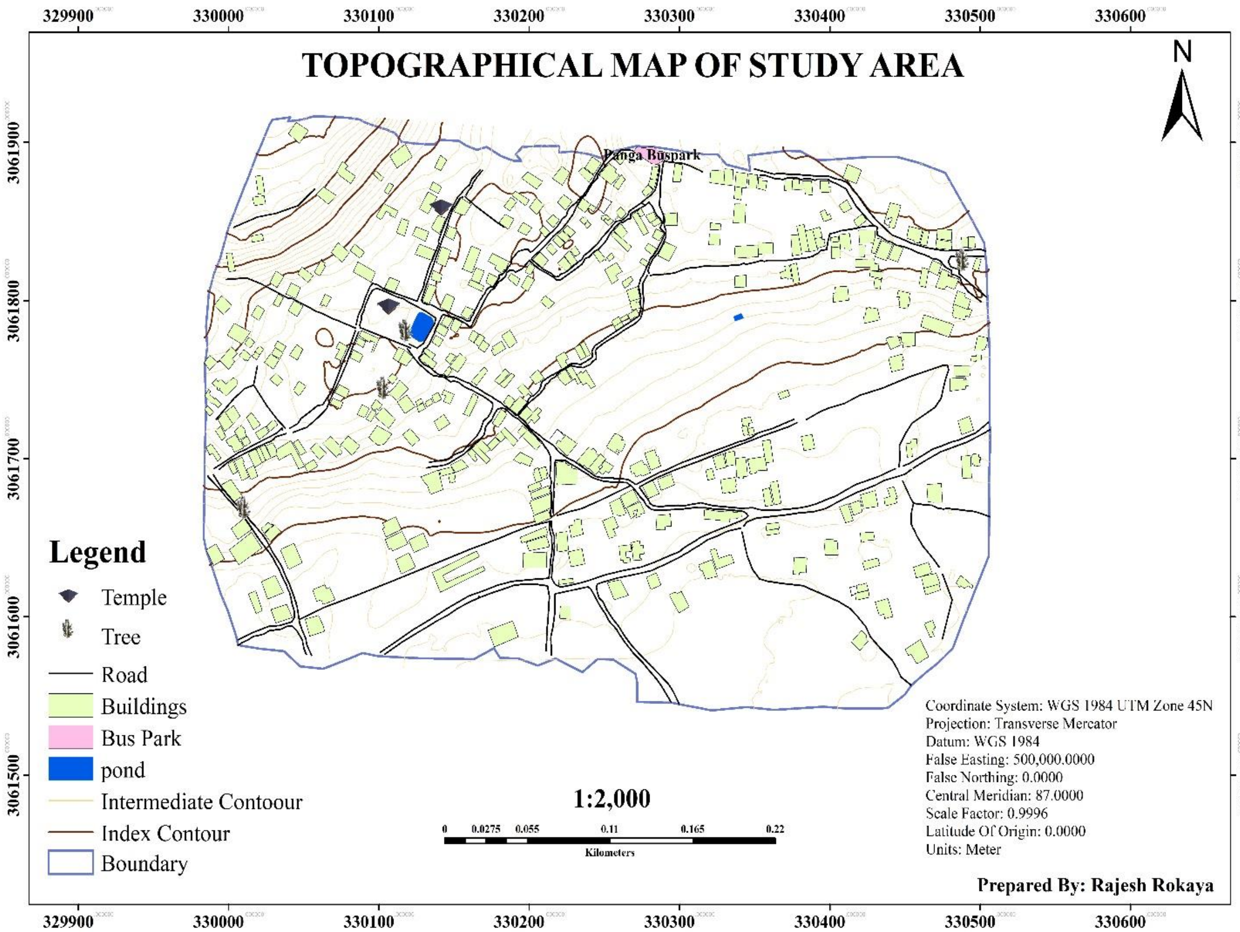

Figure 9: Topographical Map of Study Area

4.REFERENCES

[4.1]. Alkhalil. (2022). Assessment of factors affecting the use of drones in map production. Advances in Environmental and Engineering Research

[4.2]. Hinds, E. (.-s.-f.-t. (n.d.). Drones for topographic surveying. Landform Surveys. https://www.landform-surveys.co.uk/news/drones-for-topographicsurveying/Interpreting RMS error with GCP’s. (2015, October 14). Pix4D Community. Interpreting RMS error with GCP's - PIX4Dmapper / PIX4Dmapper Questions/Troubleshooting - Pix4D Community.

[4.3]. Punmia, B. C. (n.d.). Punmia, B. C., Jain, A. K., & Jain, A. K. (2015a). Surveying: Vol. I (17th ed.). Laxmi Publication

[4.4]. Hendriatiningsih SADIKIN, D. S. (2019). Topographic Mapping using Unmanned Aerial Vehicle (UAV)Technology -. *Geospatial information for a smarter life and environmental resilience, 12.*

[4.5]. Bariledum D. Nwilag, A. E. (2023). Digital topographic mapping and modelling using low altitude unmanned aerial vehicle . *Research gate, 11.*

[4.6] Lamsal, K. (no date) (PDF) *orthophoto generation using UAV: A case study of ... – research gate*.Availableat:https://www.researchgate.net/publication/373873028_Orthophoto_Generation_Using_UAV_A_Case_Study_Of_Pashchimanchal_Campus_Pokhara (Accessed: 20 December 2023).

[4.7]. USGS. (2014). What is a digital orthophoto quadrangle (DOQ) or orthoimage?, (p. 3).

[4.8]. Tziavou. (2018). Unmanned Aerial Vehicle (UAV) based mapping in engineering geological surveys: Considerations for optimum results. *Engineering Geology, 232.*

5 ANNEX

Using the DTM & DSM, we can also prepared the aspect map too. They are shown below:

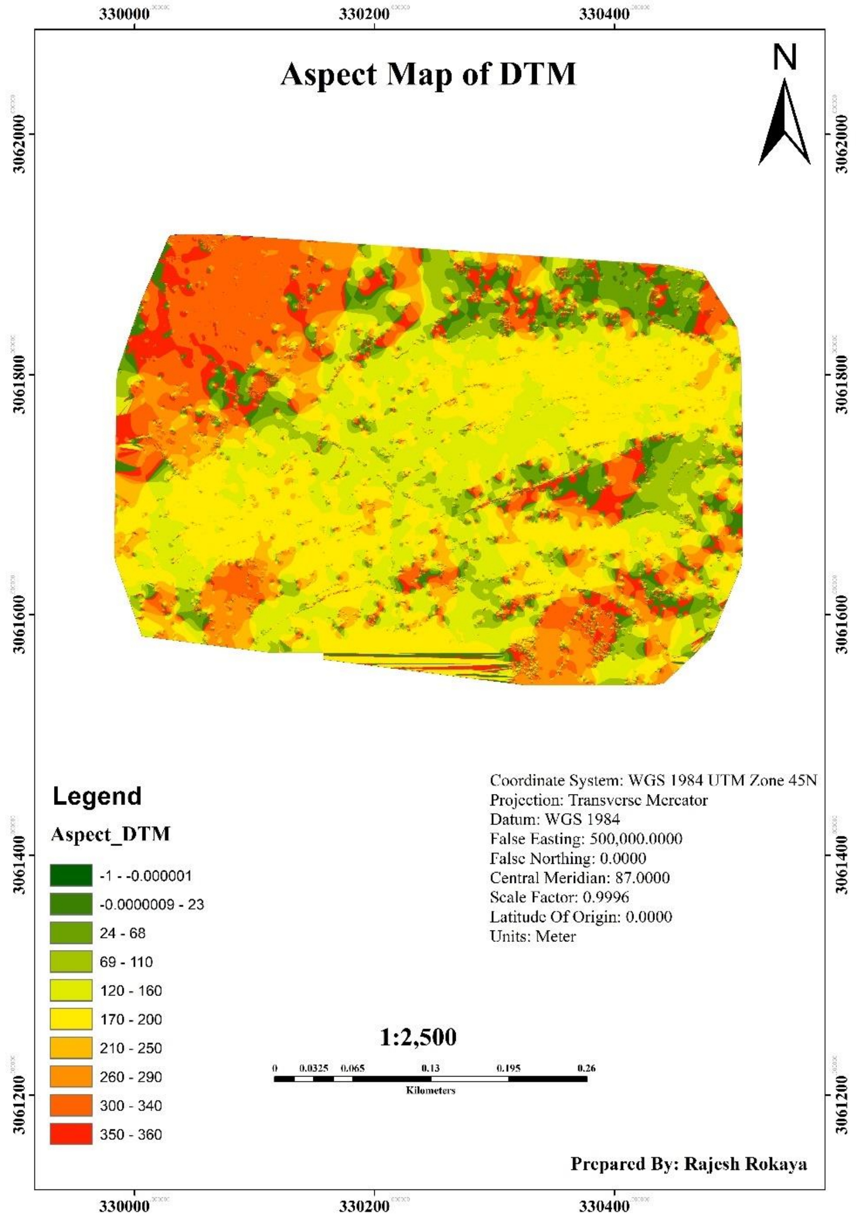

Figure 10: Aspect Map of DTM