TOPOGRAPHIC SURVEY AND RESOURCE MAPPING USING GNSS

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TOPOGRAPHIC SURVEY AND RESOURCE

MAPPING
USING GNSS

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PROJECT REPORT

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KERALA, INDIA

2018

DECLARATION

We hereby declare that this project entitled **"Topographic survey and resource mapping using GNSS"** is a bonafide record of project work done by us during the course of project and that the report has not previously formed the basis for the award to us any degree, diploma, associate ship, fellowship or other similar title of any other University or Society.

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CERTIFICATE

Certified that this project entitled **"Topographic survey and resource mapping using GNSS"** is a record of project work done jointly by **Arun P S (2014-02-011), Ignatious A Mendez (2014-02-025)** and **Smegha N C (2014-02-040)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or associate ship to them.

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ARUN   IGNATIOUS   SMEGHA

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SYMBOLS AND ABBREVIATIONS

Symbols	Abbreviations
o	Degree
!	Factorial
-	Minus
'	Minutes
/	Per
%	Percent
:	Colon
+	Plus
''	Second
^{o}c	Degree Celsius
Km^2	Kilometre square
Cm	Centimeter
DEM	Digital Elevation Model
DGPS	Differential Global Postioning System
dept.	Department
et al.	and all others
etc.	etcetera
fig.	Figure
GIS	Geographic Information System
GPS	Global Positioning System
ie.	That is
h	hour
ha	Hectare
m^3	Cubic meter
min	Minute
mm	Millimetre
R	erosivity index
MJ	megajoule
Mg	mega
SRTM	Shuttle Radar Topographic Mission
WGS84	World Geodetic System 84
EGM96	Earth Gravity Model 96
RMS	Root mean square
SPOT	Satellite Positioning and Tracking
AS2	Accounting Standard 2
HDOP	Horizontal Dilution of Precision
PDA	Personal Digital Assistant
RFID	Radio Frequency Identification
LBS	Location Based Service
GPRS	General packet radio service
SBAS	Satellite-Based Augmentation System
PC	Personal computer

DEDICATED TO AGRICULTURAL ENGINEERING PROFESSION

INTRODUCTION

Chapter 1

INTRODUCCTION

A topographic map is a detailed and accurate two-dimensional representation of natural and human-made features on the Earth's surface. For an agriculture engineer it is an important prerequisite as their sphere of activities include soil and water conservation, design and execution of irrigation systems, drainage network, location decisions of farm infrastructures, local and regional agricultural planning among other things. Areas of the land, relative elevation, nature of the terrain and land use are the important information that a topographic map generally will provide. Among the various applications of topographic maps in Agricultural Engineering, soil and water conservation may be the most important item.

Surveying or land surveying is the technique, profession, and science of determining the terrestrial or three-dimensional positions of points and the distances and angles between them. A land surveying professional is called a land surveyor. These points are usually on the surface of the Earth, and they are often used to establish maps and boundaries for ownership, locations, such as building corners or the surface location of subsurface features, or other purposes required by government or civil law, such as property sales.

Surveyors work with elements of geometry, trigonometry, regression analysis, physics, engineering, metrology, programming languages, and the law. They use equipment, such as total stations, robotic total stations, GPS receivers, retroreflectors, 3D scanners, radios, hand held tablets, digital levels, subsurface locators, drones, GIS, and surveying software.

The introduction of modern technologies of geospatial tools like Remote Sensing (RS), Geographic Information System (GIS) and Global Positioning System (GPS) have provided very powerful methods of surveying, identifying, classifying, mapping, monitoring, characterization, and to track changes in the composition, extent, and distribution of several forms of earth resources both

renewable and non-renewable, living and non-living in nature. Remote Sensing (RS) plays a significant role in providing geo-information in a spatial format and also in determining, enhancing and monitoring the overall capacity of the earth. Satellite observations of land, oceans, atmosphere, and specifically, during natural and human-induced hazards have become crucial for protecting the global environment, reducing disaster losses, and achieving sustainable development.

A topographic survey is the means of producing a topographic map. Preparation of topographic map can be done by means of theodolite, aerial photography, Total Station, GNSS etc. High accuracy, efficiency and less time requirement give more predominance and acceptance to Total Station and GNSS. Theodolite and other conventional surveying techniques are very slow and laborious and practically not feasible for a large area. Total station surveying is advancement to theodolite surveying. Many field operations such as angle and distance measuring and their field recording have been automated in Total Station Surveying.

Total Station surveying is defined as the use of electronic survey equipment for performing horizontal and vertical measurements in reference to a grid system. Total Station is a form of an electronic theodolite combined with an electronic distance measuring device (EDM). Its primary function is to measure slope distance, vertical angle, and horizontal angle from a setup point called instrument station to a foresight point. Most Total Stations use a modulated near infrared light emitting diode which sends a beam from the instrument to a prism. The prism reflects this beam back to the instrument. The portion of wavelength that leaves the instrument and returns is assessed and calculated. Distance measurements can be related to this measurement using the principle of travel of light energy through air. Angle accuracy can range from 2'' to 5''. Distance accuracy can range from +/- (0.8+1ppm*D) mm to +/- (3+3ppm*D) mm, where D is the distance measured.

Advantages of Total Station Survey

- Quick setting of instrument on the tripod using laser plummet
- Relatively quick collection of information
- Multiple surveys can be performed at one set up location
- Easy to perform distance and horizontal measurements with calculation of project coordinates (Northing, Easting and elevation)
- Local language support
- Automation of old maps
- Can prepare layout of construction site efficiently and quickly
- Digital design data from CAD programs can be uploaded to collector

Limitations of Total Station survey:

- The instrument is costlier than other conventional surveying instruments.
- It might be troublesome for the surveyor to investigate and check the work when surveying.
- Working with total station is not so easy, as more skilled surveyors are required to conduct a total station survey.
- To check the survey work thoroughly it would be necessary to come back to the office and prepare the drawings by using the right software.

GNSS (Global Navigation Satellite System) is used to find out the geographic location of a user's receiver anywhere in the world. The United States' Global Positioning System (GPS) and The Russian Federation's Global Orbiting Navigation Satellite System (GLONASS) are the two GNSS systems currently in operation. A third, Europe's Galileo has also become operational. Each of the GNSS employs a constellation of orbiting satellite's working in conjunction with a network of ground stations. Satellite based navigation systems use a version of triangulation to locate the user, through calculations involving information from a number of satellites. Each satellite transmits coded signals at precise intervals. The Receiver converts signal information into position through velocity, and time estimates. Using this information, the receiver anywhere on or near the earth

surface can calculate the exact position of the transmitting satellites and the distance (from the transmission time delay) between it and the receiver. Coordinating current signal from four or more satellites enables the receiver to determine its position.

Depending on the particular technologies used, GNSS precision varies. For example, the United States Department of Defence originally used an international degradation (known as selective availability, or SA) of GPS signals to prevent potential military adversaries from using the positioning data. Because of SA, GPS accuracy was limited to a 100-meter range for civilian users, all though military equipment enabled accuracy to within a single meter. Without SA, all GPS receivers are potentially accurate to within 15 meters. When Galileo also available, position accuracy is possible to within 1 meter.

ADVANTAGES OF GNSS

- The system is self-calibrating – Just turn on and use.
- Can be used in the field – doesn't require a laboratory or artificial environment.
- The equipment is relatively small (typical GPS system is now no larger than a small mobile phone).
- Supplies the user with Location Based information that can be used for mapping (cars), location (geocaching), performance analysis (sport), GIS (Geographic Information Services – Google Earth as an example – pick a street and the technology can link to a database showing what retail outlets are in that vicinity).
- Works anywhere on earth
- Can give bearings, directions.
- There is currently no charge to use the signal (US Department of Defence bears the cost of system maintenance and upgrade).
- Several new GNSS systems were installed globally over the last 5 years giving greater accuracy and usability.

A typical GNSS receiver specification that is used in Machine Control resembles the following:

Kinematic surveying

Horizontal……………………….10 mm + 1 ppm

RMS Vertical………………………….20 mm + 1 ppm RMS

Initialization time……….……. typically, <10 seconds

Initialization reliability…………...typically, >99.99%

Regardless of the measurement technique, there is always some error in each measurement. This is called the given error. The given error in GNSS real-time kinematic (RTK) measurements is typically 10 mm (0.033 ft.) horizontally and 20 mm (0.065 ft.) vertically as noted above. The reason that vertical accuracy is worse than horizontal is because the GNSS receiver cannot see below the horizon. With horizontal measurements, the receiver has satellites visible across all quadrants of the horizontal plane which produces strong geometry for horizontal calculations. However, in a vertical sense, the receiver can only track satellites in two quadrants of its vertical plane which does not provide the same strength of geometric calculations. Machine Control relies on a kinematic approach to GNSS measurements. Kinematic implies that the conditions will change. There will be times when the GNSS antenna has a complete view of the sky, times when the sky may be partially blocked, times when it is motion and other times when it is static.

In perfect conditions, there is 10 millimetres of error horizontally and 20millimetres vertically that are floating around on every measurement. Then there is an accumulation of given error depending upon the distances between the rover and its base station. 1 Parts per Million (PPM) error is added due to the distance between the base and the rover.The final aspect of a GNSS receiver specification relates to the amount of time it may take to get to a desired level of accuracy. This time to converge is a balance between meeting accuracy requirements, time required for measurements and budgets. With good geometry

of satellites, moderate baseline lengths, a clear view of the sky and atmospheric disturbances or multipath influences, the receiver specified above will achieve a one to two centimetres level solution within 10 seconds.

For instance, GNSS technology needs sky. The more sky that is visible, the better the equipment will perform. If your base station is within a few miles of your rover, performance is going to be better than if it is 40 miles away. Most times, firmware updates provide performance enhancements. Depending upon the levels of accuracy being sought, attention to these details may be needed to get the desired results.

Therefore, a study has been conducted to evaluate the suitability and accuracy of GNSS to perform topographic survey with the given below specific objectives.

- To conduct topographic survey of KCAET campus using GNSS.

- To compare the various aspects of GNSS and total station surveying

REVIEW OF LITERATURE

Chapter 2
REVIEW OF LITERATURE

A critical review of some of the important research work done in the area of topographic surveying using total station and GNSS are presented in this chapter.

Colosi *et al*. (2000) carried out a series of topographical surveys in the Salto Valley (Rieti-Lazio) and provided much interesting data regarding local archaeological sites, particularly along the southern slopes of the Breccioso Hills which rise between the Corvaro and Spedino plain. The objective of the survey was to highlight topographic variation and to bring to light any traces of human construction or manipulation. The survey was carried out using a DGPS Leica SR 510, and a Total Station. The integration of these two instruments produced satisfactory and innovative results. The processing of the Digital Terrain Model (DTM) of the area highlighted several characteristics of the site and the consequent production of thematic maps from this data were done, which could be used to guide future excavations at this site.

Jeyapalan and Bhagawati (2000) conducted a study on Total Station, Differential Global Positioning System (DGPS), Video logging, soft photogrammetric and virtual reality methods of collecting data on road side features of urban, city and rural roads for creating a Geographic Information System (GIS). The first 15 highest priority road side features were: intersections, signs, pavement markings, signals, curbs, guard rail, number of lanes, rail road crossings, shoulders, side walk, road names, pavement distress, roadway geometric, bridges and Right of way. The video logging system gives the digital image and the X, Y, Z coordinates of the camera locations, using this information and soft photogrammetric it is possible to determine the location of any feature. Virtual reality is the mode in which a user can view in 3D, fly through the virtual model, modify in real time and view or measure its effect. The conclusion of the study was, Total Station can be used to collect data for creating 2D GIS showing

roadside features at a scale of 1!=25" or larger and or smaller. DGPS can be used for mapping at scale 1!=50"or smaller. Both systems are time consuming in the field. Soft Photogrammetry with digital video logging imagery can be used to map roadside features at 1!=25"or smaller. It saves field data collection time; however, it requires calibration and stereo data collection time in the office.

Casasnovas*et al.* (2001) developed a method that can be used to quantify and map soil losses at field scale produced by extreme rainfall events. The amounts of sediment produced by overland flow and concentrated overland flow (inter-rill, rill and gully erosion)at the agricultural plot scale are evaluated from elevation differences computed from very high resolution digital elevation models (DEMs) , from data obtained before and just after an extreme rainfall event. Multi-temporal spatial data are analysed by GIS techniques. A mechanised vineyard plot located in the Alt Penedes–Anoia region (Catalonia, Spain) is used as the reference for case study. According to the obtained data the rainfall event, which occurred in June 2000, registered 215 mm, 205 mm of which fell in 2 h 15 min. The average intensity of the downpour was 91.8 mm/h, with a maximum intensity in 30-min periods of up to 170 mm/h. The erosivity index R reached a value of 11,756 MJ/ha mm/h, 10 times greater than the annual value for this area. The volume of soil detached by the rainfall, as measured by the proposed method, was 82819 m^3. About 57% of the detached soil particles were deposited with in the same plot. The balance was negative, with a total 35236 m^3 of soil loss from the plot, which represented a rate of 20721 Mg/ha. The paper analyses the characteristics of the rainfall event in relation to historical data and discusses the proposed method for soil erosion mapping at plot scales in relation to other measurement methods.

According to the studies conducted by Jonsson *et al*. (2003), RTK measurement was applied to test accuracy of different GPS instruments (Leica, Topcon and Trimble). A network of nine control points was established using total station. Then, the authors performed RTK measurement on the same network and compared results with different instrument. Results obtained from RTK

measurement have shown a horizontal and vertical accuracy of 10 mm and 2 cm respectively. When comparing this result with the result of the thesis, better accuracy was achieved in both horizontal and vertical coordinates.

Lin (2004) addressed in his project: (1) performance comparisons between using RTK and total station system on land use data capture and updating in terms of accuracy, speed, etc., (2) land use change styles analysis on the interested regions, (3) designing an effective land-use change spatial information collecting procedure using GPS based on the land use change styles, and (4) converting collected land use change data to GIS compatible files. The campus of NCCU (National Cheng-Chi University) was selected as a test region to test the performances of RTK and total station system on land use change data collection. The cadastral maps (on different times) of Mu-Za district of Taipei City were analyzed to find the possible land use change styles. Preliminary results indicated that: (1) the horizontal accuracies of RTK and total station system are14 mm+/-4mm and 163mm+/-63mm respectively (the coordinates of check points were determined using static GPS), (2) the time required for one point determination using RTK or total station system are about 15 seconds and 240 seconds respectively, (3) the land use change styles of Mu-Za district can be classified into 3 main types of polygon (each main type may have 2-3 styles), and (4) the field surveying works can be reduced significantly if the designed fielding surveying procedures were followed.

Agrawal R *et al*. (2006) have validated SRTM DEM with differential GPS measurements in this study. It deals with the accuracy assessment of the interferometric terrain evaluation data (DEM) from SRTM mission. The data was compared with reference to ground control points of differential GPS measurements at three different types of terrains (ranging from plain, moderately undulating and hilly region). Since the SRTM elevation values are orthometric height values in WGS84 datum, for the purpose comparing with DGPS co-ordinate were converted to WGS84 ellipsoidal value using EGM96 geoidal height model. The error statistics was generated between DGPS measurements and

SRTM WGS84 ellipsoidal heights. It was observed that for the plain area like Ahmadabad (Gujarat) the errors were quite small (3.55m) ,whereas in the cases of moderately and hilly terrain like Alwar (Rajasthan) and Chamoli (Uttaranchal) the RMS errors were of the order of 11.44m and 19.64m respectively. It is concluded that SRTM DEM can be used for any application depending upon the accuracy demand.

Ehioroboa and Izinyona (2006) located the position of all major rills and gully sites and georeferenced them using hand held GPS receiver. Based on severity rating and geopolitical considerations, six of the erosion gully sites were selected for monitoring. Control points were established around each of the gully sites by method of Differential GPS (DGPS) surveys and detailed topographical survey of gully sites were carried out using reflector less Total Station instruments. In combination with GIS and Total Station data SPOT imageries were used and location maps, contour maps along with DEM were generated using ARCGIS 9.2 software. The morphological parameters of the gullies were then determined. Volumetric estimate of the amount of soil loss from gully erosion was also carried out. Soil samples recovered from the gully sites were used to determine their erosivity and other properties to be used for soil loss modelling. The results of the studies were used as an indicator for determining the gully initiation point, slope-area relationship, and threshold of gully initiation was also established. The minimum AS2 value was 345 while the maximum was 3,267. This shows that the results lie within the two boundary layers of 41 and 814 (m^2) and 500-4000 m^2 established by Poesen *et al*.

JUNG Rea Jung (2006) studied the method of DGPS applications for the cadastral surveying in Korea. A DGPS beacon system was implemented at the coastal area for the marine ship navigation purpose. The study focused on suggesting the practical possibility of DGPS in the cadastral survey. For this, several field tests were conducted. It was found that the accuracy in horizontal components averages 74cm in the readjustment of arable land and 228cm in the forest. In the forest, the rate of Differential GPS Fix of Beacon DGPS was low

and HDOP (Horizontal Dilution of Precision) was high. It was also found that DGPS doesn't cover the cadastral boundary surveying, however it will be expected that possibility to play a role as a part of device for the ubiquitous cadastre, such as finding control points and boundary points, connected with PDA, RFID on the site could be obtained. And also, this study showed that DGPS will be applicable for high-precision-position-based services like LBS (Location Based Service), and ubiquitous cadastral surveying.

Rodriguez *et al*. (2006) conducted a study on comparison of GPS receiver accuracy and precision in forest environments and practical recommendations regarding methods and receiver selection. This study compares recreational GPS receivers (GARMIN eTrex Euro, GARMIN 12XL, GARMIN Summit, GARMIN Geko 201) and more precise GPS receivers (Topcon Hiper+). It was aimed to determine the most suitable method and receiver for position assessment under different forest canopy covers, in terms of easiness of use, accuracy, reliability, and the ratio accuracy/cost. Several positioning techniques were compared: autonomous, real-time differential, and post-processed differential modes, as well as the effect of using an augmentation system. The test course consisted of 19 points sited under different tree canopies and one point without any obstacle. Test procedure was identical for all twenty points, days and receivers. GPS positioning was repeated five times at each test point using, twenty minutes before receivers were turned on. Results showed that there were significant differences between the receivers regarding accuracy and precision measuring coordinates; moreover, accuracies were different depending on the canopy cover and forest characteristics. Therefore, practical recommendations for each case were settled in order to help foresters to select the most suitable receiver.

Filjar *et al.* (2007) studied the DGPS Positioning Accuracy for LBS (location based services).This study was based on experimental data analysis. A vehicle was equipped with two Garmin GPSIII+ receivers, one working in standard and the other in differential GPS positioning mode. Differential GPS corrections

were delivered from the Prague differential station through the EUREF-IP network and using the mobile Internet GPRS connection. Additional software was developed in order to support both the NMEA-0183 acquisition and the DGPS corrections delivery using the same serial port for GPS receiver running in differential GPS mode. Every positioning sample consists of: GPS time of sampling, Latitude, Longitude, Horizontal positioning error estimate (calculated by GPS receiver), and Number of visible satellites. The conclusion of the study was Differential GPS positioning improves the LBS positioning performance, compared with the standard (un-assisted and un-augmented) GPS positioning. However, general LBS positioning accuracy still cannot be improved in a way that would satisfy high-level requirements by deployment of differential GPS positioning alone.

Hayakawa *et al*. (2007) conducted an accuracy assessment of a post processing differential GPS device. Here they used a portable DGPS device, Mobile mapper pro by Magella Navigation Inc. This DGPS device is capable of differential correction of GPS signals by two means; real-time SBAS (Satellite-Based Augmentation System) correction (2-3 m accuracy) and post processing correction (1maccuracy). At Kaman, the measurements were taken with a relatively short duration; 131 measurements in one day. At Hacitugrul, measurements were taken with a relatively long duration; 114 measurements over 10 days. After the field measurements, the DGPS data were imported into a PC via SD memory card, and the DGPS log data of the base and mobile devices were post processed using bundled software (mobile mapper office). It was found that 2 minutes is the minimum necessary time to enable efficient post processing differential correction for the DGPS device used. The position accuracy of SBAS based differential correction is several meters, even when the measurements are taken over a period as long as 6 hours.

Mottershead *et al*. (2007) surveyed small scale terrains on salt materials with a Total Station and a series of digital elevation models (DEMs) constructed. Eight months apart two sets of observations were made, during which the terrains underwent significant erosion. The difference in elevation shown by the DEMs is a measure of surface erosion of the salt terrains. The erosion rate was analysed with respect to four terrain parameters calculated in the software. High erosion rates, and their strong control by terrain slope, are demonstrated, supporting an earlier study using erosion pins. Indications show that slope profile curvature is also having some influence. The combination of scanning Total Station and DEM software is found to be an effective tool for investigating rapid geomorphic change at this scale of study.

Baptista *et al*. (2008) conducted a DGPS survey on beach profiles using a DGPS mounted on a vehicle and a traditional pole-mounted DGPS. A vehicle mounted DGPS provided a highly accurate non time consuming measurement campaign (easily repeated). Measurements were taken using a pole-mounted DGPS in areas where the vehicle could not reach. The area surveyed was approximately 10,000m^2. A mesh measurement regime was used since beach profiles have relatively smooth features. Profile features should be the base for profile mesh size used. The volumes of points are represented by the amount of morphological change in the survey site. Due to increased elevation variability in the site, it requires more measurement points than a smoother site. Very high resolution meshes may not significantly improve the quality of a DEM and a mesh too wide will not pick up the topographic features in a site. In this study, when different mesh sizes were analyzed, the highest density mesh provided the best results.

Ray burg *et al*. (2009) assessed the quality of DEMs derived from LiDAR, DGPS and spot heights taken from a 1: 100,000topographic map. The area studied was Narran Lake Ecosystem in north western New South Wales, Australia. The DGPS survey done consisted of 20,000 points having a spatial resolution of approximately 1m along survey lines and 200m between survey lines. LiDAR

survey consisted of approximately 650,000,000 data points, with a spatial resolution of $1m^2$ and a vertical accuracy of 8 - 11cm. All DEMs were created using the kriging interpolation model. The LiDAR-derived DEM represented a wide range of topographic features and the DGPS-derived DEM gave considerably less details, but in some areas they gave similar results to the LiDAR. LiDAR- and DGPS-derived DEMs differ by a minimum of 25cm and maximum of several meters in areas. DGPS-derived DEM is of varying quality as considerable fewer points were measured compared to the LiDAR survey. This limitation was mainly due to the challenges associated with ground surveying, as the terrain was difficult to navigate. The LiDAR-derived DEM provided the best results. This resulted in the representation of more features including macro- and micro-channels, flood plains, clay pans, sand dunes, and subtle variations in lake topography.

Dattaand Kirchner (2010) used a digital elevation model (DEM) to derive the topographical characteristics of a study area. Usually, a DEM is incorporated into erosion models as a given parameter and it is not tested as extensively as the parameters related to soil, land-use and climate. In this study, they compares the erosion relevant topographical parameters (elevation, slope, aspect, LS factor) derived from 3 DEMs at original and 20 m interpolated resolution with field measurements for a 13 km^2 watershed located in the Indian Lesser Himalaya. The DEMs are: a TOPO DEM generated from digitized contour lines on a 1:50,000 topographic map; a Shuttle Radar Topography Mission (SRTM) DEM at 90-m resolution; and an Advanced Space borne Thermal Emission and Reflection Radiometer (ASTER) DEM at 15-m resolution. ASTER DEM was found to be poorest whereas, TOPODEM produced similar results to the coarser SRTM DEM, but failed to produce an improved representation of the watershed topography. Comparison with field measurements and mixed regression modeling proved SRTM DEM to be the most reliable among the tested DEMs for the studied watershed.

Ortiz *et al.* (2010) have done comparison of regional elevation heights in the Aguascalientes basin using DGPS technique with INEGI's digital terrain model. The purpose of this paper is to compare DGPS surveys using both two and three receivers, and to determine the error bar between the DTM (Digital Terrain Model) and the DGPS technique using as an example the city of Aguascalientes and surroundings. Two base receivers (Trimble 5700), and one portable receiver (Trimble 5800) was used. From this control point, elevations of the other benchmarks were determined using the TGO software. The research presented here shows that if adequate satellite coverage is available, two DGPS receivers generate an acceptable DTM model for the area under study. Three receivers give redundant information and allow the user to close the polygons offering increased confidence on the measured values. DTM models are an approximation and may be used as an initial value. Based on the results presented here, they suggest that DTM's may only be used for regional studies, and cannot be used to estimate the hydraulic gradient in aquifers in Mexico.

Connemara *et al.* (2011) carried out topographic survey at four historic bridges. Site survey control was established using a Trimble Differential GPS (R6). Subsequent surveying was carried out using both a Total Station (Leica TCR 407, Pen map Software, and Panasonic Tough book Tablet PC) and a Trimble Differential GPS (R6). The survey data was edited in AutoCAD to create a hachured ground plan and a single representative elevation drawing. The four bridges were surveyed in three dimensions and the majority of the ground plan and topographical details were collected using the Trimble Differential GPS (R6) and supplemented with the Total Station and detail pole where necessary due to poor GPS signal. So majority of the elevation data were collected by means of the Total Station's red laser feature.

Jeong *et al.* (2013) conducted accuracy and efficiency tests for four different beach-profile surveying methods of: (i) spot measurement using a Total Station; (ii) spot measurement using a RTK-GPS system; (iii) continuous walking measurement using a RTK-GPS backpack system; and (iv) continuous

measurement using a RTK-GPS system mounted on an all-terrain vehicle (RTK-GPS ATV system) at the Gosapo macro-tidal sand beach, South Korea

Pradeep Kumar *et al*. (2013) made an attempt to assess the accuracy of DGPS by comparing the data obtained from the Total Station at Indian School of Mines, Dhanbad campus. With DGPS the maximum error of 0.013m, minimum error of 0.002m and average error of 0.004m with standard deviation of 0.00554m was observed in Northing. In Easting maximum error of 0.017m, minimum error of zero meters and average error of 0.005m with standard deviation of 0.00674m was observed. The maximum error of 0.027m, minimum error of 0.005m and average error 0.007m with standard deviation of 0.01526m was observed in Reduced Level. The variation of average area from DGPS data with reference to Total Station data is 1.058m^2. The DGPS provides the more reliable and accurate data which can be used for medium to small scale maps. The accuracy of data became improved with repeated observations and it depends on the taking of averages of data.

Ragab Khalil (2013) studied the accuracy of GIS tools for transforming assumed total station surveys to real world coordinates. In this paper the effect of using Georeferencing tool, Spatial Adjustment tool (Affine and similarity) and CHaMP tool on the precision and relative accuracy of total station survey were studied. The effects of using geodetic GPS, hand-held GPS, Google Earth (GE) and Bing Base maps as sources for control points on the precision and relative accuracy of total station survey was also studied. These effects have been tested by using 111 points from a covered area of 60,000 m^2 and the results have shown that the CHaMP tool was the best tool for preserving the relative accuracy of the transformed points. The Georeferencing and spatial adjustment tools gave the same results and their accuracy were between 1/1000 and 1/300 depending on the source of control points. The results have also shown that the cornerstone to preserve the precision and relative accuracy of the transformed coordinates is the relative position of the control points.

Diwakar *et al.* (2014) investigated the horizontal accuracy of Differential-GPS (DGPS) survey with comparison of Total Station instrument data. In this study they investigated the effect of observation time and the PDOP value on the accuracy obtained. . The variation of accuracy with time and PDOP value has been analyzed by curve fitting technique. For this work 19 points were established and observations were taken by using Total Station; TRIMBLE M3 and DGPS; TRIMBLE R3. Trimble Business Centre and the GNSS solution software are used for processing of raw data collected using DGPS. Terra Model software was used for processing Total Station data. Distance and height between established points is calculated using Total Station instrument using angle and distance method. Distance calculated for successive points from DGPS data is compared with the distance calculated using Total Station. Afterward mean error, RMSE, standard deviation of distance calculated from DGPS is estimated from Total Station. The conclusion of the study was 25 minute observation time is sufficient as the accuracy in horizontal measurement for 25 minute observation Standard deviation and Standard Error is 0.013 meter and 0.003 meter respectively. Accuracy of DGPS survey is dependent upon the observation time and PDOP value. It is found in this study that for poor PDOP even long observation time does give better accuracy.

Arango *et al.* (2015) conducted a study about comparison between multicopter UAV and Total Station for estimating stock pile volumes. Since the UAV (Unmanned Aerial Vehicle) had became an alternative for different engineering applications, especially in surveying, one of these applications was the calculation of volumes of stockpiled material, but there were questions about its accuracy and efficiency, the purpose of this article was to compare traditional surveying methods for estimating total volumes through data obtained by total stations and data obtained by a multicopter UAV. In order to answer these questions they obtained data from the same location and the results and compared the results. After comparing the results it was found that there was a 2.88% difference between the volume calculated with the total station data and the actual volume, and −0.67% difference between the volume calculated with the UAV data

and the actual volume, concluding that the estimated volume with UAV data is more accurate.

Ragheb and Fayoumi (2015) dealt with how to facilitate and manage surveying methods to accomplish modernized and cost effective urban survey with best achievable accuracy. This was done by replacing traditional surveying methods with modern methods from both theoretical and practical point of view. At first, a theoretical assessment process on a tradition urban planning project in Saudi Arabia was performed by replacing traditional urban planning techniques previously used with more applicable surveying techniques as total stations regarding different matters such as applicability, cost and accuracy. After approving the main idea of this modernization process, a practical urban planning case study was performed using total station, geodetic GPS receivers and GPS navigators, on a private settlement block consisting of 6 buildings in a crowded neighborhood of Cairo city. The applied surveying techniques showed high efficiency regarding cost and effort, while saving observation time reaching to 60%. Accordingly, the adopted practical application proved to be beneficial for all desired aspects, as well as being promising for more extensive study areas in future.

Archana *et al* (2016) conducted a project work mainly focused on the preparation of topographic map of upland regions of KCAET, Tavanur using modern surveying equipments such as Total Station (LeicaTS06) and DGPS (Trimble). Using the field collected data from Total Station; a topographic map was plotted using ArcGIS10.3 software. TIN, contour map, and slope map were generated from this topographic map. In GNSS survey, post-process kinematic survey method was adopted. Post- processing of field collected data was done in Trimble Business Center software. The base line report obtained by exporting the data from the software provides the longitude, latitude, elevation, easting and northing etc. of the field point. It was found that, in Kerala terrain (with dense canopy) working with DGPS alone does not give good result whereas, in combination with TSS gives better and more satisfactory results. A contour map

and slope map with good accuracy and great speed were generated and they can be used to accommodate various engineering planning requirements.

Arjun *et al* (2017) conducted a project work mainly focused on the natural resource mapping of KCAET, Tavanur using modern surveying equipments such as Total Station (Pentax) and DGPS (Trimble). Using the field data collected from Total station, a topographic map was plotted using ArcGIS10.3 software. Total Station data lacks geographic coordinates and this give rise to difficulty of plotting the data using GIS software. So, for georeferencing, a hand held GPS was used to find out latitude and longitude of some of the points. TIN, Digital Elevation Models, contour map, slope map, flow directional map, and flow accumulation map was generated using the collected points. . GNSS was also adopted for surveying some points in the same area. Post process kinematic survey was adopted for this. . These points were post processed in PC using Trimble Business Centre Software. The processed reports were exported to the required file format. The data of the base line report helped in knowing the longitude, latitude, elevation, easting and northing and other details of the point. Geographical coordinates taken by GNSS were used during plotting maps of Total station collected field coordinates in ArcGIS.

MATERIALS AND METHODS

Chapter 3

MATERIALS AND METHODS

3.1 Study Area

The study has been conducted in KCAET campus, Tavanur, Kerala, India having a geographical location of 10°52'30" North latitude and 76°02'02" East longitude. The area is characterized by sloping and undulating terrain with moderate vegetative cover. Total area comes to about 40 ha of which 50% is upland and the balance low lying paddy fields. Climate is humid tropic with an average annual rainfall of 3000 mm.

3.2 DGPS

Differential Global Positioning System (DGPS) is an enhancement to Global Positioning System that provides improved location accuracy, from the 15-meter nominal GPS accuracy to about 10 cm in case of the best implementations. DGPS is essentially a system to provide positional corrections to GPS signals. DGPS uses a fixed, known position to adjust real time GPS signals to eliminate pseudo range errors. An important point to note is that DGPS corrections improve the accuracy of position data only. DGPS refers to using a combination of receivers and satellites to reduce/eliminate common receiver based and satellite based errors, reduce orbit errors, reduce ionosphere and tropospheric errors, reduce effects of SA, eliminate satellite and receiver clock errors. DGPS can be achieved through post-processing the data or real-time

telemetry links between a base and a rover. Real-time methods include (a) medium frequency beacon differential service, (b) L-Band satellite differential service, (c) frequency modulation sub- carrier differential service, (d) on-site, radiofrequency telemetry link. All the real-time services have a coverage area and a range limitation and require a local radio/receiver to obtain the transmitted service. Method requires operation of a transmitter by the user in addition to the radio/receiver. Post-processing differential techniques relies on two GPS receivers with storage capacity. The kinematic post-processing method relies on the base station as the reference receiver and the rover as the unit that can move around without restriction. The user will post-process the data on a computer after the GPS data have been collected. Kinematic post processing is the most preferred method of tracking motion in DGPS when accuracy and precision are a major issue.

GNSS is basically a Global Navigation Satellite System. GNSS includes GPS, GLONASS, GALILIO and COMPASS satellite systems. The GPS is a US based satellite system which is having more than 32 satellites and they are available 24 hours. GLONASS is a Russian Satellite System which is available 24 hours and having around 24 satellite system. Galileo is a European satellite system and COMPASS is a Chinese Satellite System which is under testing.

There are three types of survey which we can be done using GNSS:

1. Static Survey (Control point establishment)
2. PPK Survey (Post Processed Kinematic Survey)
3. RTK Survey (Real Time Kinematic Survey)

3.2.1 Static Survey

Static Survey is basically used to establish the control points or network in the field. We normally do Triangulation method for the setting up of control survey as mentioned in below drawing. The processing of Data will be done in TBC (Trimble Business Center) software.
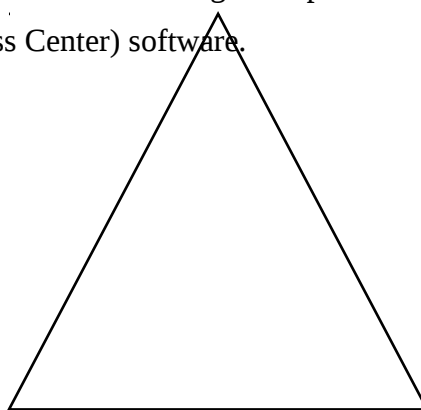
Fig. 3.1 Triangulation method for setting up control points

3.2.1.1 Starting Procedure of Static Survey

1. Base Start up

  a. Find a best, safe, secure and open location to setup the base. If possible, find high point place with open sky

  b. Setup Tripod on Known Base Point mark on field.

  c. Mount Tribrach and Prism Base on The Tripod.

  d. Mount 2.5 meter Short Pole on the Prism Base.

  e. Mount R6 GNSS receiver on the Short Pole and Controller on the Tripod with Fixing Bracket.

  f. The Setup should look like below mentioned setup image.

Plate 3.1 Base setup in static survey

g. Now switch on the R6 GNSS Receiver.

h. Switch on the Controller and Set the local time from Start ⬜ Setting ⬜Systems ⬜Clock. After setting the Clock as per the Country setting (GMT 05:30 New Delhi)

i. To start the Trimble Access software goes to Start ⬜Program ⬜Trimble Access.

j. Go to General Survey. You will get six options.

k. After opening this software, just click on the Settings.

l. Go to Survey Style. The setting for the Static survey is as below.

STATIC SURVEY:	
ROVER OPTION	Page 1
Survey Type: Fast Static	Logging Device: Controller
Logging Interval: 1 Sec	Auto File Name: ☑ (If you want to give Auto file name than correct the check box)
Elevation Mask: 15°	PDOP Mask: 6.0
Page 2	
Antenna Type: R6 2 Internal	Measured To: Bottom of Antenna Mount
Antenna Height: 2.00 M	
Page 3	
Use L2e: ☑	Use Glonass: ☑

Fig. 3.2 Base settings window for static survey

m. After doing all above setting, accept all the setting and store the survey style settings.

n. Now go to Connect ⬚Bluetooth ⬚Configuration ⬚ ☑ click the check box for turning on the Bluetooth. Select the receiver ⬚Next ⬚Next⬚OK.

o. Connect the GNSS receiver to Rover ⬚R6XXXXXXX ⬚Accept.

p. Go to Trimble Access⬚ General Survey⬚ Jobs⬚ create New Job.

q. Give Job Name

r. Select the Coordinate System as per the survey location and zone. Also link your Feature Library if you are using for your survey.

s. Give approximate project height (MSL) of location.

t. Accept to save the changes you made in new job

u. Go to Survey ⬚Static ⬚Start Base Receiver ⬚ Give a Base Point Name and Code ⬚Start

v. Now the base will start collecting the data.

2. Rover Start-up

i. Find a best, safe, secure and open location to setup the Rover.

ii. Setup Bipod on Point mark on field.

iii. Now switch on the R6 GNSS Receiver.

iv. Switch on the Controller and Set the local time from Start ⬜ Setting ⬜Systems ⬜Clock. After setting the Clock as per the Country setting (GMT 05:30 New Delhi).

The Setup should look like below mentioned setup image.

Plate 3.2 Rover setup in static survey

vi. Go to General Survey. You will get six options.

vii. To start the Trimble Access software go to Start ⬜Program ⬜Trimble Access

viii. After opening this software, just click on the Settings.

ix. Go to Survey Style.

The settings for the Static survey are as below:

STATIC SURVEY:	
ROVER OPTION	Page 1
Survey Type: Fast Static	Logging Device: Controller
Logging Interval: 1 Sec	Auto File Name: ☑ (If you want to give Auto file name than correct the check box)
Elevation Mask: 15°	PDOP Mask: 6.0
Page 2	
Antenna Type: R6 2 Internal	Measured To: Bottom of Antenna Mount
Antenna Height: 2.00 M	
Page 3	
Use L2e: ☑	Use Glonass: ☑

Fig. 3.3 Rover settings window in static survey

x. After doing all above setting, accept all the setting and store the survey style settings.

xi. Now go to Connect ⧠Bluetooth ⧠Configuration ⧠ ☑ click the check box for turning on the Bluetooth. Select the receiver ⧠Next ⧠Next⧠OK.

xii. Connect the GNSS receiver to Rover ⧠R6XXXXXXX ⧠Accept.

xiii. Go to General Survey. You will get six options.

xiv. Go to Job ⧠Create New Job.

xv. Give Job Name

xvi. Select the Coordinate System as per the survey location and zone. Also link your Feature Library if you are using for your survey.

xvii. Give approximate project height (MSL) of location.

xviii. Accept to save the changes you made in new job

xix. Go to Survey ⧠Static ⧠Measure Points ⧠ Give a Point Name and Code ⧠Start

xx. Now the Rover will start collecting the data. For a good survey keep the rover for ½ to 1 hour for each control points.

xxi. Repeat the same procedure for different Control Points.

3.2.1.2 Ending the GNSS survey

i. First do the ending of Survey in Rover.

ii.Go to Survey and Select End GNSS Survey. Now exit the Trimble Access software and off the controller.

iii.Secondly press the end option in Base. Now exit the Trimble Access software and switch off the controller.

Repeat the all above procedure when you change the base location.

3.2.2 PPK Survey

In PPK (Post Processed Kinematic) Survey we are doing Topography. After collecting all the points, we have to go for the post processing in software.

3.2.2.1 Start up procedure of PPK Survey

1. Base Setup

1.1 Mounting the base unit

i. Find a best, safe, secure and open location to setup the base. If possible, find high point place with open sky.

ii. Setup Tripod on Known Base Point mark on field.

iii.Mount Tribrach and Prism Base on The Tripod.

iv. Mount 2.5-meter Short Pole on the Prism Base.

v. Mount R6 GNSS receiver on the Short Pole and Controller on the Tripod with Fixing Bracket. The Setup should look like below mentioned setup image

Plate 3.3 Base setup in PPK Survey

vi. Now, **switch on** the R6 GNSS Receiver.

vii.Switch on the Controller and Set the local time from Start ▯ Setting ▯Systems ▯Clock. After setting the Clock as per the Country setting (GMT 05:30 New Delhi)

viii.To start the Trimble Access software go to Start ▯Program ▯Trimble Access.

ix. After opening this software, just click on the Settings.

x. Go to Survey Style.

The settings for the PPK surveys are as below:

PPK SURVEY:	
BASE OPTION	Page 1
Survey Type: PP Kinematic	Logging Device: Controller
Logging Interval: 1 Sec	Auto File Name: ☑ (If you want to give Auto file name than correct the check box)
Elevation Mask: 15°	Antenna Type: R6 2 Internal
Page 2	
Measured To: Center of Bumper	Antenna Height: (Measured with Tape)
Page 3	
Use L2e: ☑	Use Glonass: ☑

Fig. 3.4 Base settings window in PPK survey

xi. After doing all above setting, Accept⬜ Store⬜ Esc

xii. Now go to Connect ⬜Bluetooth ⬜Configuration ⬜ ☑️ Click the check box for turning on the Bluetooth. Select "None" to GNSS Rover. Enter Sl No of GNSS base. Select "None" to rest of the items. Then Accept⬜Store⬜Esc.

xiii. Press Trimble Access Button and choose Trimble Access from the screen. Go to General Survey. You will get six options.

xiv. Go to Job ⬜Create New Job.

xv. Give Job Name

xvi. Select the Coordinate System as per the survey location and zone. Also link your Feature Library if you are using for your survey.

xvii. Give approximate project height (MSL) of location.

xviii. Accept to save the changes you made in new job

xix. Go to Survey ⬜PPK ⬜Start Base Receiver ⬜ Give a Base Point Name and Code ⬜Start

xx. Now the base will start collecting the data

2. Rover Set up

i. Find a best, safe, secure and open location to setup the Rover for Initialization

ii. Attach Rover receiver to the 2m pole, then to the Bipod. Setup bipod on Point mark on field.

iii. Now level and switch on the R6 GNSS Receiver.

The Setup should look like below mentioned setup image

Plate 3.4 Rover setup in PPK Survey

iv. Switch on the Rover Controller Unit. Select Settings ⮞ Survey Styles ⮞ PPK ⮞ Rover options

PPK SURVEY:	
ROVER OPTION	Page 1
Survey Type: PP Kinematic	Logging Device: Controller
Logging Interval: 1 Sec	Auto File Name: ☑ (If you want to give Auto file name than correct the check box)
Elevation Mask: 15°	PDOP Mask: 6.0
Page 2	
Antenna Type: R6 2 Internal	Measured To: Bottom of Antenna Mount
Antenna Height: 2.00 M	
Page 3	
Use L2e: ☑	Use Glonass: ☑
TOPO POINTS	
Auto Point Step Size: 1	Quality Control: QC1
Auto Store Point: ☐ (Do not Click the Option)	Occupation Time: 0 M 5 Sec
No of Measurements: 15	

Fig. 3.5 Rover setting window in PPK survey

v. Choose or enter information as shown above. Choose antenna type as R4-3 Internal.

vi. After feeding all information, Accept 〉 Store〉 Esc

vii. Select Connect 〉Blue Tooth. Enter Sl. No of the Rover. Enter "None" to GNSS Base. Leave all other option also "None". Then Accept〉Store〉 Esc.

viii. Press Trimble Access Button and Choose Trimble Access from the screen. Select General Survey Job 〉 New Job. Enter Job name. Enter Coordinate system by selecting from Library. Then Accept〉 Store 〉Esc

ix. Then Select Measure PPK〉Measure points 〉Enter point name, Code 〉 Enter 〉 Measure (then wait for about 10 minutes for initialization of PDOP). After initialization, click Store

x. Now, the Rover is ready for topographic survey. For collecting coordinates of different points, place the Rover over those points. Then give: Point name, Code and then click Measure. Wait for few seconds as shown in the screen then press Store to save the details.

Now, the Rover is ready to be placed on the next point whose coordinates are required. Repeat the same procedure for other topographic points.

3.2.2.2 Ending the PPK Survey

Note: the survey has to be closed following the proper sequence of instruction to the GNSS.

i. In Rover Controller, Esc from the Measure menu, then select Measure 〉 End GNSS Survey. Press Yes to 'Power Down Receiver'. Click Exit.
   Select Shut down general survey and switch off the controller.

ii. In the Base Controller, press the END option. Power down receiver. Now, exit General Survey and switch off the controller.

Note: Repeat the all above procedure starting from "Base Set Up" when you change the base location.

3.2.2.3 Post process of data in Trimble Business Center

The Data collected in the field are processed in the Trimble Business Center which is office software. For doing the post process of data the below are the steps.

1. How to download the data

i. Open the TBC software and plug the software key to the USB port of computer.

ii. Create a new project. Go to Project☐ Project Setting☐ Set all the parameters like company name, coordinate system, feature code library etc.

- Give company name and feature code if needed.

- To change the co-ordinate system select☐ change☐UTM ☐43 North☐ OK

iii. Save all the settings while selecting OK.

iv. Connect the BASE controller to PC. The active sync will connect the instrument.

v. In TBC, the device menu will open. Select the file to download ☐ Just drag the file in software and select the appropriate geoid model (EGM96 global) ☐ keep the existing co-ordinate ☐ Now the check in list of base data will appear. Check all data like antenna height and receiver type. Ok to confirm the download.

vi. Same way connect the rover controller to PC and download the data.

2. How to process the Data

i. Single click on the BASE point and right click on the point to view properties. Add Coordinate of BASE while pressing ⊕ button. Now make the base coordinate as control coordinate.

ii. Now you will see the baseline in the plan view. Go to Select ☐ Select All. Go to Survey ☐ Process Baseline.

iii. Now the Baseline processing will start and save the result. After completion of the data, check the report for fixed solution. For seeing the report ☐ select report icon from main menu ☐ select the required type (point list or base line processing) ☐ save the report in the required form.

iv. To export the point data to CSV/DWG/DC /etc. Go to Menu ☐ Export. Select the format to export as per your requirement.

3.2.3 RTK Survey

3.2.3.1 Startup procedure of RTK Survey

1. Base Setup

i. Find a best, safe, secure and open location to setup the base. If possible, find high point place with open sky.

ii. Setup Tripod on Known Base Point mark on field.

iii. Mount Tribrach and Prism Base on The Tripod.

iv. Mount 2.5 meter Short Pole on the Prism Base.

v. Mount R6 GNSS receiver on the Short Pole and Controller on the Tripod with Fixing Bracket.

vi. Connect PDL 450 radio with receiver.

vii. Now switch on the R6 GNSS Receiver.

viii. Switch on the Controller and Set the local time from Start ☐ Setting ☐Systems ☐Clock. After setting the Clock as per the Country setting (GMT 05:30 New Delhi)

ix. To start the Trimble Access software go to Start ☐Program ☐Trimble Access

x. After opening this software, just click on the Settings.

xi. Go to Survey Style. The settings for the RTK survey are as below:

RTK SURVEY:	
BASE OPTION Page 1	
Survey Type: Real Time Kinematic	Broadcast Format: CMRx
Station Index: (User Defined)	Elevation Mask: 15º
Antenna Type: R6 2 Internal	
Page 2	
Measured To: Center of Bumper	Antenna Height: (Measured with Tape)
Page 3	
Use L2e: ☑	Use Glonass: ☑
BASE RADIO Page 1	
Type: Trimble PDL450	Receiver Port: Port1
Baud Rate: 9600	
After doing the setting press Connect	
Frequancy: 433.025	Radio Operating Mode: Base/Rover
Base Radio Mode: TTL 450 at 9600 bps	Sensitivity: Moderate

Fig. 3.6 Base settings in RTK survey

xii. After doing all above setting, accept all the setting and store the survey style settings.

xiii. Now go to Connect ▯Bluetooth ▯Configuration. ☑ Click the check box for turning on the Bluetooth. Select the receiver ▯Next ▯Next▯OK.

xiii. Connect the GNSS receiver to Base▯R6XXXXXXX▯Accept.

xiv. Go to General Survey. You will get six options.

xv. Go to Job ▯Create New Job.

xvi. Give Job Name

xvii. Select the Coordinate System as per the survey location and zone. Also link your Feature Library if you are using for your survey.

xviii. Give approximate project height (HAE) of location.

xix. Accept to save the changes you made in new job

xx. Go to Survey ⮕RTK ⮕Start Base Receiver ⮕ Give a Base Point Name and Code⮕Start.

2. Rover Setup

i. Find a best, safe, secure and open location to setup the Rover for Initialization.

ii. Setup Bipod on Point mark on field.

iii. Now switch on the R6 GNSS Receiver.

iv. Switch on the Controller and Set the local time from Start⮕ Setting -⮕Systems ⮕Clock. After setting the Clock as per the Country setting (GMT 05:30 New Delhi).

v. To start the Trimble Access software go to Start⮕Program ⮕Trimble Access

vi. After opening this software, just click on the Settings.

vii. Go to Survey Style. The settings for the RTK survey are as below:

RTK SURVEY:	
ROVER OPTION	Page 1
Survey Type: Real Time Kinematic	Broadcast Format: CMRx
Station Index: Any	Prompt Station Index: ☑
Elevation Mask: 15°	PDOP Mask: 6.0
Page 2	
Antenna Type: R6 2 Internal	Measured To: Bottom of Antenna Mount
Antenna Height: 2.00 M	
Page 3	
Use L2e: ☑	Use Glonass: ☑
Rover Radio	
Type: Trimble Internal	Method: Trimble 450/950
After doing the setting press Connect	
Frequency:433.025	Base Radio Operating Mode: TTL 450 at 9600bps
TOPO POINTS	
Auto Point Step Size: 1	Quality Control: QC1 & QC3
Auto Store Point: ☐	Occupation Time: 0 M 5 Sec

Fig. 3.7 Rover settings in RTK Survey

viii. After doing all above setting, accept all the setting and store the survey style settings.

ix. Now go to Connect 🞐Bluetooth 🞐Configuration. ☑ Click the check box for turning on the Bluetooth. Select the receiver 🞐Next🞐Next🞐OK.

x. Connect the GNSS receiver to Rover 🞐R6XXXXXXX 🞐Accept.

xi. Go to General Survey. You will get six options.

xii. Go to Job 🞐Create New Job.

xiii. Give Job Name

xiv. Select the Coordinate System as per the survey location and zone. Also link your Feature Library if you are using for your survey.

xv. Give approximate project height (HAE) of location.

xvi. Accept to save the changes you made in new job

xvii. Go to Survey 🞐RTK 🞐Measure Points 🞐 Esc

xviii. After getting fixed solution just store the point and proceed for Topo Survey.

xix. Measure each point for every 5 sec logging of data.

xx. Now go to next point.

xxi. Repeat the same procedure for different Topo Points.

3.3.3.2 Ending the RTK Survey

i. First do the ending of Survey in Rover.

ii. Go to Survey and Select End GNSS Survey. Now exit the Trimble Access software and off the controller.

iii. Secondly press the end option in Base. Now exit the Trimble Access software and switch off the controller.

iv. Repeat the all above procedure when the base location is changed.

ArcGIS

ArcGIS is a Geographic Information System (GIS) for working with maps and geographic information. The system provides an infrastructure for making

maps and geographic information available throughout an organization, across a community, and openly on the web.

It is used for:
- Creating and using maps
- Compiling geographic data
- Analyzing mapped information
- Sharing and discovering geographic information
- Using maps and geographic information in a range of applications
- Managing geographic information in a database

Steps involved during map formation in ArcGIS are:

Excel file input

Display points

Export to shape file

TIN

1. SLOPE MAP
2. CONTOUR MAP
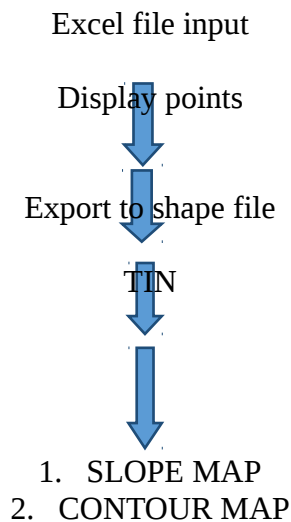
3.3 TOTAL STATION

A total station consists of a theodolite with a built-in distance meter. So it can measure angles and distances at the same time. It is also integrated with microprocessor, electronic data collector and storage system. Todays electronic total stations all have an optoelectronic distance meter (EDM) and electronic angle scanning. The coded scales of the horizontal and vertical circles are scanned electronically, and then the angles and distances are displayed digitally. The horizontal distance, the height difference and the coordinates are calculated automatically and all measurements and additional information can be recorded.

Total stations are used wherever the positions and heights of points, or merely their positions, need to be determined. Total Stations have been in use by the surveying community since the 1970s and are a proven technology. Total Stations are designed for outdoor usage and is capable of working in extreme weather conditions. It should not be exposed to heavy precipitation. Some Total Stations have robotic capabilities, enabling remote or programmed operations.

These should be applicable to automated co-location surveys or monitoring. The primary function of Total Station is to measure slope distance, vertical angle, and horizontal angle from a setup point called instrument station to a foresight point.

3.3.1 Main accessories of total station

3.3.1.1 Tripod

The most important criterion for a good tripod is its stability, quite explicitly, the torsional rigidity. Other substantial benefits are the height stability under load and the minimal horizontal drift. Also not to be underestimated are advantages such as long life, optimal vibration dampening, water resistance, outstanding behaviour in solar radiation and their weight in relation to load-bearing capacity.

3.3.1.2 Tribrach

Similar to the stability of the tripod, that of the tribrach is a significant factor in measurement accuracy. The torsional rigidity, the most important criterion of a tribrach, is constantly controlled and tested during its production. The precise alignment of the support area to the base plate of the instrument assures extremely accurate forced centering. The optical plummet is so robust that the need for adjustment during the entire lifetime of the tribrach is practically unnecessary. Its construction predestines the tribrach for all applications, including extreme temperatures and high dust and humidity.

3.3.1.3 Prism

The range of a prism results from its coating and the glass geometry. A number of original prisms have a special coating on the reflective surfaces – the Anti-Reflex Coating, and a copper coating on the reverse side. Without these, the range of distance measuring, ATR and power search would be reduced by up to 30%. The workmanship and the durability of the copper coating are decisive for a long life. The glass dimensions, the position in the holder and the spatial orientation with it are important for measuring accuracy. Even under the most extreme environmental conditions, a long life span and maximum range of the highest accuracy are the most important criterion for prism.

3.3.2 Important Operations of Total Station

3.3.2.1 Distance Measurement

Electronic distance measuring (EDM) instrument is a major part of total station. Its range varies from 2.8 km to 4.2 km. The accuracy of measurement varies from 5 mm to 10 mm per km measurement. They are used with automatic target recognizer. The distance measured is always sloping distance from instrument to the object. Angle Measurements: The electronic theodolite part of total station is used for measuring vertical and horizontal angle. For measurement of horizontal angles any convenient direction may be taken as reference direction. For vertical angle measurement vertical upward (zenith) direction is taken as reference direction. The accuracy of angle measurement varies from 2 to 6 seconds.

3.3.2.2 Data Processing

This instrument is provided with an inbuilt microprocessor. The microprocessor averages multiple observations. With the help of slope distance and vertical and horizontal angles measured, when height of axis of instrument and targets are supplied, the microprocessor computes the horizontal distance and X, Y, Z coordinates. The processor is capable of applying temperature and pressure corrections to the measurements, if atmospheric temperature and pressures are supplied.

3.3.2.3 Display

Electronic display unit is capable of displaying various values when respective keys are pressed. The system is capable of displaying horizontal distance, vertical distance, horizontal and vertical angles, difference in elevations of two observed points and all the three coordinates of the observed points.

3.2.2.4 Electronic Book

Each point data can be stored in an electronic note book (like compact disc). The capacity of electronic note book varies from 2000 points to 4000 points data. Surveyor can unload the data stored in note book to computer and reuse the note book.
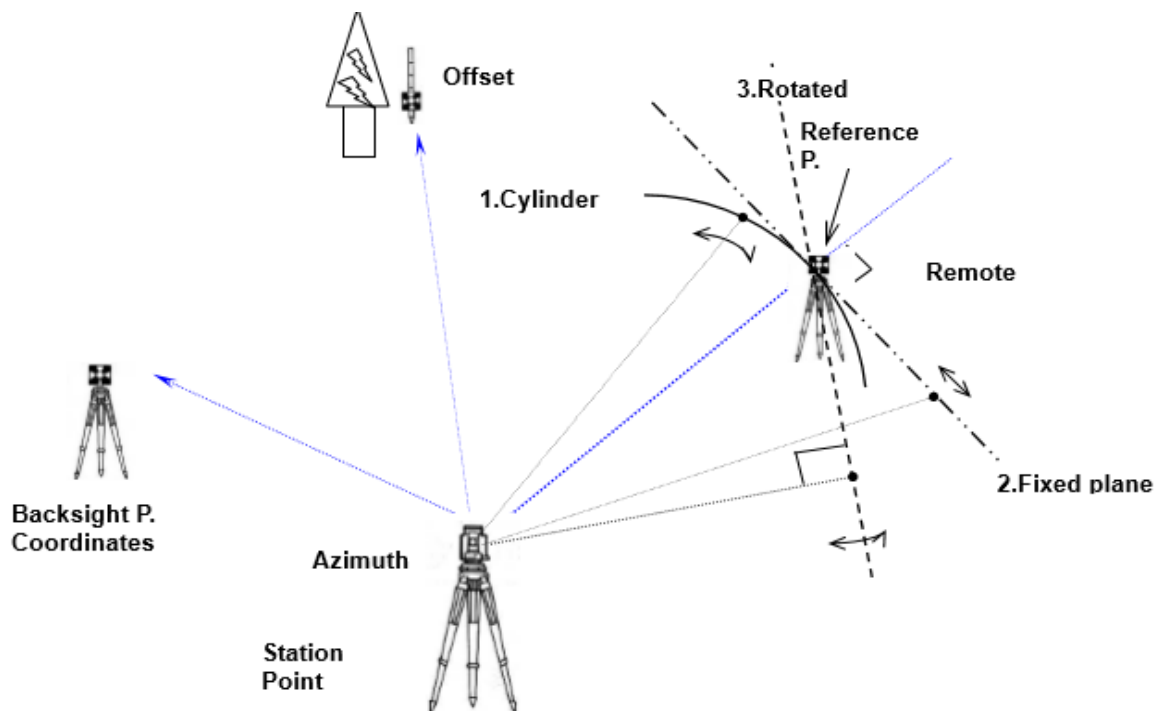
Fig. 3.8 Working of Total station

3.2.3 Instrumental setup

Step 1: Tripod Setup

- Tripod legs should be equally spaced.

- Tripod head should be approximately level.
- Head should be directly over survey point.

Step 2: Mount Instrument on Tripod

- Place Instrument on Tripod.
- Secure with centring screw while bracing the instrument with the other hand.
- Insert battery in instrument before levelling.

Step 3: Focus on Survey Point

- Focus the optical plummet on the survey point

Step 4: Levelling the Instrument

- Adjust the levelling foot screws to centre the survey point in the optical plummet reticle.
- Centre the bubble in the circular level by adjusting the tripod legs.
- Loosen the horizontal clamp and turn instrument until plate level is parallel to 2 of the levelling foot screws.
- Centre the bubble using the levelling screws- the bubble moves toward the screw that is turned clockwise.
- Rotate the instrument 90 degrees and level using the 3rd levelling screw.
- Observe the survey point in the optical plummet and centre the point by loosening the centring screw and sliding the entire instrument.
- After re-tightening the centring screw check to make sure the plate level bubble is level in several directions.

Step 5: Electronically Verify Levelling

- Turn on the instrument by pressing and holding the "on" button (you should hear an audible beep).
- The opening screen will be the "MEAS" screen. Select the [Tilt] function.

- Adjust the foot level screws to exactly centre the electronic "bubble".
- Rotate the instrument 90 degrees and repeat.

Step 6: Adjust Image and Reticle Focus

- Release the horizontal & vertical clamps and point telescope to a featureless light background.
- Adjust the reticle (i.e. cross-hair) focus adjustment until reticle image is sharply focused.
- Point telescope to target and adjust the focus ring until target is focused.
- Move your head from side-to-side to test for image shift (i.e. parallax). Repeat the reticle focus step if parallax is significance.

Step 7: Measurement using total station

- An operator can measure the Foresight point Coordinates from the "Station point Coordinates and Back sight Coordinates "or the "Station point Coordinates and Azimuth", and can store the Point name and measured Coordinates in the memory. When the Coordinates of the Station point and Back sight point are already stored in the memory, the new Coordinates input can be omitted by calling or searching from the point name LIST.
- The point name is within 15 characters and the Coordinates are within 8 in integer and 3 in decimal number. There are two Coordinates types of Rectangular and Polar Coordinates in this [MEASURE].
- The Offset at the Target point is possible and the Remote measurement by aiming at any point is possible as well when you select the Rectangular Coordinates.
- An operator can perform the [MEASURE] function only when the Telescope is at the "Face left position".
- Select the Target type before performing the [MEASURE].

- After measuring rectangular coordinates by [MEASURE] function of Power TopoLite, it is possible to display Angle and Distance by switching the [F3] key.
- When Remote mode is selected, Angle and Distance are also calculated according to the coordinates of the aiming point on real time.
- When Offset mode is selected, Angle and Distance are also calculated according to the coordinates where offset value is added.
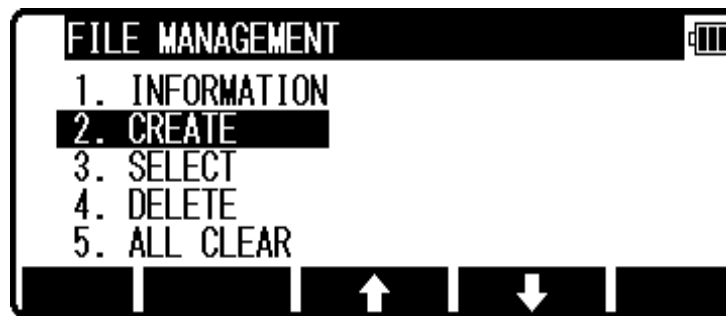
Creation of a new Job

- Select 2. CREATE by down arrow key.

Fig.3.9 Creation of a new job

- Press [ENT] to view the JOB NAME INPUT screen.
- The Job name input method can be selected by the "Input method selection" of the "Preference". This is the "10 KEY SYSTEM" inputs election.
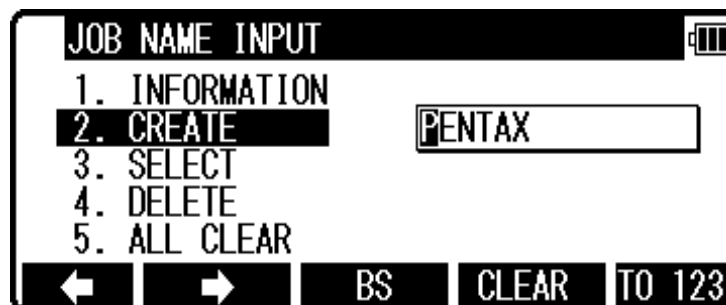

Fig.3.10 inputting of a new Job name

- If a new Job is created, the new data are stored in this new Job.

Selection of a Job name
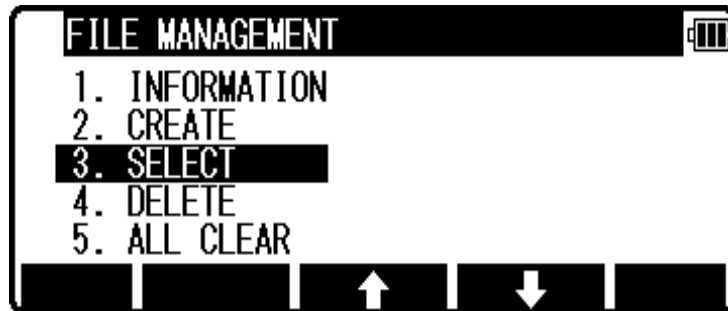
- Select 3. SELECT by pressing the down arrow key.

Fig.3.11 Selection of a Job name

- Press [ENT] to view JOB SELECTION screen.

Selection of a Job

- Select 1. JOB LIST SEARCH and press [ENT] to view its screen. JOB LIST is a list of all stored Jobs.
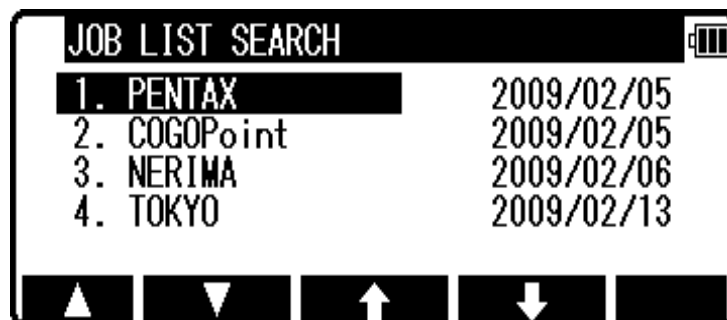

Fig 3.12 Selection of a job

- Select your desired Job name and press [ENT] to select.

Station setup [By Rectangular Coordinates]

- Press [F2][MEAS] of the Power TopoLite screen to view the MEASURE METHOD SELECTION screen
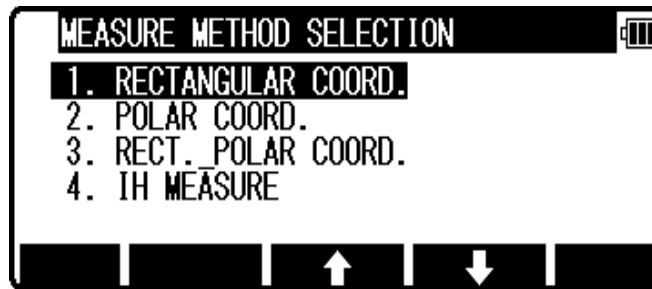
Fig.3.13 Measure method selection

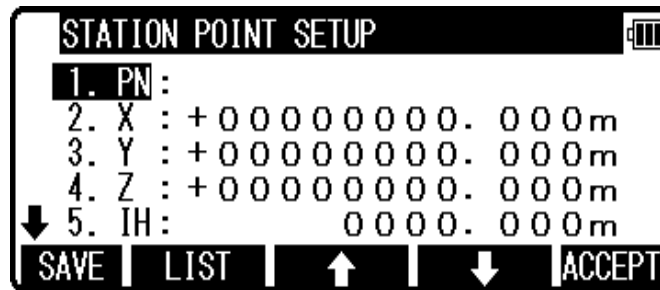- Select 1. RECTANGULAR COORD and press [ENT] to view the STATION POINT SETUP screen.

Fig.3.14 Station point setup

- The [ ] [ ] mark is used to scroll up / down. 6. PC is viewed by scrolling down.
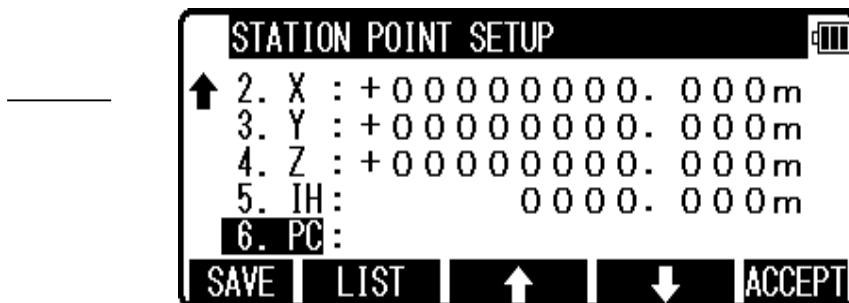

Fig.3.15 Setting point code

Point name, PN, input

- Press [ENT] to view the PN screen.

- The [ENT] is used for both accepting the selected choice and opening the input screen of the Coordinates values etc..

- Input your desired point name by pressing keys, and after all Characters are input, press [ENT].

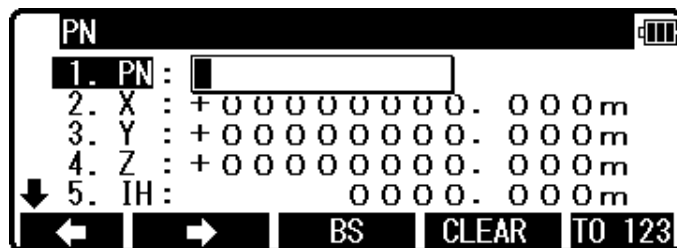- Four character selection methods are available.

Fig.3.16 Setting point name

Coordinates, X, Y, Z, IH, and PC input

- It goes 2. X coordinate automatically.

- Press [ENT] to view the X coordinate input screen. Input X, Y and Z coordinate Instrument height and PC as follows. Input your desired X coordinate value by pressing each keys. Press [ENT] to view the Z coordinate input screen. Input your desired Z coordinate value by pressing each keys.
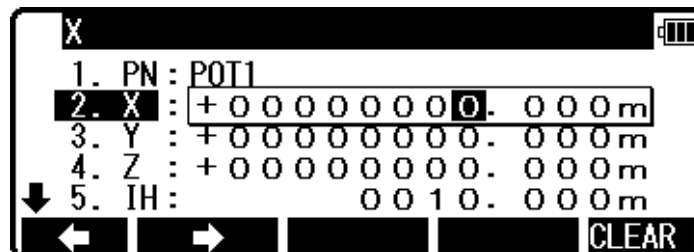

Fig.3.17 X Coordinate input

- Y coordinate: Press [ENT] to view the Y coordinate input screen. Input your desired Y coordinate value by pressing keys.
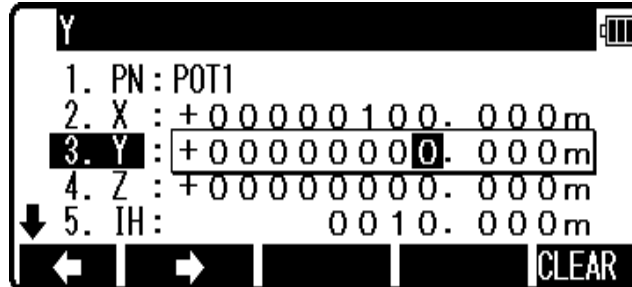

Fig.3.18 Y Coordinate input

- Z coordinate: Press [ENT] to view the Z coordinate input screen. Input your desired Z coordinate value by pressing each keys.
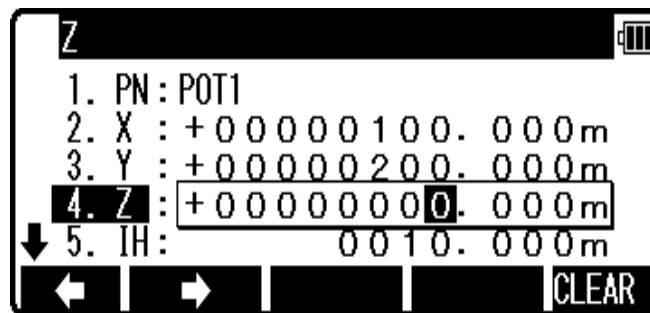

Fig. 3.19 Z Coordinate input

- IH value: Press [ENT] to view the IH, Instrument height, screen. Input your desired IH value by pressing each keys.
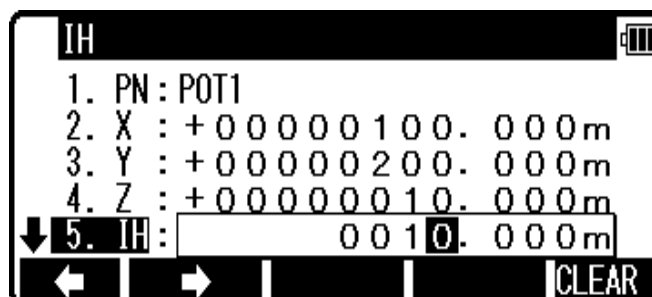
Fig.3.20 IH input

- PC, Point Code: Press [ENT] to view and input the PC, Point code, screen. If Point Code exists, you can easily select them from the list. Then after pressing [ENT], you can edit Point Code data.
- After pressing [ENT], you can edit Point Code data. Input your desired PC name by pressing keys, and press [ENT] to view next screen.
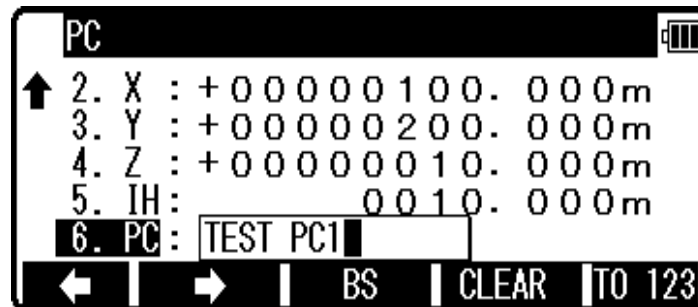
Fig.3.21 PC input

Measuring

- Aim at the reference point and press [ENT] to view the MEASURE screen. Then, aim at the Target point and press the [F1][MEAS] to measure it.
- Press [F3][ME/SAVE] to measure and save the measured data. Press [F2] [SAVE] to save the measured data.
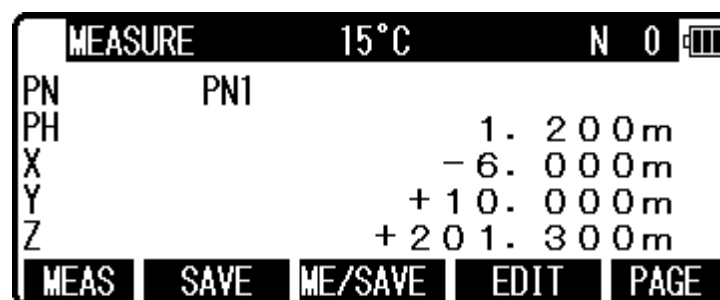
Fig.3.22 Measured data

- Press [F4][EDIT] to edit the PN, Point Name, PH, Prism Height and PC, Point Code. Input your desired Point name, Prism height and Point code. Press [F5][ACCEPT] if the current PN, PH and PC are acceptable. If Point

Code exists, you can easily select them from the list or edit one of them after pressing the [ENT].

Step 7: View and Edit

Stored data are displayed graphically, and the edit of the stored data is possible by this Function. The Z Coordinate (the height) of the point is ignored in the graphical display of the point data.

Four menu items are available:
- GRAPHICAL VIEW

- CREATE THE RECT. POINT

- EDIT THE RECT. DATA

- EDIT THE POLAR DATA

Graphical View

- From the Power TopoLite screen, press [F3][VIEW] to view its screen.
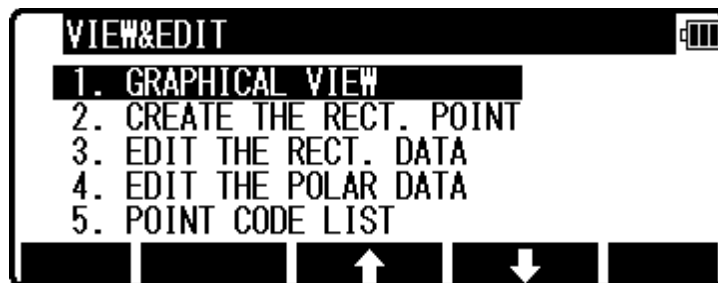
Fig.3.23 View and Edit

- Press [ENT] to view the GRAPHICAL VIEW screen. Points, Point names and their Graphics are displayed. The graphic is moved by pressing the arrow keys. The Graphics are not displayed when points are not stored. Two or more points are needed.
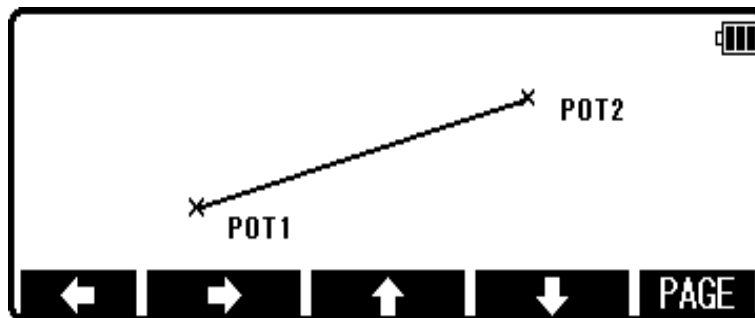
Fig.3.24 First page of Graphical view

- Press the [F5][PAGE] to view another menu.
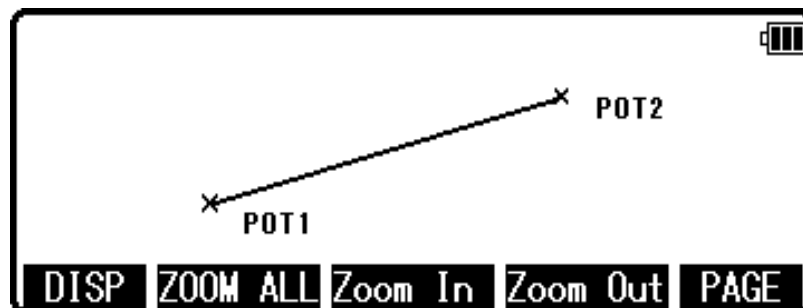
Fig.3.25 Second page of Graphical view

- [DISP]: Each Graphic is displayed as following order by pressing this key.

  Points → Points + Line → Points + Points names → Full

- [ZOOM ALL]: Return to the ordinary Graphics size

- [ZOOM IN]: Enlarge the Graphics size.

- [ZOOM OUT]: Reduce the Graphics size.

3.2.4 Exporting of data

Job data, format files, configuration sets and code lists can be exported from the internal memory of the instrument. The data stored in the internal memory is sent to the PC etc.
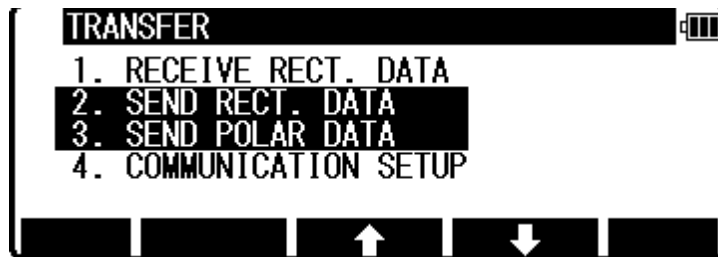
Fig.3.26 Data Export Window 1

Select the 2. SEND RECT. DATA by pressing the down arrow key, and press [ENT] to view the FORMAT SELECTION screen.
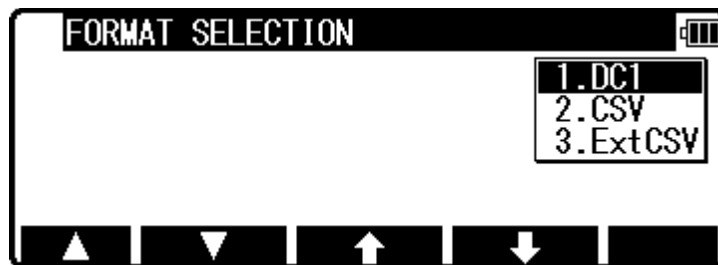
Fig.3.27 Data Export Window 2

Select DC1 format and press [ENT] to view the DATA SEND. CONFIRMATION screen. (Same procedure is performed at CSV)
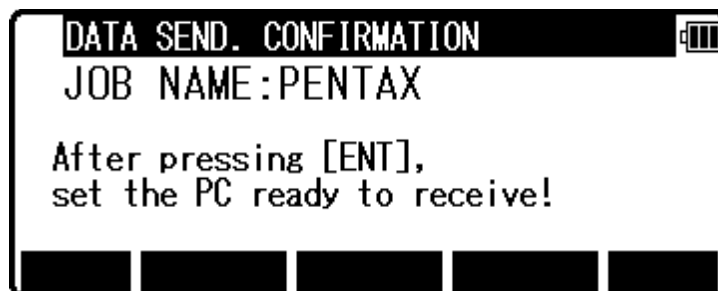
Fig.3.28 Data Export Window 3

Press [ENT], and set the PC to be ready to receive.

RESULTS AND DISCUSSION

Chapter 4

RESULTS AND DISCUSSION

4.1 DGPS SURVEY RESULTS

Post processing of data collected by DGPS was done by Trimble Business Center software. The co-ordinates of some of the points are tabulated in Table4.1.

Table 4.1 DGPS Survey data

| ID	EASTING (METER)	NORTHING (METER)	ELEVATION (METER)
1	607798.292	1199803.930	23.355
01	607785.194	1199794.018	23.292
2	607982.150	1200056.713	13.285
3	608038.792	1200086.694	10.642
4	608064.782	1200076.256	10.927
5	608111.362	1200072.406	10.705
6	608209.914	1200152.617	8.772
7	608217.012	1200176.408	8.818
8	608227.554	1200213.209	8.775
9	608230.120	1200258.331	8.957
10	608193.131	1200259.699	9.183
11	608178.767	1200265.877	9.116
12	608173.895	1200278.925	9.043
13	608170.254	1200298.856	8.961
14	608173.724	1200305.501	9.214
15	608189.366	1200308.589	9.115
16	608228.333	1200312.613	8.811
17	608230.834	1200335.284	9.199
18	608217.334	1200339.726	9.340
19	608194.655	1200339.580	9.239
20	608166.601	1200333.920	9.029
21	608101.033	1200324.451	9.190
22	608092.454	1200372.323	9.223
23	608098.132	1200374.216	9.223
24	608099.657	1200391.407	9.106
25	608104.391	1200421.085	9.329
26	608107.159	1200443.424	9.164

27	608105.994	1200459.853	9.211
28	608111.878	1200470.258	9.419
29	608105.634	1200483.684	9.986
30	608100.736	1200491.750	9.135
31	608096.707	1200501.608	9.099
32	608095.994	1200513.278	9.189

4.1.2 Map preparation in ArcGIS software

Using ArcGIS software, points were plotted and from that plot contour map, TIN (Triangulated Irregular Network) were created. Distribution of points surveyed by DGPS is shown in Fig. 4.1.
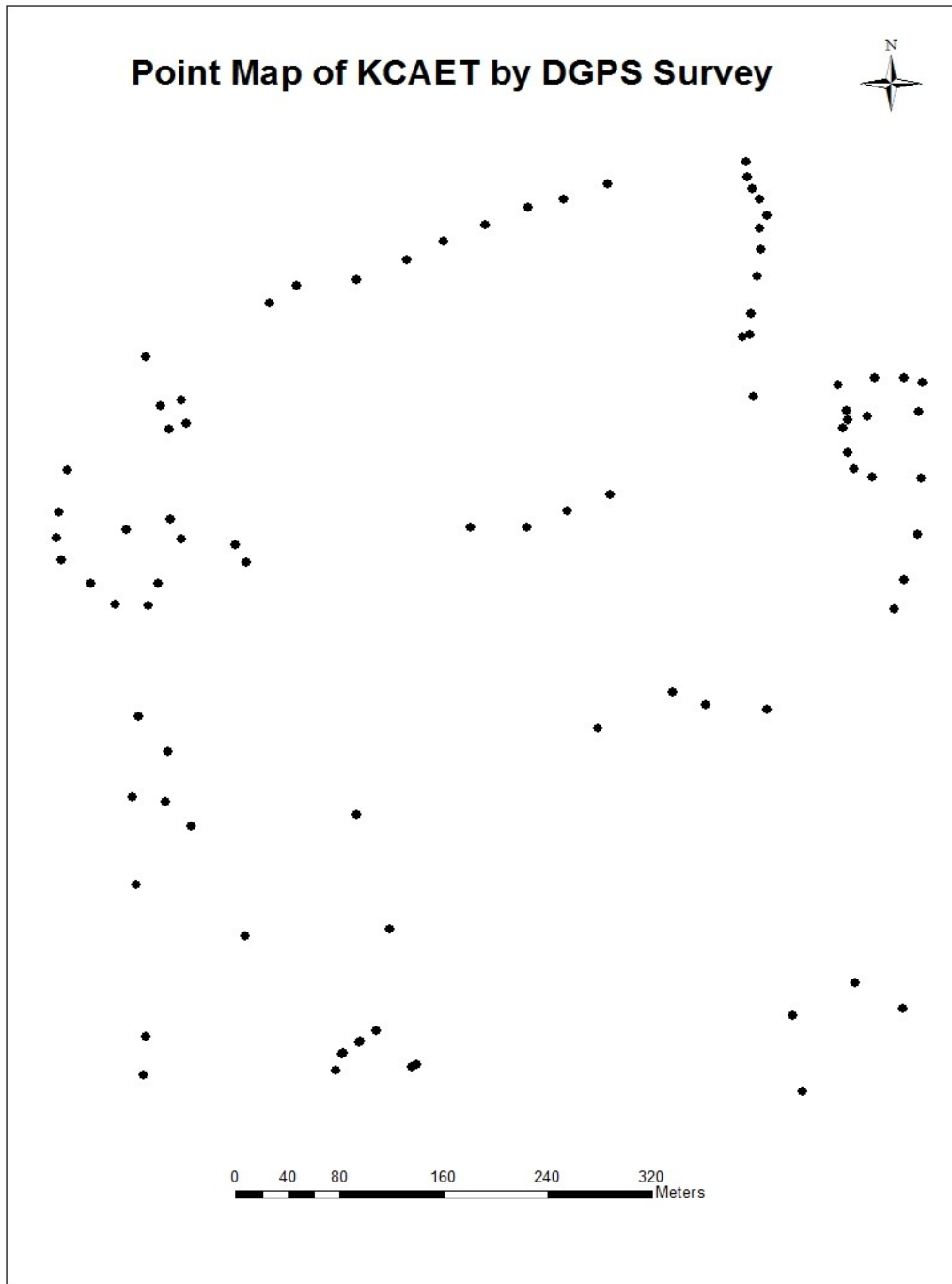
Fig. 4.1 Points surveyed using DGPS

From the above plot, a boundary map was drawn using ArcGIS software. In this boundary map, buildings, roads etc can be plotted using different layers. From this plot, the area of the KCAET campus was obtained as 37.586 ha.
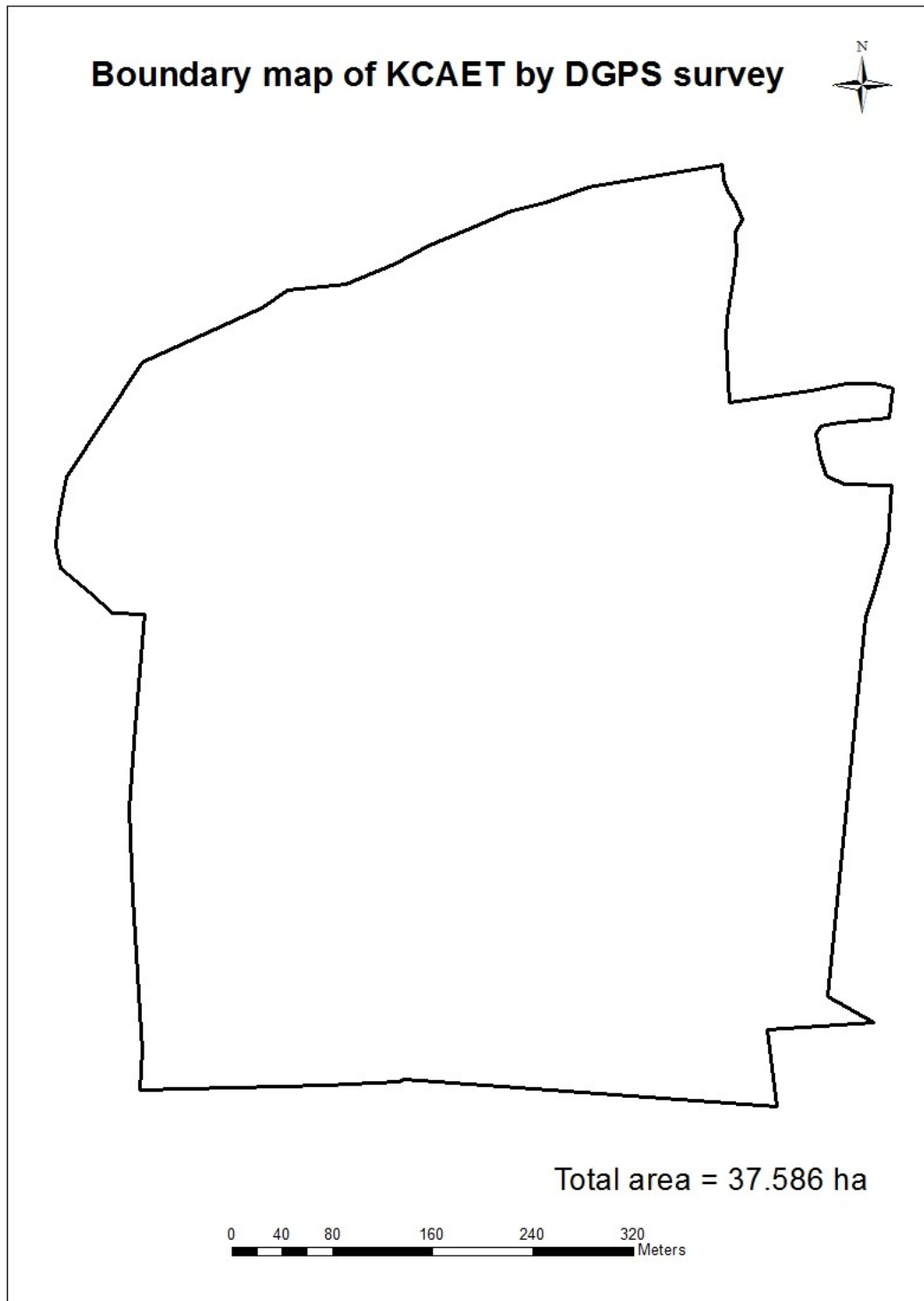
Fig.4.2. Boundary map of KCAET Campus

TIN (Triangulated Irregular Network) was generated using ArcGIS. TIN is the vector-based representation of the physical land surface, made up of

irregularly distributed lines with 3D coordinates(*x*, *y*, and *z*) that are arranged in a network of non overlapping triangles. The Fig. 4.2.shows the TIN generated.
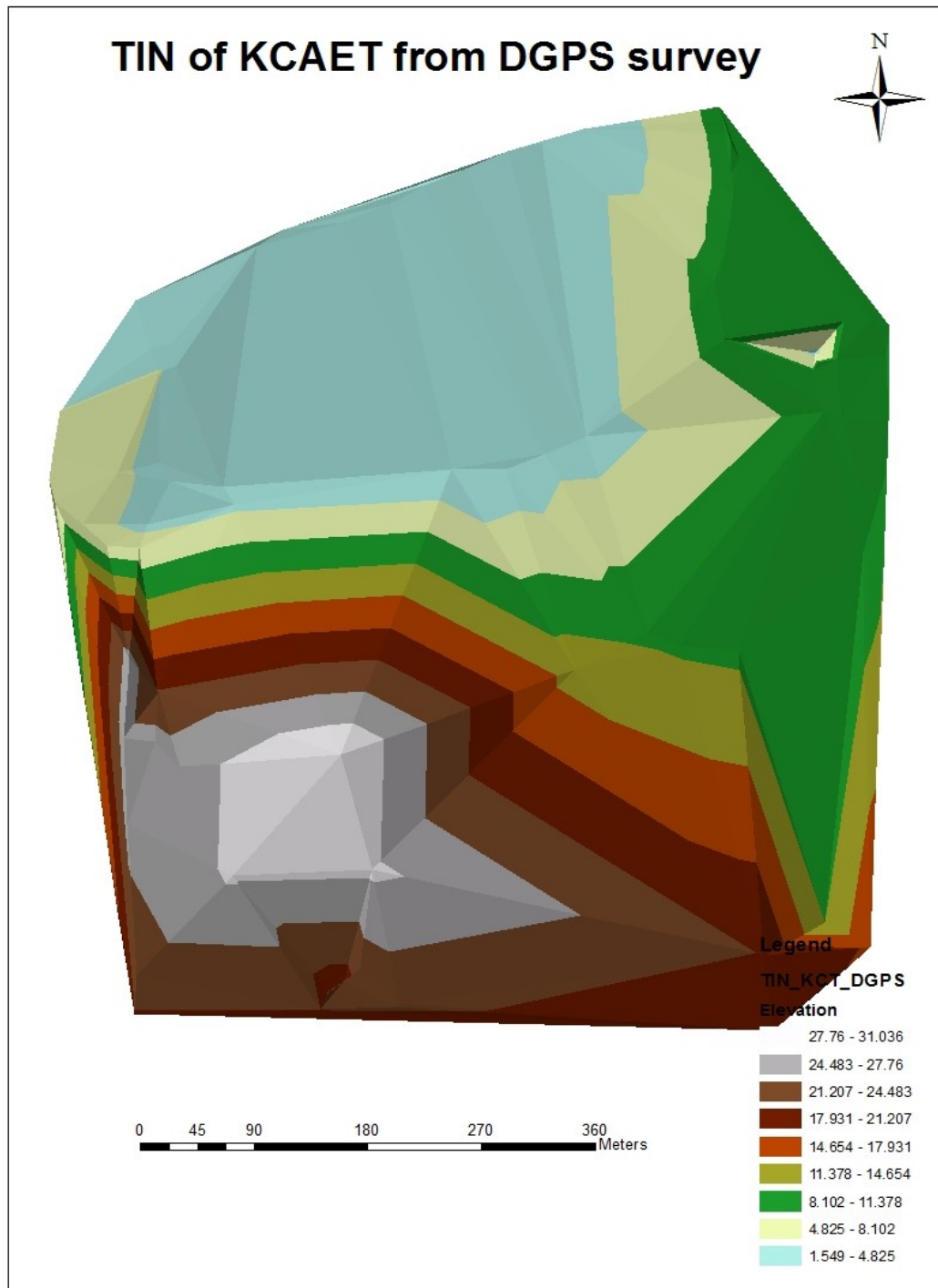
Fig. 4.3 TIN of KCAET Campus

From the Figure 4.3, it can be noted that, where regions having little variation in elevation, the points were widely spaced whereas in areas of more intense variation in elevation, the point density was more. The regions with high elevation are shown in white color in this TIN map.
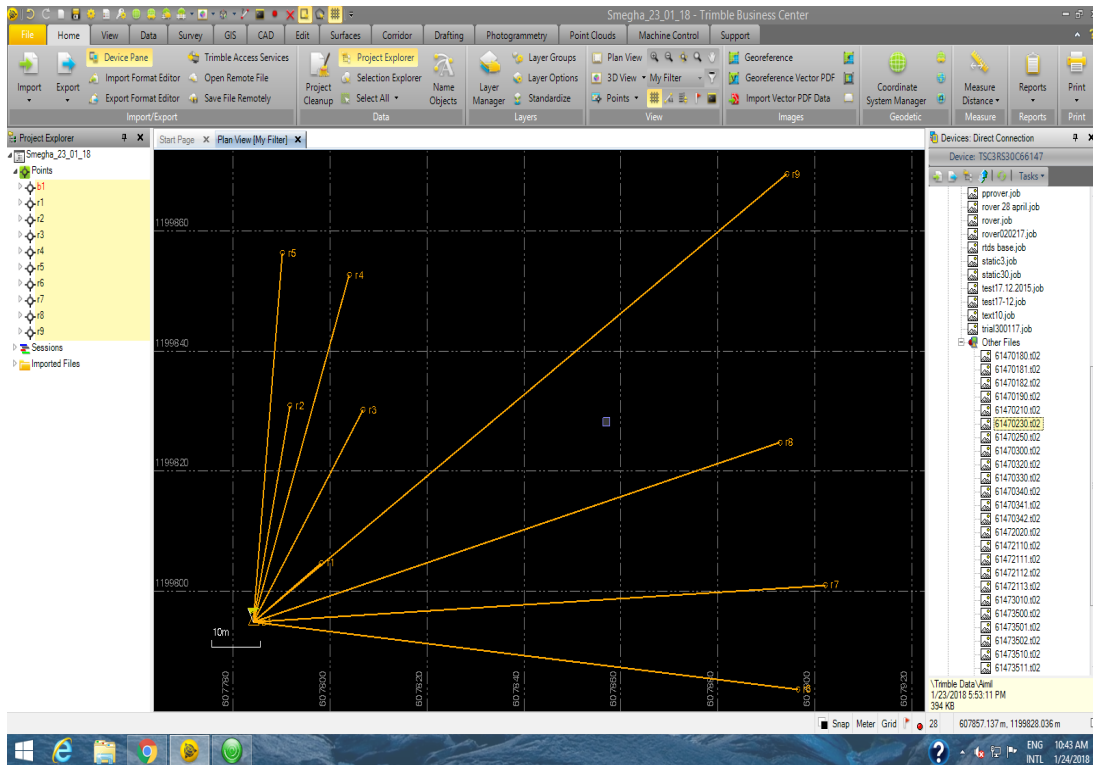
Fig. 4.4 Post processing the points collected in DGPS

In the above figure one base station is shown in triangular symbols. With respect to that Base b1, 8 points were surveyed. In the above figure unprocessed data is shown. The points are shown in the table 4.2

Table 4.2 Post processed points in TBC software

ID	Easting (Meter)	Northing (Meter)	Elevation (Meter)
b1	607772.971	1199795.036	20.334
r1	607784.841	1199790.830	20.381
r2	607791.618	1199829.359	23.233
r3	607806.713	1199828.729	23.248
r4	607803.802	1199851.083	23.295
r5	607790.035	1199854.761	23.286
r6	607817.246	1199859.926	24.417
r7	607814.082	1199901.415	27.327
r8	607820.861	1199817.053	21.950
r9	607783.306	1199818.871	22.048

In Trimble business center, Global latitude or longitude heights are in terms of a "Global co-ordinate datum" which in most modern cases is synonymous with the WGS84 datum. A Global co-ordinate datum is an approximation of the entire globe. Local latitude or longitude heights are in terms of a "Local co-ordinate datum" which is a datum that is a regional best fit, rather than a global best fit. An example for local co-ordinate datum is Australian Geodetic Datum.

Table 4.3 Total station survey data

ID	Northing	Easting	Elevation
1	1199830.785	607791.776	22.694
2	1199852.505	607803.962	22.753
3	1199852.512	607803.966	22.739
4	1199856.228	607790.159	22.736
5	1199830.156	607806.847	22.709
6	1199868.403	607786.034	23.662
7	1199850.68	607786.991	23.584
8	1199861.623	607786.466	23.634
9	1199861.605	607786.469	23.633
10	1199859.589	607786.52	23.626
11	1199862.005	607788.411	23.607
12	1199863.192	607789.377	23.669
13	1199861.91	607791.659	23.597
14	1199862.153	607799.724	23.638
15	1199862.379	607805.939	23.802
16	1199860.784	607805.71	23.776
17	1199860.951	607811.893	23.768
18	1199862.455	607812.206	23.825
19	1199861.525	607815.412	23.8
20	1199859.999	607815.02	23.727
21	1199879.577	607814.744	25.012
22	1199878.601	607817.918	24.914
23	1199813.282	607820.187	21.041
24	1199812.202	607822.771	20.99
25	1199822.636	607803.292	21.546
26	1199817.869	607802.427	21.38
27	1199822.126	607774.613	21.513
28	1199818.265	607774.527	21.39
29	1199823.964	607789.578	21.57
30	1199830.195	607778.742	22.093
31	1199837.427	607780.581	22.539

Fig. 4.5 boundary map of KCAET using TS
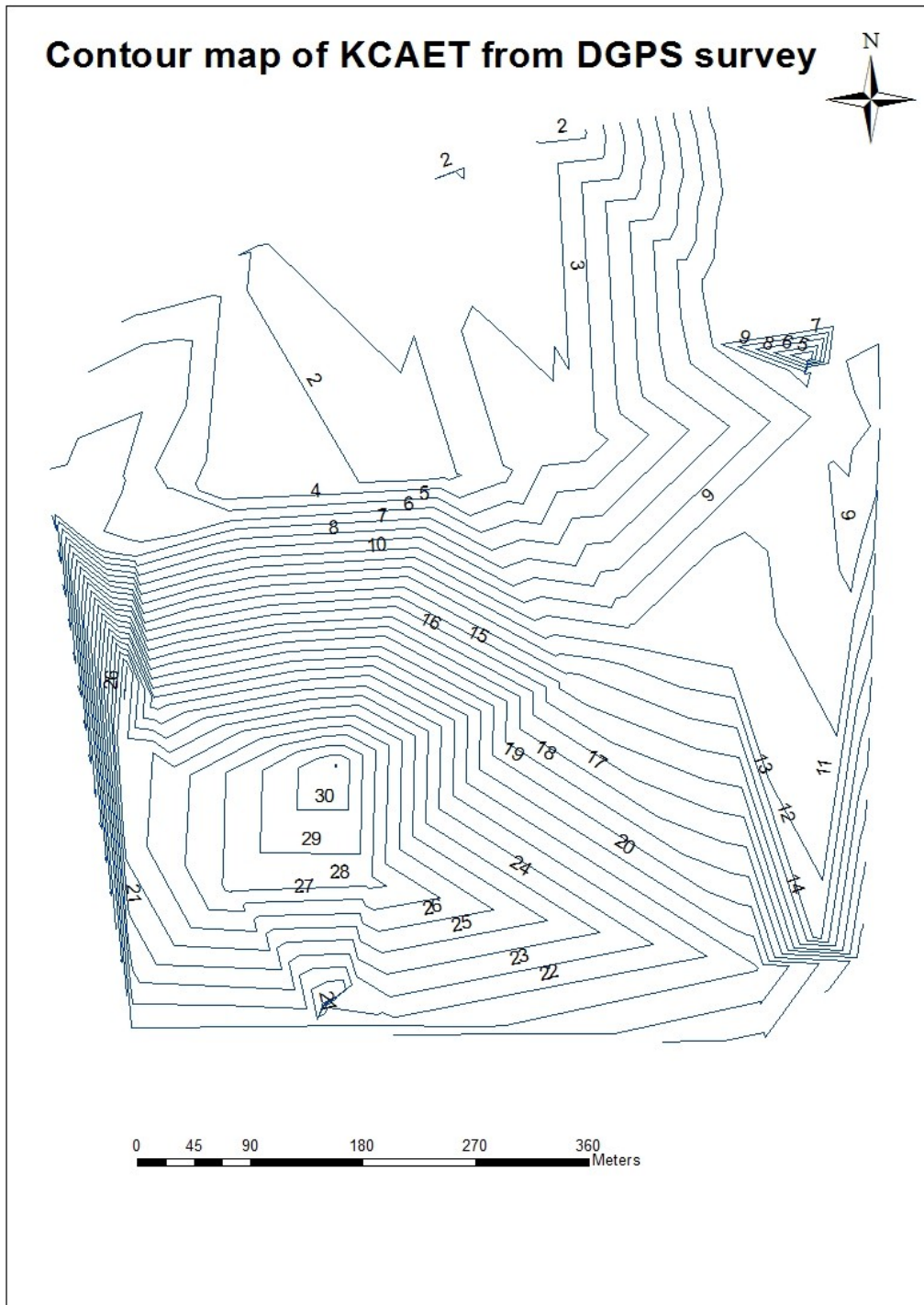
Fig.4.6 Contour map plotted from DGPS Survey

Contour map plotted using ArcGIS in which contour lines represents points of equal elevation (height) above a given level (arbitrary datum, mean sea level etc). A contour interval of 1m has been chosen. Fig. 4.7 shows the contour map of the

area surveyed using Total Station.

Contour map of KCAET from Total Station survey

N

| 0 | 45 | 90 | 180 | 270 | 360 |
Meters
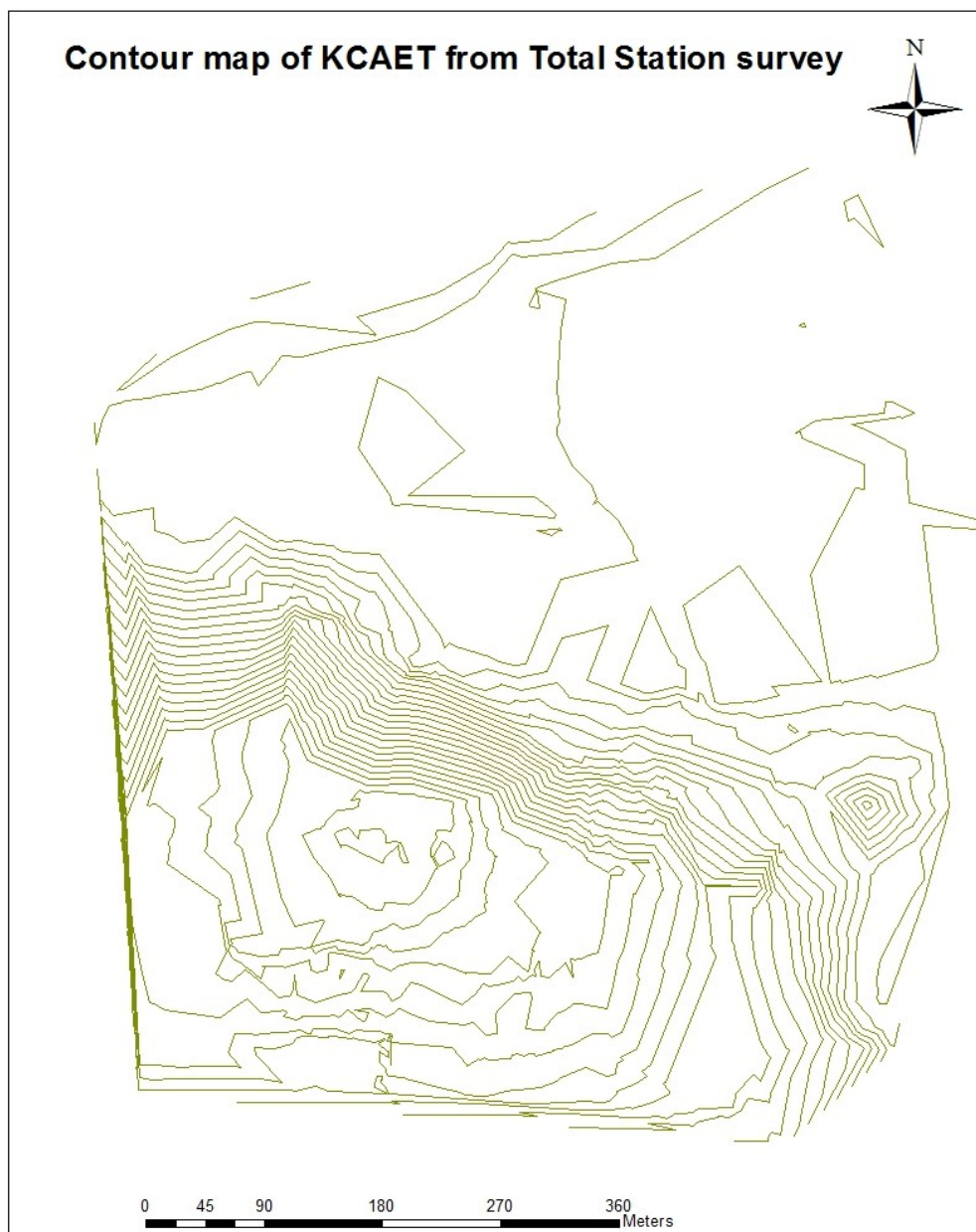
Fig. 4.7 contour map plotted from TSS
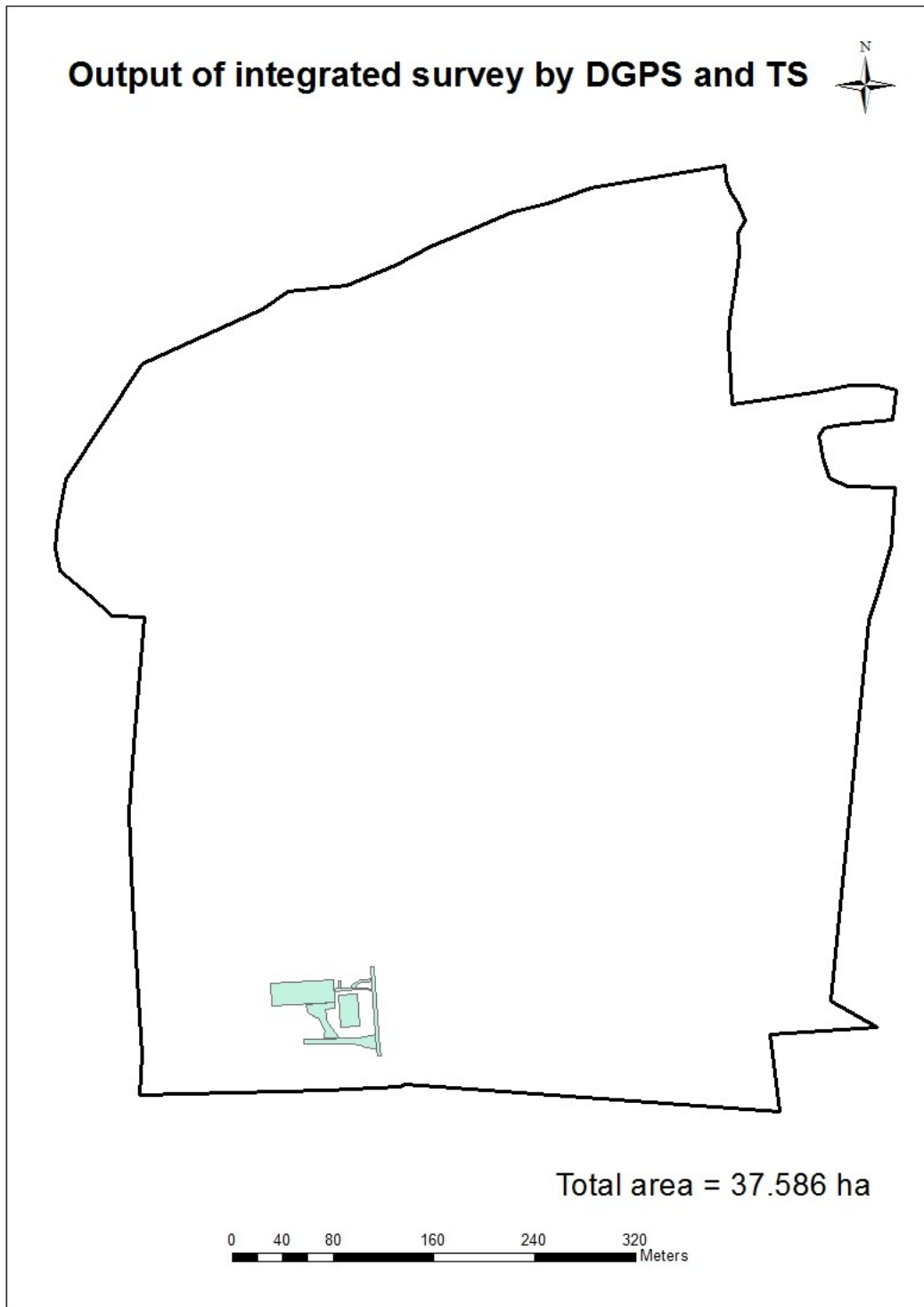
Fig.4.8 Output of integrated survey

SUMMARY AND CONCLUSION

Chapter 5

SUMMURY AND CONCLUSION

The main purpose of this project work is to conduct a topographic survey of KCAET campus and prepare natural resource map using GNSS. The topographic map is very important while planning for agricultural infrastructures and for soil and water conservation studies. For this purpose, the main equipments used were DGPS and Total station. As a part of this project the principles and working of DGPS and Total station were studied. Using DGPS, upland areas of KCAET campus were surveyed and the coordinates of all boundary corner points were taken. Post process kinematic survey was the survey method adopted for this. These points were post processed in PC using Trimble Business Centre Software. The processed reports were exported to the required file format. The data of the base line report helped in knowing the longitude, latitude, elevation, easting and northing and other details of the point. Geographical coordinates taken by GNSS were used during plotting maps of Total station collected field coordinates in ArcGIS. Using TSS coordinates of 34 points of selected features were taken to show the capability of integrated method of surveying.Using field collected data contour map, TIN were plotted. .

From this project, it can be concluded that DGPS and Total station are two efficient equipments that can be used for surveying in a short span of time in a more accurate manner. Both DGPS and Total station have advantages and disadvantages; although using GPS save efforts. In case of time, it requires very less time for taking measurements of a point than the Total station with high accuracy but when the initialization is gone we have to wait eight minutes for obtaining the initialization. Hence we can't use it in the forests, places having

good canopy and high rise buildings because of satellite interference. DGPS can cover wider areas than of TSS but shows limitations in places with dense canopy and is weather dependent. There we have to use total station. Since Total Stations works on the principle of signal reflection, line of sight must be there between Total Station and Prism reflector. In Kerala terrain, working with DGPS alone does not give good results whereas that in combination with TSS give better and satisfactory results and a map with good accuracy and great speed could be generated. Contour map can be made interactive to accommodate various engineering planning requirements. TIN has been generated using the co-ordinates of TSS and it can act as a prerequisite for generating customized maps such as degree of slope, aspect, slope curvature, contour etc.   By integrating the GNSS and TS an accurate map can be prepared at very fast rate. GNSS and TS are not replaceable equipments but, they are complimentary to each other.

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APPENDICES

APPENDICES

APPENDIX I

Point list of DGPS survey

Point ID	Easting	Northing	Elevation
b1	607798.292	1199803.93	23.355
1	607785.194	1199794.018	23.292
2	607982.15	1200056.713	13.285
3	608038.792	1200086.694	10.642
4	608064.782	1200076.256	10.927
5	608111.362	1200072.406	10.705
6	608209.914	1200152.617	8.772
7	608217.012	1200176.408	8.818
8	608227.554	1200213.209	8.775
9	608230.12	1200258.331	8.957
10	608193.131	1200259.699	9.183
11	608178.767	1200265.877	9.116
12	608173.895	1200278.925	9.043
13	608170.254	1200298.856	8.961
14	608173.724	1200305.501	9.214
15	608189.366	1200308.589	9.115
16	608228.333	1200312.613	8.811
17	608230.834	1200335.284	9.199
18	608217.334	1200339.726	9.34
19	608194.655	1200339.58	9.239
20	608166.601	1200333.92	9.029
21	608101.033	1200324.451	9.19
22	608092.454	1200372.323	9.223

23	608098.132	1200374.216	9.223
24	608099.657	1200391.407	9.106
25	608104.391	1200421.085	9.329
26	608107.159	1200443.424	9.164
27	608105.994	1200459.853	9.211
28	608111.878	1200470.258	9.419
29	608105.634	1200483.684	9.986
30	608100.736	1200491.75	9.135
31	608096.707	1200501.608	9.099
32	608095.994	1200513.278	9.189
b2	607785.552	1199795.755	19.954
1	607799.047	1199805.004	20.034
2	607988.924	1200495.453	1.549
3	607955.035	1200483.448	2.068
4	607928.534	1200476.79	2.384
5	607895.12	1200462.964	1.957
6	607863.321	1200449.761	2.391
7	607835.228	1200434.471	2.228
8	607796.09	1200418.775	2.35
9	607750.349	1200413.755	2.278
10	607729.271	1200400.003	1.918
11	607633.981	1200356.439	2.626
12	607665.553	1200303.239	4.66
13	607662.133	1200321.239	4.193
14	607645.569	1200317.047	4.313
15	607652.538	1200298.101	4.873
16	607574.046	1200265.453	4.879
17	607567.964	1200231.494	4.919
18	607565.458	1200210.655	5.15
19	607569.653	1200192.213	5.353
20	607592.096	1200174.122	5.417
21	607610.468	1200157.005	6.152

22	607636.448	1200155.518	5.809
23	607643.419	1200174.133	4.293
24	607619.534	1200216.822	5.237
25	607652.83	1200225.127	3.972
26	607661.39	1200209.772	3.995
27	607711.526	1200190.482	4.068
28	607703.019	1200205.211	2.392
29	607883.929	1200218.836	1.754
30	607926.774	1200219.369	2.637
31	607958.375	1200231.828	3.784
32	607990.956	1200245.463	3.302
33	608172.549	1200313.394	4.019
b3	607798.383	1199803.964	22.598
1	607811.619	1199813.653	22.653
2	607842.726	1199786.074	22.021
3	607838.246	1199783.614	21.834
4	607779.914	1199781.063	21.265
5	607632.616	1199777.538	20.975
6	607634.488	1199808.972	22.669
7	607627.031	1199930.683	25.401
8	607623.887	1200001.053	25.963
9	607649.111	1199998.196	25.971
10	607628.637	1200066.202	26.021
11	607628.633	1200066.204	26.025
12	607651.272	1200038.367	21.428
13	607668.842	1199978.417	26.653
14	607796.089	1199987.571	31.036
15	607821.282	1199894.778	28.362
16	607710.991	1199889.569	28.195
17	608179.955	1199851.467	11.379
18	608215.794	1199831.496	17.608
19	608131.593	1199825.521	21.074

20	608139.425	1199764.523	18.784
21	608139.365	1199764.451	18.61
b5	607772.971	1199795.036	20.334
1	607784.841	1199790.830	20.381
2	607791.618	1199829.359	23.233
3	607806.713	1199828.729	23.248
4	607803.802	1199851.083	23.295
5	607790.035	1199854.761	23.286
6	607817.246	1199859.926	24.417
7	607814.082	1199901.415	27.327
8	607820.861	1199817.053	21.950
9	607783.306	1199818.871	22.048
10	607776.712	1199839.537	23.486

Appendix II

Point list of Total Station survey

Point ID	Northing	Easting	Elevation
1	1199830.785	607791.776	22.694
2	1199852.505	607803.962	22.753
3	1199852.512	607803.966	22.739
4	1199856.228	607790.159	22.736
5	1199830.156	607806.847	22.709
6	1199868.403	607786.034	23.662
7	1199850.68	607786.991	23.584
8	1199861.623	607786.466	23.634
9	1199861.605	607786.469	23.633
10	1199859.589	607786.52	23.626
11	1199862.005	607788.411	23.607
12	1199863.192	607789.377	23.669
13	1199861.91	607791.659	23.597
14	1199862.153	607799.724	23.638
15	1199862.379	607805.939	23.802
16	1199860.784	607805.71	23.776
17	1199860.951	607811.893	23.768
18	1199862.455	607812.206	23.825
19	1199861.525	607815.412	23.8
20	1199859.999	607815.02	23.727
21	1199879.577	607814.744	25.012
22	1199878.601	607817.918	24.914
23	1199813.282	607820.187	21.041
24	1199812.202	607822.771	20.99
25	1199822.636	607803.292	21.546

26	1199817.869	607802.427	21.38
27	1199822.126	607774.613	21.513
28	1199818.265	607774.527	21.39
29	1199823.964	607789.578	21.57
30	1199830.195	607778.742	22.093
31	1199837.427	607780.581	22.539
32	1199838.58	607773.524	22.788
33	1199847.834	607757.352	23.469

TOPOGRAPHIC SURVEY AND RESOURCE MAPPING USING GNSS

By

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ABSTRACT

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Faculty of Agricultural Engineering and Technology

Kerala Agricultural University

Department of Land and Water Resources & Conservation Engineering

Kelappaji College of Agricultural Engineering & Technology

Tavanur P.O.-679573, Malappuram

Kerala, India

2018

ABSTRACT

A topographic map is a detailed and accurate two-dimensional representation of natural and human-made features on the Earth's surface. For an agriculture engineer, it is an important prerequisite as their sphere of activities include soil and water conservation, design and execution of irrigation systems, drainage network, location decisions of farm infrastructures, local and regional agricultural planning among other things. This project work mainly focused on the preparation of topographic map of KCAET campus, Tavanur using modern surveying equipments such as DGPS (Trimble) and Total Station (Pentax). Using the field collected data from DGPS, a topographic map was plotted using ArcGIS10.3 software. TIN, contour map were generated from this topographic map. In GNSS survey, post-process kinematic survey method was adopted. Post- processing of field collected data was done in Trimble Business Center software. The base line report obtained by exporting the data from the software provides the longitude, latitude, elevation, easting and northing etc. of the field point. It was found that, in Kerala terrain (with dense canopy) working with DGPS alone does not give good result whereas, in combination with TSS gives better and more satisfactory results. The integrated survey using DGPS and TS gives more accuracy and great speed in topographic surveying

and they can be used to accommodate various engineering planning requirements. GNSS and TS are not replaceable equipments but, they are complimentary to each other.

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