SPATIAL MAPPING OF WATER SUPPLY & DISTRIBUTION NETWORK OF KCAET CAMPUS USING TOTAL STATION SURVEY & GIS

By

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DEPARTMENT OF IRRIGATION AND DRAINAGE ENGINEERING

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

TAVANUR-679573, MALAPPURAM

KERALA, INDIA

2023

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PROJECT REPORT

Submitted in partial fulfillment of the requirement for the degree of

Bachelor of Technology

In

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Kerala Agricultural University

DEPARTMENT OF IRRIGATION AND DRAINAGE ENGINEERING

KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

TAVANUR-679573, MALAPPURAM

KERALA, INDIA

2023

DECLARATION

We hereby declare that this project entitled "**SPATIAL MAPPING OF WATER SUPPLY & DISTRIBUTION NETWORK OF KCAET CAMPUS USING TOTAL STATION SURVEY & GIS**" is a bonafide record of project work done by us during the course of study and that the report has not previously formed the basis for the award to us of any degree, diploma, associate ship, fellowship or other similar title of another university or society.

Place: Tavanur

Date: 30.05.2023

BALAGA SUPRAJA (2019-02-016)

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CERTIFICATE

Certified that the project entitled "**SPATIAL MAPPING OF WATER SUPPLY & DISTRIBUTION NETWORK OF KCAET CAMPUS USING TOTAL STATION SURVEY & GIS**" is a record of project work done jointly by **Ms. Balaga Supraja(2019-02-016), Ms. Nida Fathima (2019-02-031), Ms. Parvathy C V (2019-02-032), Ms. Shafna PP (2019-02-035) and Soorya K (2019-02-040)** under my guidance and supervision and that it has not previously formed the basis for the award of any degree, diploma, fellowship or association ship to them.

Place: Tavanur

Date: 31.05.2023

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DEDICATED

TO

ALMA MATER

ACKNOWLEDGEMENT

Any project work requires the efforts of many people, and our work is not different. With due respect, we would like to express our sincere gratitude to our guide **Dr. Asha Joseph**, Professor, Department of Irrigation and Drainage Engineering, KCAET, Tavanur for her immense encouragement, valuable advices and constant guidance throughout our endeavor. We also reflect our sense of indebtedness to co-guide **Dr. Sheeja P S**, Assistant Professor, Department of Irrigation and Drainage Engineering, KCAET, Tavanur, for imparting her skills towards the fulfilment of our project.

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SYMBOLS AND ABBREVIATIONS

Symbols	Abbreviations
EDM	Electronic Distance Measuring device
et al.	And others
mm	Millimetre
cm	Centimetre
ppm	Parts Per Million
m	Metre
RS	Remote Sensing
GIS	Geographic Information System
GPS	Global Positioning System
“	Seconds
CAD	Computer Aided Design
GRASS	Geographic Resources Analysis Support System
viz,	Namely
ArcGIS	Aeronautical Reconnaissance Coverage Geographic Information System
QGIS	Quantum Geographic Information System
etc.	Et cetera
KCAET	Kelappaji College of Agricultural Engineering & Technology
3D	Three dimensional
TS	Total Station
DGPS	Differential Global Positioning Model
DTM	Digital Terrain Model
sq.km	Square Kilometre
RMSE	Root Mean Square Error
SD	Standard Deviation

GNSS	Global Navigation Satellite System
LBS	Location Based Services
SOI	Survey Of India
DEM	Digital Elevation Model
GE	Google Earth
WSDN	Water Supply and Distribution Network

INTRODUCTION

CHAPTER I

INTRODUCTION

A water distribution network serves the purpose of carrying water from the source to different outlet points. It co-exists with human society by serving people's daily water consumption quietly after being laid underground. They are necessary and important but seldom noticed by the public, except when they are under construction or maintenance. Due to deterioration, infrastructures are likely to suffer from problems such as corrosion, cracking and leakage, which can result in several operational problems. The water supply system design concerns the locations and capacities of diversion works and storage, as well as the operations of these to meet multiple purposes (Gavekar and Nandavadekar, 2013).

A system for distributing water can be described as a complex and centralized collection of components. (Kadhim *et al.*, 2021). Hence, it necessitates the need for mapping the water supply and distribution network for ease of operation and maintenance. A map represents detailed and accurate locations of natural and human-made features above, on, or beneath the Earth's surface. Land surveying is the science and art of making all essential measurements to determine the relative position of points or physical details and to depict them in a usable form. These points are usually on the earth's surface and are often used to establish land maps and boundaries for ownership or governmental purposes. Furthermore, it is the detailed study or inspection by gathering information through observations, measurements in the field, questionnaires, or research of legal instruments and data analysis for the purpose of planning, designing, and establishing property boundaries. Advanced surveying instruments like Total Station have provided accurate measurements with the least time requirement and GIS platform is effective geospatial tool for mapping and analyzing the spatial features.

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 tracking changes in the composition, extent, and distribution of several forms of earth resources both renewable and non-renewable, living and non-living in nature. GIS is a powerful configuration of computer hardware and software used for compiling, storing, managing, manipulating, analyzing, and mapping (displaying) spatially-reference information. GIS provides the hub technology for planning, deploying, operating and optimizing water distribution systems.

GIS is also used in computer-aided design (CAD) services because it can provide data used for plans and surveys in the development of buildings, bridges, and highways. ArcGIS is a cloud-based mapping and analysis platform. Like many other GIS solutions, ArcGIS can be used to make maps, analyze data, and collaborate with team members.

The water supply and distribution network of KCAET campus consist of various components like pump houses, mainlines, service connections, sump tank, overhead tank, slow sand filter, valves like scour valves, butterfly valve, non-return valves, gate valves, ball valves, sluice valves etc., hydrants and junctions. The daily water requirement of the hostels and the premises is met from this supply and distribution network. A spatial map of Water Distribution Network of KCAET campus will be really useful for understanding the components and their location of the network and planning further changes or expansion of the network. So far, no such effort was taken to prepare a spatial map of the water supply and distribution network of KCAET Campus. Hence an attempt was made to prepare a water supply and distribution network map of KCAET Campus using Total Station and GIS tools with the following specific objectives:

- To conduct a reconnaissance survey to collect various information related to water supply and distribution network of KCAET campus

- To carry out a total station survey to locate the various components of water supply and distribution network
- To create a spatial map of the water supply and distribution network of KCAET campus

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

An attempt has been made in this chapter to review the various research conducted in the relevant fields with respect to the objectives of the study. The reviews are grouped under following subheads.

1. Total Station surveying- a modern surveying instrument
2. Use of GPS in surveying
3. Use of GIS technology in mapping water supply and distribution networks.
4. Application of Google earth in mapping.

2.2 TOTAL STATION SURVEYING - A MODERN SURVEYING INSTRUMENT

Rao and Prasad (2017) described the use of total station surveying in a water supply system in India. The authors discuss the advantages of using total station surveying for mapping and designing water supply systems, including its ability to provide accurate measurements of elevations and distances, and its ability to capture detailed information about the existing infrastructure.

In another study by Ali (2018), validated Total station as an accurate way of measuring horizontal distances and angles. The study area involved campus of Baghdad University at college of engineering department. The data from Consulting Engineering Bureau was used to select the sanitary sewer manholes and pipelines in this study. This data provided useful information on location of points, and its specifications. Nikon Nivo Total station was used to survey the sanitary sewer manholes around the buildings of the study area. The data was easily passed to a computer with program designed to calculate the 3D coordinates of each point to present the map as a 2-dimensional or 3-dimensional drawing.

Diriye and Abdi (2018) examined the use of total station surveying for water distribution system planning and design in Hargeisa, Somaliland. The study shows that total station surveying can help improve the accuracy of network design and analysis, but also highlights some of the challenges associated with the technique, such as the need for skilled surveyors and the difficulty of obtaining accurate data in complex terrain.

Kavitha *et al.* (2018) conducted a comparative study of advanced Surveying techniques for the accuracy of measurements of distance, height, area and positional information of an area. They stated Total station as an advanced instrument which is mainly used for measuring horizontal distance, slope distance, remote objects height and area of a land parcel and now-a-days this instrument is majorly used for determining the land area information. The major objective of the study was to evaluate and compare accuracy and time expenditure of conventional methods like Chain, Tape, Plane Table and Theodolite with Total Station (TS) and Global positioning system (GPS). Comparing the accuracy and the required time of these measurements would help in understanding the effectiveness of these instruments in the conduction of various methods of study. It is possible to conduct survey requiring less man power and less time while using Total station. The study area was at the Campus of Karpagam Academy of Higher Education (KAHE) football Ground and the area was measured using conventional methods like Chain, Tape, Plane Table and theodolite Total Station (TS) and Global positioning system (GPS). Further the collected data was processed in AutoCAD and terrasync. Finally, the results were analyzed and the plots were represented separately with the scale and area information. It was deduced that total station gave good accuracy compared to other instruments.

A study conducted by Kannan *et al.* (2019) compared the relative accuracy of total station survey by incorporating real world coordinates taken from geodetic GPS, hand-held GPS, Google Earth and Bing Base maps for at least two control points. The paper also studied the effect of Georeferencing tool, Spatial Adjustment tool and Champ tool on the precision and accuracy of surveying. The effects were tested on an area of 60,000 m^2 using 128 points and it was found that Champ tool is best for preserving the accuracy of points.

Islam *et al.* (2019) presented a case study using total station surveying to map and analyze the water distribution network in Mymensingh City, Bangladesh. The study shows that total station surveying is an effective method for determining the precise locations of water pipes, valves, and other network components, which can help improve the accuracy of network modeling and analysis.

Chaitanya *et al.* (2023) stated that in order to operate quickly and most efficiently in surveying, modern tools like Total Station are used. It utilizes the starting points from one station, to calculate horizontal and vertical distances as well as areas. The collected data could be directly transferred to a computer to generate the required map. It is a highly accurate tool which provides readings with slight inaccuracy.

2.3 USE OF GPS IN SURVEYING

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.

Rodriguez *et al.* (2006) conducted a study for the comparison of different GPS receivers' 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 data were collected in 17 forest locations. Test procedure was identical for all points, days and receivers. GPS positioning was repeated five times at each test point. Results showed that there were significant differences between the receivers with regard to accuracy and precision measuring coordinates. Also, 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. Comparison of GPS Receiver Accuracy and Precision in Forest Environments. Practical Recommendations Regarding Methods and Receiver Selection.

The importance of GPS in mapping is evident in a paper by Kumar *et al.* (2007) in which GPS Technology was used for visualization, network planning and mapping of water distribution at Nitte village in Udupi. Further this study also tries to analyze and link GIS facilities for the mapping of rural drinking network, positioning of the storage water tank and selection of the source of water for the water supply system, water quality at the end users, with consideration of ground surface properties. The whole water supply network data is collected by GPS survey which contained eighteen water sources with sixteen bore wells and two water tanks to supply water to a population of 12,000.

Kumar *et al.* (2013) made an assessment of the positional accuracy of Differential Global Positioning System (DGPS) at the Indian School of Mines (ISM) in Dhanbad, Jharkhand, India. The authors aimed to investigate the accuracy of the DGPS system at the ISM campus and identify any potential sources of errors in the system. The study involved collecting data from 12 different locations at the ISM campus using a DGPS receiver. The authors employed different statistical tests to evaluate the accuracy of the DGPS system, including Root Mean Square Error (RMSE) and Standard Deviation (SD). The study found that the DGPS system at the ISM campus provided a good level of accuracy, with an RMSE of 0.78 meters and an SD of 0.45 meters. However, the study also identified some potential sources of errors in the system, such as atmospheric interference, satellite visibility, and signal multipath. Overall, the paper provides a useful insight into the assessment of positional accuracy of DGPS systems, especially in the context of the ISM campus. However, it is worth noting that the study had some limitations, such as the small sample size and the specific location of the study. Therefore, further research may be necessary to validate the findings of this study in other locations and under different conditions.

GPS surveying was used to determine the accuracy of traditional surveying methods in a rural area of Ghana. The researchers used a Trimble R8 GNSS receiver to collect data at 20 survey points and compared the results to those obtained from traditional surveying methods. The study found that GPS surveying was more accurate and efficient than traditional surveying methods in the rural area of Ghana. The researchers concluded that GPS surveying can be a useful tool for surveying in rural areas where traditional surveying methods may be difficult to implement. This study was done by Amekudzi *et al.* (2014).

Khadri *et al.* (2014) has linked GIS and RS facilities the mapping of urban drinking network, positioning of the storage water tank and selection of the source of water for the water supply system, with consideration of ground surface properties.

They addressed the use of GIS, GPS and RS technology for visualization and network planning and Mapping. In Chalisgaon City in Dhule District Maharashtra Four Storage Tank have connected through the branches of network to supply drinking water to consumers. The whole water supply network data is collected by GPS Surveyed. The necessary water network maps or information were collected from Chalisgaon Council. A spatial database was designed and created using related database analysis approaches for this project. Results obtained were displayed in GIS maps, tables, and graphics.

Shen and Stopher (2014) provided an overview of GPS survey being used in transport data collections. They substantiated that GPS devices are very accurate with regards to recording time and positional characteristics of travel.

Times Of India (2017) reported that Hyderabad Metropolitan Water Supply and Sewage Board (HMWS&SB) had decided to make use of digital global positioning system (DGPS) for watersupply network to check water pipeline status, including its alignment, choke points and defects. A sum of Rs. 2 crore was spent to put DGPS over a network of 2700 kilometers.

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.

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 74 cm 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.

2.1 USE OF GIS TECHNOLOGY IN MAPPING WATER SUPPLY AND DISTRIBUTION NETWORKS

A study on Remote Sensing and GIS based landslide susceptibility assessment using Binary Logistic Regression Model was conducted in Ganeshganga Watershed, Himalayas by Kundu *et al.* (2013) with an objective of forming various thematic layers of the area of study. The study area was a highly landslide prone area of about 50 sq. km. in the Ganeshganga watershed in Chamoli district of Uttarakhand. The sources for thematic data layer generation were Survey of India (SOI) topographic maps, geological and structural maps prepared by Geological Survey of India. A total of 13 thematic data layers were formed like slope, relief aspects, lithology, density, structural features etc. DEM and its derivatives were formed from the collected map. The relevant thematic layers pertaining to the causal factors for landslide occurrence have been generated using Remote sensing technology supplemented with ancillary data. The GIS has been used for organizing the data base and carrying out mathematical modelling. Statistical model, either bivariate or multivariate, is used for spatial prognosis of slope failures which are based on the distribution of landslides and its statistical relationship with the geo-environmental parameters responsible for landslide activity in a particular region. GIS was used for computation of statistical parameters and integration of various thematic layers. The study concluded by pointing out the limitations of the GIS based mapping along with completing the objectives.

Sudhakar and Alivelamma (2018) conducted a study on generation of thematic layers in Mothkuri watershed using Geo-spatial techniques in Nalgonda district of Telengana state. The study emphasis on the significance of preparing thematic layers and the step by step process to do for that in both ArcGIS and ERDAS. They point out that thematic maps use the base data, such as coastlines, boundaries and places, only as points of reference for the phenomenon being mapped. The study focuses on generating thematic layers such as settlements, locations and transport network, drainage and surface water bodies, Geomorphology, slope, aspect, land use and land cover of the Mothkuri watershed. The methodology clearly describes the steps to be followed while mapping and forming thematic layers in GIS. Thus, thematic map generated Action plan map of Study area. The study area was indicated in different vector layers added in the same area and final map shows the Arc map window interface (Land use/Land cover map, Geology map, Water bodies map, hydro-geomorphology map, Transportation map, Settlement map, slope map, Stream Order map and Linear Aspect map).

Ayad *et al.* (2012) has done a detailed study on utilizing the ArcGIS as a tool to map the water distribution network and analyzing the features with the same. They utilized the GIS technology to provide graphical display of results which were obtained from both hydraulic simulation and optimization models. Their geometric network consists of edges and junctions. Example for the edges are water lines, hydrant line layer etc. whereas junctions indicate valves, hydrants, fittings etc. Using GIS, they were able to identify problems like breakage of lines, leakage and providing quick solutions to optimize network maintenance and provide a framework for continuous improvement.

Development of a GIS-based system for mapping and analyzing the water supply network of a city in India was discussed by Jain and Wani (2014). ArcGIS was used to digitize and visualize the water distribution network, and various analyses were performed to identify areas of low pressure and assess the impact of demand growth on the network.

Khadri *et al.* (2014) studied on the practical possibilities of utilizing GIS, GPS and RS technologies on mapping the water supply network and positioning of various components. The paper points out the use of these features for visualization, network planning and mapping. The study was conducted in the city of Challisgaon, which is in Jalgaon district of Maharashtra with the objectives of generating thematic layers of the city using GIS and RS technology, surveying the whole network from source to consumer level and to digitize the water distribution network for various hydraulic parameters. Required data were collected and using the digital elevation model (DEM) of the city, formed various thematic layers, created a base map and integrated the same with land use- land cover map. The study lights on the significance of GIS, GPS and RS in various mapping activities in a professional level.

Pindiga *et al.* (2015) stated that GIS is a powerful configuration of computer hardware and software used for compiling, storing, managing, manipulation, analyzing, and mapping (displaying) spatially-reference information. In order to ensure proper surveillance and maintenance of laid down pipes around Bauchi metropolis at Nigeria, they attempted the conversion of analogue map obtained from BSWB to digital raster map by digitization and georeferencing using GIS. Several features like valves, water hydrants etc. were located on the map using GPS coordinates from the surface. The resulting positions (coordinates) of the various features within the water distribution network helped the management of the Bauchi state water board in decision-making, strategic planning, and effective resource and operation management, so as to achieve the business objectives such as customer satisfaction, business growth and customer-based expansion.

This study by Mansi *et al.* (2016) at Baspa Village, Sami Taluka, Patan District Gujarat explained the paucity of water supply systems in Baspa village and the planning of sufficient water supply and distribution network using GIS technique. For assessing the exact site conditions a field survey has been carried out. The application of GIS in this project will help to plan a sufficient water distribution network. The study has been carried out by developing various thematic maps and integrating various field and administrative information in a GIS environment. Planning and designing in respective sectors like water distribution network, Road network, and information on land use has been carried out by using ArcGIS Software.

Sudhakar and Alivelamma (2018) conducted a study on generation of thematic layers in Mothkuri watershed using Geo-spatial techniques in Nalgonda district of Telengana state. The study emphasis on the significance of preparing thematic layers and the step by step process to do for that in both ArcGIS and ERDAS. They point out that thematic maps use the base data, such as coastlines, boundaries and places, only as points of reference for the phenomenon being mapped. The study focuses on generating thematic layers such as settlements, locations and transport network, drainage and surface water bodies, Geomorphology, slope, aspect, land use and land cover of the Mothkuri watershed. The methodology clearly describes the steps to be followed while mapping and forming thematic layers in GIS. Thus, thematic map generated Action plan map of Study area. The study area was indicated in different vector layers added in the same area and final map shows the Arc map window interface (Land use/Land cover map, Geology map, Water bodies map, hydro-geomorphology map, Transportation map, Settlement map, slope map, Stream Order map and Linear Aspect map).

Mia *et al.* (2020) conducted a study in Arad City, Romania to create a situation plan of the underground infrastructure of the natural gas distribution network using Geographic Information Systems (GIS) technology. The study involved the use of various surveying instruments like total station and other advanced instruments. The study emphasized on the growing importance of obtaining precise information about the layout of the underground utilities, and how GIS technology can help in achieving this objective. Finally, the article explained how the collected data was used to create a plan in AutoCAD with various parameters such as postal codes, street names, pipe materials, pipe diameters, burial depth, pressure regime, vertical component, length of the main network, and embranchment. Overall, the article highlights the importance of GIS technology in acquiring and managing spatial data in various fields.

Jnana *et al.* (2021) described that Geographic information system is a system that allows us to capture, store, manage and analyze digital information, as well as create graphs and maps, and consider alphanumeric data that can help improve civilization understanding their infrastructures. Water distribution network is a structure which is crucial to ensure the population gets water they needed. The main objective of this study was to make an Information System of a water distribution network with computerized documentation that will make it easier for the upcoming population that will use the service.

Kadhim *et al.* (2021) attempted to evaluate water distribution network in Kamada region using GIS application and found that there were no engineering errors. They have used many tools in GIS which helped in finding malfunctioning of water distribution network. The result indicated the advantage of using new technologies in water distribution network management programs to help in finding faults in the network.

2.4 APPLICATION OF GOOGLE EARTH FOR MAPPING

Potere (2008) found that Google Earth high resolution imagery has a horizontal positional accuracy that is sufficient for assessing moderate-resolution remote sensing products across most of the world's peri-urban areas. Hence Google Earth serves a significant, rapidly expanding, cost-free and largely unexploited resource for scientific inquiries.

The use of GIS in public health is growing, a consequence of a rapidly evolving technology and increasing accessibility to a wider audience. Google Earth (GE) is becoming an important mapping infrastructure for public health. However, generating traditional public health maps for GE is still beyond the reach of most public health professionals. Kamadjeu (2009) has conducted polio eradication activities in the Democratic Republic of Congo, he used GE as a planning tool and generated public health map. The use of GE improved field operations and resulted in better dispatch of vaccination teams and allocation of resources. It also allowed the creation of maps of high quality for advocacy, training and to help understand the spatiotemporal relationship between all the entities involved in the polio outbreak and response. Through this study he concluded that GE has the potential of making mapping available to a new set of public health users in developing countries. High quality and free satellite imagery, rich features including Keyhole Markup Language or image overlay provide a flexible but yet powerful platform that set it apart from traditional GIS tools and this power is still to be fully harnessed by public health professionals.

An analysis by Yuvaraj (2017) used google earth as a reliable source of network data and topology within a short period of time. Various elements in the network could be located with google earth's place mark and add path commands which are then transported to ArcGIS for further application.

Liang *et al.* (2018), conducted a detailed study on the applications and impacts of Google Earth which epitomized the first-generation of Digital Earth prototypes, during the period of 2006-2016. The study aims to develop a structured understanding of the influence and contribution associated with Google Earth by quantifying the multifaceted impacts. A total of 2115 Scopus publication records were studied using scientometric methods and then proceed to discussion with a selected set of applications. They analyzed Google Earth's various functions and organized them into a hierarchy to understand the functional relations of Google Earth's applications. The decadal development of Google Earth has been systematically reviewed, the study ponders on succinctly summarize how Google Earth has been used in and influenced different research fields. The study leads to the significance of Google Earth in the field of surveying, mapping, agriculture and urban development.

Ronald *et al.* (2019) conducted a study using Google Earth and Geographical Information System data as method to delineate sample domains for urban household surveys: the case of Maroua (Far North Region-Cameroon). A hundred numbered of points were put along the edges of an updated map of Maroua. Then two numbers were randomly drawn at a time and a line was drawn between those two numbers. A lot of different kinds of shapes of different sizes obtained were numbered. Ten shapes were randomly drawn and the one selected was considered as 'neighbourhoods'. This study aimed to test an alternative method using freely available aerial imagery.

Qiang *et al.* (2020) observed that Earth system science has changed rapidly due to global environmental changes and the advent of Earth observation technology. Therefore, new tools are required to monitor, measure, analyze, evaluate, and model Earth observation data. This paper reviewed the applications and trends in the use of GE and GEE. Finally, in this paper, the merits and limitations of GE and GEE, and recommendations for further improvements, are summarized from an Earth system science.

MATERIALS AND METHODS

CHAPTER III

MATERIALS AND METHODS

3.1 STUDY AREA

The study was carried out in KCAET campus, Tavanur, Kerala, India having a geographical location of 10°51’30” North latitude and 75°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, temperature ranges from 26-31°C and average relative humidity of 72%. Groundwater in the study area varies from 5 m to 15 m below ground level.

3.2. RECONNAISSANCE SURVEY TO IDENTIFY THE COMPONENTS OF WATER SUPPLY AND DISTRIBUTION NETWORK

The reconnaissance survey is an extensive study of entire area. It is the preliminary survey done to check if the execution of the work is possible technically and economically. It is used at the commencement of any project work by suggesting possible alternative paths and routes. It has to be done with greater efficiency and accuracy. The reconnaissance survey was conducted on KCAET campus to identity various components of the Water Supply and Distribution Network. The survey was done by conducting a transect walk through the area. Various components the Water Supply and Distribution Network were identified at the field, their geographic location was noted down with the aid of a GPS device Garmin GPS 12H and photographs were taken using a mobile camera.

The Global Positioning System (GPS) is a space-based radio-navigation system consisting of a constellation of satellites broadcasting navigation signals and a network of ground stations and satellite control stations was used for monitoring and control. Captures, stores, checks and displays data related to positions on Earth's surface. The specifications of the GPS device used is shown in the table 3.1 and view of GPS is shown in plate 3.1.

Table3.1. Specifications of GPS

Category	**Specification**
Brand	Garmin
Model	GPS 12H
Screen Size	2.6 Inch
Water Rating	IPX7
Battery Life	Up to 18 hours with 2 AA batteries (not included)
Physical dimensions	6.6 × 15.2 × 3.0 cm
Display size	2.6 diagonal (6.6 cm)
Display type	4 level grey LCD
Weight	203.11 g with AA batteries (not included)
Interface	USB and Serial
Storage	1,000 waypoints and 100 tracks

Plate 3.1. GPS device of model Garmin GPS 12H

3.2.1 Working steps of Garmin GPS 12 H

The device was calibrated for elevation at Kuttippuram railway station. After proper calibration, the device was taken to the field during the transect walk. The steps followed to obtain the geographic location of the components of the networks were as follows;

1. The GPS device was switched on
2. The "FIND " button was pressed
3. "COORDINATES" was selected and pressed "ENTER"
4. Latitude and Longitude coordinates were displayed on the screen
5. The component names and the corresponding coordinates were noted down

3.3 TOTAL STATION SURVEY TO LOCATE THE POINTS OF WATER SUPPLY AND DISTRIBUTION NETWORK

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) which uses 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. The data procured data could then be transferred to computer systems for further processing.

A Total station is shown in plate 3.2 consists of a theodolite with a built-in distance meter, and so it can measure angles and distances at the same time. It is also integrated with a microprocessor, electronic data collector and storage system. 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. 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.

Plate 3.2. A view of Total Station

3.3.1 Main accessories in total station

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, its advantages are long life, optimal vibration dampening, water resistance, outstanding behaviour in solar radiation and their weight in relation to load-bearing capacity.

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.*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 glasss 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 longlife span and maximum range of the highest accuracy are the most important criterion for prism.

3.3.2 Important operations in the total station:

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.

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.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.

3.3.3 Traversing by total station

The survey started from the intake well, which is at the north-east part of the campus. The work progressed via the supply line from the intake well through a sloping topography and reaches the slow sand filter and then to ladies' hostel. Survey was done continuously through the survey area which includes academic area, residential area including hostels and KVK. The end point was the second source, open well which is in the north-west part of the campus.

3.3.4. Instrumental set up

Step 1: Tripod set up

- Tripod legs were equally spaced.
- Tripod head was approximately levelled
- Head was kept directly over survey point.

Step 2: Mount Instrument on Tripod

- Instrument was placed on Tripod and secured with centering screw
- Battery was inserted in instrument before levelling
- Instrument was kept over the station point by switching on laser

Step 3: Levelling the Instrument

- Levelling foot screws were adjusted to level the instrument to center the bubble in the plate level
- Horizontal clamp was loosened and the instrument was turned until plate level is parallel to 2 of the levelling foot screws
- Once the bubble moved towards the center, the instrument was rotated 90 degrees and it was levelled using the 3rd levelling screw.
- After re-tightening the levelling screws, it was ensured that plate level bubble is level in all directions

Step 4: Electronically Verify Levelling

- The instrument was turned on by pressing and holding the “on” button (Indicated by an audible beep).

- The opening screen will be the “ELECTRONIC VIAL” screen as shown in plate 3.2.
- The electronic bubble was made sure to be exactly at the centre.
- The instrument was rotated in all directions and rechecked

Plate 3.3 Display of Total station

Step 5: Adjust Image and Reticle Focus

- The horizontal & vertical clamps were released and telescope was pointed to a featureless plain background
- The reticle was adjusted (i.e, cross-hair) until reticle image was sharply focused.

Step 6: Measurement using total station

- An operator could perform the [MEASURE] function only when the Telescope is at the “Face left position”.
- The target type is selected before performing the [MEASURE].
- After measuring rectangular coordinates by [MEASURE], it is possible to display Angle by switching function button.

Step 7: Creation of a new Job

- CREATE option is chosen in FILE as shown in plate 3.4.

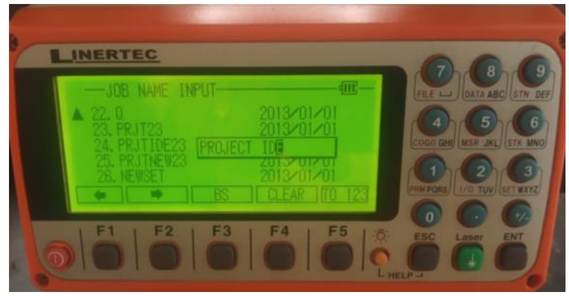

Plate 3.4 File creation in Total station **Plate 3.5 Naming the file**

- [ENT] was selected to view the JOB NAME INPUT screen as shown in 3.5.
- If a new Job was created, the new data are stored in this new Job.

Step 8: Selection of a Job

- In JOB LIST SEARCH, [ENT] is pressed to view its screen. JOB LIST was a list of all stored Jobs.
- The desired Job name was selected

Step 9: Station setup [By Rectangular Coordinates]

Select options as shown in plate 3.6 for measuring and [MEAS] screen was opened to view the MEASURE METHOD SELECTION screen

Plate 3.6 Steps for Station Setup

RECTANGULAR COORD was selected to view the STATION POINT SETUP screen.

- The ↑/↓ arrow mark was used to scroll up / down

- PC was viewed by scrolling down

Step 10: Point name (PN) input

- PN screen was selected
- The desired point name was entered by pressing keys
- Four-character selection methods are available

Coordinates, N, E, Z, PH, PN and PC input

- N and E values were fixed as 1000
- Elevation that is Z value was given as 100
- Prism Height, Point Code and Point name were entered similarly

Step 10: Measuring

- The Target point was aimed and measured.
- [MEAS/SAVE] option was used to measure and save the measured data. [SAVE] saves the measured data.

Step 11: View and Edit

- Stored data was displayed, and editing is possible by this Function.

Step 12: Exporting of data

- Job data, format files, configuration sets and code lists can be exported from the internal memory of the instrument. Steps followed for exporting data is shown in plate 3.7. The data stored in internal memory is sent to the PC, Memory cards etc.
- I/O option was selected to choose Text File Transfer.

Plate 3.7 Steps to export data

- Further Rectangular Data Text Write was selected to view the FORMAT SELECTION screen as shown in plate 3.8

Plate 3.8 Selection of file format

- Format was chosen as CSV format and Data Save Place as SD Card.
- Finally, the job name was selected as in plate 3.9

Step 13: conversion of coordinates into spatial reference system

- False coordinate system (1000, 1000, 100) was converted into spatial coordinates using online UTM converter
- The conversion was done in reference to geographic information taken from the very first point using GPS device
- Converted data exported into an excel sheet for adding the data on GIS software for mapping the features.

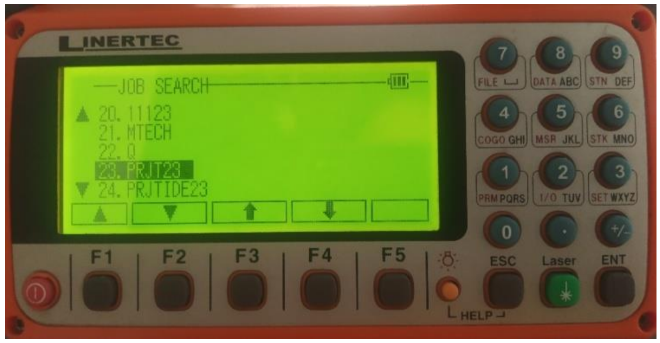

Plate 3.9 Job selection

3.3.5. Work plan of total station survey in the field

The surveying using Total Station was started from the north-west part of the campus. Intake well was fixed as first station point (benchmark) and the survey was done with respect to this benchmark point. The survey was planned with minimum shifts having maximum area coverage. The survey progressed from the intake well via the farm area beside coconut garden and reached upto the slow sand filter and then to the main overhead tank, near ladies' hostel. A non-return valve and a butterfly valve (behind the filter) was there in this pathway. All the major components were surveyed along with the pipelines and other landmarks. Thus, completed the first set of observations in the supply line network.

The second set of observations in the supply side, started from the north-east part of the campus, where the second major source is situated. This was an open well and pump house near the Farm Office. The survey was done in accordance with the existing roads. All the buildings and other landmarks were taken. The area was surveyed with minimum shifts. Surveying progressed towards the main overhead tank by tracing the supply line and its components. And the survey ended with overhead tank as the last station point.

In the distribution network, there were two overhead tanks, viz overhead tank of ladies' hostel, and the main overhead tank of the campus near ladies' hostel. The survey started from a station point near the slow sand filter. The filtered water stored in the ground level storage tank was pumped to the overhead tank of ladies' hostel. From there it is delivered to men's hostel and hence, this distribution path was surveyed accordingly. The water from the main overhead tank is distributed to staff quarters, KVK, academic block, canteen, workshops and laboratories. Thus, the distribution line survey to all directions were completed with Total Station and GPS.

3.4 PLOTING USING GEOGRAPHICAL INFORMATION SYSTEM (GIS)

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. By relating seemingly unrelated data, GIS can help individuals and organizations better understand spatial patterns and relationships. ArcGIS 10.7 was used for the preparation of thematic layers including the pipeline network, major components of the Water Supply and Distribution network, buildings, roads on the campus etc. 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
- Managing geographic information in a database

3.4.1 Steps involved during preparation of map in ArcGIS are:

Step 1:

ArcMap was launched, by clicking: Start→All Programs→ArcGIS→ArcMap10.7.

Step 2:

Data was added by clicking Add Data button which opens a window as shown in fig 3.1. The file containing surveyed data in excel sheet format is selected.

Step 3:

The required XY fields and coordinate system were chosen as in fig 3.2.

Step 4:

Label Features were checked so that the surveyed points will be displayed on the map as shown in fig 3.3.

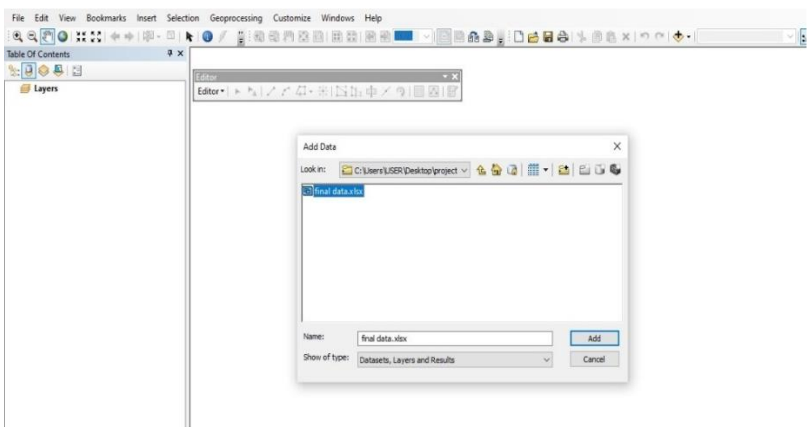

Fig 3.1 Adding data into GIS

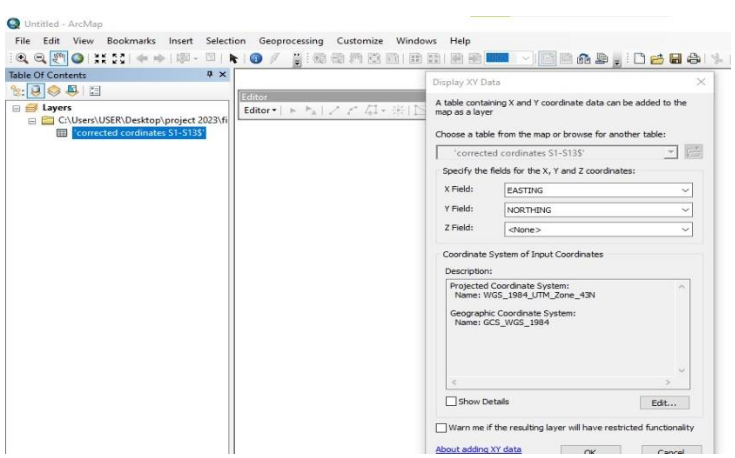

Fig 3.2 Adding X, Y coordinates

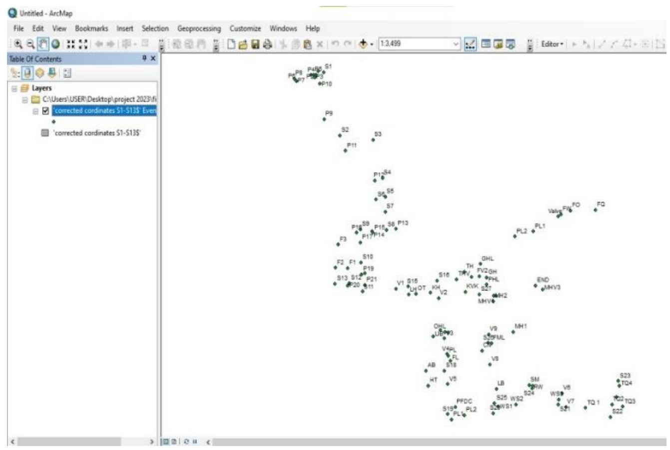

Fig 3.3 Plotting of survey points

Step 5:

Shapefiles were created as in fig 3.4 to represent each geometrical feature within the map. Eg: Buildings, Pipelines, Valves, Hydrants etc. For pipelines, polyline was choosen as shown in fig 3.5.

Step 6:

Features were drawn either by using Editor toolbar or by choosing Start Editing as in fig 3.6 and fig 3.7.

Step 7:

Google earth imagery was added as base map as by steps shown in fig 3.8. Additional points were excluded and the points referring to the network were connected to complete the map.

Step 8:

Attribute table of each layer was used to input information like name, unique ID etc. The attribute table of valves and hydrants are shown in fig 3.9.

Step 9:

Finally, the map layout was created after inserting elements like legend, title, scale bar and North arrow

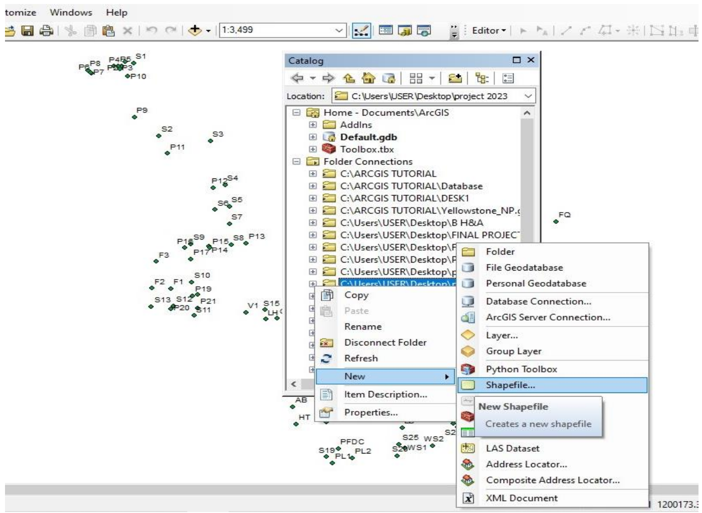

Fig 3.4 Creating shape file

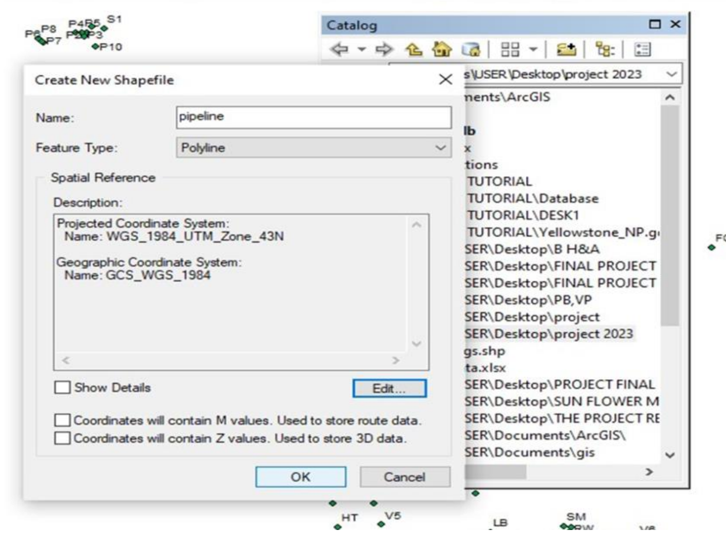

Fig 3.5 Shape file for pipeline

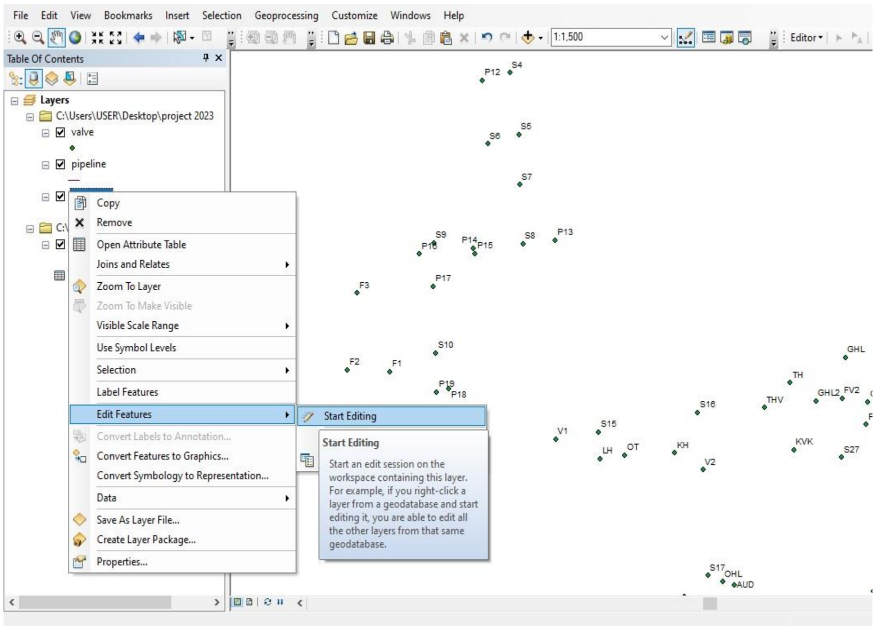

Fig 3.6 Drawing lines by joining points

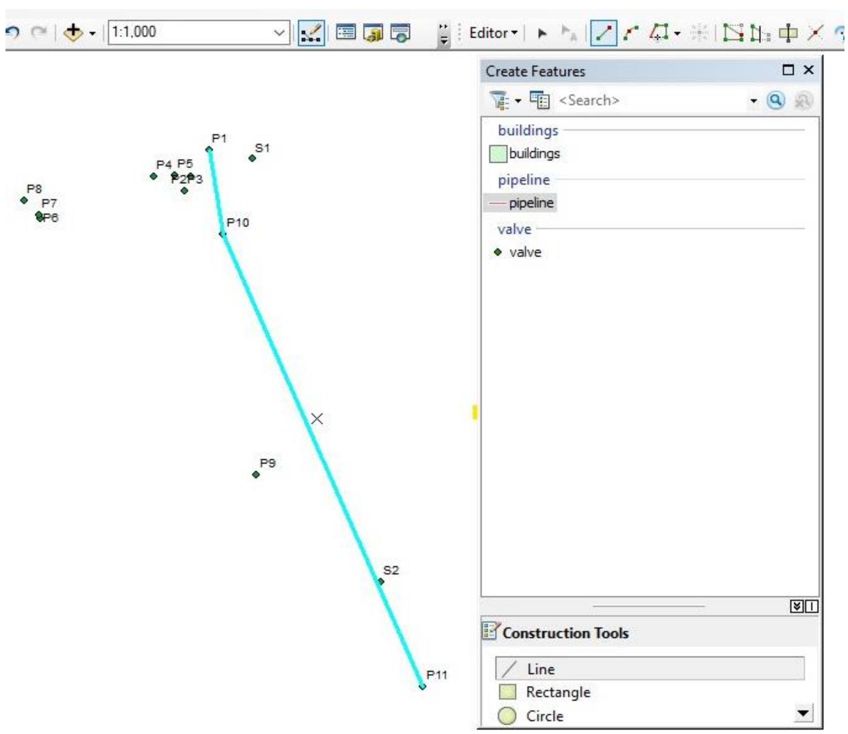

Fig 3.7 Editing using Create Features

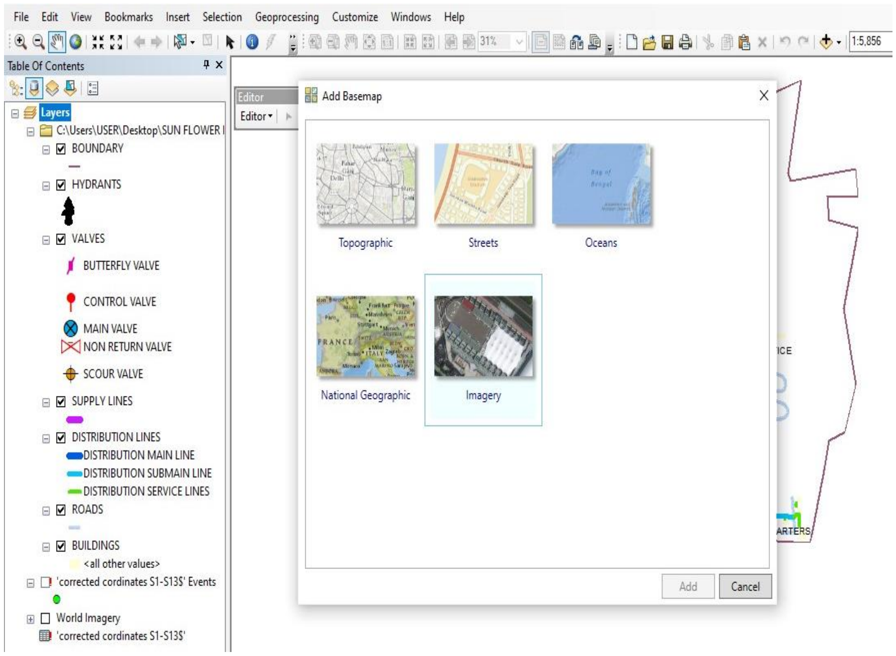

Fig 3.8 Adding base map

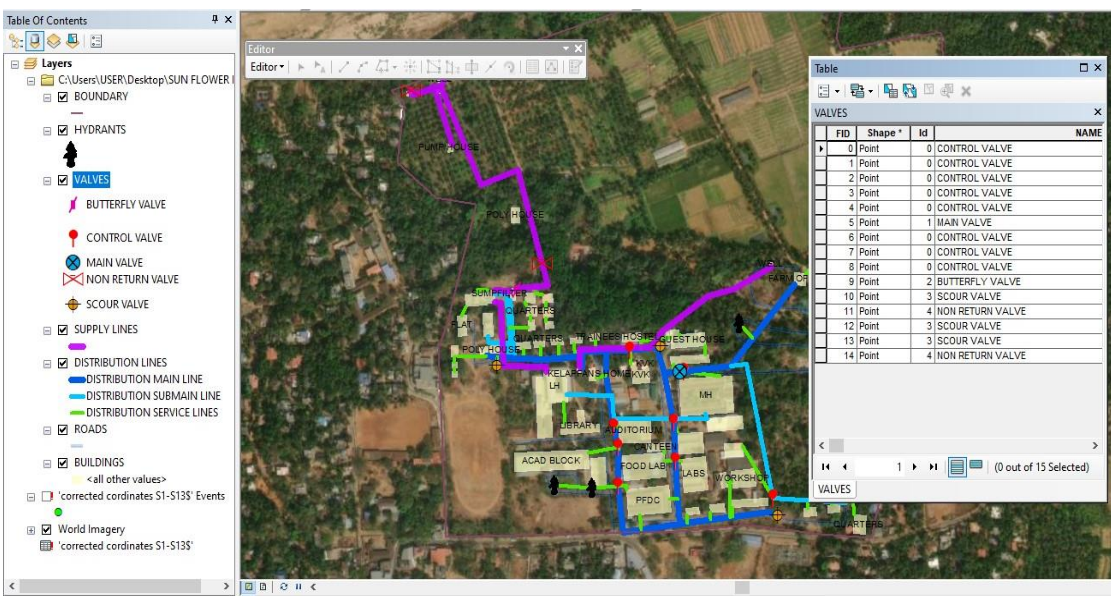

Fig 3.9 Editing the attribute table

RESULTS

AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

The KCAET Campus area was surveyed using Total Station and GPS to locate the water supply and distribution lines and its various components. The data obtained from survey was exported into GIS after converting it into tabular form (.xlsx). Georeferencing of the data was done to provide a spatial reference system. The mapping of Water Supply and Distribution network was done using ArcGIS 10.7 software. Various thematic layers were added and detailed observation was done on each part of the network. The details of the water supply and distribution network, included the details regarding the source, various components, the dimensions & specifications of pipe lines, overall consumption rate and the landmarks in the study area.

4.1 RECONNAISSANCE SURVEY TO IDENTIFY THE COMPONENTS OF WATER SUPPLY AND DISTRIBUTION NETWORK

Initially, a visit to the entire campus was done to identify the pattern of water distribution network. Once the sources and the pathways were identified, a rough sketch was prepared accordingly and a detailed study on the dimensions & specifications of the components were done.

The KCAET Campus is mainly having two water sources which contributes to the water supply network. The first source is an intake well (at the north-west part) which delivers water to the slow sand filter and the second source is an open (at the north-east part of the campus) well near the Farm Office, which delivers water to the overhead tank. All the components associated with the water supply and distribution network were identified during the reconnaissance survey. It included wells like filter point well & open well, pump houses, mainlines, service connections, sump tank, overhead tank, slow sand filter, hydrants, valves like scour valves, butterfly valve, non-return valves, gate valves, ball valve, sluice valves etc.

The total station surveying was conducted in two sections: 1. supply lines and 2. distribution lines. The supply was met by two open wells. The water from the intake well (open well) which is shown in plate 4.1, pumped to the slow sand filter and the filtered water is stored in the nearby ground level storage tank as shown in plate 4.5. From there its pumped to the overhead tank of ladies' hostel and distributed to both ladies' hostel and men's hostel. Three filter point wells and their pump houses were also situated near the intake well, but only one among them is connected to water supply as standby which is shown in plate 4.3. A butterfly valve was found to control the flow of water to the slow sand filter. The other supply source was an open well situated near the farm office as shown in plate 4.2, from which water is pumped to the campus main overhead tank, near ladies' hostel, which is shown in plate 4.4 and distributed to the remaining areas of the campus. One main valve (which is a sluice valve/delivery valve) was found adjacent to overhead tank which regulates the flow of water. Some non-active pipe connections (especially cast-iron pipes) were also seen in between as old connections.

The water distribution network consists of cast iron pipelines (old connections) and PVC pipelines. A 2 inch PVC pipeline starts from the intake well as supply line which further changes to 4 inch when it reaches to slow sand filter. The pipeline which collects water from the slow sand filter is of 2 inch till it reaches the ladies' hostel. The pipeline starting from the open well near farm office is of 2 inch made of galvanized iron. It changes to 5 inch just before non-return valve till guest house, then 4 inch up to overhead tank. All the main lines are of 5 inch cast iron, since there are old connections. Three hydrants are currently functioning in this supply line which are aided with pop-up valves and ball valves. In addition to this, separate sources are provided for the instructional farm and Krishi Vigyan Kendra working within the study area for their irrigation and dairy barn usages. It was found that the KCAET campus needs approximtely 2 lakhs litres of water to meet the daily requirement

Plate4.1 Intake well with pumphouse

Plate 4.2 Open well near farm office

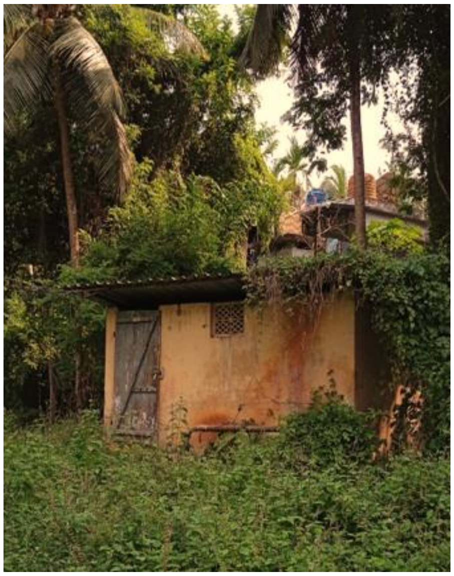

Plate 4.3 Filter point wells and pump houses near intake well

Plate 4.4 Main overhead tank

Plate 4.5 Ground level sump

..

(a) (b) (c)

Plate 4.6 Different hydrants in the campus

(a) at BB Court (b) at farm road(c) at college lawn

4.2 TOTAL STATION SURVEY TO LOCATE THE POINTS OF WATER SUPPLY AND DISTRIBUTION NETWORK

The survey was conducted for both the supply line and distribution line network. The intake well was taken as station point 1 and the final station point was taken near to the old MH where the entry of Instructional Farm area starts. All the water sources were surveyed. Some technical errors happened during survey due to the change in the rotational direction. Hence, the area after station points 15 were re-surveyed and made as a separate set of data. The errors in the area, till station point 13, were subjected to some theoretical corrections by the principle of rotation of axes. The angle of rotation at S2 was found to be 3^{o}, hence correction was done using the following formulas:

$x = X\cos\theta - Y\sin\theta$ and $y = X\sin\theta + Y\cos\theta$

where,

x = actual x coordinate

y = actual y coordinate

X = measured x coordinate

Y = measured y coordinate

Corrected coordinate data from S1 to S13 is given in Table 4.1.

Table 4.1 Corrected coordinate data

Points	Northing	Easting
S1	1200288.06	607623.7
P1	1200290.111	607614.444
P2	1200284.199	607610.605
P3	1200281.109	607609.262
P4	1200284.221	607602.669
P5	1200284.442	607606.989
P6	1200274.933	607578.229
P7	1200275.724	607578.052
P8	1200278.935	607574.859
P9	1200218.561	607624.664
P10	1200271.454	607617.477
S2	1200195.03	607651.22
P11	1200172.06	607660.37
S3	1200188.24	607706.56
S4	1200131.68	607722.15
P12	1200128.31	607708.83
S5	1200104.04	607726.51
S6	1200100.01	607711.33
S7	1200081.71	607726.91
S8	1200055.28	607728.52
P13	1200056.88	607743.93
P14	1200053.32	607704.26
P15	1200050.89	607705.14
S9	1200055.69	607685.34

P16	1200050.81	607678.14
P17	1200036.34	607684.86
S10	1200006.6	607686.16
P18	1199990.58	607692.55
P19	1199989.13	607686.54
S11	1199963.92	607688.37
P20	1199972.68	607663.75
P21	1199973.77	607692.28
P22	1199996.88	607723.57
S12	1199976.12	607666.8
S13	1199975.38	607642.86

The second set of data were surveyed from S15. The coordinates of some of the points are tabulated in Table 4.2.

Table 4.2 Survey data obtained from Total Station

STATION	N	E	Z
S15	1000	1000	100
V1	996.816	979.565	99.343
LH	988.16	1001.046	100.325
OT	989.693	1012.758	100.862
S16	1008.867	1048.083	100.652
V2	983.114	1050.879	100.636
KH	990.702	1036.979	100.856
S17	936.01	1053.252	99.324
V3	923.174	1060.231	98.374
V4	899.949	1064.812	96.779
AUD	931.846	1066.207	98.473

LIB	926.687	1041.743	98.922
OHL	933.176	1060.394	98.971
S18	875.391	1059.784	95.431
FL	890.122	1070.51	96.293
PL	897.482	1066.263	96.743
AB	875.74	1029.116	95.632
V5	855.712	1065.781	94.23
HT	853.049	1033.033	94.656
S19	811.235	1065.308	91.894
PFDC	821.707	1078.103	93.414
PL1	803.068	1071.528	91.442
PL2	809.808	1093.367	92.431
S20	812.612	1141.75	92.747
WS1	822.347	1150.164	93.028
WS2	825.52	1179.127	92.885
S21	825.799	1249.986	91.636
WS3	833.074	1250.457	91.842
V6	842.402	1256.343	92.297
V7	821.98	1262.947	90.746
TQ 1	820.569	1295.159	89.498
S22	807.245	1336.744	87.11
TQ2	825.714	1339.677	88.986
TQ3	822.33	1357.114	87.204
TQ4	853.365	1351.837	88.836
V6PL	836.235	1347.032	88.594
S23	860.244	1349.718	89.721
S24	849.663	1206.258	92.571
RW	853.201	1207.06	92.813
SM	854.463	1201.109	93.321

S25	827.651	1143.586	92.421
LB	848.418	1146.892	93.559
V8	884.703	1136.276	94.573
S26	916.826	1133.332	95.683
CN	905.146	1122.633	95.657
FML	916.021	1139.005	95.704
MH1	933.161	1175.099	95.037
V9	928.984	1133.615	95.868
S27	988.779	1117.829	96.397
MH2	978.277	1141.125	94.724
MHV1	986.437	1142.256	95.196
MHV2	986.95	1146.372	95.054
MHV3	995.72	1224.245	93.649
PHL	1003.37	1130.018	95.975
GH	1013.438	1130.654	95.21
FV2	1015.206	1118.432	96.429
TH	1022.128	1093.077	97.829
THV	1010.943	1080.535	98.12
KVK	992.17	1094.944	97.37
END	1001.29	1212.081	93.641

4.3 VARIOUS THEMATIC LAYERS GENERATED

The components of the water supply and distribution network were identified from the obtained points from the total station survey, which were used as the input for preparation of spatial map. They are labeled for creating various feature classes on GIS platform using ArcGIS 10.7. Mapping of supply lines, distribution lines and roads were done as polyline features. Valves and Hydrants were plotted as point features and buildings was added as polygon features. The boundary of KCAET campus was collected from Geospatial Lab of KCAET was added to the various thematic layers prepared. Thus, various thematic layers were prepared which includes supply lines, distribution lines, major components, boundary, buildings, roads etc.

4.3.1. Thematic layer of Supply line Network

The Fig 4.1 shows the thematic layer of supply lines of the campus water supply & distribution network. The map indicates the two major water sources viz, the intake well & the open well. The intake well (provided with submersible pumps of 7.5 hp) supplies water to the slow sand filter and the filtered water is collected in a ground level sump having two chambers, which is installed with two pumps of 5 and 3 hp (standby). The water from the sump is pumped to the two overhead tanks of ladies hostel. From these tanks it is further delivered to new mens hostel and later to the old mens hostel. An additional connection is also provided from the ladies hostel to the library.

The supply line starting from the intake well is of PVC, of diameter 2 inch. Later, the diameter increases to 5 inch upto the non-return valve and then it reduces to 4 inch when it reaches the filter. The pipeline which conveys water from the sump to the ladies hostel is of 2 inches.

The open well, which is at the north-east part of the campus, adjacent to farm office is provided with a 15 hp mono-block pump. Generally, 3-4 hours of pumping is done from this well daily, in one or two shifts. The pipeline starting from this well is made of galvanised iron having a diameter of 2 inches. It further changes to 5 inch just before non-return valve upto the guest house part and decreases to 4 inch upto overhead tank. All the main lines are of 5 inch cast iron, since these all are old connections.

4.3.2. Thematic layer of Distribution line Network

Thematic layer indicating the water distribution network is indicated in the fig 4.2. The distribution starting from the slow sand filter, from which water is collected in a ground level sump and later stored in the overhead tanks of ladies hostel. This tanks, having two chambers has a capacity of 35000 litres each. This water is supplied to the new mens hostel and later to the old mens hostel. The water distributed in the men's hostel (new) is in fact delivered from the storage tank of ladies' hostel. In the case of old men's hostel, there are two connections for water distribution, which includes one from the ladies' hostel (via new men's hostel) and one directly coming from overhead tank (which is unfiltered). The water from overhead tank is utilized in bathrooms only on one side.

Other connection starts from the overhead tank (beside ladies hostel) to the entire part of the campus. Overhead tank is having a capacity of 75000 litres which is bearing unfiltered water. The map seperately indicates the mains, submains and service lines. There are 10 filter point wells over the study area, comprising 3 for drinking water supply (currently unused), 5 for irrigation and 2 under Krishi Vigyan Kendra. There are 12 pump house connections (three phase) in this area.

4.3.3. Thematic layer of Valves and Hydrants

Thematic layer containing various valves and hydrants are shown in fig 4.3. The pump houses which are associated with sources that conveys water to the pipelines are provided with different types of valves including non-return valves, gate valves, scour valves, ball valves and butterfly valves. The non-return valves are provided at the beginning of the mainlines, which allows only unidirectional flow of water. The gate valves are frequently given to control the flow rate. Scour valves are provided at the lower points of the network, particularly at the pipe ends, to enable flushing out during maintenance. This helps to mitigate clogging troubles. Ball valves, commonly known as service valves are provided to regulate the water flow through the lines.

A total of six scour valves are present in the water distribution network. The locations include premises of Dean's quarters, guest house, auditorium, farm office, sports ground, men's hostel. There are 3 hydrants identified in this network. Hydrants are an outlet taken from the mains particularly for irrigation purposes. In KCAET campus, hydrants are provided at basketball court and lawn before the academic block for gardening purposes and one at the farm road (near to the nursery) for irrigation needs. Butterfly valves are provided at slow sand filter, but is not working currently.

4.4 MAPPING OF WATER SUPPLY AND DISTRIBUTION NETWORK

The water supply and distribution network of KCAET campus was prepared using the software ArcGIS 10.7. Various thematic layers were prepared which consists of the layers including supply lines, distribution lines, major components like valves and hydrants, buildings, roads etc.

Fig 4.4 indicates the water supply and distrubution map of KCAET campus. The two major sources ie, the intake well and open well, the pipelines starting from sources, pump houses, valves, slow sand filter, ground level storage tank, overhead tank and all the service lines in the campus were plotted and mapped.

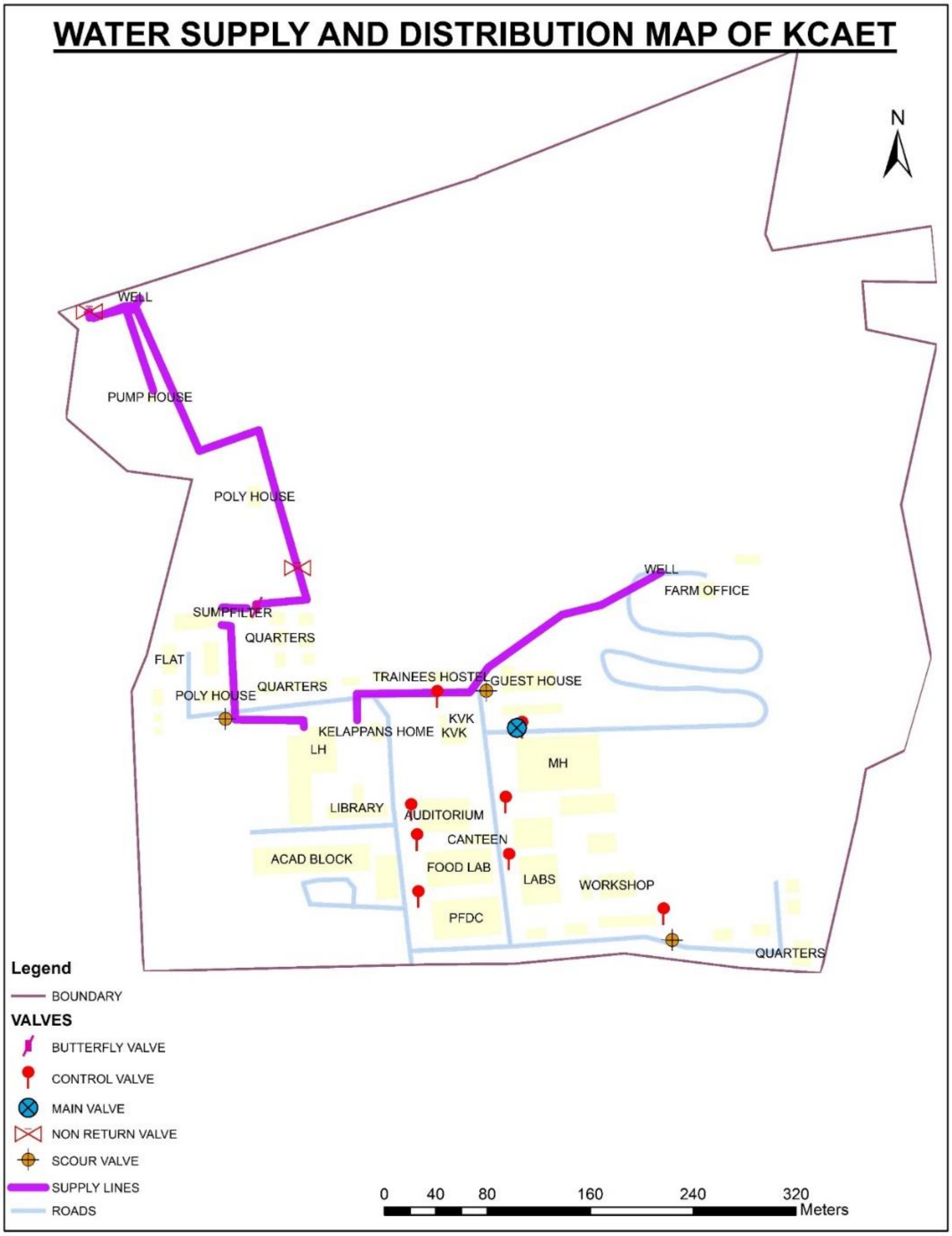

Fig 4.1 Supplyline network

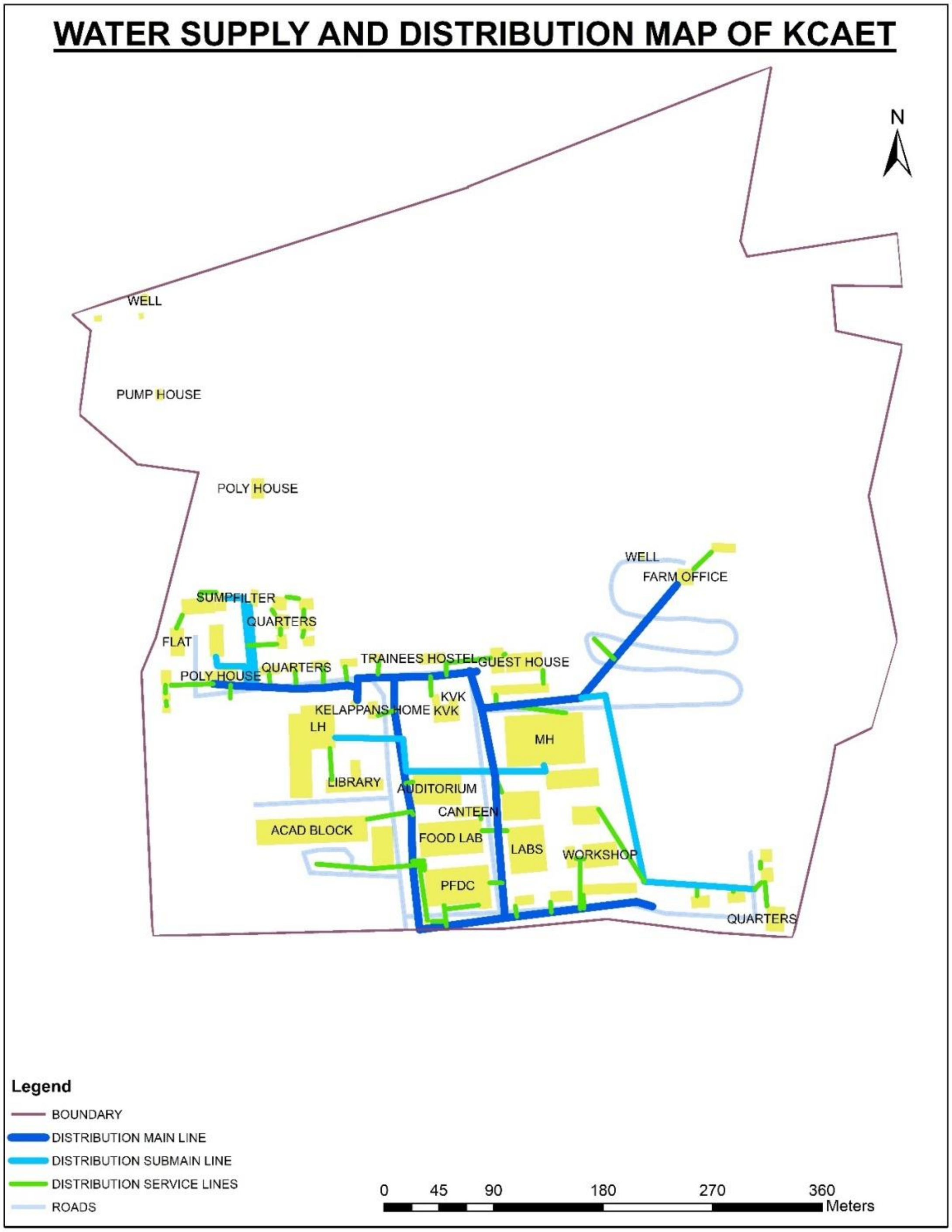

Fig 4.2 Distribution network

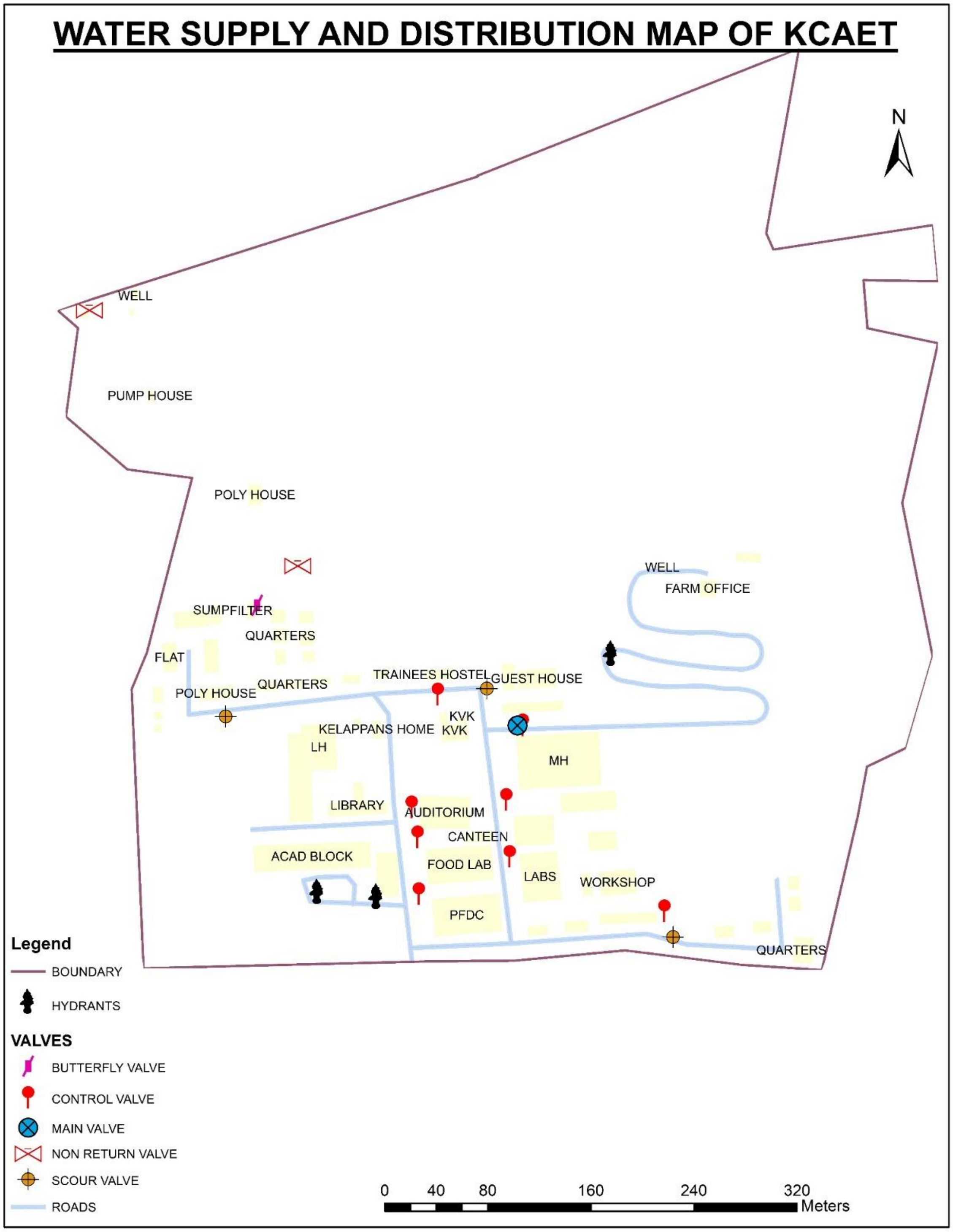

Fig 4.3 Valves and hydrants

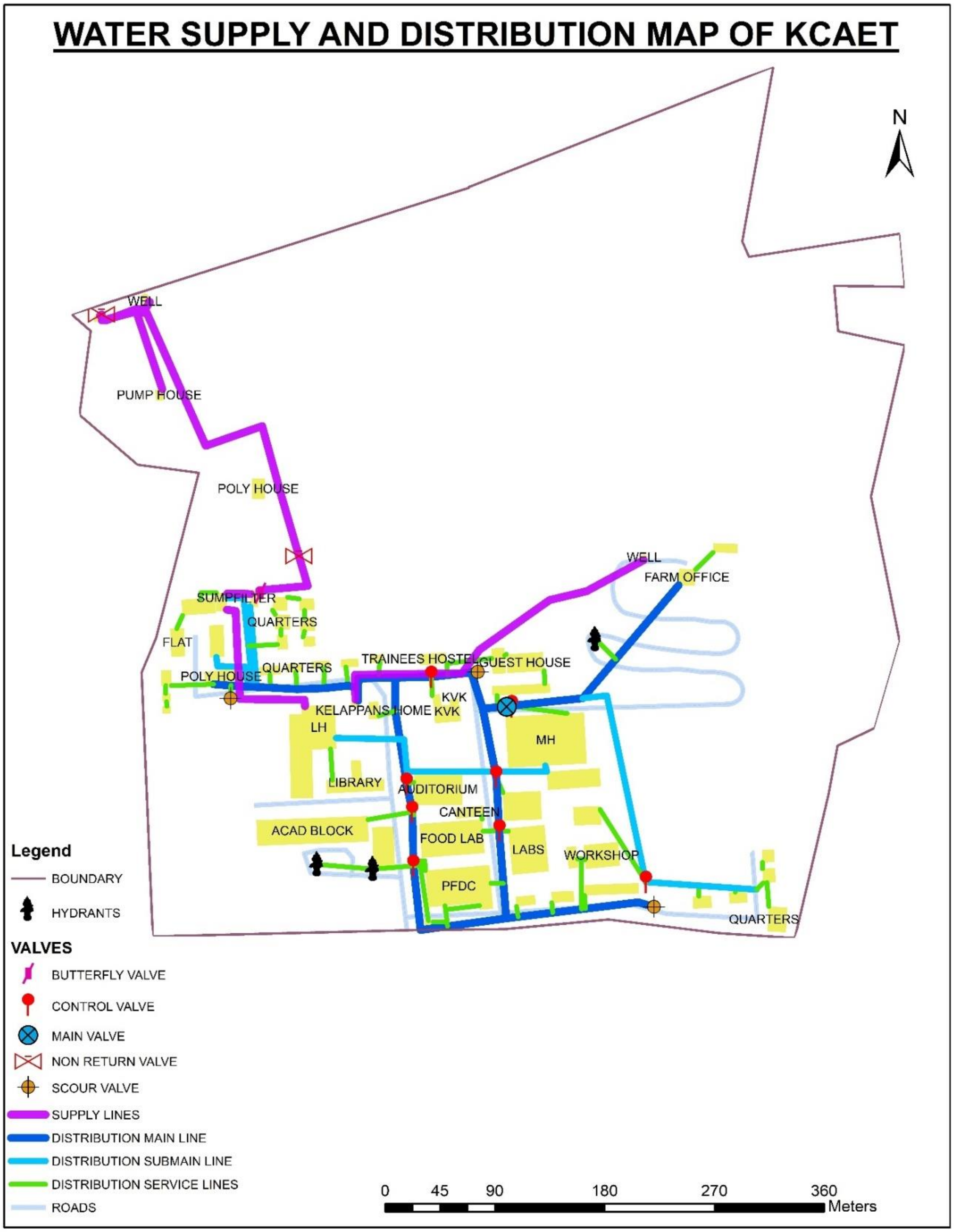

Fig 4.4 WSDN of KCAET

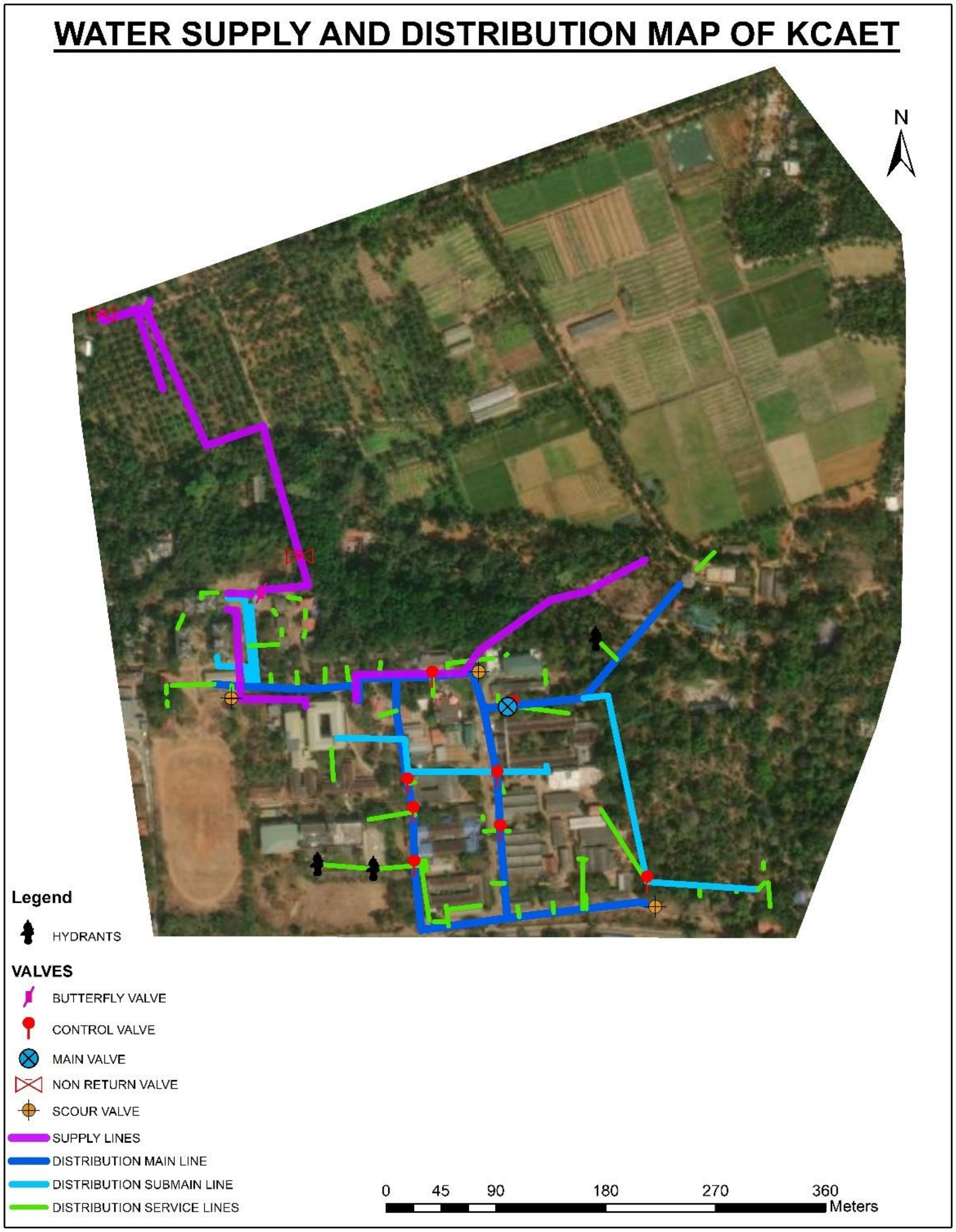

Fig 4.5 WSDN map overlayed on Google earth imagery

Fig 4.5 depicts the water supply and distribution network of KCAET campus overlayed on Google Earth imagery. This is done for getting a better understanding of the network and the map which was already created. Thus, the overall map containing the water supply and distribution network of KCAET campus was prepared.

The spatial map of Water Supply and Distribution Network was prepared in ArcGIS was superimposed with in Google earth imagery by adding Google earth as a base map for the ease of viewing and understating the components clearly. This map can be used as a reference for existing Water Supply and Distribution Network of KCAET campus for identifying the layout, components and planning future expansion works.

Various constraints regarding the maintenance of the water supply and distribution network of our campus were obtained during the project. In order to mitigate those difficulties and for the ease of maintenance, some suggestions are noted below:

- There are low pressure areas in the campus which include auditorium premises and high-pressure areas including Dean's quarters and premises of intake well. To resolve this pressure variations, elbow connections can be reduced or the diameter of the pipe can be altered, so that high pressures can be controlled.
- In order to increase pressure in areas facing low pressure, direct connections from overhead tank can be taken.
- Water meters can be provided in the water supply and distribution network.
- Incorporating aerators in the network.
- Provision of sediment tank in the system

SUMMARY

AND CONCLUSION

SUMMARY AND CONCLUSION

Water supply and distribution network conveys water from source to different outlet points. It is a complex and centralized collection of components which is not much easy to figure out and handle. The water supply and distribution network of KCAET campus was little complicated because of its age. For the ease of handling, maintenance and other services, mapping of water supply and distribution system is essential. This study focuses on mapping of Water Supply and Distribution Lines of KCAET campus with the aid of Total Station, GPS and GIS tools.

The methodology consists of a reconnaissance survey was conducted to identify the pattern of pipeline distribution and to figure out the exact map of the system, Total Station survey to locate various points and features in the field and Preparation of thematic layers and mapping of the Water Supply and Distribution Network on the campus on GIS platform. The reconnaissance survey was done by conducting transect walk on the campus. Garmin GPS 12 H was used to identify the geographic location of major components during the transect walk. The survey started from the north-west part of the campus and finished at the north-east part. Two major water resources namely an intake well and an open well were identified on the campus. It was identified from the survey that the hostels on the campus are supplied with the water from the intake well which is located at the north-west part of the campus. This water is supplied after filtration in a slow sand filter which is situated near the KVK quarters in the campus. It was also observed that that the remaining area of the campus was supplied from overhead tank which is located near ladies' hostel. The connection to overhead tank from the open well, various pipeline networks, major components like hydrants, valves, pumps, storage tanks etc. could be identified in the field during the reconnaissance survey.

Total Station Survey was carried out to locate all the points of the Water Supply and Distribution Network in the field. The index sketch from the preliminary survey was the reference for total station survey. The survey began at the north-west corner of the campus and proceeded the traversing through all the supply lines, distribution lines and service lines. The data was exported to ArcGIS 10.7 software available in Geospatial lab of KCAET to prepare thematic layers of the map.

Georeferencing of the transferred points from total station was carried out to transform the coordinates to a spatial reference system. Points representing the various pipeline network, valves and buildings were identified and labeled prior to mapping. Different thematic layers such as supply lines, distribution and service lines, valves, buildings and roads and boundary were prepared. These thematic maps were overlaid for preparing the map of Water Supply and Distribution Network. A base map of the study area was also added and the map was superimposed to view and understand the layout clearly. The capacity of overhead tank was identified as 75000 L and of the slow sand filter was 150-200 L/hr. The diameters of the pipeline network were observed as 5 inches for supply line, 2-4 inch for distribution line. The open well near the farm office was found as 1,30,000 litres per day.

Water supply and distribution system of KCAET campus is operated with the water sources available inside the campus. All the requirements of water inside the campus is met with the water available from two wells. For the ease of operation and maintenance a spatial map of Water Supply and Distribution System was prepared thus the complexity, location of various components and the layout of pipeline system can be thoroughly understood. Thus, the spatial map of the Water Supply and Distribution System of KCAET Campus can give proper information and pattern of supply and distribution network. Further it forms a reference for future expansion works of the network. Modern tools like GIS, GPS, and Total station were found to be effective in collecting the spatial information of various components of the water supply and distribution network, traversing the points and preparation of a spatial map.

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SPATIAL MAPPING OF WATER SUPPLY & DISTRIBUTION NETWORK OF KCAET CAMPUS USING TOTAL STATION SURVEY & GIS

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PROJECT REPORT

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KELAPPAJI COLLEGE OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

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ABSTRACT

Water supply and distribution system conveys water from source to different outlets. For the ease of handling, maintenance and other services mapping of water supply and distribution network of KCAET campus is done. The study focuses on mapping using on GIS, GPS and Total Station. Through reconnaissance survey two major sources intake well and open well near the farm were identified. The hostels in the campus are supplied by intake well after filtering through slow sand filter. Rest of the area is supplied by open well near farm house. After making an index sketch from reconnaissance survey, Total Station survey was carried out to locate all the points of the water supply and distribution system in the field. The survey started from north-west part of the campus and finished at north-east part. The Total Station data was exported to ArcGIS 10.7 for mapping. Different thematic layers such as supply lines, distribution and service lines, valves, buildings roads and boundary were prepared. These thematic maps were overlaid for preparing the map of Water Supply and Distribution Network. The capacity of overhead tank was identified as 75000 L and of the slow sand filter was 150-200 L/hr. The open well near the farm office was found as 1,30,000 liters per day.

The spatial map of the Water Supply and Distribution System of KCAET Campus can give proper information and pattern of supply and distribution network. Further it forms a reference for future expansion works of the network.