DGPS BASED DIGITAL TOPOGRAPHIC SURVEY

A Case Study of Tembhapuri Reservoir, Aurangabad District, Maharashtra, India.

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Abstract:

Forlarge-scale infrastructure projects like Dam, Canal, Railways, Highways and many more, topographical information is veryimportant. This information is made available either by studying various kinds of mapsor by traditional surveying. In estimation of area and volume data of elevation plays vital role. Conventional instruments of surveying like, dumpy level, theodolite, totalstationetc. are used for collecting the data. The surveys conducted by using conventional instruments is laborious and time consuming. In recent years GPS and GIS system have emerged as a powerful tool for conducting large scale survey for mapping and to create spatial data base of the Geographical area at any scale. Differential Global Positioning System (DGPS) provides the dependable data to the field engineers. The technology has advantage over traditional surveying, that time and human resources required for doing detailed survey can be reduced and mapping can be done in lesser time. Hence this technique can be implemented with fair degree of accuracy.

In the present study topographical survey oftheTembhapuri reservoir in Aurangabad District of Maharashtra(India)is carried out using DGPS. It is found that DGPS Surveying is one of the fast, reliable, and cost effective technic when compared with the submerged area survey by conventional method. Paper focuses on methodology, ground survey with DGPS, use of software and generation of statistics and maps.

IndexTerms – DGPS; Survey; Elevation; Contour; Digital map, GPS, GIS

1.INTRODUCTION

The existing practice of carrying out field survey by dumpy level, theodolite, total station, auto level and generating observed database is very laborious and time-consuming. Skilled personnel are required to set the instruments. The entire process and calculations is also a tedious one. One of the limitation while carrying out surveys by conventional instruments is, clear weather condition and stationindivisibility with the existing practices, three dimensional surveys, night observations with high precision is not possible.

Many researchers have carriedouttopographical survey in different countries, based on geological maps and traditional surveying instrument. Ramesh M.Nikum et al (2015)carriedoutastudyofKhadkiM.I.Project, in Washim District, Maharashtra, andfocuses on methodology, ground survey with DGPS, use of software and generation of statistics and maps.. Tang Shilu (2008) hasused the Remote Sensing and GIS techniques,as a spatial information monitoring of coal refuse disposal piles at WangpingGully in Beijing. B. Gopala Krishna et al (2008)have carried out Topographical Mapping from Space by using Cartosat-1 and Cartosat-2 Imagery. Amin Beiranvand Pour et al (2018) have carried out satellite-based remote sensing of Regional geology mapping at Northern Victoria Land, Antarctica. Amna Butt et al (2015) have carried out a case study of Simly watershed, Islamabad, Pakistan, and suggest that how the Remote Sensing and GIS is used in mapping and analysis. Elizabeth J Young (2012) have suggest that DGPS is an accurate and versatile geomorphological tool and can be used successfully either as a stand-alone method for surveying, or in conjunction with other methods of survey.

In the present study topographical survey oftheTembhapuri reservoir in Aurangabad District of Maharashtra (India) is carried out using DGPSin collaboration with Maharashtra Engineering Research Institute, MERI, Nasik a wing of Water ResourcesDepartment of Government of Maharashtra.By this technique it is observed that a survey team can generate the necessary analysis and statistics in short time whereas the same task by conventional methods may take few days to few weeks. The methodology used for this study will be helpful for identifying and mapping spatial/ non-spatial details accurately in lesser time.

1.1 MODE OF GPS SURVEY

1)Static, 2) Fast Static,3) Kinematic,4) Real Time Kinematic.

Base unit setup in static mode. In this mode the receiver logs the data continuously for a preplanned length of time. Rover unit setup in kinematic mode. This mode is used when the antenna is in motion. The stationary receiver called the Base receiver is placed in static mode at know elevation while the second receivers called Rover will visit all the unknown points. This kinematic surveying method is also called 'stop-and-go.' In this method it is also possible to operate more than one 'rover' with the same base station.

1.2 BASE STATION GPS SETUP

Setup the Base station antenna on a level tripod and measure the height of antenna above the ground.

Install the charged battery into the Base and also attach external battery supply to the Base. Push the power button on.

Create the file in the control unit and start the Base receiver.

The Base unit now starts logging its position.

1.3 ROVER GPS SETUP

Install the charged battery into the Rover and push the power button on.

Start instillation of Rover unit for required time.

Create file and start logging points from submergence area.

2. OBJECTIVE

The objective of the present study is to envisage the DGPS based survey to collect the survey data about the natural and man-made features of the land, as well as its elevation.

To digitize the contour map of the ground and existing features on the surface of the earth or slightly above or below the earth's surface.

To estimate the present live storage capacity of reservoir.

To generate a digital map.

3. STUDY AREA

It is decided to estimate the present live storage capacity of Tembhapurireservoirwhich is located at 19o44' 33'' North latitude and 75o11' 29'' East longitude impound to Nagzari river near Tembhapuri village of Aurangabad Taluka in Aurangabad District, Maharashtra. Total catchmentarea of the reservoir is 42.22 sq.km. The designed gross storage capacity of the reservoir at FRL 495.00 m is 21.31 Mm3and live storage capacity between FRL & MDDL is 18.476 Mm3. The MDDL of the reservoir is 489.40 m. The designed dead storage capacity is 2.834Mm3. The reservoir was first impounded in the year 2004.The location map of Tembhapuri Reservoir is shown in fig. 1.
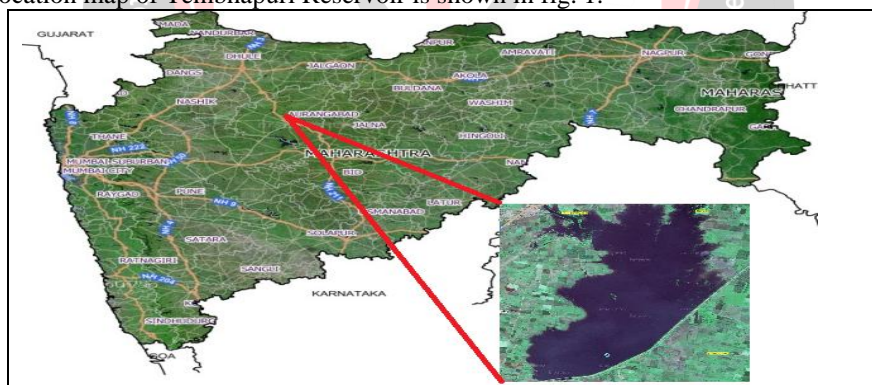

Figure No.1. Location Map

3.1FIELD WORK

In the present work DGPS survey is conducted at the Tembhapurireservoir to collectground levels. The base station was installed at the pre-determinedlocation by the field officers. The field survey was conducted 9th &10th Oct 2017 and 5th & 10th March 2018to record the position of the various levels of the reservoir as shown in fig.2such as Full Reservoir Level(FRL), MaximumDrawdown Level (MDDL), for geo-reference purpose. The GPS receiver used in the survey was Trimble R-4. The post processing kinematic method of surveying is used. Firstly, the readings are taken along the boundary line of FRL and MDDL at a distance of every10m to 20m and submersible areareadings were also taken in the form of grid pattern of 30m intervalin gorge portion readings are taken along the nallasat a distance of every 5m to 10m.

| Setting of Base Station | Reading taken with Rover Unit | Reading taken with Rover Unit |

Figure No. 2. Field survey

4. METHODOLOGY

Differential GPS (DGPS) is a set of two GPS receivers which are operated sub sequentially. One set is stationed as a base and other roving around, for measurement of latitude, longitude, height of a point as a rover. The stationary receiver i.e. base is the key as it receives all the satellite measurement and combines into a stable local reference. The base receiver measures the timing error and then provide the correct information to the rover receiver. In this way all errors can be eliminated from the system. The idea is to put the base receiver on to a point that has been very accurately surveyed. This base receiver receives thesame GPS signals as the rover receiver but instead of working like a normal GPS receiver it operates the equations backwards.In DGPS the base station is fixed and the rover is moving for collecting field data without any restriction. Then the post processing is done to determine the precise location of rover. With this technique a centimeter of accuracy is possible.

4.1SOFTWARE USED

Post processing and mapping is done using the software TRIMBLE BUSINESS CENTER (TBC) version 2.7and ARC-GIS version 9.3. This software provides the following facilities.

Importing the data file from base and rover.
Post processing the data.
Generating the post processed results.
Creating the contours.
Exporting the maps file to .shp, .kml
Mapping of data.

The field information recorded in base and rover receivers are now imported in Trimble Business Center (TBC) software. The kinematic method used in surveying is a relative positioning method where one receiver antenna is stationary and one receiver antenna is moving. Firstly, the stationary receiver called base is corrected for its positions. The post-processing kinematic method is used to correct the moving receiver called rover readings which are collected from different field locations. The rover readings are relatively corrected with the basereceiver as shown in Table 1.After the rover receiver readings corrected with base receiver the processing results are generated and levels are computed as shown in Table 2.

Table 1: Base Processing Result.Table 2: Post processing data of Tembhapuri reservoir.

Base Processing Result				Point List				
Observation	Hz. Precision	Vz. Precision	Length (m)	ID No.	Latitude (Local)	Longitude (Local)	Height (m)	Feature Code
tem-09102017..p1	0.009	0.022	21.226	1	N19°44'59.15770"	E75°11'44.55624"	494.995	GRIDE
tem-09102017..p2	0.009	0.023	46.212	2	N19°45'11.26203"	E75°11'54.35467"	494.989	GRIDE
tem-09102017..p3	0.009	0.024	111.221	3	N19°45'14.80737"	E75°11'57.48267"	494.905	GRIDE
tem-09102017..p4	0.010	0.026	138.657	4	N19°45'19.22166"	E75°12'01.69776"	494.974	GRIDE
tem-09102017..p5	0.010	0.025	144.573	5	N19°45'17.63572"	E75°12'00.26648"	494.936	GRIDE

4.2 PROCESSING IN TBC

From the processed data in TBC software as shown in fig.3. The surface of the reservoir is now prepared by using create contour tool as shown in fig.4.Rectified digital level topographic maps in vector format are carried out.
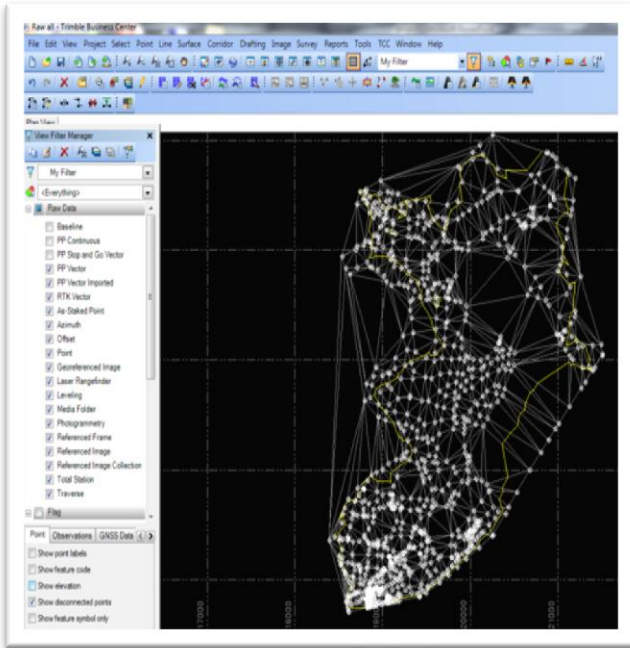
FigureNo. 3. GPS points of Reservoir   FigureNo. 4. Reservoir surface on Google Earth

4.3 MAPPING IN GIS

ARC-GIS Software was used to generate the contour maps. The created contour map in TBC was then exported in .kml feature and imported in ARC-GIS Software for final drawing preparation. From the drawing, area between successive contours were calculated for the volume calculation. Table 3 shows the contour vise areaofTembhapur reservoir in Mm^2.

Table 3:Contour vise area of Tembhapuri reservoir in Mm^2

Elevation (m)	489.4 MDDL	489.5	490.0	490.5	491.0	491.5	492.0	492.5	493.0	493.5	494.0	494.5	495.0 FRL
Area (M.sqm)	1.010	1.080	1.540	2.075	2.493	0.134	3.125	3.660	4.139	4.745	5.447	6.061	6.621

Moreover, the information which is useful to field authority for execution of reservoir topography is tabulated. The probable submersible area of the project is calculated at different contour intervals.Total probable submersible area of the Tembhapuri reservoir is measures to be 662.1ha.

4.4 EVALUATION OF SILT DEPOSITS

On the basis of survey, topographic map(scale 1:8500)is prepared for half-meter interval as shown in fig.5 The area inscribed in each contour was measured.Computation of reservoir capacity at different elevations has been carried out using Prismoidal formula.

$$V = H/3*\{A_1 + A_2 + SQRT (A_1 * A_2)\}.$$

Where,

V = Reservoir capacity between two successive elevations h_1 and h_2.

H = Elevation difference $(h_2 – h_1)$.

A_1 and A_2 are areas of reservoir water spread at elevation h_1 and h_2.

Comparison of capacity with the original survey data is given in table4.

(Scale 1:8500)

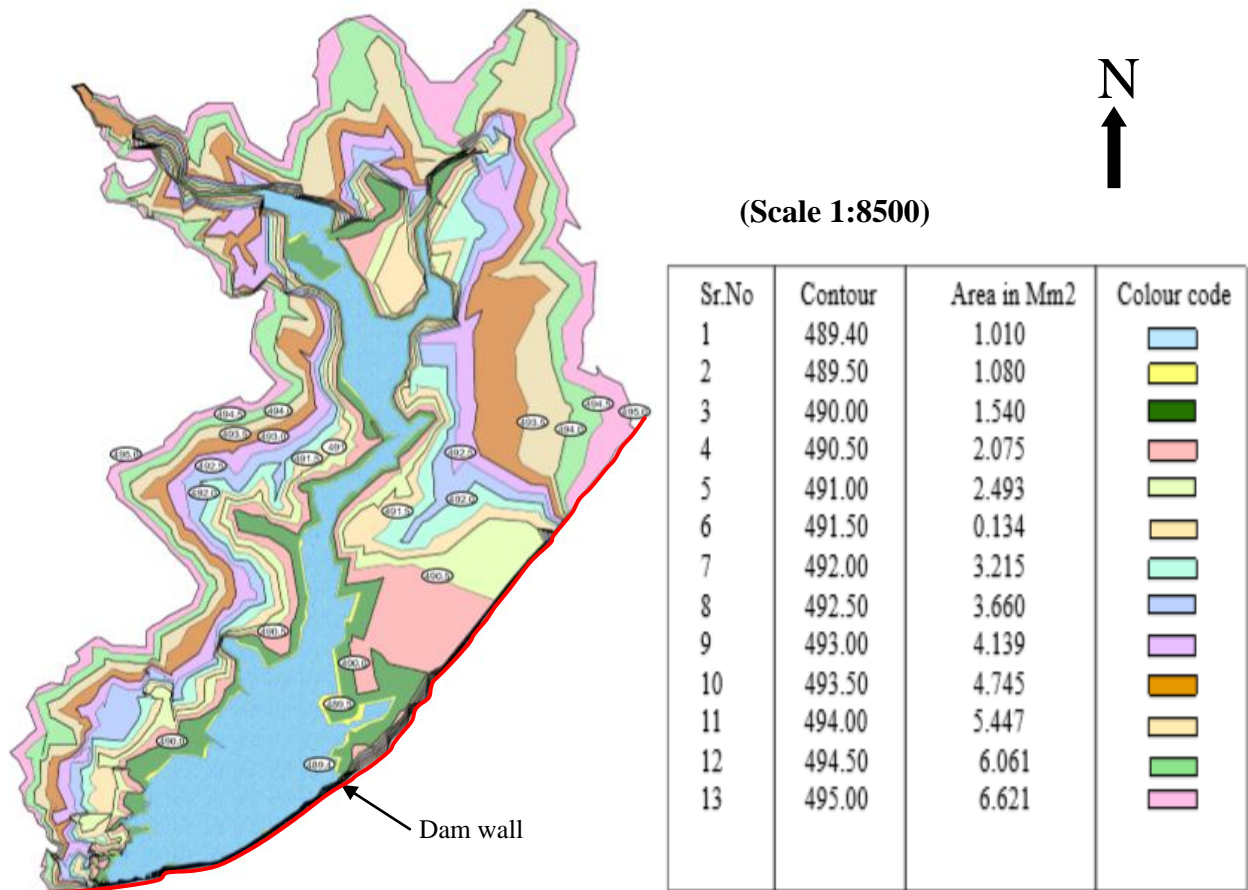| Sr.No	Contour	Area in Mm2	Colour code
1	489.40	1.010	
2	489.50	1.080	
3	490.00	1.540	
4	490.50	2.075	
5	491.00	2.493	
6	491.50	0.134	
7	492.00	3.215	
8	492.50	3.660	
9	493.00	4.139	
10	493.50	4.745	
11	494.00	5.447	
12	494.50	6.061	
13	495.00	6.621	

Figure No.5. Topographic Map with half-meter contour interval.

Table 4: Details of Contour and Capacity Coverage.

Elevation (m)	Area (M.sqm)	Interval (H) (m)	Volume (V) (M.cum)	Cumulative Volume (M.cum)
495.000 FRL	6.621	0.500	3.169	18.476
494.500	6.061	0.500	2.875	15.307
494.000	5.447	0.500	2.546	12.432
493.500	4.745	0.500	2.219	9.886
493.000	4.139	0.500	1.948	7.667
492.500	3.660	0.500	1.718	5.719
492.000	3.125	0.500	0.668	4.001
491.500	0.134	0.500	0.534	3.333
491.000	2.493	0.500	1.140	2.799
490.500	2.075	0.500	0.901	1.659
490.000	1.540	0.500	0.652	0.758
489.500	1.080	0.100	0.105	0.105
489.400 MDDL	1.010			

5. RESULTS AND CONCLUSIONS.

1. With the present study topography survey for 42.22 sq. km and submersible area survey for 662.1Ha could be easily managed in 5 days.

2. From the above study, we can conclude that DGPS based Digital surveying technique can be used as an effective tool for accurate mapping of topographical features/data. Accuracy obtained in mapping and calculation of various parameters like Water Spread Area, volume of submergence is far more better than conventional method of survey. It does not only reduces the man power but it also saves the considerable time when compare to traditional method of survey.

3. The entire process of mapping and generation of required statistical data are in digital environment and maintenance as well retrieval of data is very convenient.

4. With the help of DGPs survey, we can take well informed decisions in short time as well as we can deliver final output to the client in digital environment.

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