IOSR Journal of Applied Geology and Geophysics (IOSR-JAGG)
e-ISSN: 2321–0990, p-ISSN: 2321–0982. Volume 13, Issue 4 Ser. I (July – August 2025), PP 74-85
www.iosrjournals.org

DGPS Survey – A Modern Tool In Applied Geology: A Case Study Of Survey Conducted In Premises Of Govt. NPG College Of Science Raipur, Chhattisgarh

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Abstract:
The Differential Global Positioning System (DGPS) is a sophisticated geospatial technology that improves the accuracy of traditional GPS by employing differential correction, allowing for precision ranging from sub-meter to centimetre-level. This research showcases the utilization of DGPS in applied geology, demonstrated through a case survey carried out at the Government NPG College of Science campus in Raipur, Chhattisgarh. The methodology encompassed the establishment of a primary control point, execution of a boundary survey using base and rover units, and the integration of survey data with Google Earth imagery via GIS software for georeferencing and spatial analysis. The survey accurately outlined the college premises, covering a surveyed area of 0.39 hectares with high precision. The amalgamation of DGPS and GIS proved to be successful in generating legally defensible, minimally erroneous, and reproducible spatial results. In addition to land boundary delineation, this study emphasizes the extensive potential of DGPS in modernizing land records, mining, urban planning, environmental monitoring, and entrepreneurial endeavours. The findings solidify the position of DGPS as a dependable and adaptable tool in applied geology and related geosciences.
***Key Word**: DGPS, primary control point, rover, GIS, integration,*

Date of Submission: 19-08-2025 Date of Acceptance: 29-08-2025

I. Introduction

The Global Positioning System, more commonly known as GPS, has a more advanced iteration called the Differential Global Positioning System (DGPS). In DGPS, the letter D represents 'Differential', indicating that unlike GPS, two GPS systems work simultaneously to cross-check and minimize errors. The development of DGPS aimed to improve positioning and distance measuring accuracy, resulting in significantly enhanced location precision compared to GPS. Differential GPS (DGPS) operates using two units: a stationary base unit and a moving rover unit. For reliable three-dimensional positioning, a GPS receiver must acquire signals from at least four satellites, ideally distributed across the sky. The receiver then conducts mathematical calculations to determine its position based on the distance from each satellite. Following this, the GPS receiver records and stores this position, along with any additional descriptive information, in the field.

II. Principle Of DGPS

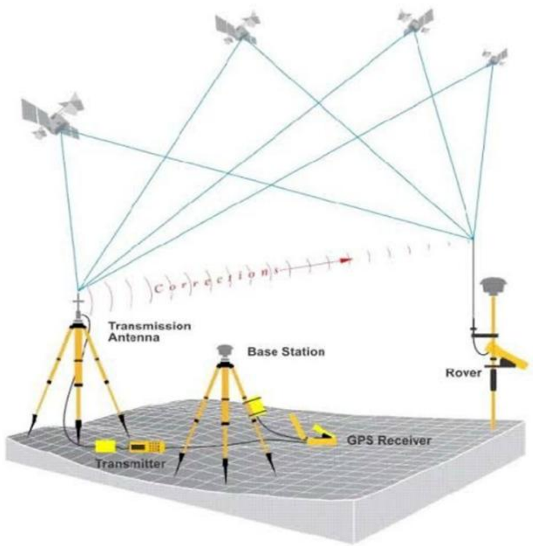
Differential GPS (DGPS) operates by implementing the principle of differential correction for GPS signals. A reference or base station is established at a precisely surveyed location to serve as a known point from which it can determine the error in received GPS signals, arising from factors such as ionospheric delay and satellite clock drift. Subsequently, this error data is transmitted in real time to nearby roving GPS receivers. The roving GPS receivers then utilize these corrections to enhance the accuracy of their own GPS measurements, improving positioning accuracy from the standard GPS level of about 10-15 meters to sub-meter or even centimetre precision in the case of DGPS/RTK GPS.

In summary, DGPS involves correcting GPS positioning by comparing signals at a known reference point and applying the same correction to unknown positions.

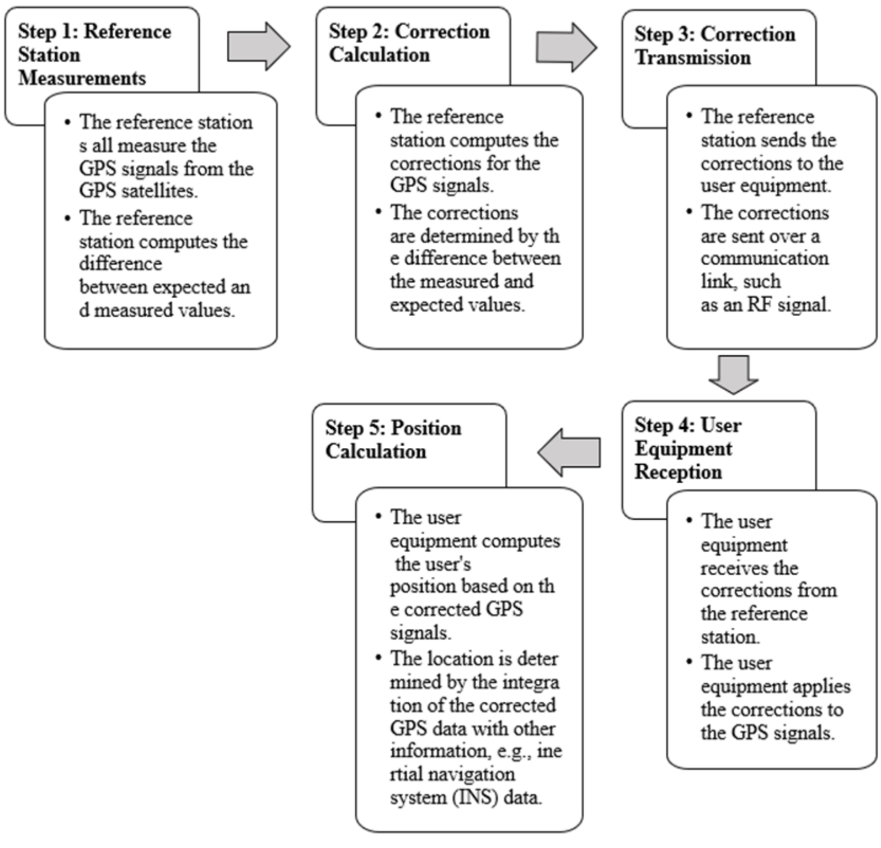
- Differential Correction: DGPS employs the method of differential correction to eliminate errors in GPS signals.
- Reference Station Network: A network of reference stations is established to supply corrections to GPS signals.
- Real-Time Corrections: Corrections are transmitted in real time to DGPS receivers.
- Improving Accuracy: DGPS achieves significantly improved positioning accuracy compared to standalone GPS.

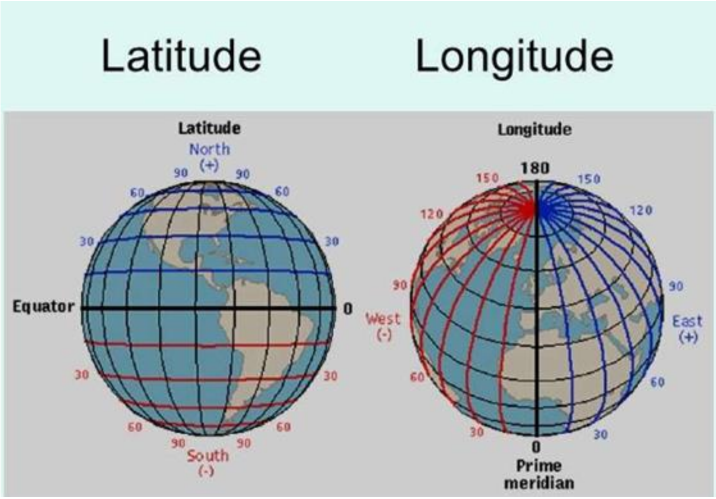
III. Mechanism Of DGPS

DGPS equipment operates by utilizing satellite signals from the GPS/GNSS (Global Navigation Satellite System) to precisely determine global positions. The GPS Operational Constellation consists of 24 satellites orbiting the Earth in highly accurate orbits, emitting continuous navigation signals for location determination. Each GPS satellite transmits data indicating its location and the current time, synchronized to ensure simultaneous transmission of recurring signals. DGPS enhances positioning accuracy by utilizing a network of reference stations to provide corrections to GPS signals. The two main components of DGPS are the reference stations, which are equipped with GPS receivers and a communication link, and the user's GPS receiver, which is equipped with a DGPS receiver to receive corrections from the reference station. Mechanism of DGPS is shown in Figure



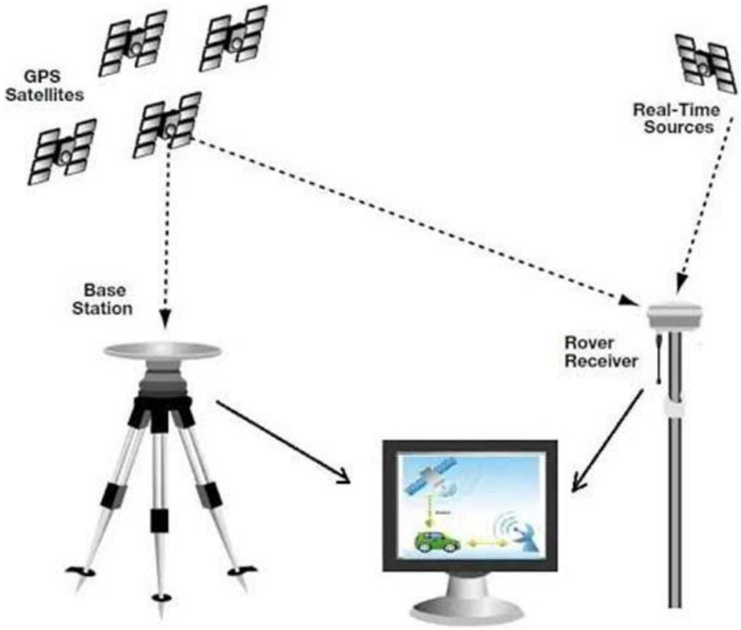
The detailed explanation of how DGPS works, along with a flow chart is given below.





The travel time of signals from a constellation of GPS satellites orbiting the Earth is measured in order to determine position. GPS satellites are strategically positioned in orbits to ensure that at least four satellites can be accessed for determining latitude, longitude, altitude, and time. Latitude and Longitude serve as spherical coordinates on the Earth's surface, with Latitude being defined as North or South of the Equator and Longitude being defined as East or West of Greenwich. These Latitudes and Longitudes are utilized by DGPS to reference locations.

Differential GPS (DGPS) is a system designed to enhance the accuracy of GPS receiver positions by broadcasting differential corrections, which are differences between observed and computed coordinates at a specific known point, to GPS receivers at other locations. In differential positioning, the user determines their position from satellite signals and then applies corrections to that position. These corrections, which are the differences between the known position and the determined position, are calculated by a Reference Receiver with a known position and are used by the second Receiver to adjust its internally computed position. This process is known as Differential GPS positioning. Differential correction is a method that significantly improves the precision of collected DGPS data.



It involves using a receiver located at a predetermined position, known as the "base station," and comparing this data with DGPS readings obtained from unspecified locations using "roving receivers." The application of differential correction can be in real-time in the field or during the post-processing of data in the office. While both approaches are based on the same fundamental principles, they rely on different data sources and produce varying levels of accuracy. Integrating both methods provides increased flexibility in data collection and strengthens data integrity.

IV. Status Of DGPS Use: Mandatory And Advisable Rules In India

- The legal and policy framework in India regarding the use of Differential GPS (DGPS) is multifaceted and well-defined.
- The Digital India Land Records Modernization Programme (DILRMP), previously known as NLRMP, is a central government initiative focused on modernizing land records nationwide. Under the DILRMP, efforts are made to digitize maps, integrate textual and spatial data, and establish the foundation for high-precision georeferencing and the utilization of DGPS.
- State-level implementations have explicitly integrated DGPS-based surveys, such as Real-Time Kinematic (RTK), for achieving high-resolution, centimeter-level mapping.
- The Department of Science & Technology (DST) has issued comprehensive guidelines permitting the generation, publication, and dissemination of geospatial data, including DGPS outputs, without prior approval or licensing, except where specifically restricted.
- In Chhattisgarh, the Department of Land Records, under the government of Chhattisgarh, has implemented the use of DGPS surveys for both departmental and private activities. This initiative aims to enhance the accuracy and efficiency of land-related surveys and activities within the state.

In summary, while there is no singular statutory act mandating DGPS use, its adoption is strongly encouraged and legally supported through national programs like DILRMP, state-level policy implementation, judicial validation, and permissive data generation policies, forming a robust legal and institutional foundation for employing DGPS in geology, land surveying, and land records modernization.

- The use of DGPS (Differential GPS) in mining operations in India is governed by a mandatory legal framework.
- The Mineral Conservation & Development Rules (MCDR), 2017, amended in 2021, explicitly mandates the use of DGPS or equivalent high-precision surveying tools for preparing plans and sections for mining leases.
- For leases with an annual excavation of ≥1 million tonnes or with a leased area of ≥50 hectares, lessees are required to conduct drone surveys of the leased area and a 100 m buffer outside during April–May each year, submitting processed survey outputs to the Controller General of Mines by 1st July.
- Smaller leases must submit georeferenced, orthorectified multispectral satellite imagery covering the lease and its buffer zone within the same timeline.
- The Mines and Minerals (Regulation and Development) Act, 1957, regulates the issuance and governance of mining rights and leases, although it does not specifically prescribe DGPS or digital surveying requirements.
- However, detailed technical and procedural mandates, including precise surveying methods, are covered under the MCDR, 2017, and IBM-sanctioned guidelines.
- The Directorate General of Mines Safety (DGMS) oversees safety standards in mining under the Mines Act, 1952, and related safety regulations, but it does not typically issue directives specifically about DGPS-based surveying, as this falls under IBM's purview.
- The legal requirement for the use of DGPS or equivalent precision surveying techniques in Indian mining regulations is particularly emphasized for larger or high-extraction leases.
- The MCDR, 2017, as amended in 2021, establishes this requirement in the interest of scientific planning, mineral conservation, and improved oversight, while the overarching Mineral Act, 1957, supports these directives but does not itself contain technical mandates (obviously the technical aids like DGPS was not available at the time).
- The usage of DGPS (Differential GPS) in geography and geomorphology-related activities in India is governed by specific legal and policy frameworks.
- In 2021, the Geospatial Data Guidelines issued by the Survey of India and DST brought about significant liberalization in the collection and use of geospatial data, including DGPS-based data.
- According to these guidelines, Indian entities are not required to obtain a prior license or approval for generating geospatial data, provided it meets the acceptable accuracy thresholds. This includes the use of DGPS for data collection.
- Furthermore, the guidelines specify that up to 1 meter horizontal and 3 meters vertical accuracy is permitted without restrictions, while finer accuracy data, such as DGPS-level data, may be used but must be produced, stored, and processed within India by Indian entities.
- Survey of India (SoI) plays a crucial role in setting the official geodetic reference frames, topographical control networks, and standards for accurate mapping, encompassing geomorphological mapping and geographic surveys.
- Although not explicitly DGPS-centric, SoI's guidelines implicitly support the use of DGPS in scenarios where high accuracy is essential for terrain, contour, and geomorphological surveys.

V. Applications Of DGPS

DGPS surveys are utilized across various sectors to provide accurate positioning and navigation information for a wide range of applications:

a) Land Surveying :

- Land Surveying involves various types of surveys, such as boundary surveys, which determine property corners and boundaries using DGPS technology.
- Topography surveys utilize DGPS data to create detailed topographic maps.
- Control surveys define specific points that serve as control for mapping and surveying projects, all achieved through DGPS.

b) Hydrographic Surveying

- Hydrographic Surveying includes bathymetric surveys, where DGPS is used to measure water depths and generate bathymetric maps.
- Shoreline mapping involves the use of DGPS to survey coastal and shoreline areas.
- Hydrographic charting utilizes DGPS to produce navigational charts for water bodies.

c) Aerial Surveying

- Aerial Surveying encompasses the use of DGPS for processes such as aerophotogrammetry geo-referencing in aerial photography.
- Airborne LiDAR data is obtained for topographic mapping through the use of DGPS in aerial surveying.
- Aerial mapping is achieved using DGPS technology to create maps and orthophotos from aerial perspectives.

d) Precision Agriculture

- Precision Agriculture benefits from DGPS technology in activities like crop monitoring, where it aids in monitoring crop health and growth.
- Precision farming, made possible with DGPS, focuses on maximizing crop yield while minimizing waste.
- Detailed soil mapping is conducted with the assistance of DGPS technology in precision agriculture.

e) Infrastructure Development

- The design and construction of roads are carried out using DGPS technology, ensuring precision and accuracy in the process.
- Similarly, bridges are designed and constructed with the assistance of DGPS, enhancing the overall quality and reliability of the structures. In building construction,
- DGPS technology is utilized to implement precise design and construction methods, contributing to improved efficiency and accuracy.

f) Environmental Monitoring

- DGPS technology plays a crucial role in monitoring water quality, ensuring comprehensive and accurate data for environmental assessment and management.
- Likewise, air quality is monitored with the aid of DGPS, providing valuable insights for environmental analysis and decision-making.
- Furthermore, DGPS is instrumental in studying climate change, enabling researchers to gather precise and reliable data for in-depth analysis and evaluation.

g) Disaster Response and Recovery

- Following natural disasters, DGPS is employed for damage assessment, facilitating a thorough and accurate evaluation of the affected areas.
- Additionally, DGPS technology is utilized in search and rescue operations, aiding in the precise location and retrieval of individuals in need of assistance.
- The use of DGPS in disaster recovery efforts enables the accurate plotting and implementation of recovery strategies, contributing to efficient and effective response measures.

h) <u>Other Applications</u>

- In the mining sector, DGPS technology is essential for exploration and extraction, with regulatory bodies mandating its use for mining plan submissions and surveys.
- Forestry management and monitoring benefit from the application of DGPS, enhancing precision and efficiency in forest-related activities.
- Moreover, urban development plans are increasingly incorporating DGPS technology, with governmental bodies utilizing survey reports to create comprehensive databases for land use and infrastructure planning.
- Local government bodies also prefer DGPS survey reports for planning roads, land boundaries, and farm boundaries, minimizing errors and enhancing overall planning accuracy.

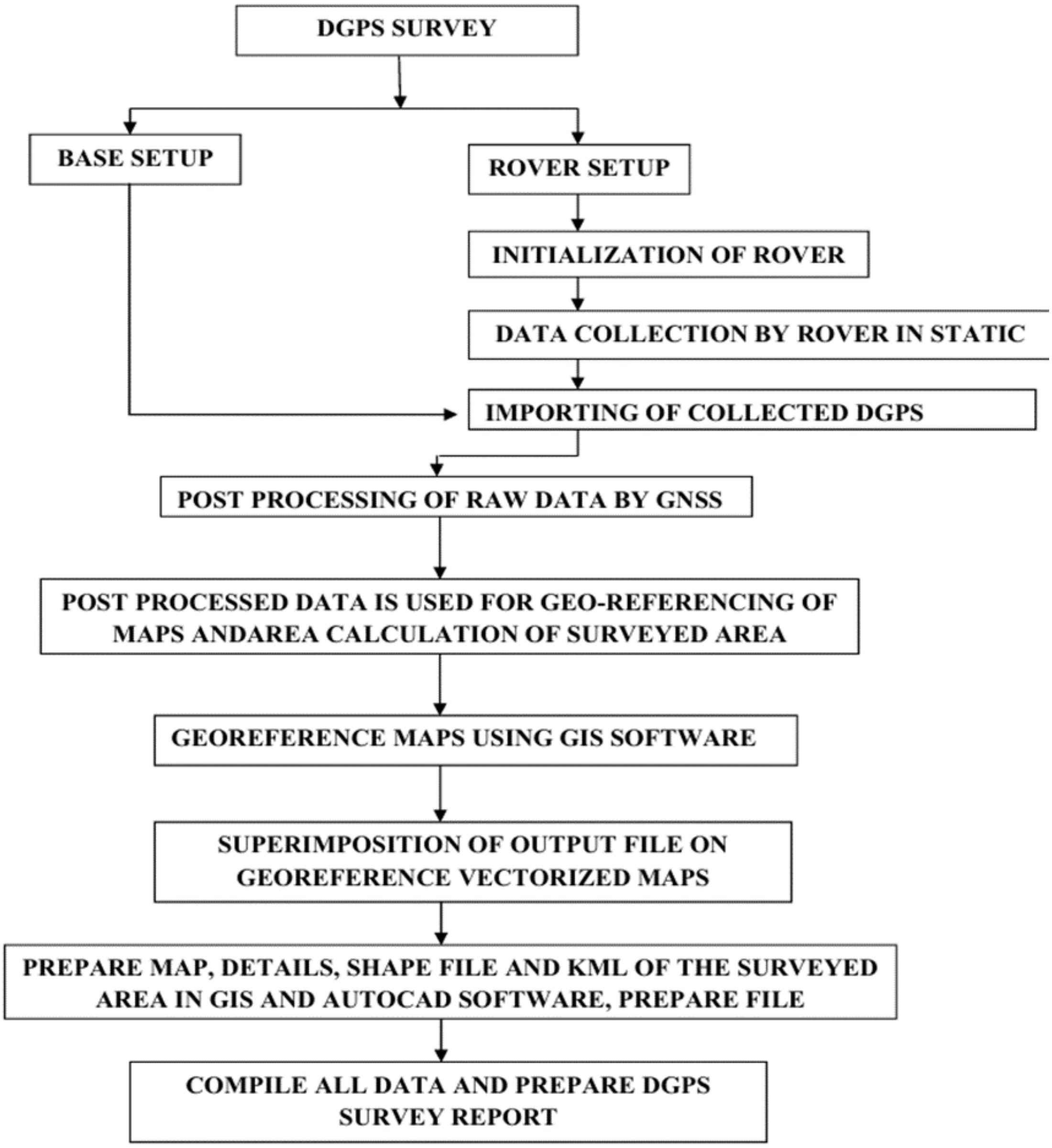
The topic discussed above is the possible fields of applications for the DGPS instrument. To understand the procedure and mechanism of the DGPS instrument, a survey was conducted at Govt. NPG College of Science in Raipur, which is presented as a case study. It's important to note that the procedure may vary based on the specific field of application within the domains discussed earlier, but studying this case study can be beneficial for grasping the fundamentals of its working and mechanism.

VI. A Case Study Of Survey Conducted In Premises Of Govt. NPG College Of Science Raipur, Chhattisgarh

DGPS Survey Procedure:

The procedure of Differential Global Positioning System (DGPS) varies depending on the specific application, but a generalized procedure can be summarized as follows.

- Firstly, the survey planning stage involves defining the objective, such as topographic mapping, cadastral survey, road/rail alignment, or mining lease boundary, and choosing the appropriate survey mode based on the required accuracy. This also includes checking the availability of satellites using GPS planning software, considering the Position Dilution of Precision (PDOP), and taking into account any survey area constraints.
- Next, establishing a base station is crucial, which involves selecting a fixed, stable, and open location, and utilizing a dual-frequency GPS/DGPS receiver mounted on a tripod. The precise coordinates are inputted from known geodetic control points or Survey of India benchmarks, and the base receiver starts logging signals from GPS satellites while calculating error corrections.
- Operating rover units comes next, where surveyors carry rover receivers and collect the same satellite signals as the base station. In real-time mode, the rover receives correction data from the base via radio, internet, or satellite, while in post-processing mode, rover data is corrected using base station data on a computer.
- Data collection involves logging survey points at required intervals and tracing features like roads, field boundaries, rivers, mining pits, or construction alignments by moving with the rover, while also storing metadata such as time, PDOP values, and quality flags.
- The processing and adjustment stage includes applying corrections instantly in the rover and storing them as accurate coordinates in real-time kinematic (RTK), or processing raw data from base and rover together in software in post-processing kinematic (PPK)/Static DGPS to minimize errors like ionospheric delays, tropospheric delays, and satellite clock errors.
- After data processing, the final positions are computed in the desired coordinate system, and the surveyor checks residual errors, repeat measurements, and confidence levels to ensure accuracy meets project requirements.
- For cadastral/engineering purposes, centimeter accuracy is aimed for, while for navigation/mapping, sub-meter accuracy is targeted.
- Finally, using GIS/CAD software, corrected positions are plotted into maps or digital layers, and decisions are made based on the validated rover data against known benchmarks to ensure positional accuracy meets the project requirements.
- This procedure can be illustrated in a flowchart Fc given below.



Specification of the DGPS Instrument Used :- We deployed a high performance GNSS board 600 channels and capable of supporting multiple satellite constellations devices to carry out the DGPS survey. The instrument name was STONEX S900A.

Survey Methodology:

1. **Establishment of Primary Control Point:** Based on the input data and information provided by the DGPS device and Google Earth map, DGPS base station (Primary Control Point) was established near the Science College building, Besides G.E. road, in front of NIT Raipur.

Co-ordinate of the Primary Control Point

POINT NAME	Geo Graphical Co-ordinates (Datum-WGS84)	
	LONGITUDE (E)	LATIDUTE (N)
BASE	81° 36' 09.59027" E	21° 14' 51.65912" N

2. **DGPS Survey of College Boundary:** A DGPS survey was conducted using a pair of DGPS instruments. One of the instruments served as the Base Station, while the other functioned as the Rover. The Base Station was fixed at a stationary position, while the Rover was moved by the survey team as they walked along the College boundary. The survey team collected survey points at each turn or bend and at 50-meter intervals along the lease boundary. Throughout the survey, the distance between the Base Station and the

Rover was maintained at less than 3 kilometers. The survey was carried out in Static mode, ensuring precise and accurate data collection.

3. **Geo-referencing of Map**: Google Maps has been utilized for geo-referencing, obtained from Google Earth, available on the internet (please see plate 1). In GIS software, the map is registered based on the collected survey points by inputting four or more different coordinate values (WGS 84 Datum) of the survey points at specific locations marked on the map. After minimizing the errors created during geo-referencing, the map is finally geo-referenced, and the Science College boundary vector is prepared in the form of a shapefile.
4. **GIS Analysis:**
   Upon completion of a DGPS survey and the acquisition of a georeferenced base map, the central tool for analyzing, visualizing, and integrating DGPS data becomes GIS software. The use of GIS software in a DGPS survey after georeferencing the base map involves several key steps. The first step is the importing of DGPS data, which typically comes in formats such as CSV, shapefile, containing corrected latitude, longitude, and elevation of all surveyed points. In GIS software such as ArcGIS, QGIS, GRAM++, ERDAS, etc., the data is projected into the same coordinate system as the georeferenced base map, such as WGS84, UTM, or Indian Grid. Next, the DGPS points, lines, and polygons are overlaid directly onto the georeferenced base map, which serves as the background, ensuring alignment with real-world positions. Following this, GIS aids in data cleaning and topology checking to identify and rectify errors in the DGPS data, such as duplicate or missing points, gaps in boundary surveys, and misaligned features due to projection mismatch. Thematic layers are then created using the DGPS data, categorizing features into point layers (e.g., benchmarks, wells, boreholes), line layers (e.g., road/rail alignments, pipelines, rivers), and polygon layers (e.g., mining lease boundaries, agricultural fields, urban land parcels), with attribute data linked in GIS. GIS software enables spatial analysis of DGPS data, including buffering, area/perimeter calculation, elevation profiling, and change detection, allowing for deeper insights and understanding. In our study MapInfo software was used to create thematic layers. High-quality maps are generated with integrated DGPS survey results on base maps, including scale bars, legends, and coordinates, and are prepared in digital and print formats for various purposes. Finally, GIS supports decision-making processes across various fields, such as mining, land records, civil engineering, and geology/geography, by providing the necessary spatial database for planning, monitoring, and decision-making. In summary, after georeferencing the base map, GIS serves as the platform for aligning, validating, analyzing, and converting DGPS survey points into meaningful maps and reports, ensuring that the data is an integral part of spatial databases for effective planning, monitoring, and decision-making.
   In this case, The actual **Science College boundary** on field was surveyed by DGPS instrument and collected a boundary point on each and every turn on 50 meter interval from each point of the college boundary. The surveyed points captured through DGPS were plotted in the MapInfo Software and the boundary line was created by joining the points. The boundary polygon was created by using the boundary lines. After Geo-referencing the Google Earth map, the total surveyed area is digitized and new vector layers are prepared. The boundary polygon vector layer are superimposed on Geo-referenced Google map, and created a map layout of the surveyed area. After this final area statement is computed from the digitized layers.
5. **Output:**
   After DGPS survey of Science College boundary, the total area demarcated was 0.39 hectares. The coordinates are given in table below.

DGPS SURVEYED BOUNDARY CO-ORDINATES

POINT ID	GEOGRAPHIC CO-ORDINATES (WGS-84 DATUM)	
	LATITUDE	LONGITUDE
npg01	21° 14' 53.30810" N	81° 36' 09.11801" E
npg03	21° 14' 54.31897" N	81° 36' 10.04384" E
npg04	21° 14' 54.22043" N	81° 36' 10.15314" E
npg05	21° 14' 53.97427" N	81° 36' 09.92776" E
npg06	21° 14' 53.71619" N	81° 36' 09.70155" E
npg07	21° 14' 53.35026" N	81° 36' 09.64522" E
npg08	21° 14' 52.78162" N	81° 36' 09.83647" E
npg09	21° 14' 52.29294" N	81° 36' 09.94369" E
npg10	21° 14' 51.94465" N	81° 36' 10.09421" E
npg11	21° 14' 51.61290" N	81° 36' 10.48624" E

npg12	21° 14' 51.45589" N	81° 36' 10.37265" E
npg13	21° 14' 51.45990" N	81° 36' 09.89578" E
npg14	21° 14' 51.38544" N	81° 36' 09.39079" E
npg15	21° 14' 51.71301" N	81° 36' 09.08037" E
npg16	21° 14' 51.93459" N	81° 36' 08.78284" E
npg17	21° 14' 52.18592" N	81° 36' 08.30689" E
npg18	21° 14' 52.18592" N	81° 36' 08.30690" E
npg19	21° 14' 52.62520" N	81° 36' 08.10670" E
npg20	21° 14' 53.09438" N	81° 36' 07.84310" E
npg21	21° 14' 53.48089" N	81° 36' 07.64012" E
npg22	21° 14' 53.79331" N	81° 36' 07.57902" E
npg23	21° 14' 53.98852" N	81° 36' 07.82629" E
npg24	21° 14' 53.87509" N	81° 36' 08.49110" E
npg25	21° 14' 53.73024" N	81° 36' 09.26690" E
npg26	21° 14' 53.91515" N	81° 36' 09.65172" E
gcp01	21° 14' 51.21149" N	81° 36' 09.93043" E
gcp02	21° 14' 51.97297" N	81° 36' 10.10449" E
BASE	**21° 14' 51.65912" N**	**81° 36' 09.59027" E**

LAND CLASSIFICATION:

Land Classification of Science College Premises						
S.NO.	**District**	**Tehsil**	**Area**	**Type of Land**	**Location**	**Surveyed Area (In Ha.)**
1	**Raipur**	**Raipur**	**Amanaka**	**Govt. College Premises**	**Infront of NIT Raipur**	**0.39 Ha.**
	Total DGPS Surveyed Area					**0.39 Ha.**

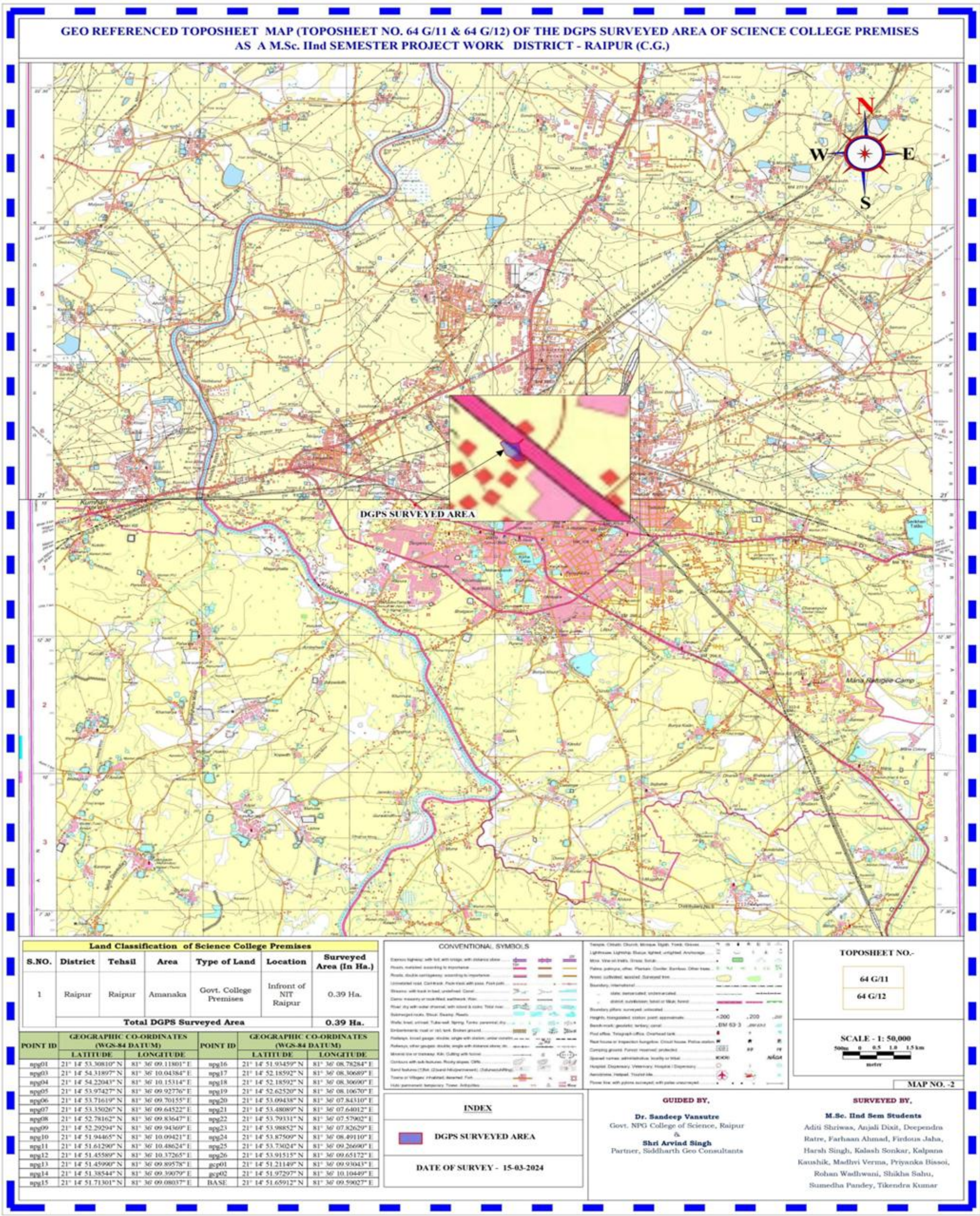


Plate 1

Photographs during Survey:

VII. DGPS: A Promising Tool For Startup Ventures

- Startups often rely on innovation and precision to succeed in their ventures. DGPS provides a high level of accuracy, ranging from sub-meter to centimetre-level, surpassing the capabilities of normal GPS, which makes it particularly suitable for specialized applications where precision is of great value.
- The recent liberalization of the Indian geospatial policy in 2021 now allows private entities to create, use, and commercialize DGPS data without the need for lengthy government permissions.
- One promising area for DGPS-enabled startups is in the field of Agritech and Precision Farming. DGPS can be utilized to facilitate variable rate sowing, irrigation, and fertilization, as well as for soil mapping, crop monitoring, and yield forecasting. Startups have the potential to offer affordable DGPS-based farm mapping services to small and marginal farmers.
- Another area with great potential for DGPS-enabled startups is in Smart Cities and Urban Planning. This includes the use of high-resolution 3D maps, utility mapping, and underground infrastructure surveys, along with the assistance of DGPS-enabled drones for construction monitoring, land encroachment detection, and green cover assessment. Startups in this sector can provide valuable data services to municipalities and the real estate industry.
- In the domain of Mining and Natural Resources, DGPS-based surveys are now mandatory for lease boundary demarcation as per the Indian Bureau of Mines. This presents an opportunity for startups to specialize in DGPS-based exploration, monitoring of illegal mining activities, and compliance reporting.
- DGPS also plays a significant role in Transport and Logistics, offering precise fleet tracking for goods transportation, ride-sharing, and delivery applications. Its enhanced accuracy is particularly beneficial in dense urban areas where traditional GPS systems are prone to multipath errors.
- Furthermore, there are opportunities for DGPS-enabled startups in Environmental and Geomorphological Applications, such as monitoring river erosion, landslides, coastal geomorphology, and forests. Startups can collaborate with NGOs and government entities to create climate risk maps using DGPS-integrated drones.
- Lastly, DGPS is crucial for the development of Autonomous Vehicles and Drones, providing essential support for driverless cars, UAV navigation, and delivery drones. This creates opportunities for startups specializing in robotics and AI to integrate DGPS for real-time precision navigation.

Prerequisite Study for Startup Ventures:-

- The plan for Startup Venture should involve conducting thorough market research to understand the demand for DGPS technology and its potential applications across various industries.
- Additionally, it is essential to outline the specific goals and objectives of the startup, such as developing innovative DGPS solutions or providing consulting services in this field.
- Furthermore, the plan should address the financial aspects, including budgeting for initial investment, operational expenses, and potential revenue streams.
- Moreover, it is crucial to consider the technical aspects of implementing DGPS, including the required infrastructure, technology partners, and potential challenges.
- Lastly, the plan should encompass a comprehensive marketing and sales strategy to promote the startup's DGPS products or services to the target audience.

VIII. Discussion

The DGPS survey of the Science College boundary at Raipur was conducted in a systematic manner, starting with the establishment of a primary control point with accurately determined WGS-84 coordinates. The survey involved using one DGPS instrument as a base station and another as a rover to collect survey points at each turn and at 50-meter intervals along the boundary. To ensure high positional accuracy, the static survey method was employed, keeping the rover within 3 km of the base station at all times. Following the collection of survey points, they were georeferenced using Google Earth imagery and processed in GIS software to minimize spatial errors and integrate the DGPS data with the base map. The GIS software further facilitated the creation of thematic layers, boundary vector polygons, and the calculation of the total surveyed area for the Science College boundary. Through digitization and the joining of corrected survey points, a seamless representation of the college premises was generated in the form of a polygon. Additionally, GIS analysis enabled the verification of the area extent, topology correction, and the preparation of high-quality output maps for the Science College boundary.

IX. Conclusion

The methodology employed effectively showcased the usefulness of integrating DGPS and GIS for accurate land boundary mapping. Through the survey, the Science College premises were precisely delineated, resulting in a final surveyed area of 0.39 hectares. This delineation was clear, well-defined, and mapped with georeferenced imagery. By utilizing a combination of field-based DGPS data collection and GIS-based processing, the study generated precise, validated, and reproducible spatial information. This spatial information can be utilized to support land classification, institutional record-keeping, and future planning. The findings emphasize that the combination of DGPS and GIS provides a robust framework for creating legally defensible boundary maps and spatial databases, facilitating effective land management and decision-making. The toposheets 64G/11 and 64G/12 were used to locate the area, and the final output, in the form of georeferenced imagery from Google Earth, is provided in Plate 1.

X. Acknowledgement

The authors are thankful to the Principal, Govt. NPG Science College, Raipur (C.G.) for their encouragement. Thanks are due to Mr. Siddharth Singh and Mr. Alok Verma from Siddharth Geo-Consultants, Raipur for providing the instrument and assisting in conducting the survey. Thanks are due to all the known and unknown researchers who have enriched the understanding of DGPS instrument, its working and application in various field.

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