# INTEGRATING DGPS AND DRONE SURVEY FOR SUSTAINABLE VILLAGE PLANNING IN DEVELOPING COUNTRY.

GOAL 17: Partnerships to achieve the Goal.

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## Abstract: -

This manuscript presents a comprehensive study conducted in the villages of Pokharni and Nagav in India, employing advanced Geographic Information System (GIS) technology through Differential Global Positioning System (DGPS) and drone-based surveys. The study is part of an overarching effort to introspect and align with the Sustainable Development Goals (SDGs) set forth by the United Nations.

The primary objective of this research project was to use geospatial data collecting and analysis to inform the long-term development of a tiny Indian community. The research team utilized cutting-edge DGPS technology to precisely map and geolocate the village's geography, land use, and existing infrastructure. In addition, drone surveys were used to acquire high-resolution aerial photographs and 3D models of the hamlet, allowing for a comprehensive understanding of its spatial dynamics. The Post-Processing of the collected data was done using the Softwares of AutoCAD Map 3D and Pix4D software. The collected data served as a core resource for the establishment of the village's long-term development goals. The key challenges covered included the Efficient Sustainable Drinking Water Scheme, Sustainable Wastewater Management, and Solid Waste Management Infrastructure Planning.

Furthermore, local community input and participation were key to the development planning process, ensuring that solutions were customized for the specific requirements and goals of village people. This publication adds to the conversation about sustainable development by demonstrating how advanced geospatial technology can be used to generate precise, context-aware plans that correspond with the SDGs. The case study described here can be used as an example for similar projects in other rural areas, providing a scalable strategy for sustainable development based on data-driven decision-making and community engagement.

**Keywords:** Sustainable Development Goals, DGPS, Drone Survey, Rural Development, Geospatial Technology, Community Engagement, AutoCAD Map 3D and Pix4D.

## 1. Introduction

With the use of drones and DGPS technology, land surveying in Pokharni is progressing and supplying accurate data for environmental protection and urban planning. By removing dangers for surveyors, this integration not only improves safety but also increases productivity, cutting costs and project schedules. Sustainable development is made possible by enhanced environmental impact assessments. Drones and DGPS are essentially transforming land-related projects in Pokharni by providing precise, effective, and environmentally friendly solutions. Drone surveying and the DGPS (Differential Global Positioning System) have changed land surveying in Pokharni. This integration provides important insights for regional infrastructure development, urban planning, and environmental preservation by combining accurate geospatial data collecting, efficiency, and safety.

### 1.1 Importance of DGPS & drone surveying -

Precision and data accuracy in land surveying have revolutionized with the usage of DGPS & Drone technologies. By creating a geodetic reference framework, DGPS guarantees the highest level of accuracy for data points. This level of accuracy is essential for infrastructure development, catastrophe risk assessment, and urban planning. Decision-makers are empowered to make well-informed decisions by having access to trustworthy and exact information when using drones and DGPS to map environmental characteristics, determine land borders, and measure elevation changes.

The exceptional cost and efficiency savings this integration provides to land surveying projects is what makes it unique. Traditional surveying techniques can include lengthy and labor-intensive steps. Drones and DGPS, on the other hand, speed up data processing and collecting. This efficiency reduces expenses and expedites project completion times. The capacity to finish projects more quickly and affordably has revolutionary effects in the context of urban growth and village planning, where prompt and economic advancement is essential. The lower labor needs also result in savings on human resources and other related expenses.

### 1.2 Steps to Conduct a DGPS Survey in a Village –

a) **Equipment and Software Preparation** - obtained the required DGPS hardware, such as a base station and GPS receivers for the rovers. made sure the rover and base station could connect and interact with one another. used DGPS software for device configuration and monitoring. The updated GPS data was recorded and processed using this program.

b) **Established Control Points** - Control locations in and around the settlement have been identified. As a point of reference for the DGPS survey, control points were survey-grade reference locations with established coordinates. Choose a control location where the base station may be positioned with a good view of the sky.

c) **Base Station Setup** - switched on the base station and set it up to continually gather GPS data from several GPS satellites.

d) **Rover Setup** - Set up the rover GPS receiver at the location where we wanted to conduct the survey in the village. Ensured that the rover was configured to receive corrections from the base station. Made certain the rover was set up to accept adjustments from the base station.

e) **Data Collection** - Started data collection on both the base station and rover. The base station collected high- precision data, and the rover collected data that needed correction. Allowed the rover to collect data for an appropriate amount of time, typically at least 15 minutes to ensure accuracy.

f) **Data Post-Processing** - created AutoCAD drawings and reports using the survey data and the 3D model. For design, analysis, or other engineering and planning needs, these outputs can be employed.

g) **Quality Control** - carried out quality control tests to guarantee that the surveyed terrain and other elements are appropriately represented in the 3D model.

h) **Documentation** - kept thorough records of the data post-processing procedures and the 3D model that was produced.

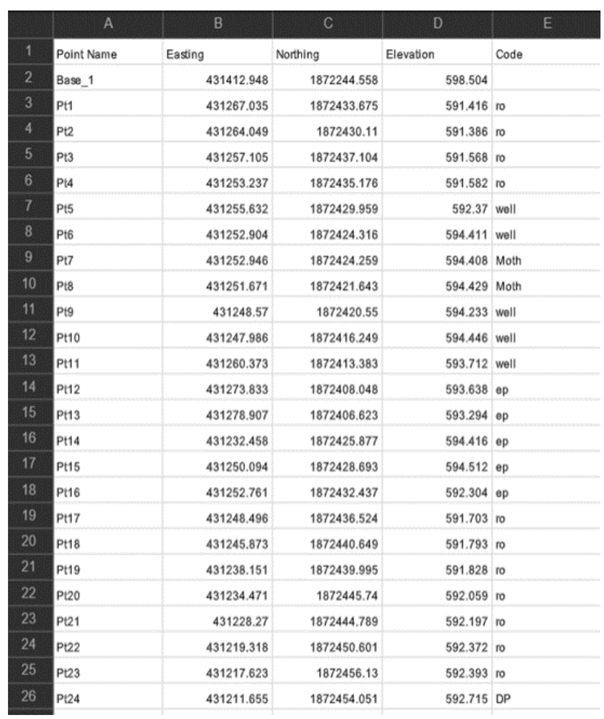

***Fig – (1) DGPS - FOIF A90***


***Fig – (2) Surveying Group***

*Fig – (3) DGPS had a base fix on a villager's home terrace.*


*Fig – (4) Connected the rover to the base.*


*Fig. – (5) Using the rover to obtain ground points*



| | A | B | C | D | E |
|---|---|---|---|---|---|
| 1 | Point Name | Easting | Northing | Elevation | Code |
| 2 | Base_1 | 431412.948 | 1872244.558 | 598.504 | |
| 3 | Pt1 | 431267.035 | 1872433.675 | 591.416 | ro |
| 4 | Pt2 | 431264.049 | 1872430.11 | 591.386 | ro |
| 5 | Pt3 | 431257.105 | 1872437.104 | 591.568 | ro |
| 6 | Pt4 | 431253.237 | 1872435.176 | 591.582 | ro |
| 7 | Pt5 | 431255.632 | 1872429.959 | 592.37 | well |
| 8 | Pt6 | 431252.904 | 1872424.316 | 594.411 | well |
| 9 | Pt7 | 431252.946 | 1872424.259 | 594.408 | Moth |
| 10 | Pt8 | 431251.671 | 1872421.643 | 594.429 | Moth |
| 11 | Pt9 | 431248.57 | 1872420.55 | 594.233 | well |
| 12 | Pt10 | 431247.986 | 1872416.249 | 594.446 | well |
| 13 | Pt11 | 431260.373 | 1872413.383 | 593.712 | well |
| 14 | Pt12 | 431273.833 | 1872408.048 | 593.638 | ep |
| 15 | Pt13 | 431278.907 | 1872406.623 | 593.294 | ep |
| 16 | Pt14 | 431232.458 | 1872425.877 | 594.416 | ep |
| 17 | Pt15 | 431250.094 | 1872428.693 | 594.512 | ep |
| 18 | Pt16 | 431252.761 | 1872432.437 | 592.304 | ep |
| 19 | Pt17 | 431248.496 | 1872436.524 | 591.703 | ro |
| 20 | Pt18 | 431245.873 | 1872440.649 | 591.793 | ro |
| 21 | Pt19 | 431238.151 | 1872439.995 | 591.828 | ro |
| 22 | Pt20 | 431234.471 | 1872445.74 | 592.059 | ro |
| 23 | Pt21 | 431228.27 | 1872444.789 | 592.197 | ro |
| 24 | Pt22 | 431219.318 | 1872450.601 | 592.372 | ro |
| 25 | Pt23 | 431217.623 | 1872456.13 | 592.393 | ro |
| 26 | Pt24 | 431211.655 | 1872454.051 | 592.715 | DP |

*Fig – (6) Using SWDTM software to export all ground*

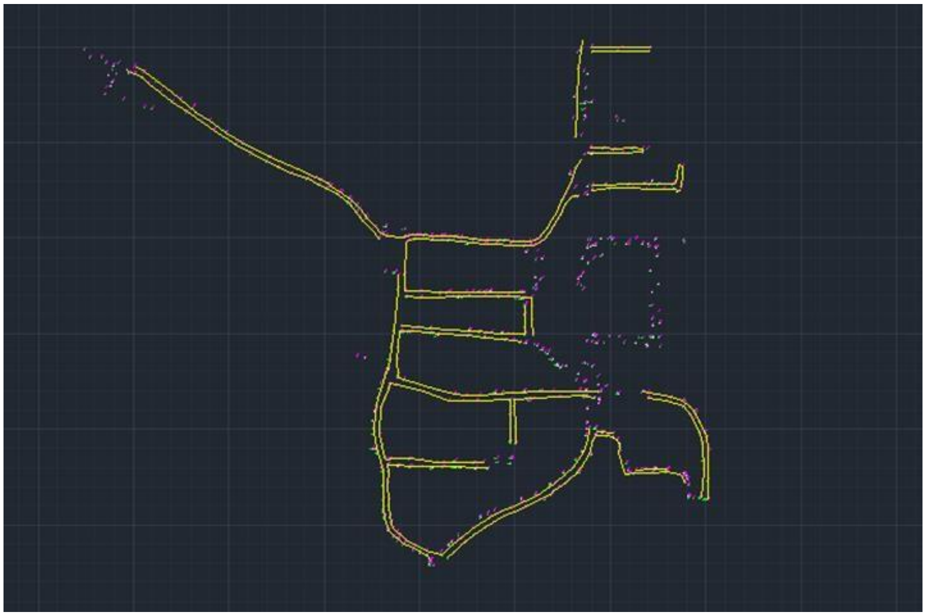


*Fig. (7) - Import these points into AutoCAD, connect the coordinates, and then generate a village road map*

## 1.3 Steps to Conduct a DRONE Survey in a Village -

a) **Regulatory Compliance and Permissions -** Before using a drone in the village, make sure you are in compliance with all applicable laws and regulations. Adherence to privacy regulations and aviation legislation is crucial.

b) **Mission Planning -** Determine the survey's goals, such as infrastructure inspection, land use analysis, and mapping. Specify the village's borders and survey area. Based on the lighting and weather, choose the best time to fly the drone.

c) **Equipment Setup -** Verify that your drone is completely charged and in operational order. To obtain the necessary data, attach the suitable camera or sensor (e.g., RGB camera, thermal camera, LiDAR).Verify the drone's GPS accuracy and adjust it if required.

d) **Flight route Planning -** To designate a flight route, use drone flight planning software. With the aid of this software, the drone is able to cover the whole survey area with enough overlap to produce accurate data. Establish the mission's height, speed, and waypoints.

e) **Pre-flight Safety Inspections -** Perform a pre-flight inspection, making sure to examine the drone's sensors, propellers, and batteries. Check to make sure the communication and remote control systems are operating correctly.

f) **Takeoff and Flight -** Launch the drone from a place that has been approved and is safe. Keep an eye on the drone's flight and make sure it stays on the intended course. Keep your distance from the flight plan as much as you can, but be ready to make manual corrections if necessary.

g) **Data Capture -** The drone uses its inbuilt sensors or cameras to gather data while in flight. Make that the data is recorded with the proper overlap and at the required resolution for post-processing.

h) **Safety and Emergency Procedures:** Have a plan in place for handling unforeseen circumstances like shifting weather or signal loss. Establish a secure landing spot that is reserved for emergencies.

i) **Data Processing and Transfer:** After the flight, move the gathered data to a computer so that it may be further processed. Utilize specialist software to handle various data sources, such as LiDAR, or to assemble together photos (photogrammetry).

j) **Data Analysis and Visualization:** Depending on the survey's goals, analyze the processed data to produce maps, 3D models, or other visualizations.

k) **Quality Control and Accuracy Evaluation:** Check if the survey data is accurate and evaluate the caliber of the output.

***Fig. (8) – Drone -***

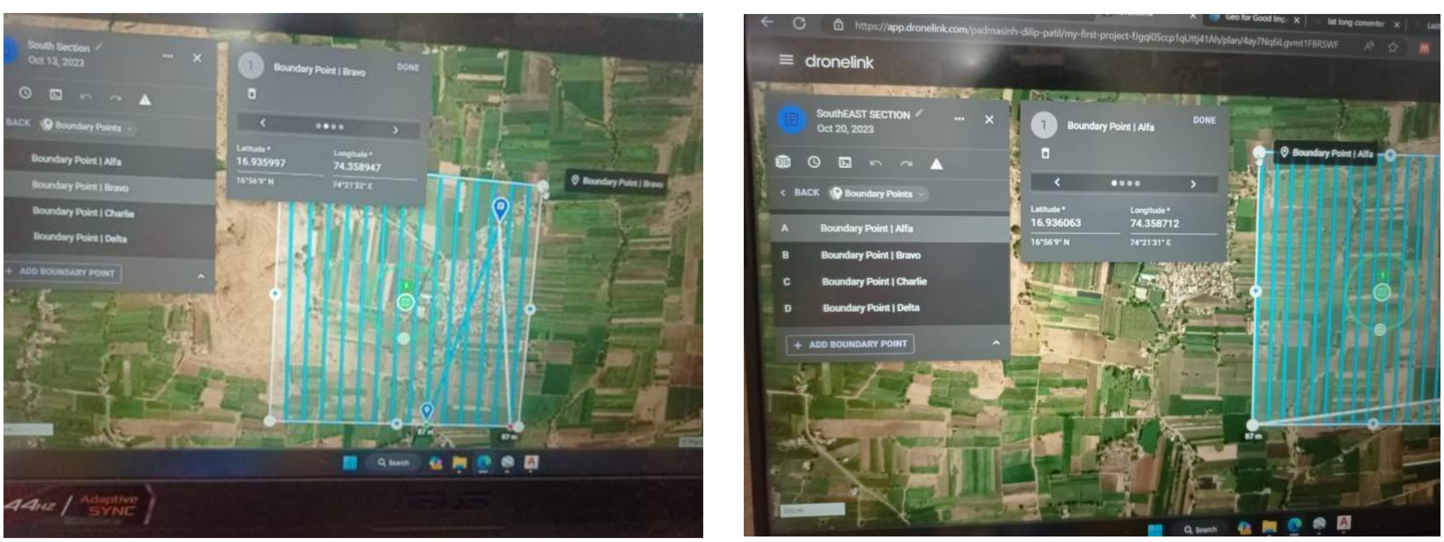



***Fig. (9) – Setting up waypoints and settings on Dronelink is necessary to be ready for a drone flight.***

***Fig. (10) – Drone overlapping images***

***Fig. (11) Using a drone to capture a complete photo of a village allows for comprehensive aerial documentation and analysis.***

### 1.4 The post-processing of drone survey data using Pix4D software-

Certainly, here's the summary of the procedure for post-processing drone survey data using Pix4D software without titles:

a) Open the Pix4D program and import the raw photos that were taken during the drone survey.
b) An Orthomosaic and a preliminary point cloud are created by the program automatically organizing and aligning the pictures.
c) If the software's automatic procedures need to be adjusted, add manual tie points to enhance the alignment and precision of the images.
d) Pix4D uses a dense matching procedure to produce a comprehensive point cloud that provides a three-dimensional representation of the scanned region.
e) Create a DSM that accurately depicts the region's terrain, including features like trees and buildings. Make a Digital Terrain Model (DTM) that excludes all objects and only shows the ground surface.

f) To produce a high-resolution Orthomosaic, stitch the various pictures together. The surveyed region is faithfully depicted on this 2D map.
g) To generate a 3D model of the surveyed region, use the point cloud data. The landscape and any items shown in the photos are both included in this model.
h) To guarantee that the Orthomosaic and 3D model have precise geographic coordinates, apply georeferencing information to them.

## 2. Methodology

The methodology adopted for the study was as follow -

1. In the initial project phase, goals are established, permits acquired, equipment selected, and the survey schedule coordinated.
2. A site visit is conducted to assess the environment and identify potential ground control points (GCPs).
3. A base station and rover are established using DGPS technology to ensure accurate real-time GPS corrections.
4. Prior to drone takeoff, thorough checks, calibrations, and meticulous flight path planning are carried out.
5. During the survey, the drone captures images or video as per the predetermined flight plan.
6. Physical markers are placed, and DGPS technology records their precise coordinates as ground control points (GCPs).
7. DGPS data is collected simultaneously while the drone is in flight, providing valuable location information.
8. DGPS data is post-processed to correct inaccuracies and account for atmospheric influences, enhancing its reliability.

9. Aerial photos are processed using DGPS data to produce georeferenced outputs, ensuring spatial accuracy in photogrammetry.
10. DGPS and drone data are integrated and thoroughly analyzed to meet the project's specific objectives.
11. Comprehensive project deliverables and reports are generated to communicate the findings and outcomes effectively.
12. Rigorous quality checks are conducted to verify precision and validate the survey results for accuracy.
13. The project is concluded by finalizing all necessary paperwork and properly archiving the survey results for future reference and record-keeping.

## 3. Result & Discussion

### 3.1 DGPS Land Surveying Results –

| | |
|---|---|
| **High-Accuracy Geospatial Data** | Boundary surveys, property delineation, and topographic mapping can all benefit from the centimeter-level accuracy of precise location data that DGPS can deliver. |
| **Property Boundary and Land Parcel Mapping** | Land features, parcel boundaries, and property borders can all be precisely defined using DGPS surveys. Land management and property ownership records depend on this. |
| **Elevation Data** | DGPS can provide elevation data, which is crucial for terrain modeling, floodplain mapping, and land development planning. |
| **Utility Mapping** | DGPS can be used to map underground utilities and infrastructure for construction and maintenance purposes. |
| **Cadastral Surveys** | With DGPS, cadastral surveys for land registration and titling can be completed precisely, guaranteeing safe land tenure. |

### 3.2 Drone Surveying Results –

| | |
|---|---|
| **Aerial Imagery** | Drones are able to take detailed aerial photos of the surveyed region, giving researchers a complete visual record of the terrain. |
| **Orthomosaic** | Orthomosaics are precise, georeferenced maps that may be made by processing drone footage. These are helpful for property appraisal, land-use planning, and tracking changes over time. |
| **Real Estate and Property Assessment** | Drones provide visual documentation for real estate marketing and property assessment. |
| **3D Models** | Drones can create 3D models of the terrain and structures, which are valuable for urban planning, construction, and infrastructure projects. |

### 3.3 Road Design -

| Sr.no | Pavement | Location | Length | Width | Thickness |
|---|---|---|---|---|---|
| 1. | Rigid Concrete Pavement | Main Road | 1000m | 3.5m | 0.20m |
| 2. | Rigid Concrete Pavement | Panchayat to Main road | 250m | 3m | 0.20m |
| 3. | Rigid Concrete Pavement | Santosh Nagar | 1650m | 3m | 0.20m |
| 4. | Rigid Concrete Pavement | Near Mountain area | 1600m | 3m | 0.20m |
| 5. | Rigid Concrete Pavement | Jyotirling Temple-Mountains | 350m | 3m | 0.20m |

*Table 1: Road Design*

### 3.4 Rigid pavement cross-section-

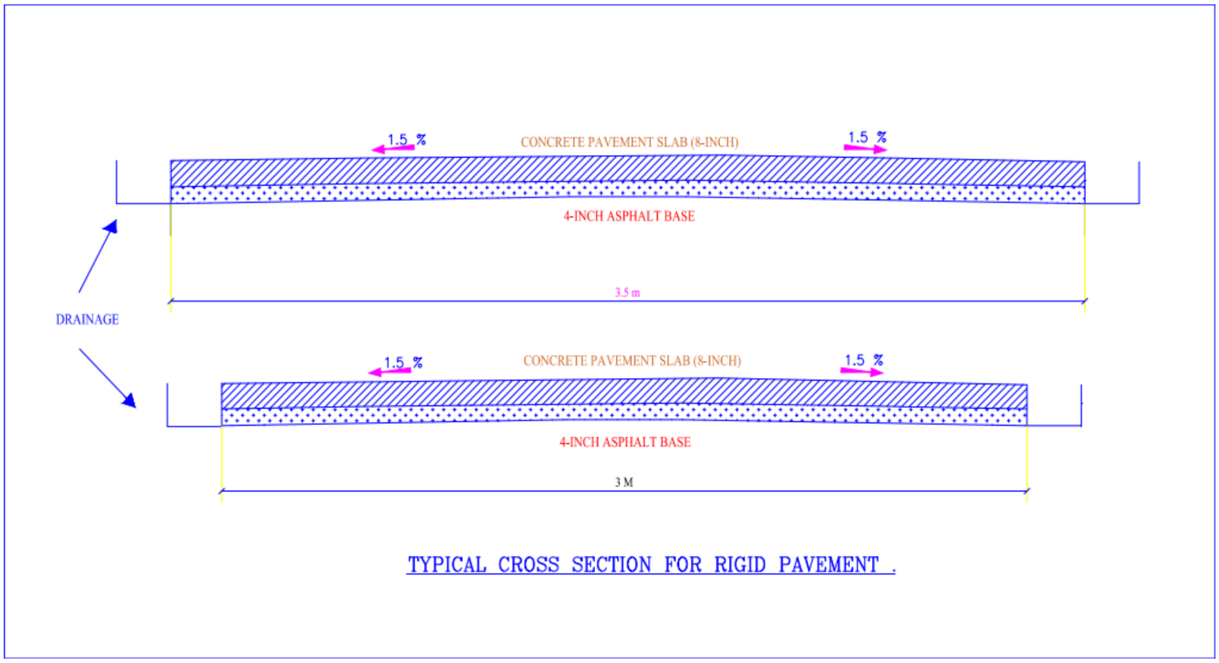



Fig. (12) typical cross-section of rigid pavement

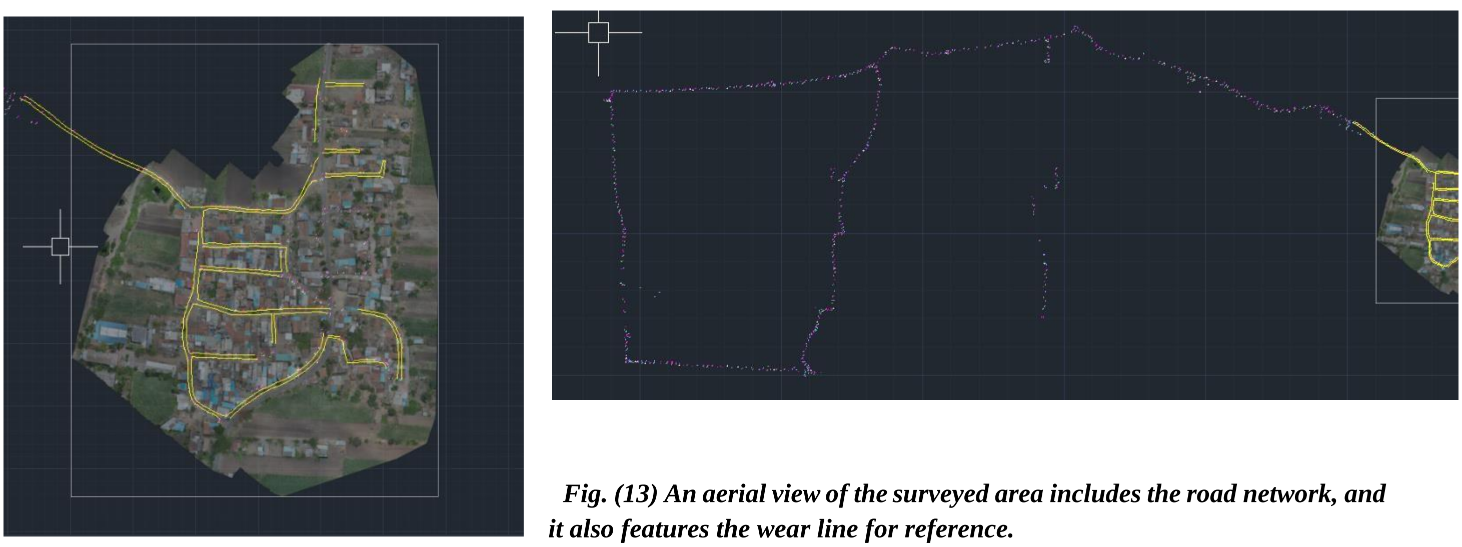


***Fig. (13) An aerial view of the surveyed area includes the road network, and it also features the wear line for reference.***

*Fig. (14) Creating an Orthomosaic image with a drone requires capturing overlapping images and using software to generate a georeferenced map.*

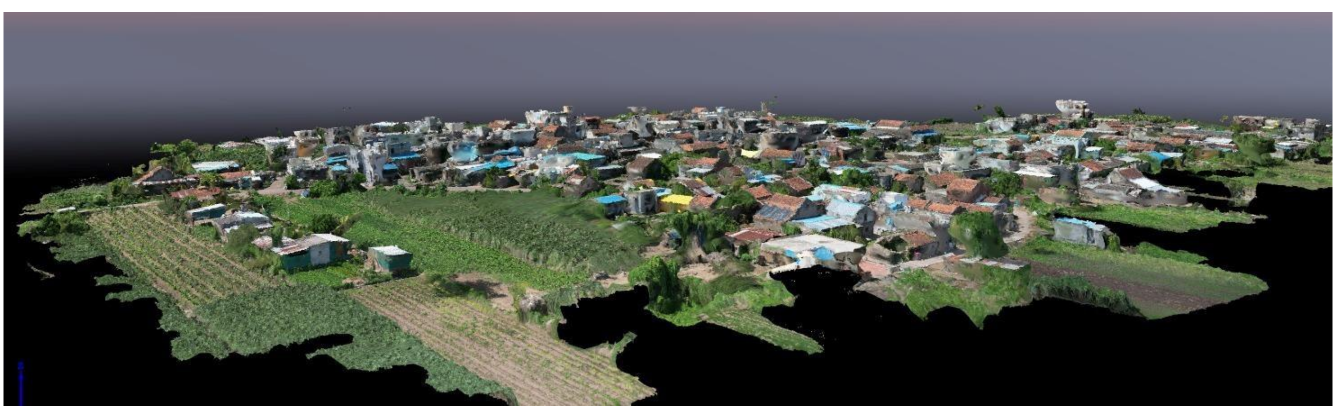


*Fig. (14) 3D view of Phokharni village provides a three-dimensional perspective of the village's topography and structures.*

In Pokharni village, the identification and evaluation of wells, small water bodies, and streams depend heavily on the integration of drone technology and DGPS. The incredibly accurate elevation data provided by DGPS helps locate these water sources. Drones that possess sophisticated cameras and, under some situations, thermal imaging capabilities are able to take precise pictures of these characteristics. In order to manage water resources and provide a steady and sustainable supply of water, this knowledge is crucial. Furthermore, it aids in the preservation of aquatic ecosystems by offering information on the existence and state of small streams and bodies of water.

## 4. Conclusions

In conclusion, DGPS and drone surveying have revolutionized rural land surveying in villages like Pokarni. DGPS ensures precise positioning and comprehensive coverage, while drones provide detailed terrain and forest data for informed land-use planning and environmental conservation. This technology streamlines road surveys, reducing costs and improving safety. Specialized software aids in property boundary identification, simplifying land management, registration, and taxation. Additionally, it's instrumental in identifying and managing essential water resources, ensuring a reliable water supply. Overall, these technologies enhance the quality and efficiency of rural land surveying, facilitating informed decision-making and sustainable development.

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