



# APPLICATION OF DRONES IN MINING INDUSTRY - RULES, GUIDELINES AND CASE STUDY

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## ABSTRACT

Today, many industries are adopting technological advancements like drone technology, rather than conventional methods of surveying. Drones offer cost-effective, safe, and quick aerial surveys for data collection and are very useful for industries like mining, which requires constant monitoring. Mining operations, which are typically in remote locations and hard to access places, often make human accessibility difficult. This, in turn leads to either delay in decision making or sufficient information leading to loss of mining efficiency and threat to worker safety.

As drone technology evolves, becomes more affordable and regulations get more defined, the use of drones in the mining sector is likely to increase manifold.

Surveyors and engineers can use the data captured from UAVs to make statements and forecasts about the development of the mines. In mines, drones can provide valuable information about the condition of the above ground area, thus improving the workers' safety in the process.

**Keywords-** Mining, Geology, Indian Bureau of Mines, Mine Survey, Mineral Exploration, Mineral Reserve Estimation, Drones, Drilling, Artificial Intelligence, Granite, Industrial mineral, Geological Mapping & Interpretation, Photogrammetry, GIS, Land Use.

## INTRODUCTION

The Ministry of Civil Aviation vide gazette notification CG-DL-E-26082021-229221 dated August 25, 2021 published the Drone Rules<sup>1</sup> and vide gazette notification CG-DL-E26012022-232917 dated January 26, 2022 published the Certification Scheme for Unmanned Aircraft Systems.

Drones are Unmanned Aerial Vehicles (UAVs) or Remotely Piloted Aerial Systems (RPAS) that are controlled either by a pilot on the ground or with the help of technology.

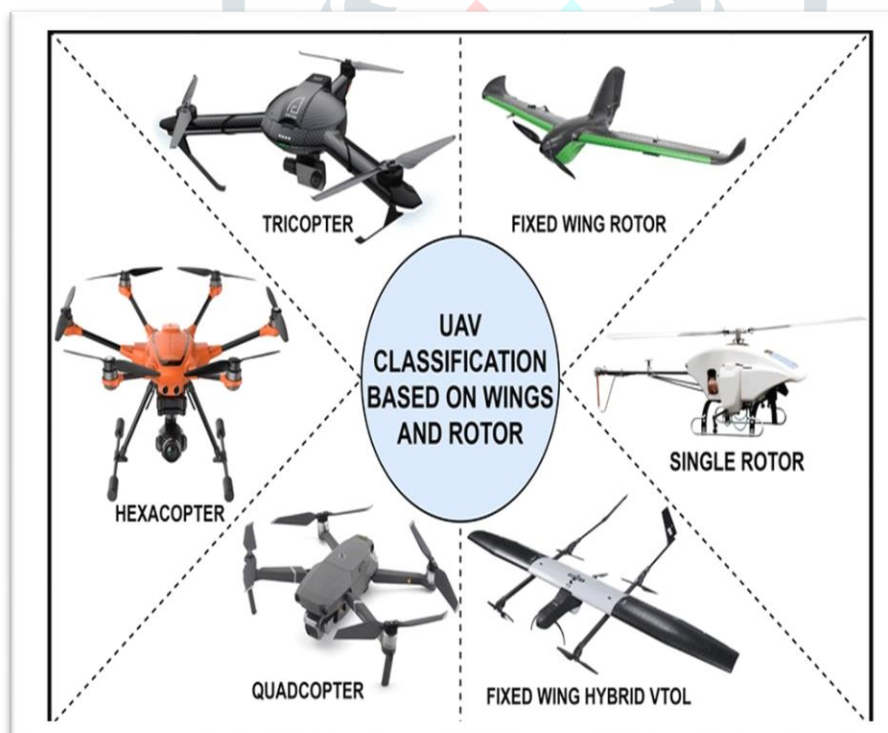
Drones offer tremendous benefits to almost all sectors of the economy like – agriculture, mining, infrastructure, surveillance, emergency response, transportation, geospatial mapping, defense and law enforcement etc. Drones can be significant creators of employment and economic growth due to their reach, versatility, and ease of use, especially in India's remote and inaccessible areas.

In view of its traditional strengths in innovation, information technology, frugal engineering and huge domestic demand, India has the potential to be global drone hub by 2030.

## CATEGORIES OF UNMANNED AIR CRAFT SYSTEM

The unmanned aircraft system shall be categorized into the following three categories, namely:

- a) aeroplane;
- b) rotorcraft; and
- c) hybrid unmanned aircraft system



## CLASSIFICATION OF UNMANNED AIRCRAFT SYSTEM

Based on their weight, drones can be classified into five categories —

1. nano (weighing up to 250 g),
2. Micro air vehicles (MAV) (250 g - 2 kg),
3. Miniature UAV or small (SUAV) (2-25 kg),

4. medium (25-150 kg), and
5. large (over 150 kg).

 Nano	 Micro	 Small	 Medium	 Large
Up to 250 gm	More than 250 gm	More than 2 kg	More than 25 kg	More than 150 kg
	↓	↓	↓	
	Up to 2 kg	Up to 25 kg	Up to 150 kg	

## CERTIFICATIONS OF UNMANNED AIRCRAFT SYSTEM

Digital sky platform being developed as a user-friendly online single-window system. There will be minimal human interface and most permissions will be self-generated.

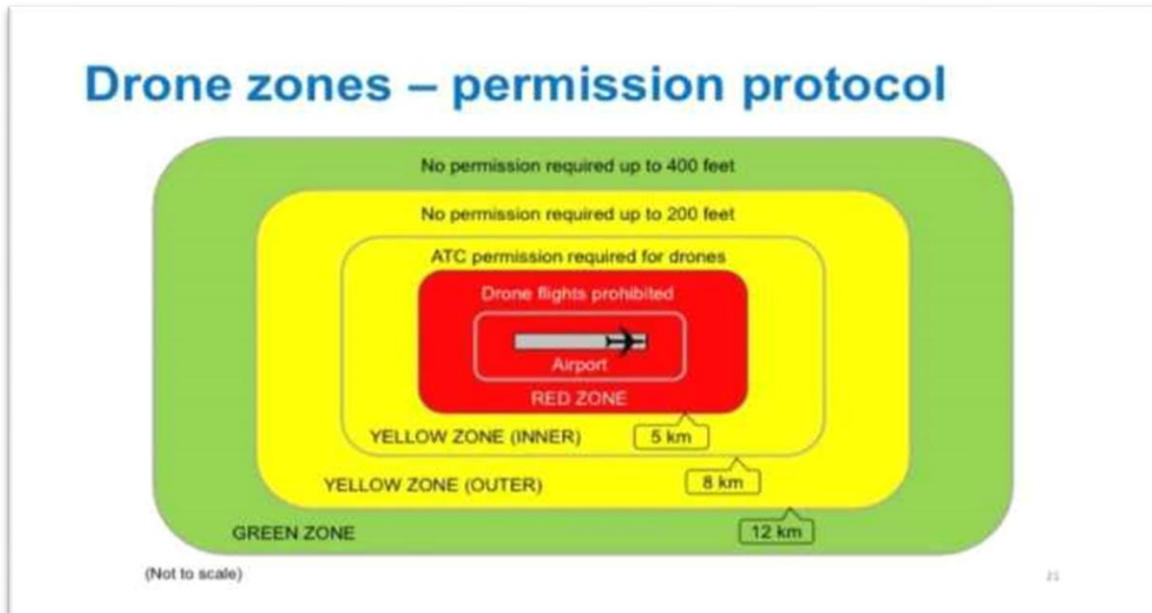
1. Interactive drone airspace map with red and yellow zones shall be displayed.
2. No permission required for operating drones in green zones.
3. No requirement of Type Certificate, unique identification number and remote pilot licence by R&D entities operating drones in own or rented premises, located in a green zone.
4. Remote pilot licence to be issued by DGCA within 15 days of pilot receiving the remote pilot certificate from an authorized drone school through the digital sky platform
5. Testing of drones for issuance of Type Certificate to be carried out by Quality Council of India or authorized testing entities.

## CATEGORY OF ZONES

**“Red Zone”** means the airspace of defined dimensions, above the land areas or territorial waters of India, or any installation or notified port limits specified by the Central Government beyond the territorial waters of India, within which unmanned aircraft system operations shall be permitted only by the Central Government.

**“Yellow Zone”** means the airspace of defined dimensions above the land areas or territorial waters of India within which unmanned aircraft system operations are restricted and shall require permission from the concerned air traffic control authority. The airspace above 400 feet or 120 metres in the designated green zone and the airspace above 200 feet or 60 metres in the area located between the lateral distance of 8 kilometres and 12 kilometres from the perimeter of an operational airport, shall be designated as yellow zone.

“Green Zone” means the airspace of defined dimensions above the land areas or territorial waters of India, up to a vertical distance of 400 feet or 120 metres that has not been designated as a red zone or yellow zone in the airspace map for unmanned aircraft system operations and the airspace up to a vertical distance of 200 feet or 60 metres above the area located between a lateral distance of 8 kilometres and 12 kilometres from the perimeter of an operational airport.



## REGISTRATION OF UNMANNED AIRCRAFT SYSTEM

1. No person shall operate an unmanned aircraft system without first registering it on the digital sky platform and obtaining a unique identification number, unless exempted from the requirement of a unique identification number under Drone Rules, 2021.
2. A registration record shall be maintained by the Director General of all such unmanned aircraft systems to which unique identification number has been issued under Drone Rule, 2021.
3. It shall be the responsibility of the person operating an unmanned aircraft system to ensure that such unmanned aircraft system conforms to a valid type certificate.

## REMOTE PILOT LICENSE

1. General – No individual other than a holder of a valid remote pilot license enlisted on the digital sky platform shall operate an unmanned aircraft system. •
2. Classification – A remote pilot license shall specifically mention the category, sub-category and classification of the unmanned aircraft system or a combination of these, for which it is issued
3. Eligibility for Pilot License

An individual shall be eligible to obtain a remote pilot license, if he:

- a) is not less than eighteen years of age and not more than sixty-five years of age
- b) has passed class tenth examination or its equivalent from a recognized Board
- c) has successfully completed such training as may be specified by the Director General, from any authorized remote pilot training organization.

**GUIDELINES FOR MINING INDUSTRY – ISSUED BY INDIAN BUREAU OF MINES**

Mineral Conservation and Development (Amendment) Rules, 2021.

“34A. Digital aerial images of mining lease area. —

(1) Every lessee having—

(a) an annual excavation plan of one million tonne or more in a particular year; or

(b) leased area of fifty hectare or more, shall carry out a drone survey of the leased area and up to hundred metres outside the lease boundary in the month of April or May every year and submit the processed output [digital elevation model (DEM) and Orthomosaic] images obtained from such survey or any other format may be specified by Indian Bureau of Mines. SOP has been issued by Indian Bureau of Mines.

**CASE STUDY- OPEN CAST MINES****Scope of Work**

Survey of mining leases using UAV and providing accurate output in desired formats for the different Mining Leases.

**Details of work**

Topographical survey of Mining lease of mineral different minerals. The Drone survey and data capturing will be done as per rule no 34A of Mineral Conservation and Development (Amendment) Rules, 2021, Orthomosaic and DEM will be prepared as desired by Indian Bureau of Mines.


Data capturing within mining leases and up to 100m from its boundary using drone instrument. Data capturing for Mining Lease will be done so as to create 3-dimensional models. The scope area to be surveyed will be provided in kml / Auto cad drawing file. The data capturing should be carried out by flying drone about 60-100m (Maximum) above ground only. Flight path will get adequate overlapping of images and to get accuracy mentioned below. The scope will include marking of the required number of ground control points (GCP) in the field.

**Deliverable of the case study**

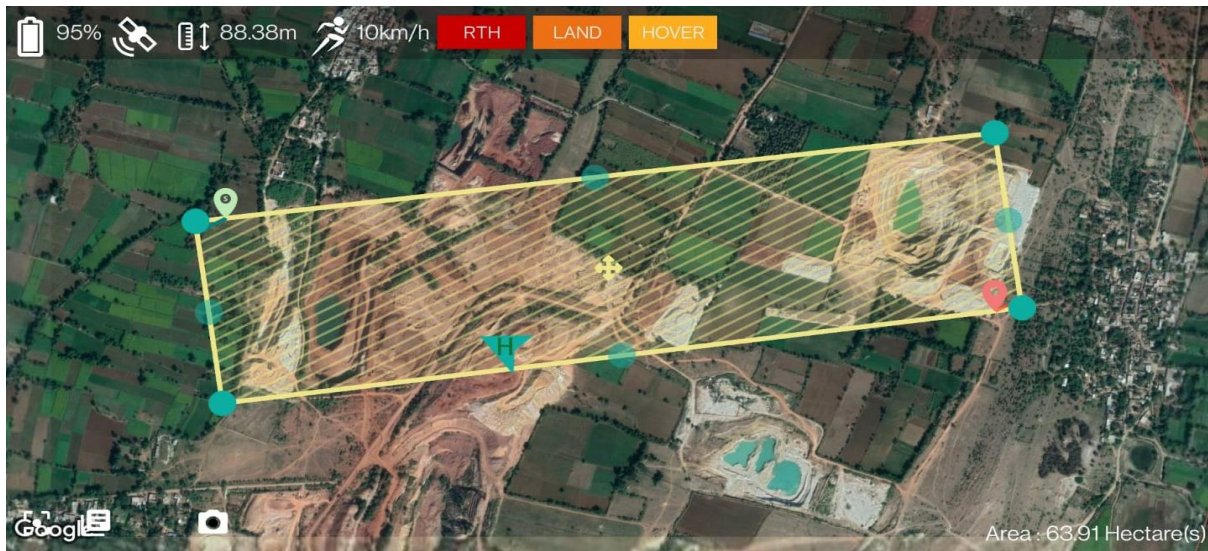
S No	Particular
1	After data processing following will be given in DVD/soft copy.
a)	Geo referenced tiff file and .csv file of area surveyed at a suitable pixel size as desired by user
b)	Contour map of the area surveyed having a suitable contour interval as desired by user
c)	DTM, DEM of area surveyed, Break lines of Quarry and dumps.
d)	Volume calculation of open stock pile.

e)	Excavated / filled volume compared to last survey	
f)	Output file in any other format as desired by user	
S No	Data Type	Format
1	Raw Photographs	<b>.JPEG</b>
a)	Ortho Mosaic images	<b>.tiff (geo tiff)</b>
b)	Digital Elevation Model (3D)	<b>.tiff (geo tiff)</b>
c)	Contours	<b>.shp/.dwg (geo tagged)</b>
d)	GCPs data	<b>.shp and MS-Excel</b>
e)	Lease boundary pillar co-ordinates	<b>.shp and MS-Excel</b>
f)	Flight plan of the survey area in 1:5000scale on surface plan including 500m buffer zone along with GCPs	<b>.pdf or .jpeg</b>

## DRONE USED FOR SURVEY

Drone	
	<b>Drone type</b> Quad rotor type
	<b>Weight</b> 1.99 kg including payload (micro category)
	<b>Battery capacity</b> Lithium Ion Chemistry (155wh)
	<b>Radio link</b> 3.2km bidirectional in direct line of sight, interference and ground effect may reduce the range
	<b>Payload &amp; communication</b> GoPro Hero 7 Black and Hero 8 Black
	<b>Flight speed</b> 10 m/s (max)
	<b>Wind Resistance</b> 8.3 m/s (30 kmph)
	<b>Flight time</b> 27-33 min

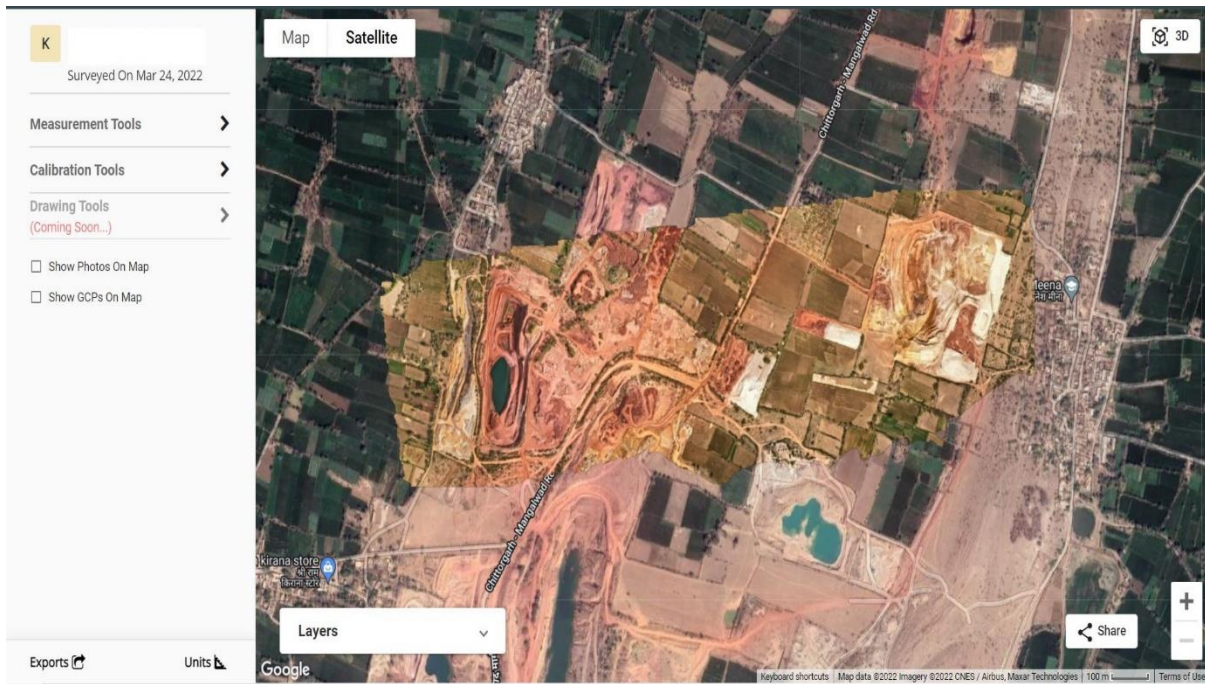
## DEFINING DRONE SURVEY AREA- KML OF MINING LEASE



## GCP – MISSION PLANNING



## PROCESSED IMAGE/ ORTHOMOSAIC

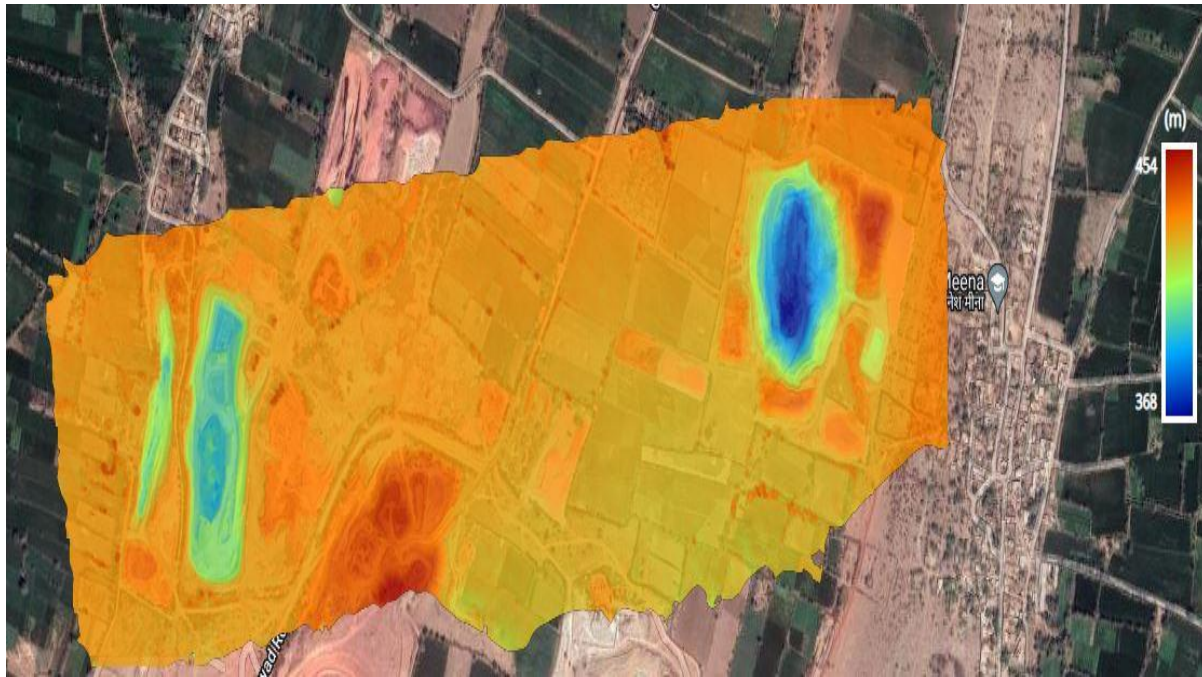


## MEASUREMENT TOOLS





### ELEVATION PROFILE



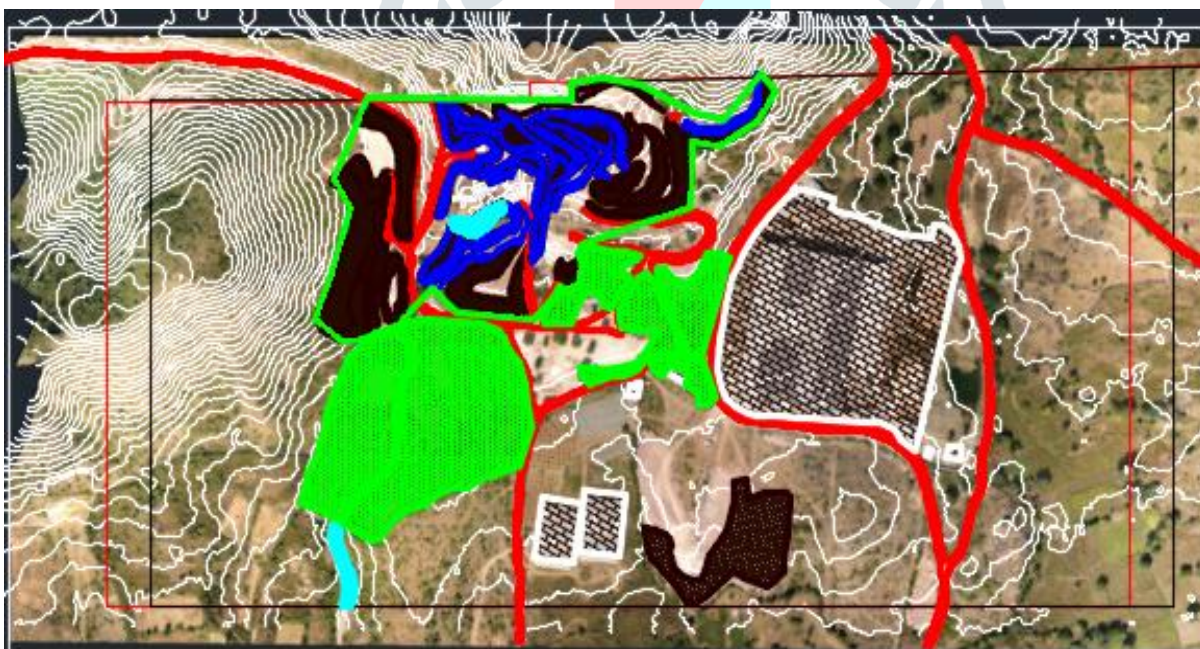
### SLOPE MAP



### DIGITAL ELEVATION MODEL/ CONTOURS



### USE OF CAD WITH PROCESSED OUTPUT



## So, according to case studies in Mining Operations following are the application of Drones in Mining Industry: -

1. Autonomous Mines inspection, Survey operational planning and monitoring.
2. Hydrological and water Resource Management and Planning
3. Land Use Mapping and Designing of Diversion of Water channels.
4. Stockpile Measurement and Volume Calculations
5. Geological mapping, planning and Interpretation of Mineral resources.
6. Drilling and Blasting Management with Pre and Post Blast Analysis.
7. Forest Land Diversion Mapping Environment Monitoring.
8. Haul road inspection, Designing and Management.
9. Plantation and Vegetation analysis and Management.
10. Industrial Plant, Plant Inspection with Monitoring of Waste Management.

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<https://static.pib.gov.in/WriteReadData/specificdocs/documents/2022/mar/doc202232932501.pdf>

