

DronaMaps

Recreating Reality



DronaMaps recreates the world with centimetre level accuracy in 3D. We set out to create UAV based solutions to transform the way organisations use physical assets. In the process of searching for ourselves, we performed pilots with some of the most critical government, commercial, and non-profit institutions in India to solve problems we had not even dreamed of while setting out on this journey.

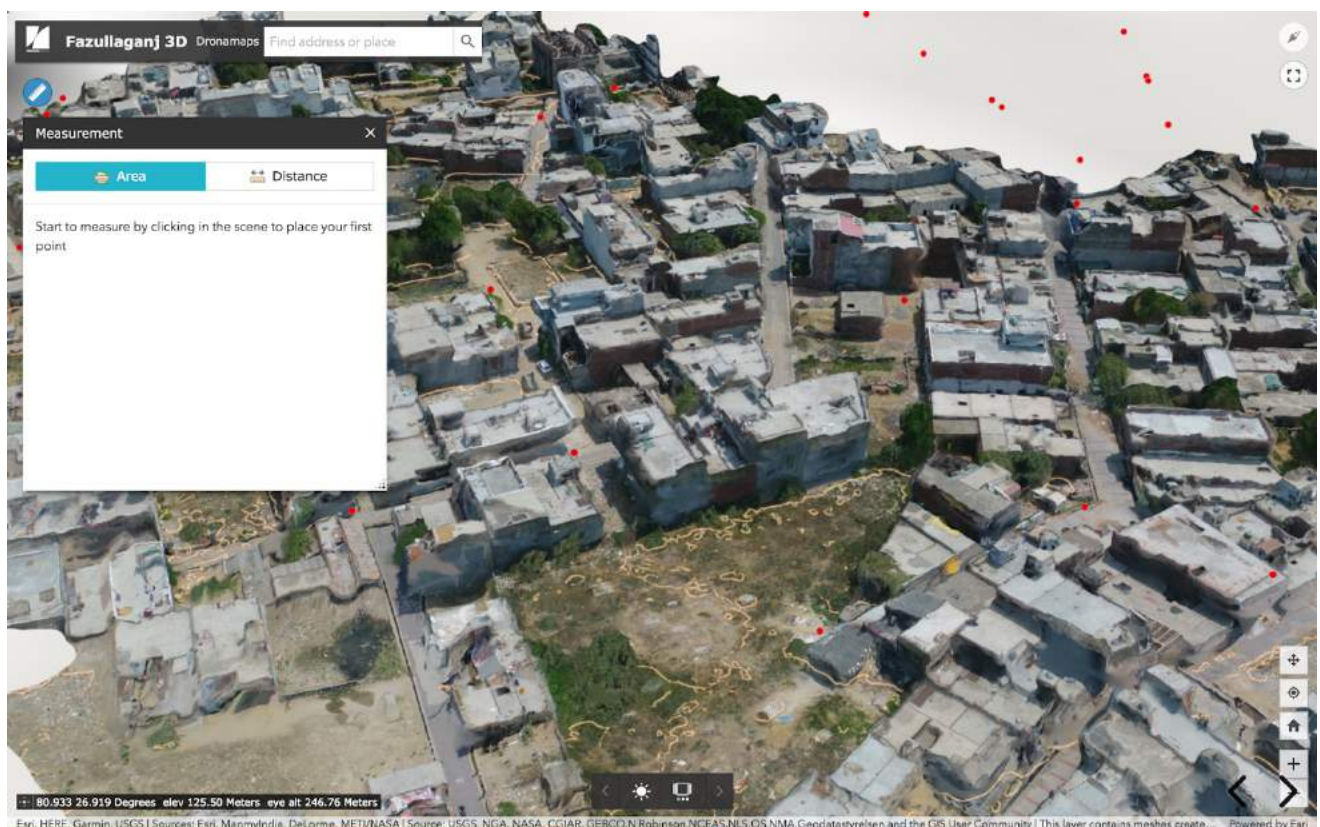
Maps make places on the edges of imagination graspable and placable. With good data about their assets and the right technology, people, and institutions today can solve hard problems and bring change. When we looked at the available solutions, we realised there is a gap between physical infrastructure as it exists and the data we have about it. Governments and industries are plagued by disorganised data. We provide a common visual platform to observe, measure, monitor, plan, and use physical assets. We understand that rather than all-or-nothing access controls, an adaptive approach is required and our maps allow for selective

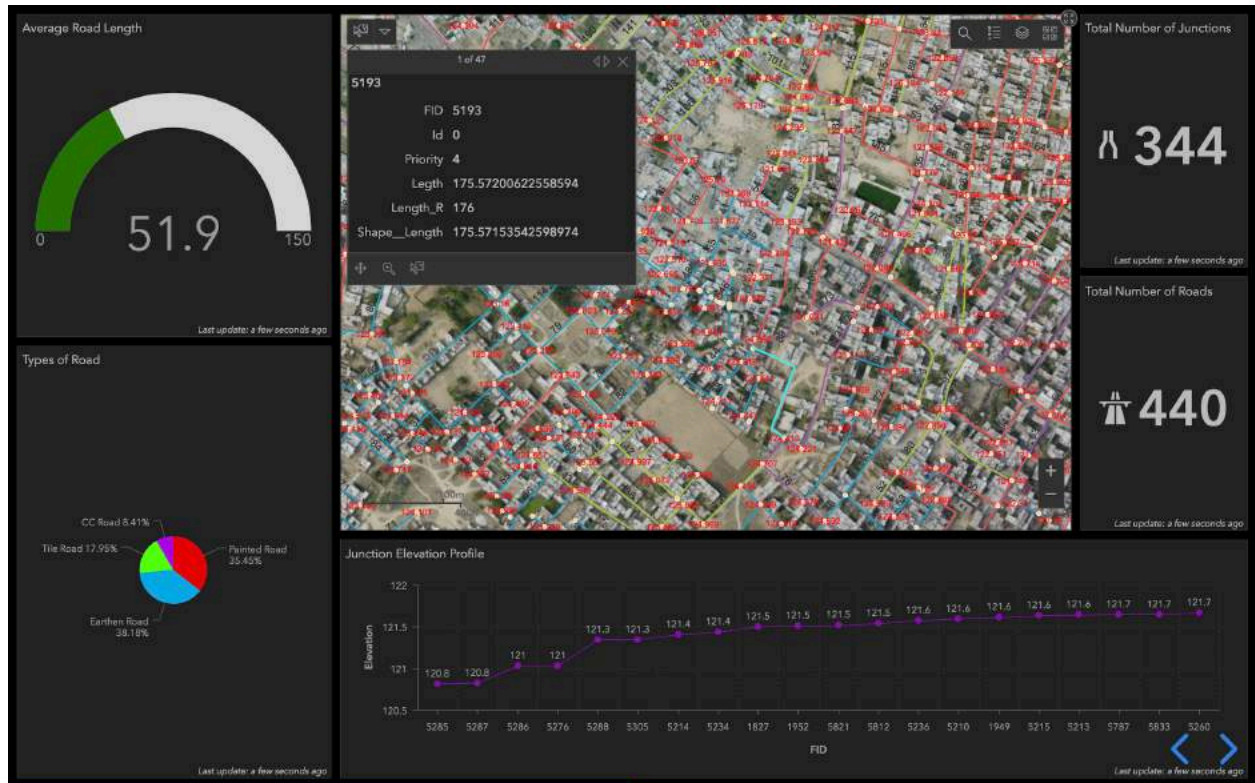
Page 1 of 26

access. Organisations would no longer need to make the trade-off between collaborating and securing sensitive information.

We saw the need of a different kind of 3D mapping company. That's why we founded DronaMaps. Traditionally, satellite maps are used by our customers to guide their decision making process. However, satellite maps do not provide the kind of granularity needed, DigitalGlobe, the leader in satellite imagery, offers public images that display detail at 30 centimeters-per-pixel. The images used by district and state governments in emerging markets like India are usually about 60 centimeters-per-pixel. Our maps rendered using drone technology are capable of up to 1-5 centimeters-per-pixel.

At DronaMaps, we believe in mapping with a purpose. Our team travels to where the problems are- we gather data and intelligence from major stakeholders in the field. The process is designed to mobilize for change, shape strategies, and drive execution for our clients.





Our Objective: The Mapping and |Surveying|

Surveying large swaths of land has inherent challenges: limited accessibility, safety and liability concerns, and the sheer size of sites can make inspecting these sites difficult. DronaMaps provides commercial drone solutions for surveyors to rapidly and repeatedly collect and analyse comprehensive imagery of their land. DronaMaps is recognised by the CII committee on Civil Aviation and are fully FRTOL compliant. Our customers get the combined power of an enterprise-focused workflow and powerful industry-specific analytics, to help turn aerial data into actionable business insight and better survey your areas in a cost-effective manner. We propose a topographical survey- 3D mapping sequence, each phase achieving the following:

Target Activities

- To capture high-resolution aerial images of the project area using state of- the-art drone technology
- To generate 2D and 3D output from drone data (ortho images, Digital Surface Model, contours superimposed on images)
- A heavily detailed 3D map at about a hundred million points per square kilometer, totaling to a target of about a Billion points for the entire area of interest. Delivered as web-application and exportable as OBJ/PLY/LAS on-demand.
- Once this baseline 3D data is computed, it would result in three key departmental segregations: GIS (for contour and measurement extractions), AI/ML (for training the core deep-learning models with this data such that the computer system 'knows' what it is and can tell us what we don't even know to ask), and finally the Architectural Integration Division (to inform the planning and design aspect, and integrate those features as they are developed).

- Surveying and contour extractions at centimeter level accuracies will be available as extractions on demand on the web application. Ortho, DSM exports in TIFF/ECW/JPEG, and contour extractions in SHP, PDF and DXF formats will be available to download on demand.
- Construction planning exports into architectural applications in, as well as final renderings on existing topography once architectural planning are done would be provided.
- The best data is repeated data. We propose a quarterly/annually updated 3D map for the purpose of progress assessment and monitoring of targets.
- Marketing exports of 3D maps would be provided after each mapping sequence.
- The existing macro over ground electric and hydro drains/rivers/canals, nullahs would be mapped on to the 3D Elevation, and associated hydrological flow maps are thus created. The information for the existing underground drainage and utility infrastructure can be integrated as provided. Revenue/khasra maps can also be imported as a layer as provided (must have GCPs).
- Flow analysis would be conducted on mathematical models derived out of centimeter level data.
- A central dashboard which will provide the central point for all data and analysis as well as status monitoring would be the one-stop shop for this entire mission.

Our idea of helping the organizations make a record attempt at its construction speed and planning can all be achieved utilizing such heavy 3D mapping sequences as invented by our team. The privilege to have our own educational training in such cutting-edge technologies comes from Johns Hopkins and IIT Bombay, and we take immense pride in the quality of education and research that allowed us to invent such record-breaking technology. The target is similar, provide immense data for furthering what no human has achieved before, because AI works best with more and more data, and that dense repeated data is the unicorn.

Technicals |UAV Surveying|

The motive behind conducting a UAV survey is to eliminate the need of all ground surveying and measurement activities and make available all surveying data exportable from a 3D web-application interface on-demand and with varying quality/customizations/formats as necessary. All measurements will be distance, height, area and volume enabled.

DronaMaps UAV aided data collection capabilities allow for data procuring, processing, and analysis in a time bound manner.

- Autonomous drones with near real-time 3D mapping capability
- **User- Friendly Platform:** Easily upload and process images while being on the ground.
- **Real- Time insights:** Survey the area for types of roads, building footprint, encroachment, junctions, elevation of junctions etc.
- **Surveying Processing Engine:** Image stitching solution to map uniformed sections of land.
- **Works With Your Tools:** Use our APIs and results to integrate with your planning software.
- **GIS accurate:** Resolution: 3-5 cm
- **3D Mapping Resolution:** ± 1 to 5 cm, for the XY and Z co-ordinates
- **Contour Intervals:** ~ 0.25 m
- **Financial Viability of the initiative:** Govt.'s savings are estimated to be between 40-60% compared to current surveying and planning techniques when done at scale.
- **Error Margins:** Calculation errors are always maintained within less than the ceiling 1% of the ground surveys. Mean errors are in centimeter scale.

| Service Offerings|

❖ **DronaPlots:** Property Tax Assessment, Encroachment Analysis

Clientele: Kanpur Municipal Corporation (Uttar Pradesh), Vasai Municipal Corporation (Maharashtra), Guwahati Municipal Corporation (Assam) and counting

❖ **DronaFarms:** Precision Agriculture and Advanced Farm Analytics

Clientele: Reliance Jio Foundation (Andhra Pradesh), Lateral Praxis (Dhaboi, Gujarat)

❖ **DronaBlocks: Industrial and Construction Planning-**3D Map for showcasing, planning, and monitoring of construction and industrial infrastructure assets.

Clientele: MPSEDC for Pithampur SEZ, Madhya Pradesh; APSIDC for Peddapuram and Vakalapudi Industrial Areas, Kakinada, Andhra Pradesh; UPSIDC for Kanpur Industrial Belt; GIDA for Gorakhpur Industrial Area, Jio Institute (Karjat, Maharashtra)

❖ **DronaRivers: Flood Management:** Risk Hazard Analysis, Vulnerability and Capacity Assessment, Resource Mapping, Urban Flood Mapping, River training and Flood zoning analysis.

Clientele: Rehabilitation & Resettlement Polavaram Project (Andhra Pradesh), Gorakhpur Development Authority (Uttar Pradesh)

❖ **DronaFlow: Pipeline & Drainage Solutions:** Electric Cable Line Planning, Water Pipeline Planning, Water Drainage Planning

Clientele: Rehabilitation & Resettlement Polavaram Project (Andhra Pradesh), Lucknow Jal Nigam (Uttar Pradesh), Gorakhpur Development Authority (Uttar Pradesh)

❖ **DronaCity: Smart City Integration-**City Master Planning, Geo-tagging of public assets, Infrastructure Planning, Traffic Management, Waste Management, Centralised e-Portal

Clientele: UC Berkley Smart Village Project (Andhra Pradesh), Sagar Smart City (Madhya Pradesh), Maheshwar (Madhya Pradesh)

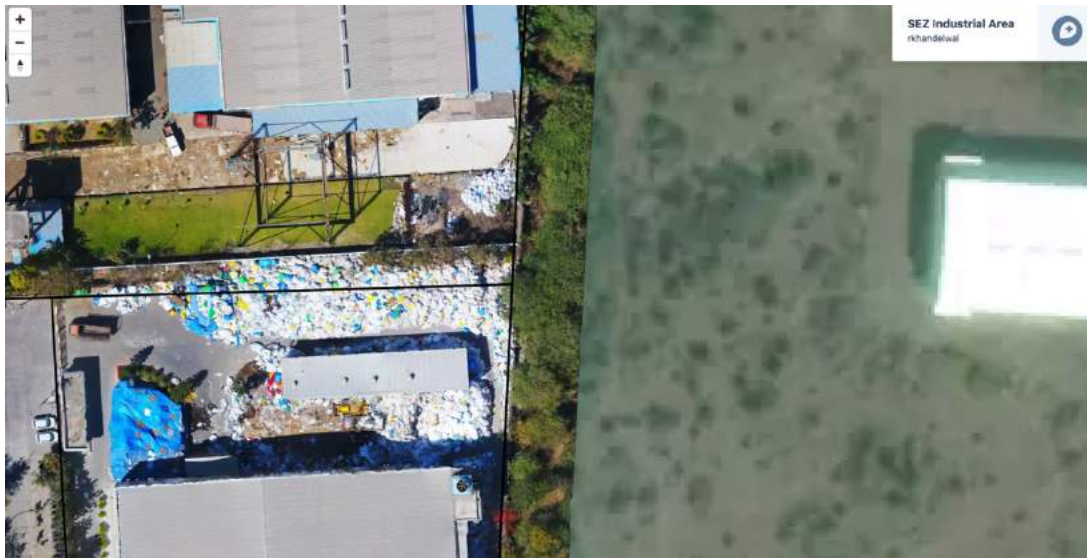
❖ **DronaSee: Security and Surveillance-**Security Planning, Evacuation Planning and Disaster Management

Clientele: Ayodhya Sawan Jhula Mela (Uttar Pradesh)

Product | Deliverables |

1. 2D Orthomosaic Map

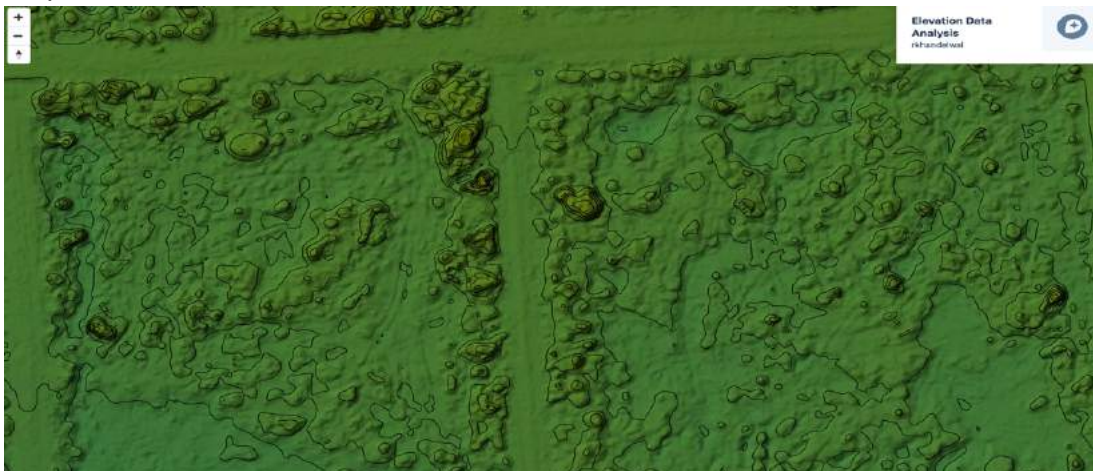
A highly detailed, orthorectified up-to-date map in true scale with accuracy ranging from 1-5 cm per pixel.



(Right: Google Maps, accuracy ~1m-30m per pixel | Left: DronaMaps, accuracy 1-5cm per pixel)

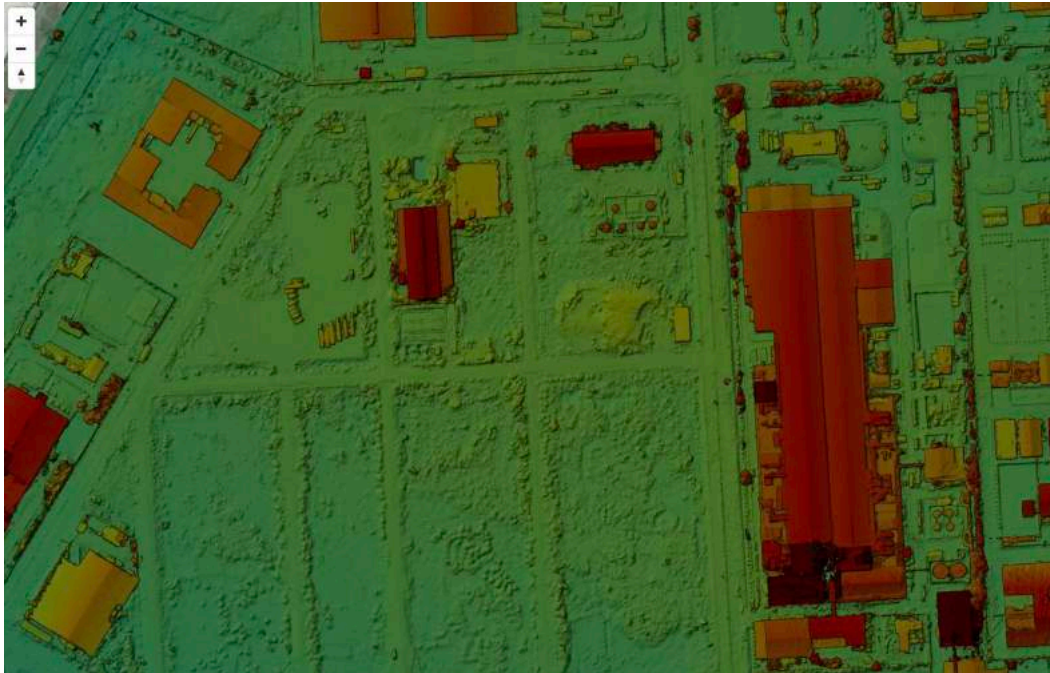
2. 2D Contour Map

Map illustrated with contour intervals of ~25cm.



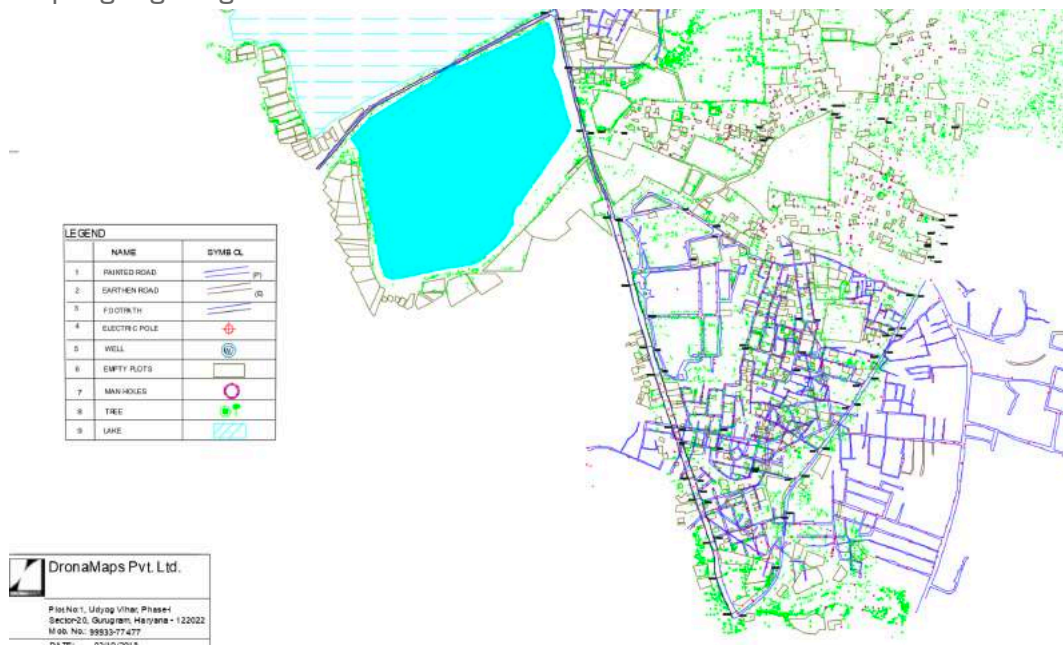
3. 2D DSM

Map representing the highest and the lowest elevation terrain details all geo-referenced.



4. CAD Map

Map highlighting the different GIS features



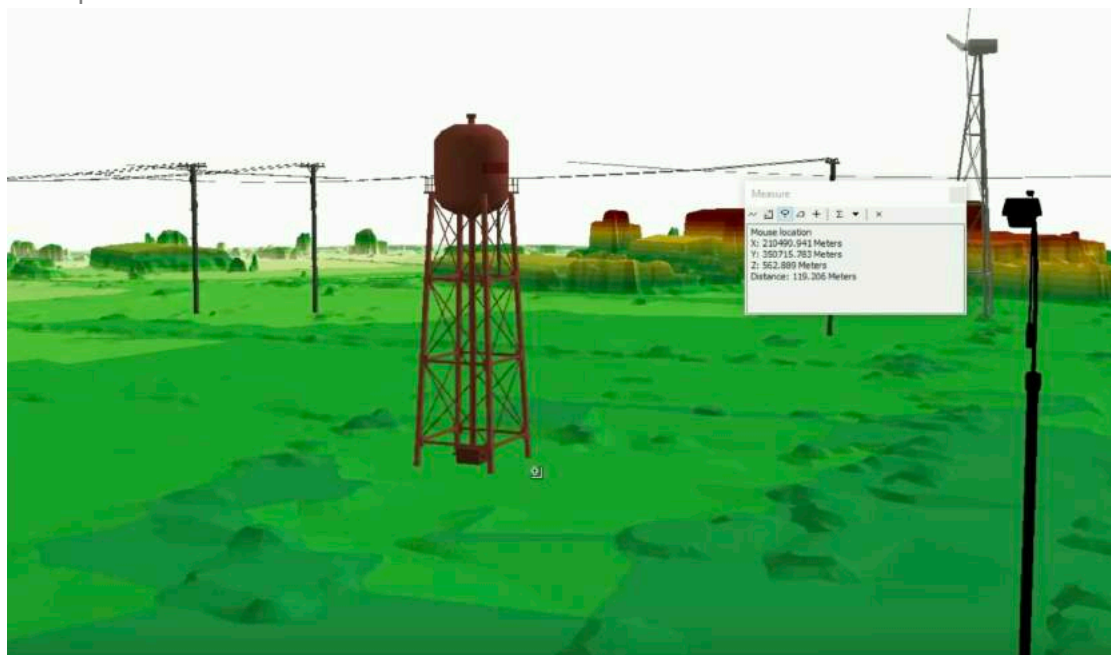
5. 3D Map

Point Cloud generated GIS enabled 3D maps at centimeter level accuracy



6. 3D DEM

3D representation of the elevation model



Behind the Curtains | The Technology |

An unmanned aerial vehicle (UAV), commonly known as a drone, is an aircraft without a human pilot aboard. The flight of UAVs may operate with various degrees of autonomy – either under remote control by a human operator, or fully or intermittently autonomously by onboard computers.



The following are the different aircrafts used:

- UAVs: (Multi-rotor/Quadcopter) with 28 minutes of flying time for autonomous oblique trajectory flights.
- Fixed-wing UAV with RGB-d+multispectral grid mapping sequencer with up to 60 minutes of flight time for nadir images.

Utilizing the fully autonomous capability of these customized aircraft, the camera takes hundreds and thousands of overlapping pictures with between 60-80% lateral overlap and between 70-90% frontal overlap, and up to 4-10 degree separation for oblique images. Using advanced computer vision algorithms based on streaming parallel reconstructions and VSLAM (which extracts geometry to calculate camera position for generating accurate maps and 3D Models), we then analyze the millions of keypoints in these images to eventually generate an orthorectified 3D digital re-creation model, which makes the basis of our highly accurate maps. Along with Orthomosaic and 3D Elevation data, we also generate the vegetation index files of the same dataset where the NIR and Red-Edge spectral lines come in heavy use.

The UAVs are completely autonomous with manual override, but this comes at a huge cost and effort. To start with, we follow the normal curve of data collection — only the best points and the minimum amount of dataset is sent for processing based on quality reports. This is because 3D processing algorithms are extremely memory intensive, and after a point, more data reduces the overall quality and resolutions for the entire map.



(Custom MTD fixed wing for grid flight sequences)

To accomplish this goal, we have designed autonomous flight trajectories for grid and oblique imagery capture using the principles of UAV Trajectory Optimization where we only capture the best, and the most dense points for accurate reconstructions at centimeter level.

The data that these UAVs capture goes into a scalable processing grid. The grid is made up of $n \times 4$ units of processing clusters. Each cluster has a 128 core, 768GB RAM, and 4x2048GB SSD units, with 30,000 CUDA cores per cluster. The grid is spun up and scaled as per the load derived from the input channels to deliver a near real time 3D assessment capability.

Behind the Curtains | The Technology |

Platform

- UAVs based on multi-rotor and fixed-wing autonomous fleet-controlled systems in fixed geo-fenced areas for autonomous flights.
- 30,000 CUDA cores per cluster with nx4 cluster grids operating in parallel to handle the processing load.
- Sensors: RGB-d with multi-spectral capability based on narrow band NIR and Red-Edge spectrums.
- Outputs: continuous dense 3D maps (geo-referenced), orthomosaics, DSMs, DTMs, 3D DEM, TIN Networks and VRMLs, Map Tiles, and Densified Point Clouds.
- Tracing: Database logged outputs with intermediary files for process control flow.
- Security: Encryption at rest with 2048-bit Diffie-Hellman supported communications for end-to-end security over cluster nodes. Processing and Database units are behind the firewall with only the application servers in public domain, controlled by SSL3.0 protected user authentication based on SAML.
- Error Margins: Calculation errors are always maintained within less than the ceiling 1% of the ground surveys. Mean errors are in centimeter scale.

Scalability

- Back-end processing framework based on containers with scalable virtualized infrastructure and ability to spin up hundreds and thousands of nodes as per load average.
- Data distributed and replicated over three physically separated data-centers for enhanced disaster recovery.
- Institutional Support: Active advisory group of researchers within Computer Vision, Robotics and Machine Learning, and PS2 Cycle.
- Service scalability using UAVs being able to map from 0.3 sq km to 16 sq km per hour and ranging from multi-rotor to fixed-wing aircrafts for nadir and oblique imagery. All UAV operations are completely automated using intelligence from pre-assessment analysis.
- Bandwidth: Redundant dedicated Gbps lines to the data-centers with 10GBe lines between server units within the data-center. Triple level redundancy with three-separations for immediate disaster-recovery and backups. The entire system,

including fleet control for UAVs is hosted on our cloud platform, making it very, very safe and scalable.

Sustainability

- **Relevance:** High resolution centimeter level mapping & 3D models are useful for any planning and development, regardless of the location and department of the government. It's immediate high-level data intelligence, delivered.
- **Cost Effectiveness:** Initial costs are high because of quality requirement (backups, network infrastructure, supercomputing engines, software, delivery) and breakeven costs. Amortized costs per unit are very low when done at scale. Can map an entire state of India (e.g. Andhra Pradesh) every year repeatedly with cost effective solution.
- **Financial Viability of Initiative:** Savings are estimated to be between 40-60% compared to current surveying and planning techniques when done at scale. There will be structured and scientific planning across over 32 departments and maybe more, at half the cost with immediate high-accuracy data intelligence captured at scale and updated frequently.

Status Tracking

- Live GPS enabled tracking of all aircraft and operators with by-the-minute flight-planning and monitoring. Automated logging of all operations and audit & compliance ready systems.
- Live monitoring of any actionable areas for any government reporting for status checks.
- All data is uploaded onto the cloud-based web platform which can give remote encrypted access to any authorized officer for keeping check on progress reports.

About the Team



Name: Utkarsh Singh
Designation: Founder & CEO
Company: DronaMaps Pvt. Ltd
Education: Computer Science, Johns Hopkins University

Our warrior and the CEO, DronaMaps is his brainchild. He specializes in Machine Vision and Autonomous Systems. As comfortable behind the screen as he is leading the team in execution on the ground. He is the creator of our entire technical stack and brings valuable research experience in 3D image reconstruction.



Name: Raghav Palriwala
Designation: Chief Strategy Officer
Company: DronaMaps Pvt. Ltd
Education: MBA, IIM Indore

Mr. Raghav Palriwala is a wizard with the enterprise landscape and is a master of getting things done. His education in management at IIM Indore has given him a bird's eye perspective on the evolution of this industry and how to create a thriving business within it. He has been the key personnel in curating and implementing short-term strategies for different verticals of the business, encompassing sales, customer relations, tech-R&D, team expansion, geographic expansion, investments and public relations, while aligning them with the long-term vision and road map of the company. Under his leadership, the company has expanded its operations in three Indian states with multiple offices running 24 hours a day. Raghav brings a mix of corporate and public-sector work experience that lends itself well to large scale public projects.



Name: Sajil KR

Designation: Director of Geospatial Intelligence

Company: DronaMaps Pvt. Ltd

Education: M Tech, IIT Bombay

He is the spine of our 3D maps and contributes to our projects by bringing an expertise in Geospatial studies. He has done his under-graduation from NIT Calicut in electronics and communication engineering, a background that gives him an understanding of UAV technology. He went on to study Remote sensing and GIS at IIT Bombay. During his post graduate education, he also worked with Mumbai Municipal Corporation.



Name: Ms. Ayushi Mishra

Designation: Director of Strategic Partnerships

Company: DronaMaps Pvt. Ltd

Education: MS (Johns Hopkins University)

Ayushi is an engineer and a graduate from Johns Hopkins University who has recently made her way back home to India. She is passionate about the application of cutting-edge technology in rural/urban development and therefore, the Smart Village project is particularly close to her heart. Ayushi specialises in executing projects in partnership with large private or public organisations here in India and abroad.



Name: Ms. Komal Premchandani
Designation: Product Manager
Company: DronaMaps Pvt. Ltd
Education: MBA, IIM Indore

Komal comes with immense experience in consulting from world's leading technology consultancy, Genpact. Her acumen about technology and its application towards the development of urban and industrial infrastructure brings great value to the table. Having deployed technological solutions at multiple MNCs in Europe and Asia, she understands the needs and wants of big organizational structures and delivers with the appropriate quality and commitment.

LAURELS

AWARDED "BEST STARTUP" BY **HON'BLE CM OF MADHYA PRADESH**
 AWARDED "JURY'S CHOICE (MOST INNOVATIVE STARTUP)" AT **NASSCOM PRODUCT CONCLAVE 2017**
 NASSCOM INNOTREK 2018

PARTNERS

CLIENTS



BUSINESS



KNOWLEDGE



MEDIA MENTIONS



Portfolio Projects

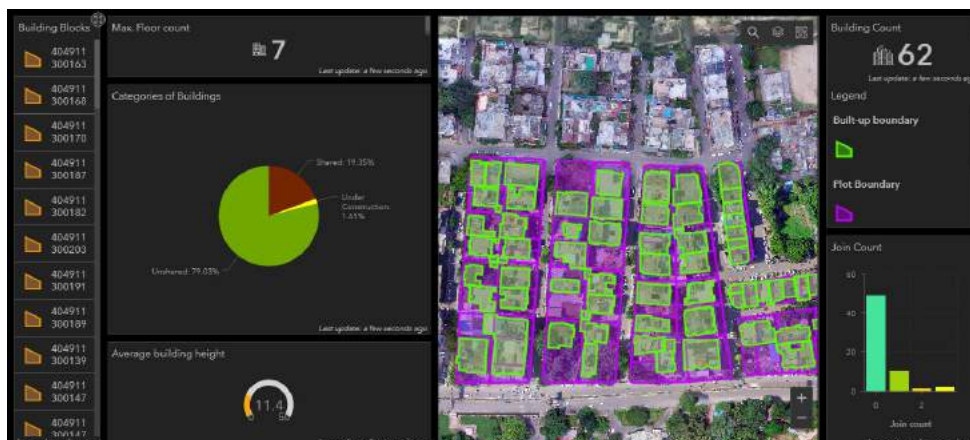
Urban:

1. Remote Management and Surveillance:
 - a. Ayodhya, Uttar Pradesh, 2016



(A still from our map of Ayodhya)

2. Property Tax Assessment and Geotagging of Urban Infrastructure:
 - a. Maheshwar, Madhya Pradesh, 2017
 - b. Kanpur, Uttar Pradesh, 2018 (In-progress)



(Screenshot of Property Tax Dashboard, Kanpur)

3. Water Pipeline Planning:

a. Lucknow, Uttar Pradesh, 2018



(Screenshot of UP Jal Nigam Pey Jal II Dashboard, Lucknow)

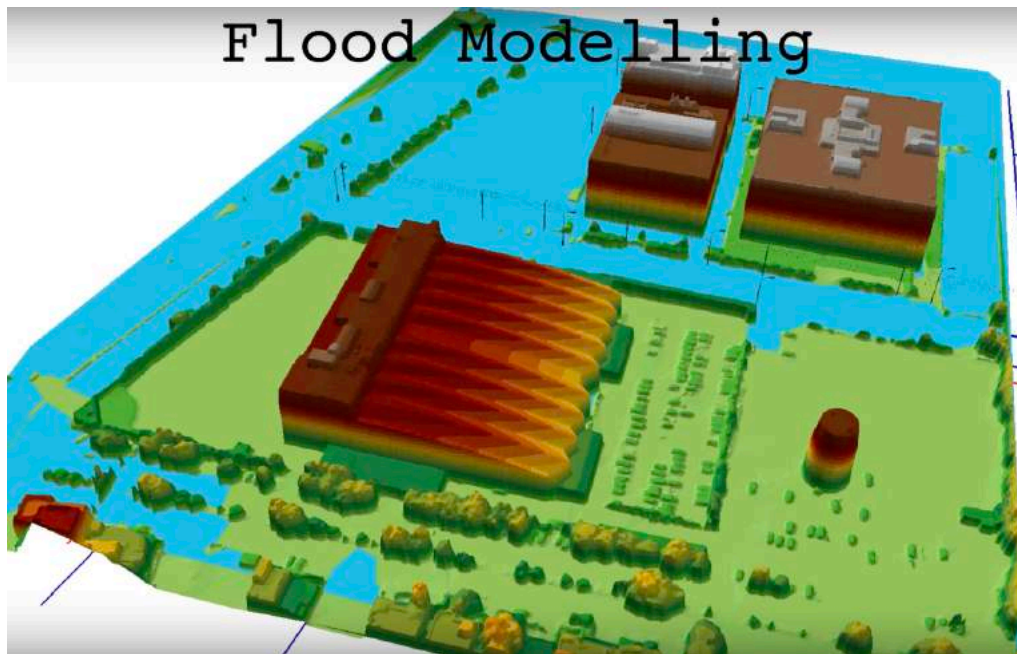
4. Urban Water Logging, Flood Modelling and Drainage Master Plan:

a. Lucknow, Uttar Pradesh, 2018

b. Gorakhpur, Uttar Pradesh, 2018



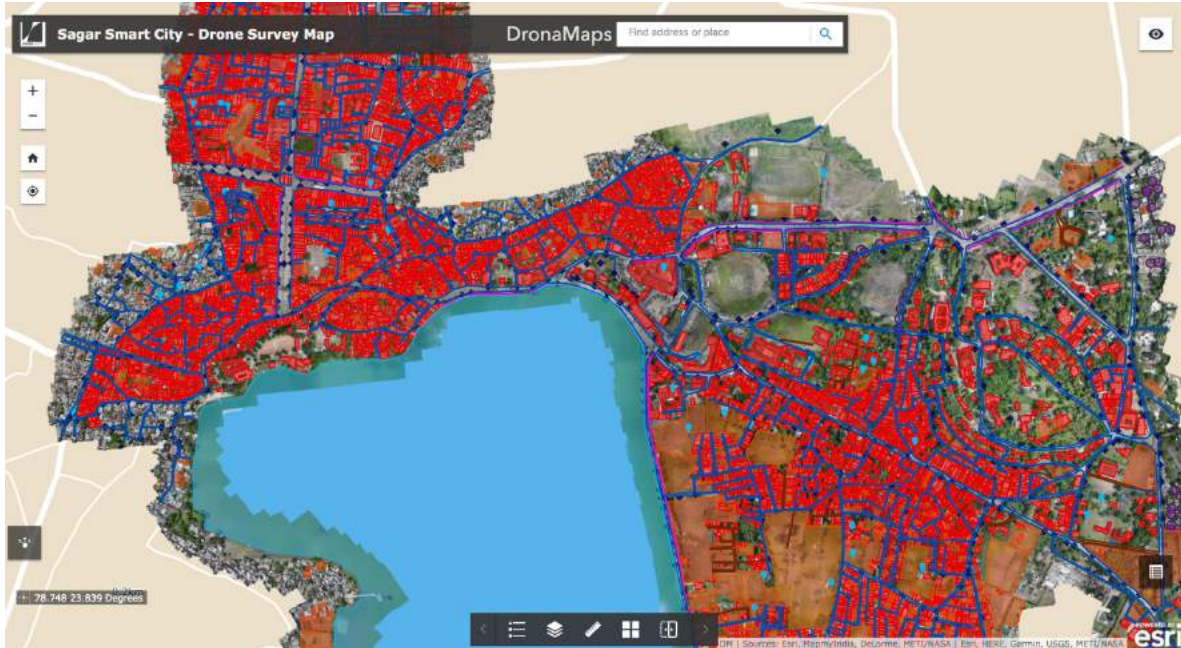
(Screenshot of Urban Flood Model, Lucknow)



(Screenshot of 3D demo of flood modelling)

5. Smart City Mapping and Master Plan

a. Sagar Smart City, Madhya Pradesh, 2018



(Web Application of Sagar Smart City, Madhya Pradesh)

Rural:

1. Geotagging of Rural Infrastructure and Land Records Integration:
 - a) Shivdaspur Grant, Lohia Gram, Uttar Pradesh, 2016
 - b) Antervedi, Andhra Pradesh, 2017
 - c) Pallipelam, Andhra Pradesh, 2017



(Infrastructure Identification at Shivdaspur Grant, Lohia Gram, Uttar Pradesh)

2. Relocation and Rehabilitation, Village Planning:

- 1) 3D mapping of villages:
 - a) Madipalle, East Godavari, Andhra Pradesh, 2017
 - b) Dandanggi, East Godavari, Andhra Pradesh, 2017
 - c) Toyyeru, East Godavari, Andhra Pradesh, 2017
 - d) Penkalupadu, East Godavari, Andhra Pradesh, 2017
 - e) Gangampalem, East Godavari, Andhra Pradesh, 2017
- 2) 3D mapping and planning of new rehabilitation villages:
 - a) Mussullakunta, East Godavari, Andhra Pradesh, 2017
 - b) Pedibhimpalli, East Godavari, Andhra Pradesh, 2017



(A Still from the 3D model of Madipalle, Andhra Pradesh)

Infrastructure:

1. 3D Mapping of Industrial Parks for Showcase to Investors:
 - a) Pithampur, Indore, Madhya Pradesh, 2017
 - b) Vakalapudi, Kakinada, Andhra Pradesh, 2017
 - c) Peddapuram, Kakinada, Andhra Pradesh, 2017
 - d) Kanpur Industrial Belt, Uttar Pradesh, 2018 (In-progress)
 - e) Gorakhpur Industrial Area, Uttar Pradesh, 2018 (In-progress)



(3D model for showcasing Industrial area Pithampur- Madhya Pradesh)

2. Construction Progress Monitoring with Volumetric Analysis:

a) Polavaram Dam, Polavaram, Andhra Pradesh, 2017



(3D model and stills from UAV Live streaming of Polavaram Dam for the Hon'ble President of India)

Agriculture:

1. Reliance Jio Foundation (Andhra Pradesh)
2. Lateral Praxis (Dhaboi, Gujarat)

