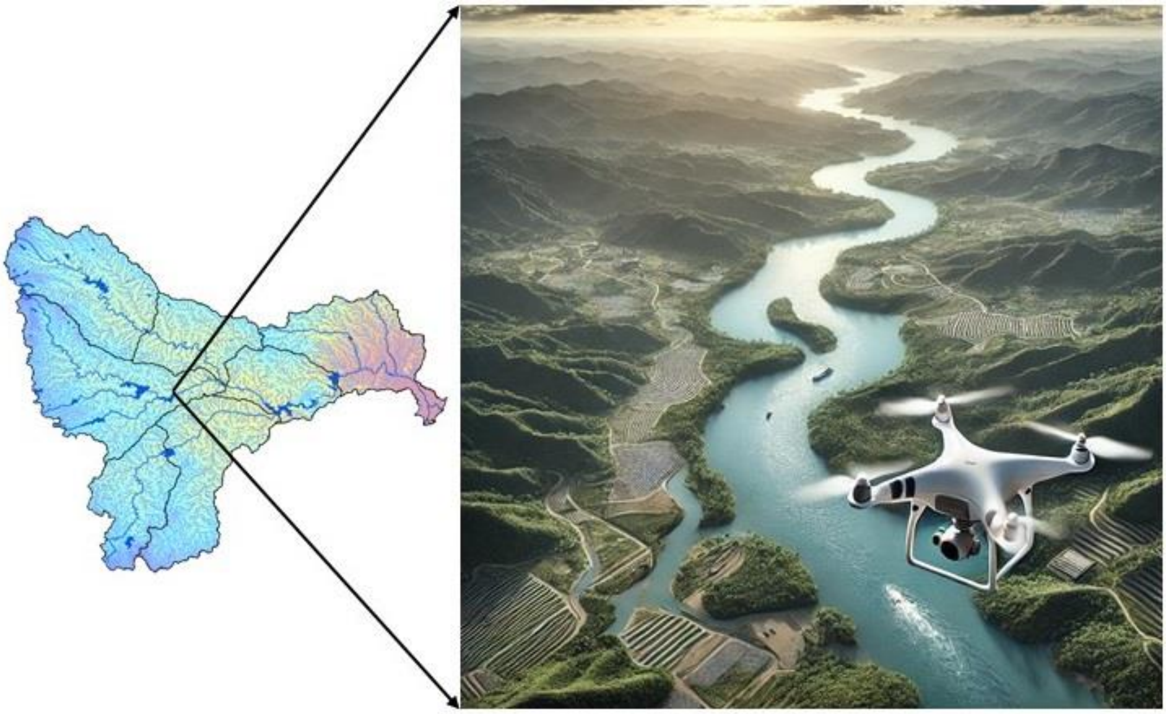
National River Conservation Directorate
Department of Water Resources,
River Development and Ganga Rejuvenation
Ministry of Jal Shakti
Government of India

STATUS OF AERIAL/DRONE SURVEY OF KRISHNA RIVER BASIN



March 2025

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National River Conservation Directorate (NRCD)

The National River Conservation Directorate, functioning under the Department of Water Resources, River Development & Ganga Rejuvenation, and Ministry of Jal Shakti providing financial assistance to the State Government for conservation of rivers under the Centrally Sponsored Schemes of 'National River Conservation Plan (NRCP)'. National River Conservation Plan to the State Governments/ local bodies to set up infrastructure for pollution abatement of rivers in identified polluted river stretches based on proposals received from the State Governments/ local bodies.

www.nrcd.nic.in

Centres for Krishna River Basin Management and Studies (cKrishna)

The Center for Krishna River Basin Management and Studies (cKrishna) is a Brain Trust dedicated to River Science and River Basin Management. Established in 2024 by NIT Warangal and NIT Surathkal, under the supervision of cGanga at IIT Kanpur, the center serves as a knowledge wing of the National River Conservation Directorate (NRCD). cKrishna is committed to restoring and conserving the Krishna River and its resources through the collation of information and knowledge, research and development, planning, monitoring, education, advocacy, and stakeholder engagement.

www.ckrishna.org

Centres for Ganga River Basin Management and Studies (cGanga)

cGanga is a think tank formed under the aegis of NMCG, and one of its stated objectives is to make India a world leader in river and water science. The Centre is headquartered at IIT Kanpur and has representation from most leading science and technological institutes of the country. cGanga's mandate is to serve as think-tank in implementation and dynamic evolution of Ganga River Basin Management Plan (GRBMP) prepared by the Consortium of 7 IITs. In addition to this, it is also responsible for introducing new technologies, innovations, and solutions into India.

www.cganga.org

Acknowledgment

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Preface

In an era of unprecedented environmental change, understanding our rivers and their ecosystems has never been more critical. This report aims to provide a comprehensive overview of our rivers, highlighting their importance, current health, and the challenges they face. As we explore the various facets of river systems, we aim to equip readers with the knowledge necessary to appreciate and protect these vital waterways.

Throughout the following pages, you will find an in-depth analysis of the principles and practices that support healthy river ecosystems. Our team of experts has meticulously compiled data, case studies, and testimonials to illustrate the significant impact of rivers on both natural environments and human communities. By sharing these insights, we hope to inspire and empower our readers to engage in river conservation efforts.

This report is not merely a collection of statistics and theories; it is a call to action. We urge all stakeholders to recognize the value of our rivers and to take proactive steps to ensure their preservation. Whether you are an environmental professional, a policy maker, or simply someone who cares about our planet, this guide is designed to support you in your efforts to protect our rivers.

We extend our heartfelt gratitude to the numerous contributors who have generously shared their stories and expertise. Their invaluable input has enriched this report, making it a beacon of knowledge and a practical resource for all who read it. It is our hope that this report will serve as a catalyst for positive environmental action, fostering a culture of stewardship that benefits both current and future generations.

As you delve into this overview of our rivers, we invite you to embrace the opportunities and challenges that lie ahead. Together, we can ensure that our rivers continue to thrive and sustain life for generations to come.

Centers for Krishna River Basin Management and Studies (cKrishna)

NIT Warangal, NITK Surathkal

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Basin Overview

The Krishna River also known as Krishnaveni is one of the longest rivers in the Deccan plateau is the third-longest river in India, after the Ganges and Godavari. The Krishna River is a significant river in India, originating in the Western Ghats near Mahabaleshwar in Maharashtra. Flowing eastward across the Indian states of Maharashtra, Karnataka, Telangana and Andhra Pradesh, it eventually empties into the Bay of Bengal. Spanning approximately 1,400 kilometres, the Krishna River has a drainage basin covering around 258,948 square kilometres. **Error! Reference source not found.** represents the catchment area of Krishna River Basin (KRB) covering four states in India and spatial variation of elevation of the KRB.

The Krishna River has 13 major tributaries, which contribute to its water flow and overall hydrology. The Krishna basin is split into 7 sub-basins namely Bhima lower sub-basin (9.28%), Bhima upper sub-basin (17.58%), Krishna lower sub-basin (15.5%), Krishna middle sub-basin (8.73%), Krishna upper sub-basin (21.4%), Tungabhadra lower sub-basin (16.31%), and Tungabhadra upper sub-basin (11.2%).

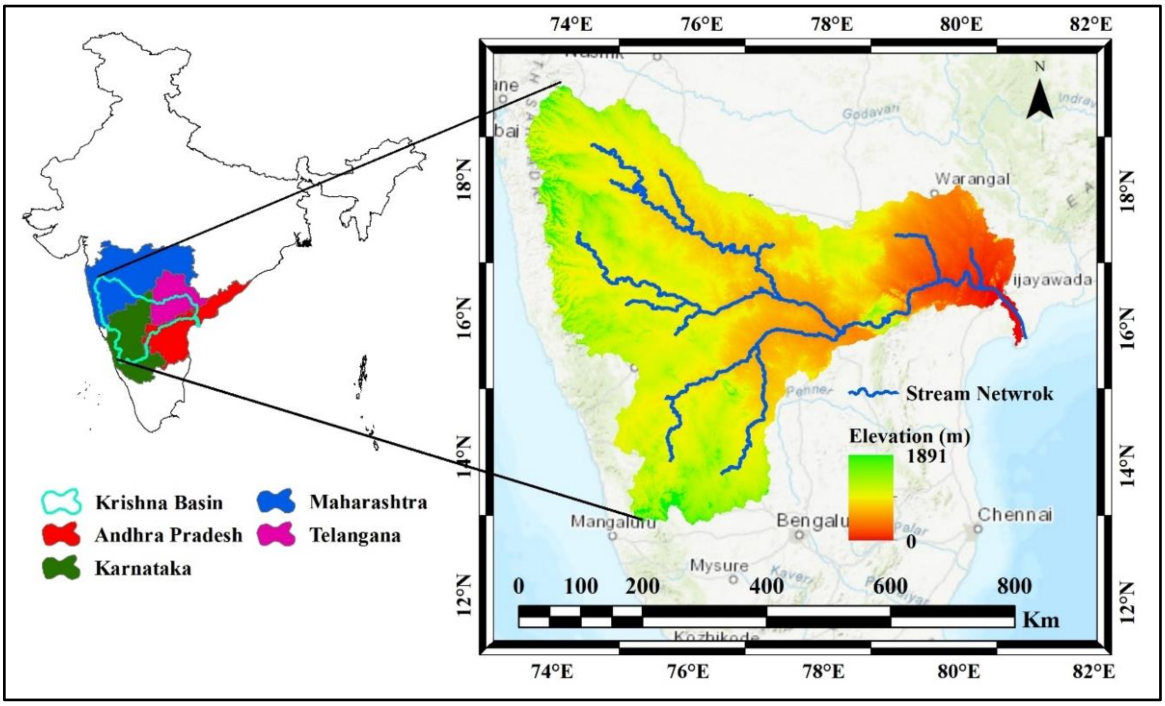

Figure 1. Catchment area of Krishna River Basin covering four states in India and spatial variation of elevation of the basin

1. Introduction

Uncrewed Aerial Vehicles (UAVs), commonly referred to as drones, have become a transformative tool in water resource mapping and management. These aerial systems bridge the gap between satellite-based and ground-based observation techniques, offering unparalleled advantages in data collection. While satellite imagery provides large-scale coverage, it often lacks the high spatial and temporal resolution required for detailed hydrological studies. Similarly, ground-based observations, though precise, are often limited in accessibility, particularly in remote or hazardous locations (Mishra et al. 2023). Drones effectively address these challenges by providing high-resolution, real-time data at a relatively low cost (Alvarez-Vanhard, Corpetti, and Houet 2021). Their ability to conduct surveys at specific times, as determined by the operator, adds further flexibility, allowing researchers and policymakers to capture critical hydrological events as they unfold (Jain and Pandey 2021). Additionally, drones offer the advantage of customizable payloads, enabling the integration of advanced sensors such as thermal, multispectral, and LiDAR, which enhance their applicability in diverse hydrological studies (Pajares 2015). Given their affordability, adaptability, and operational safety, UAVs are increasingly being employed for monitoring, assessing, and managing water resources.

The Krishna River Basin, one of the largest river systems in India, spans across Maharashtra, Karnataka, Telangana, and Andhra Pradesh, serving as a crucial water source for agricultural, industrial, and domestic needs. However, the basin faces numerous challenges, including seasonal water scarcity, increasing groundwater depletion, and sedimentation in major reservoirs, which significantly impact water availability. Additionally, rapid urbanization, inefficient irrigation practices, and unregulated industrial discharge contribute to deteriorating water quality and ecological degradation. Climate change further exacerbates these issues, leading to more frequent droughts and floods. Addressing these challenges requires modern technological interventions, and UAV-based aerial surveys have emerged as a promising solution. By providing high-resolution spatial data and real-time monitoring capabilities, drones can support better decision-making in water resource management. Their ability to assess changing hydrological conditions, track pollution sources, and optimize irrigation planning makes them an invaluable tool in sustainable river basin management.

Beyond water management, UAVs are crucial for monitoring environmental changes, including deforestation, wetland degradation, and land-use alterations impacting the basin's ecosystems. They also contribute to infrastructure development, providing precise geospatial data for projects like dam construction, canal excavation, and groundwater recharge identification. These advancements not only enhance the efficiency of development efforts but also promote long-term sustainability of the Krishna River.

Incorporating aerial and drone surveys into the management of the Krishna Basin is a forward-thinking strategy that supports informed decision-making, environmental conservation, and sustainable regional development, ensuring a more resilient future for both the basin’s water resources and its communities.

Table 1. Comparison of aerial surveying technologies

Technology	**Description**	**Cost**	**Coverage**
Aerial Photographs	Traditional aerial photography uses manned aircraft to capture large-scale images, providing extensive area coverage. Typically requires post-processing to create terrain models.	High	High
UAV-based Images	Drones capture high-resolution images for various applications, providing flexible coverage and quick data acquisition without the need for extensive post-processing.	Low	High
UAV-based Photogrammetry	Unmanned Aerial Vehicles (drones) equipped with cameras capture aerial imagery that, after post-processing, can be used to generate detailed terrain models. This method offers flexibility in coverage and is more cost-effective.	Low	High
UAV-based LiDAR	Drones equipped with Light Detection and Ranging (LiDAR) sensors provide high-resolution mapping of terrain, offering greater flexibility for smaller areas compared to manned aircraft. Post-processing required for data analysis.	High	Medium

2. Potential Use of Drone/UAV/Aerial Survey in Condition Assessment of River Basins

Drones have the potential to revolutionize the assessment and management of river basins by offering detailed and efficient mapping of surface water bodies, sub-surface water resources, and critical infrastructure ***(Shi et al. 2019***). UAV surveys provide highly accurate imagery, enabling precise delineation of water features such as river channels, reservoirs, and wetlands. These aerial observations are particularly useful for tracking seasonal variations in water levels, detecting sediment accumulation, and analyzing changes in river morphology. Additionally, UAVs can be used for bathymetric surveys, sediment transport analysis, and aquatic habitat monitoring, offering valuable insights into the hydrodynamic behavior of river systems ***(Mishra et al. 2023***).

Beyond surface water monitoring, drones play a crucial role in terrain analysis and watershed management. High-resolution aerial imagery allows for detailed mapping of catchment areas, stream networks, and floodplain zones. This information is vital for understanding hydrological connectivity and predicting flood risks (***Darji et al. 2024***). UAV surveys can also capture changes in land use and vegetation cover, which influence water availability and quality (***Husson, Hagner, and Ecke 2014***). By integrating thermal and hyperspectral sensors, drones can assess groundwater recharge areas, detect seepage zones, and evaluate soil moisture variations, contributing to more effective groundwater management (***Rahman et al. 2017***).

In the context of infrastructure assessment, UAVs are increasingly used to inspect irrigation systems, embankments, and water retention structures. Traditional methods of monitoring these structures are often labor-intensive and time-consuming, whereas drones provide a faster and more comprehensive alternative ***(Chao et al. 2008; Rathinam, Kim, and Sengupta 2008)***. UAV-based remote sensing enables the early detection of structural vulnerabilities such as erosion, seepage, and breaches, allowing for timely maintenance and repair. Additionally, drone surveys aid in assessing the efficiency of irrigation canals by identifying blockages, sedimentation, and water loss, ultimately improving water distribution and usage(***Cucchiaro et al. 2021***).

Drones also offer significant advantages in environmental monitoring and pollution assessment. UAVs equipped with optical sensors can detect algal blooms, track pollutant dispersion, and monitor industrial discharge points ***(Messinger and Silman 2016***). By capturing real-time data on water quality indicators such as turbidity, temperature, and vegetation indices, drones facilitate more effective pollution control strategies. Their ability to monitor riparian ecosystems, assess vegetation health, and track ecological changes makes them valuable tools in river conservation efforts.

3. Uncrewed Aerial Systems (UAS): Overview and Applications

Uncrewed Aerial Systems (UAS), commonly referred to as drones, consist of an aircraft, a ground control station, and a communication data link. Initially developed for military applications, UAS technology has advanced to serve a wide range of civilian and environmental monitoring purposes

3.1 Unmanned Aerial Systems (UAS) Classification

The Directorate General of Civil Aviation (DGCA) classifies Unmanned Aerial Systems (UAS) into different categories based on their weight and operational purposes. These categories range from **Nano drones** (weighing up to 250g) to **Large UAVs** (weighing above 150kg), each serving specific applications such as aerial photography, environmental monitoring, disaster response, and cargo transport (***Table 2***).

Table 2: Classification of UAS Based on DGCA Guidelines.

Category	Weight Range	Common Applications
Nano	Up to 250g	Hobbyist, indoor research
Micro	250g – 2kg	Aerial photography, small-scale mapping
Mini	2kg – 25kg	Environmental monitoring, surveying
Small	25kg – 150kg	Disaster response, precision agriculture
Large	Above 150kg	Long-range surveillance, cargo transport

3.2 Types of UAVs and Their Functionalities

UAVs are broadly classified based on their structural design and operational characteristics. **Fixed-wing UAVs** offer extended flight durations and efficient area coverage, making them suitable for large-scale surveys, while **multi-rotor UAVs** provide excellent maneuverability for localized studies. Additionally, **single-rotor UAVs** are known for their higher payload capacity, whereas **hybrid UAVs** integrate both fixed-wing efficiency and vertical takeoff capabilities (***Table 3***).

Table 3: Types of UAVs and Their Features

UAV Type	Structure	Advantages	Limitations
Fixed-Wing	Airplane-like	Longer flight time, efficient coverage	Requires runway for takeoff/landing
Multi-Rotor	Quadcopters, hexacopters	High maneuverability, vertical takeoff	Limited battery life, lower range
Single-Rotor	Helicopter-style	Higher payload capacity	More complex maintenance
Hybrid	Fixed-wing with VTOL	Combines efficiency and vertical takeoff	Higher cost, complex design

3.3 Sensor Technologies for Water Resource Monitoring

Various sensor technologies are integrated into UAVs to enhance water resource management. **RGB cameras** are widely used for basic mapping, while **multispectral and hyperspectral sensors** enable advanced vegetation and water quality assessments. **LiDAR** plays a crucial role in flood mapping and terrain modeling, and **thermal sensors** are essential for detecting temperature variations and water leakage issues. A comparative overview of these sensors and their applications is presented in (***Table 4***).

Table 4. Sensors and Their Applications in Water Resource Monitoring

Sensor Type	Description	Applications
RGB Camera	Standard imaging	General mapping, vegetation analysis
Multispectral	Captures multiple wavelengths	Crop health, water quality assessment
Hyperspectral	High spectral resolution	Pollution detection, mineral mapping
Thermal Camera	Measures heat signatures	Water temperature, leakage detection
LiDAR	Uses laser pulses for topography	Flood mapping, terrain modeling
Radar Sensors	Penetrates cloud cover	Large-scale hydrological monitoring

4. Flying Zones under the Drone Rule,2021

Under the Drone Rules, 2021, India has categorized airspace into different zones to regulate the operation of Unmanned Aerial Vehicles (UAVs). These zones are defined using a digital airspace map, which is periodically updated by the Directorate General of Civil Aviation (DGCA). The classification of drone flying zones is as follows:

1. Green Zone

- No special permission is required for operating drones in these areas.
- It includes airspace up to 400 feet above ground level in uncontrolled airspace.
- In areas near airports, operations are allowed up to 200 feet within a lateral distance of 8–12 km from the airport perimeter.

2. Yellow Zone

- This is a controlled airspace where drone operations require prior Air Traffic Control (ATC) permission.
- It extends from 400 feet to the lower limit of controlled airspace.
- Any drone operation in this zone requires explicit clearance from the DGCA via the Digital Sky platform.

3. Red Zone

- These are no-fly zones where drone operations are strictly prohibited unless approved by the Central Government or military authorities.
- Typically includes strategic locations, military bases, government buildings, international borders, and sensitive areas such as nuclear power plants.

No-Fly Zones (Specific Restrictions)

- Drones are not allowed to fly near international borders, including along Pakistan, China, Nepal, Bhutan, Myanmar, and Bangladesh.

- No drone flights are permitted within a 5 km radius of international airports.
- Areas such as military zones, government buildings, prisons, and strategic installations are also classified as restricted airspace

The specific boundaries of no-fly zones in the Krishna River Basin can vary and are subject to periodic updates based on security, air traffic regulations, and environmental concerns. The most accurate and up-to-date information on restricted, controlled, and free-fly is available on Digital Sky (https://digitalsky.dgca.gov.in/) platform maintained by the Directorate General of Civil Aviation (DGCA).

❖ **Airports & Airbases (Restricted Zones)**

- Rajiv Gandhi International Airport, Hyderabad
- Begumpet Airport, Secunderabad
- Kalaburagi Airport, Karnataka
- Belagavi Airport, Karnataka
- Kolhapur Airport, Maharashtra
- Pune International Airport, Maharashtra
- Vijayawada Airport, Andhra Pradesh
- Warangal Airport, Telangana
- Solapur Airport, Maharashtra
- Bidar Airport, Karnataka

❖ **Military & Defence Zones (No-Fly Areas)**

- AOC Centre (Army Ordnance Corps), Secunderabad
- Indian Army Headquarters, Secunderabad Cantonment
- Air Force Academy, Dundigal
- Hakimpet Air Force Station
- National Defence Academy (NDA), Pune
- Southern Command HQ, Pune
- DRDO Research Centre, Hyderabad & Pune
- ISRO Propellant Complex, Kurnool
- Kurnool Police Networks Circle (Critical Security Area)
- Nuclear Fuel Complex (NFC), ECIL, Hyderabad

❖ **Industrial & Power Plant Restrictions**

- Thermal Power Station, Vijayawada (NTPC)
- Ullarthikaval Industrial Area (Karnataka)

- Khudapur Industrial Area (Karnataka)
- Ammunition Factory, Khadki (Pune)
- Defence & Aerospace Research Facilities in Pune & Hyderabad

❖ **Key Dams & Water Infrastructure (Sensitive Areas)**

- Nagarjuna Sagar Dam (Andhra Pradesh/Telangana Border)
- Srisailam Dam (Andhra Pradesh/Telangana Border)
- Pulichintala Dam, Andhra Pradesh
- Almatti Dam, Karnataka
- Koyna Dam (Western Maharashtra - Basin Headwaters)

❖ **Critical Government & Security Areas**

- High Court of Telangana, Hyderabad
- Governor's Residence (Raj Bhavan), Hyderabad
- Amaravati Buddha Statue & Government Complex (High Security Zone)

There are other places like major railway stations, religious sites including Mahabaleshwar, Sangameshwar, Hampi, Vittaleshwara Temple, Alampur Jogulamba Temple, Srisailam, Pandharpur, and Kolhapur Mahalaxmi Temple.

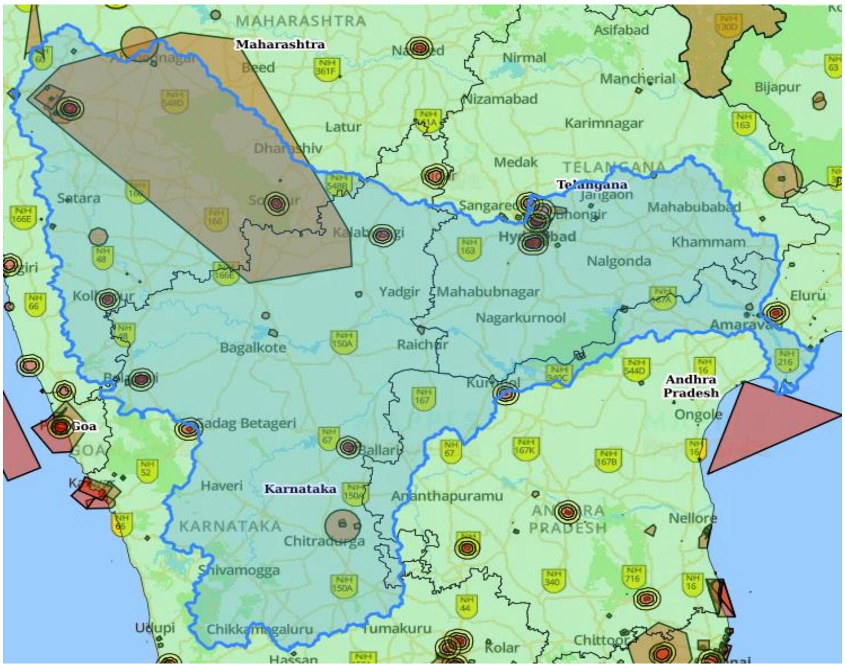

Figure 2. Flying Zones under the Drone Rule, 2021.

5. Drone Survey Conducted on Krishna River Basin

The drone survey of the Musi River in Hyderabad has been conducted as part of the Musi Riverfront Development Project. The **Musi Riverfront Development Corporation Limited (MRDCL)** carried out this survey along a 55-kilometer stretch of the river. The survey identified approximately 10,600 houses and structures within the riverbed and buffer zone limits. These findings are crucial for planning the river's rejuvenation and addressing issues related to encroachments and frequent flooding. Following the survey, the MRDCL has initiated the preparation of a comprehensive master plan for the river's development, incorporating the collected data to guide the rejuvenation efforts effectively (https://telanganatoday.com/musi-riverfront-project-telangana-govt-firm-on-demolition-but-says-no-forceful-evictions). Furthermore, stock footage platforms like Alamy (https://www.alamy.com/video/aerial-drone-shot-of-krishna-river-dam-with-mountain-and-vijayawada-city-649802147.html?) and Envato Elements (https://elements.envato.com/aerial-drone-shot-of-krishna-river-dam-with-mounta-7C94ZX9?) offer aerial drone footage of the Krishna River Dam and surrounding landscapes, providing visual insights into the region's topography and infrastructure. Some of the tender details that have been found on the drone surveys conducted in the Krishna Basin

- Tender for Drone Survey Work for Nira—Bhima Link Tunnel Alignment from Ch 0 To 1200 M under Krishna Bhima Stabilization Project (Link-5), Osmanabad-Maharashtra(https://www.tenderdetail.com/IndianTenders/TenderNotice/34710649/13246cdd4c02d3aad63cbe025942f155?).
- Drone Survey for land acquisition in back waters of Almatti reservoir (https://bidassist.com/karnataka-tenders/krishna-bhagya-jala-nigam-limited/detail-2557a4e9-aae7-46a7-9976-3932b4890da7?).

An open aerial imagery dataset from OpenAerialMap (https://openaerialmap.org/) is available near Vijayawada Urban City, captured during the 2024 floods and uploaded in the same year, as shown in **Figure 3.**

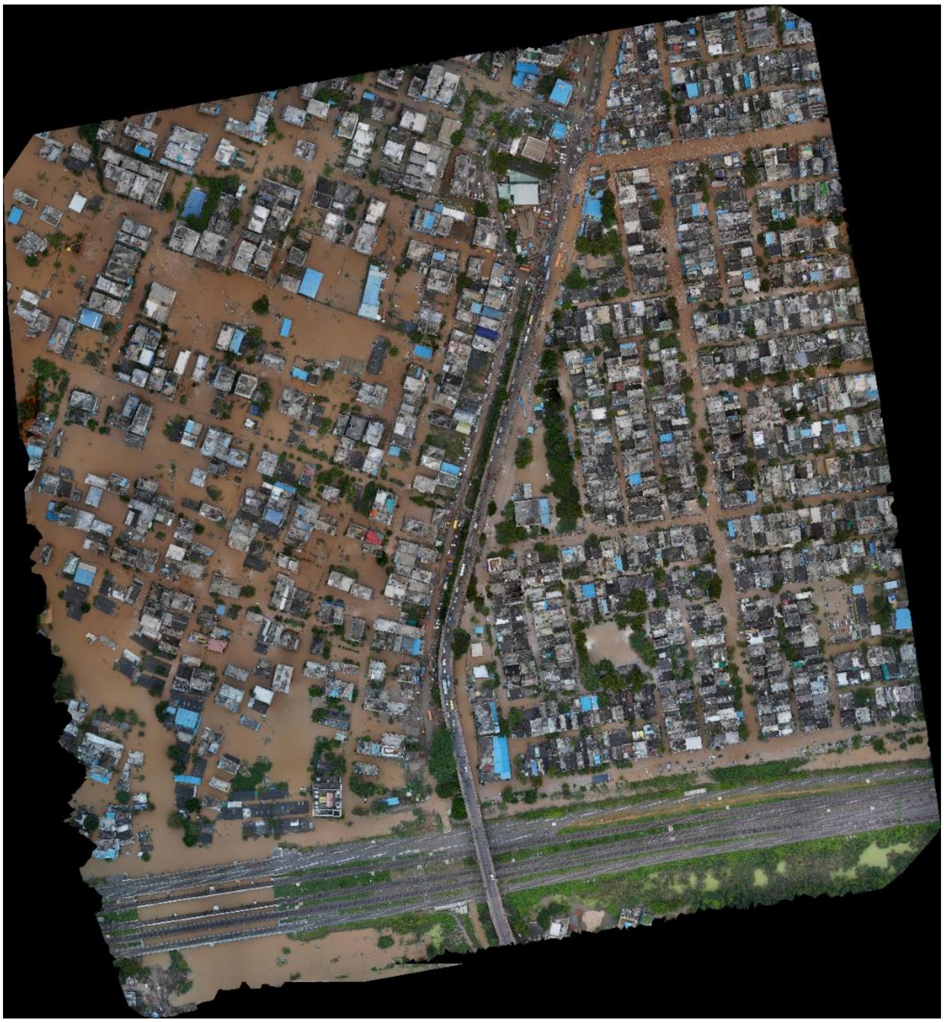

Figure 3. UAV imagery of agricultural fields in Vijayawada district, Andhra Pradesh

While drone-based surveys over the Krishna River Basin are not extensively documented, significant remote sensing and geospatial studies utilizing satellite imagery and GIS technologies have analyzed various aspects of the basin. The table below categorizes available research studies from reputed sources based on their focus areas:

Table 5: Drone Survey Companies with corresponding name and address

Category	Study Title	Authors	Journal/Source
Flood Analysis	Run-off and Flood Estimation in Krishna River Delta Using Remote Sensing and GIS	(Rao et al. 2011)	Indian Geographical Journal
Flood Analysis	Assessing Flood Susceptibility Mapping in the Krishna River Basin Using Geospatial Techniques	(Gaikwad, Navale, and Hande 2025)	SSRN Electronic Journal
Flood Analysis	HEC-RAS 2D Modeling for Flood Inundation Mapping: A Case Study of	(Vashist and Singh 2023)	Water Practice and Technology

	the Krishna River Basin		
Flood Analysis	Integrated Remote Sensing and GIS for Flood Hazard Mapping in Upper Krishna River Basin (India)	(Sathe, Khire, and Sankhua 2011).	International Journal of Science and Technology
Land Use & Land Cover	Land Use and Land Cover Changes Using Remote Sensing and GIS: A Case Study in Krishna River Basin	(Gogineni, Kumar, and Yerrakula 2013)	Asian Academic Research Journal
Morphometric Analysis	Digital Elevation Model Based Morphometric Analysis of Krishna River Basin	(Sangwai and Nagne 2024)	Springer
Groundwater Assessment	Regional Groundwater Assessment of Krishna River Basin Using Integrated GIS Approach	(Harini et al. 2018)	Journal of the Indian Society of Remote Sensing

6. Approximate Cost of Data Acquisition for Krishna River Basin

This section provides the cost estimation of the companies/Institutes that are being contacted for the aerial drone survey. Table 6 provides the name and address of the company/Institute, while Table 7 offers an approximate cost estimate for data acquisition.

Table 6: Drone Survey Companies with corresponding name and address

Sl.No	Name and address of the company/institute
1	**DNR Surveys,** 7-45, street no.2, Bapuji Nagar, Nacharam, Hyderabad, 500076. **Email:**Dnrsurveys360@gmail.com **Cell:**9949385759
2	**National Institute of Technology Karnataka, Surathkal,** NH 66, Srinivasnagar Surathkal, Mangalore Karnataka 575025 0824 2474000 info@nitk.edu.in

Table 7: Price estimation from Drone Survey Companies

DNR Surveys			
Sl. No.	**Particulars**	**Qty.**	**Rate**
1	Drone Survey Charges Deliverables: 1) GSD – 5 to 6 cm 2) Orthomosaic in TIFF/JPEG Format 3) DTM-20cm 4) DSM-20cm 5) DEM – 20cm 6) Contours-@10 Mtrs. interval 7) Overlay of Boundary on Orthomosaic	**1 Sq.km**	**40,000.00**
2	(Above rate includes Drone Field Data Capturing, DGPS, GCP Data Observation and Processing, Drone Team Travel Expenses, Lodging & Boarding, Office Drone Data Processing, Output etc.)		
3	30% Mobilization Advance, 60% on submission of Data, 10% on acceptance of Data		
	Taxable Amount		**40,000.00**
	IGST @ 18%		**7,200.00**
	Total Amount		**47,200.00**

National Institute of Technology Karnataka, Surathkal			
S. No.	**Type of data processing**	**Specific data**	**Price* (per sq. km)**
1.	**DEM Creation**	DEM Creation: Generating DEMs from classified point clouds to represent the terrain.	**Rs. 8,300 + 18% GST**
2.	**DSM Creation**	DSM Creation: Creating Digital Surface Models (DSMs) to capture the surface of objects (e.g., buildings, vegetation) above the ground.	
3.	**Contour Generation**	Contour Generation: Producing contour lines from DEMs for topographic analysis.	
	Topographical Survey DGPS and Drone with centimetre	• Orthomosaic • Dense Point Cloud (.laz/.las) • RSME Report • 3D Surface Model	

4.	accuracy (for more than 100 sq. km)	• GIS-Based Map / .dwg • Shape File / KML File GCP CSV Data with Both Projections (GCS & PCS)	
5.	**Point Cloud Data (LiDAR)**	Point Cloud Classification: Distinguishing different types of points (e.g., ground, vegetation, buildings) to improve the accuracy of subsequent analysis	
6.	**Feature Extraction Object Detection**	Object Detection: Identifying and classifying objects such as buildings, roads, and vegetation from LiDAR or photogrammetric data. Change Detection: Analysing temporal changes in the landscape by comparing current data with historical datasets. Topographic Analysis: Identifying landforms, slopes, and drainage patterns for environmental and planning purposes.	**Rs. 48,000 + 18% GST**
7.	**GIS Integration**	Georeferencing: Aligning drone and LiDAR data with spatial reference systems to ensure proper location accuracy. Spatial Analysis: Performing operations like buffering, overlay analysis, and proximity analysis to derive insights from geospatial data.	
8.	**Lidar Survey**	• DTM/ DEM/ DSM • Tile Photos • RMSE Report • Contour 3D Surface Model	
9.	**Thematic Mapping Land Use/Cover Mapping**	Identifying and classifying land use or land cover types based on remote sensing data. Vegetation Analysis: Assessing vegetation health, density, and distribution using spectral and LiDAR data. Understanding these types of GIS processing tasks can help you effectively scope out and execute drone and LiDAR mapping projects. Each type of data and processing method contributes to a	**Rs. 19,000 + 18% GST**

		comprehensive understanding of the surveyed area, aiding in decision-making for planning, analysis, and management.	
10.	**Data Management and Quality Control Data Cleaning**	Removing noise and erroneous data points from LiDAR point clouds or imagery. Data Fusion: Combining data from multiple sources (e.g., different drone flights or sensors) to create a comprehensive dataset. Metadata Management: Ensuring that all data is properly documented with metadata for future reference and use.	**Rs. 3,100 + 18% GST**
11.	**Data Acquisition**	with PPK VTOL	**Rs. 26,000 + 18% GST**
12		with PPK Multirotor	

*** Price estimates vary based on the type of sensors utilized, the resolution (ground sampling distance), and other factors.**

7. Summary

Aerial photography and drone imaging are invaluable tools for managing and preserving the Krishna River Basin, offering high-resolution, real-time data for various essential applications. These technologies enable precise mapping of the basin's intricate topography, including river channels, floodplains, and catchment areas, which are key to understanding regional hydrological processes. By delivering up-to-date information on river flow, reservoir storage, and flood-prone zones, aerial and drone surveys support the development of effective flood control strategies, optimizing water resource management, particularly during monsoons and extreme weather events. Beyond water management, drone imagery is crucial for tracking environmental changes within the basin. It helps monitor land-use modifications such as deforestation, agricultural expansion, and urbanization, providing insights into their impact on hydrological balance and ecosystem health. For instance, drones can assess sediment deposition in rivers and reservoirs, influencing water storage capacity and quality for agricultural and domestic purposes. Regular sedimentation monitoring also aids in formulating erosion control strategies, ensuring the sustainability of water bodies. Drone technology also enhances agricultural management through precision farming. High-resolution images help identify variations in crop health, soil moisture levels, and irrigation effectiveness, leading to improved water use efficiency and higher yields. Given the basin's reliance on Krishna River water for agriculture, these insights empower farmers and water managers to make informed decisions that reduce wastage and maximize productivity.

Additionally, aerial and drone surveys contribute to long-term conservation efforts in the Krishna River Basin. They help identify ecologically significant areas, such as wetlands and biodiversity hotspots, that require protection from human activities. Continuous monitoring of vegetation and land cover changes allows policymakers to develop conservation strategies that safeguard natural resources and ecosystems. Integrating aerial photography and drone technology into basin management represents a progressive approach that enhances both daily resource allocation and long-term sustainability. By delivering accurate, comprehensive, and real-time data, these tools facilitate informed decision-making, ensuring the balanced and responsible management of water resources, agriculture, and environmental conservation.

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