ERASMUS-EDU-2023-CBHE
Project number: 101129032

Duration: 36 months
(01/01/2024 – 31/12/2026)

LESLIE
LAND MANAGEMENT ENVIRONMENT & SOLID-WASTE

Co-funded by the European Union

TIIAME

MICRO-CREDENTIAL

LAND MANAGEMENT IN CENTRAL ASIA

12.- Sensors and Remote Sensing Platforms

Aerial and UAV Platforms

LM-W12-V82

Why study aerial and UAV platforms?

They bridge the scale gap between field observation and satellite remote sensing.

Learning outcomes

Explain the role of aerial and UAV platforms in remote sensing.

Compare aircraft, helicopter, fixed-wing UAV, multirotor UAV, and VTOL UAV platforms.

Identify common payloads used for aerial and UAV mapping.

Describe flight planning, ground control, and data processing steps.

Select suitable platforms for land, water, and agricultural monitoring tasks.

Core idea

Aerial and UAV platforms provide customized timing, high spatial detail, and direct connection with field validation.

Why this matters

Universities can use UAVs for practical teaching and local research.

Agencies can collect targeted data where satellite images are too coarse or cloudy.

Field teams can validate satellite classifications and models.

A platform ladder: from field to aircraft

Platform height changes coverage, detail, and operational cost.

Higher coverage | Higher local detail

Satellite	m–km scale	repeat broad coverage
Aircraft	dm–m scale	regional surveys
High-altitude UAV	dm scale	larger local missions
Low-altitude UAV	cm–dm scale	field and parcel mapping
Field sensors	cm scale	calibration and ground truth

Aerial platforms: aircraft and helicopters

Manned aerial platforms remain important for high-quality regional surveys.

Typical strengths

large sensor payloads, stable flights, professional-grade mapping

Aircraft platforms

Suitable for large survey areas and heavy payloads.

Can carry large-format cameras, LiDAR, hyperspectral sensors, and thermal systems.

Often used for cadastre, topography, infrastructure, and regional mapping.

Helicopters and special aircraft

Useful for low-speed flight, complex terrain, and targeted surveys.

Provide flexibility, but operational cost and logistics can be high.

Best when payload quality and mission reliability matter more than low cost.

UAV platform types

Different UAV designs create different mapping possibilities.

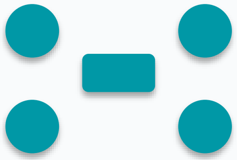
Multirotor UAV

vertical takeoff and landing

excellent for small sites

high maneuverability

shorter flight time



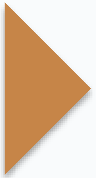
Fixed-wing UAV

longer endurance

larger area coverage

needs launch/landing space

efficient for corridors and farms

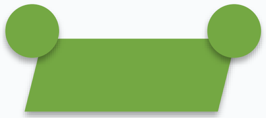


VTOL hybrid UAV

combines vertical takeoff with fixed-wing cruise

useful where runway space is limited

more complex and costly



Common aerial and UAV sensor payloads

The platform carries the sensor; the payload determines what physical information is measured.

RGB camera

true-color mapping, inspection, visual interpretation

Multispectral camera

vegetation indices, crop vigor, water and land-cover studies

Thermal camera

surface temperature, irrigation stress, heat anomalies

LiDAR

3-D point clouds, canopy height, terrain and infrastructure

Hyperspectral sensor

fine spectral signatures and material discrimination

GNSS / IMU

position, orientation, and georeferencing support

Flight planning variables

Good aerial mapping begins before takeoff.

Weather
wind, clouds, and haze affect safety and quality

Altitude
controls ground sampling distance

Time of day
changes illumination and shadow length

Mission design
balance detail, coverage, safety, and data quality

Overlap
supports photogrammetric reconstruction

Sensor angle
influences geometry and shadows

Speed
affects blur and image spacing

Ground control and validation

High-detail UAV data is only useful when it is spatially reliable and scientifically checked.

Field link

Ground targets, GNSS measurements, and field notes connect images to real coordinates and real land-cover conditions.

Ground control points

Visible targets with accurately measured coordinates improve georeferencing and reduce positional error.

Check points

Independent points are used to evaluate accuracy rather than build the model.

Field validation

Crop type, vegetation condition, soil state, and land-cover labels make interpretation trustworthy.

Aerial and UAV processing workflow

Most UAV mapping follows a repeatable photogrammetric and GIS workflow.

1. Plan
area, altitude, overlap, weather

2. Fly
capture images and metadata

3. Align
match images and estimate camera positions

4. Build
point cloud, DSM, orthomosaic

5. Analyze
indices, classification, measurements

6. Report
maps, tables, decisions

Main data products from aerial and UAV mapping

The same flight can produce several useful geospatial outputs.

Orthomosaic

geometrically corrected image map

basis for visual interpretation and digitizing

Digital surface model

height of terrain plus objects

supports drainage, volume, and terrain analysis

Point cloud

3-D representation of surfaces

useful for structures, vegetation, and engineering

Index maps

NDVI and other vegetation or water indices

support agriculture and environmental assessment

Aerial, UAV, and satellite platforms compared

Platform choice depends on scale, cost, revisit need, and project purpose.

Criterion	UAV	Manned aircraft	Satellite	Practical meaning
Spatial detail	very high	high	variable	UAV is best for parcel-level detail
Coverage	small to medium	medium to large	regional to global	satellites and aircraft cover larger areas
Timing control	high	medium to high	limited by orbit/tasking	UAV and aircraft are flexible for field campaigns
Weather limits	strong	moderate	sensor-dependent	optical systems are cloud-sensitive
Operational cost	low to medium	high	low to high	cost depends on mission scale and data source

Take-away

UAVs do not replace satellites; they complement satellite monitoring with detailed local evidence and field validation.

Application areas for aerial and UAV platforms

These platforms are especially strong where local detail and flexible timing are needed.

Agriculture
crop vigor mapping
plant counting and gaps
irrigation and stress diagnosis

Land management
parcel boundaries
erosion and land-use change
cadastre support and local inspection

Water and environment
riverbank change
wetlands and small reservoirs
pollution or algal bloom inspection

Infrastructure and hazards
roads, canals, and pipelines
landslides and flood damage
construction monitoring

Limitations, safety, and data-quality challenges

A successful mission is not only about flying: it is about safe, legal, and scientifically reliable data collection.

Regulation and permissions

flight approvals, airspace restrictions, privacy concerns

Weather and safety

wind, rain, dust, battery limits, emergency landing areas

Data quality

blur, insufficient overlap, poor georeferencing, weak calibration

Processing complexity

large datasets, storage, photogrammetry settings, QA/QC needs

Professional rule

How to choose a platform for a project

Start from the question, then select platform, sensor, and processing workflow.

Question
What needs to be measured?

Scale
parcel, corridor, district?

Sensor
RGB, multispectral, thermal, LiDAR?

Platform
UAV, aircraft, or satellite?

Output
orthomosaic, DEM, index, map

Review questions

Why might a UAV be better than a satellite for a small experimental field?

When would aircraft be better than UAVs?

Why are ground control points important?

Key message

Aerial and UAV platforms provide high-detail, flexible, field-linked data that complements satellite observation.

References

Selected introductory and authoritative sources

Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote Sensing and Image Interpretation. Wiley.

Jensen, J. R. (2016). Introductory Digital Image Processing: A Remote Sensing Perspective. Pearson.

Campbell, J. B., & Wynne, R. H. (2011). Introduction to Remote Sensing. Guilford Press.

American Society for Photogrammetry and Remote Sensing (ASPRS). Manual of Photogrammetry and remote sensing resources.

NASA Applied Remote Sensing Training Program. Fundamentals of Remote Sensing and applied Earth observation training materials.

USGS and NASA Earth observation educational resources on aerial imagery, UAS, and remote sensing data products.

FAO and international Earth observation teaching resources on UAV applications in agriculture, land, and water monitoring.

Independent study suggestion

Students are encouraged to compare one UAV orthomosaic, one aircraft image, and one satellite image of similar landscapes to evaluate scale and detail.

ERASMUS-EDU-2023-CBHE
Project number: 101129032

Duration: 36 months
(01/01/2024 – 31/12/2026)

LESLIE
LAND MANAGEMENT ENVIRONMENT & SOLID-WASTE

MICRO-CREDENTIAL

LAND MANAGEMENT IN CENTRAL ASIA

12.- Sensors and Remote Sensing Platforms

Aerial and UAV Platforms

LM-W12-V82

Co-funded by the European Union

TIIAME