LAND MANAGEMENT, ENVIRONMENT & SOLID-WASTE: INSIDE EDUCATION AND BUSINESS IN CENTRAL ASIA

ERASMUS-EDU-2023-CBHE Project Number: 101129032

MICRO-CREDENTIAL

LAND MANAGEMENT IN CENTRAL ASIA

12.- Sensors and Remote Sensing Platforms

Activity

Compare satellite and UAV data

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Activity Overview and Source Base

This activity trains students to compare satellite and UAV data for the same or similar land-management problem. Students do not simply say that UAV images are "better" because they are sharper or that satellites are "better" because they cover larger areas. Instead, they compare what each platform contributes, what each misses, and how the two can support each other in a practical workflow.

The activity is aligned with Week 12 materials on sensor classification, satellite platforms, aerial and UAV platforms, resolution, and sensor-platform selection. It is supported by NASA, USGS, ESA/Copernicus, FAO, ASPRS, and standard remote sensing textbooks. It can be implemented with real imagery in ArcGIS Pro, QGIS, Google Earth Engine, SNAP, or a photogrammetry/GIS workflow, but it can also be completed using the sample tables in this manual.

Learning Outcomes

- Compare satellite and UAV data by spatial resolution, coverage, temporal flexibility, cost, processing needs, and validation value.
- Explain why high spatial detail does not automatically mean higher scientific quality.
- Identify which platform is more suitable for field-level mapping, regional monitoring, time-series analysis, and validation.

- Recognize limitations related to clouds, flight permissions, georeferencing, ground control, mixed pixels, and processing level.
- Write a justified recommendation for a land-management case using evidence from sensor and platform properties.

Required Materials and Preparation

Material	Minimum option	Recommended option
Satellite data	Printed Sentinel-2 or Landsat image example	Cloud-free Sentinel-2/Landsat surface reflectance in GIS
UAV data	Printed orthomosaic example	UAV orthomosaic with known GSD and ground control information
Reference data	Classroom case description	Field points, parcel boundaries, canal map, or high-resolution reference image
Software	Calculator and worksheet	ArcGIS Pro, QGIS, Google Earth Engine, or photogrammetry/GIS tools
Output	Completed worksheet	Short report with map screenshots and recommendation

Suggested Timing

Stage	Student task	Time	Output
Warm-up	Discuss what “better data” means	10 min	Initial criteria list
Part A	Compare satellite and UAV characteristics	20 min	Platform comparison table
Part B	Inspect images or sample products	25 min	Observation notes
Part C	Link resolution to interpretation errors	20 min	Quality-risk table
Part D	Recommend a workflow for one case	25 min	Short recommendation
Discussion	Groups defend their selection	15 min	Oral explanation

Conceptual Reminder

Satellite and UAV data are not competitors in every situation. They answer different parts of the same evidence chain. Satellites provide systematic coverage, long archives, and regional consistency. UAVs provide detailed local observations, flexible timing, and validation evidence. A strong workflow may use satellite data to monitor a district and UAV data to check selected fields, train models, or explain uncertain patterns.

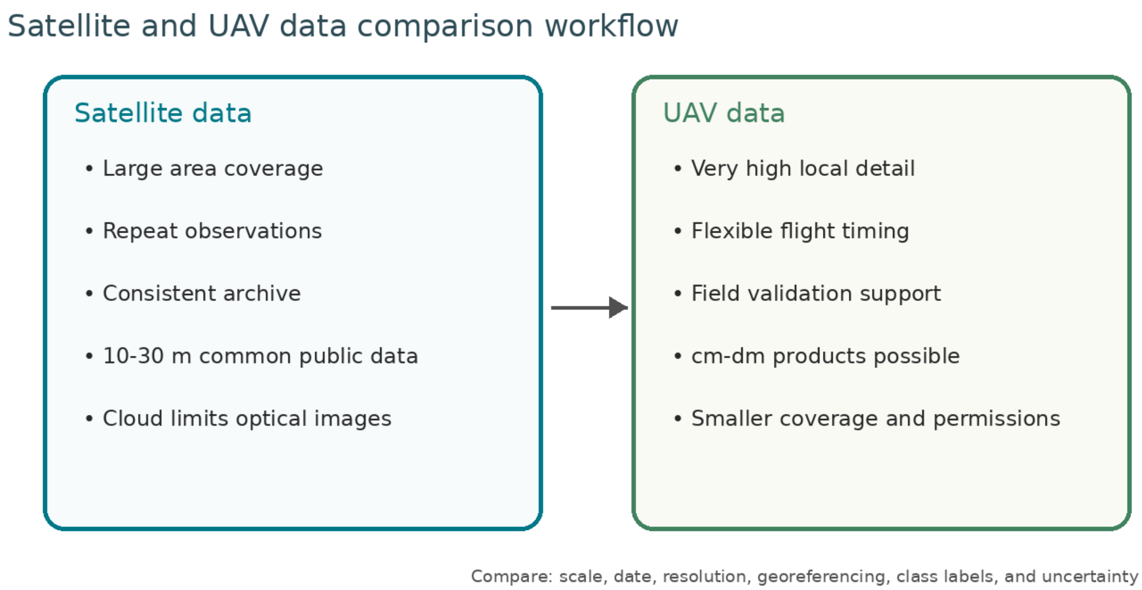

Figure 1. Satellite and UAV comparison workflow.

Part A: Compare Platform Characteristics

Students complete the table below. They should focus on practical consequences, not only definitions.

Criterion	Satellite data	UAV data	Practical meaning
Spatial detail	Usually meter to hundreds-of-meters depending on mission	Often centimeter to decimeter level	UAV supports field details; satellites support broader monitoring.
Coverage	Regional to global	Local to small/medium project area	Satellites are better for district or basin coverage.
Timing control	Limited by orbit, revisit, cloud, and tasking	High if flight permissions and weather allow	UAVs can be flown near field visits or events.
Historical archive	Often long and systematic, especially Landsat	Usually project-specific and short-term	Satellites are stronger for long-term trends.
Weather limits	Optical satellites are cloud-sensitive; SAR is less cloud-limited	UAVs are limited by wind, rain, dust, safety, and visibility	Both need weather planning.
Geometric accuracy	Depends on product and correction	Depends strongly on GNSS/IMU, GCPs, processing	High detail requires careful georeferencing.
Data volume	Moderate to large	Can be very large for high-overlap flights	Storage and processing must be planned.
Validation value	Needs field or reference support	Can provide detailed reference evidence	UAV can help validate satellite classification.

Task A1. In pairs, choose the three most important criteria for your case: crop monitoring, flood mapping, salinity assessment, canal inspection, or urban expansion.

Task A2. Write a short sentence explaining why each selected criterion matters.

Part B: Inspect and Compare Data Products

If real images are available, students should inspect the same area in a satellite image and a UAV orthomosaic. If real data are not available, use the sample observations below as a classroom scenario.

Observation item	Satellite image example	UAV image example	Interpretation note
Field boundaries	Some large fields visible; small plots partly mixed	Individual plots, furrows, roads, and small canals visible	UAV improves parcel detail.
Crop vigor	NDVI pattern visible at field scale	Row-level variability and plant gaps visible	Satellite supports regional indices; UAV explains local causes.
Canals and drains	Main canals visible; narrow channels may be mixed	Small channels and bank erosion visible	UAV is stronger for inspection.
Bare soil/salinity clues	Bright surfaces visible but causes uncertain	Crusts, texture, wet patches, and management signs may be visible	Field sampling still needed.
Regional context	Nearby settlements, drainage network, and landscape pattern visible	Limited to flight area	Satellite provides context around UAV site.

Task B1. List three patterns visible in both datasets and three patterns visible only or more clearly in the UAV data.

Task B2. Identify one interpretation that cannot be confirmed from imagery alone and requires field validation.

Part C: Link Resolution to Interpretation

Students connect resolution to possible errors. The aim is to understand how data quality changes with platform, not to memorize a rule.

Quality issue	How it appears in satellite data	How it appears in UAV data	How to reduce the problem
Mixed pixels	Field edges, canals, and roads may combine several surfaces	Less common but can occur along shadows and small objects	Use finer data, parcel averages, or careful sampling.
Temporal mismatch	Image date may not match field observation or crop stage	Flight can be scheduled but may still miss an event	Record dates and use crop calendar.
Cloud/shadow	Cloud and shadow can hide or distort optical data	Cloud less important under low flight, but shadows still affect images	Use masks, time selection, and consistent illumination.
Georeferencing error	Usually product-dependent and modest for official products	Can be large without GCPs or RTK/PPK support	Use GCPs/checkpoints and report accuracy.
Scale mismatch	Satellite values may not represent small management units	UAV may be too detailed for regional decisions	Match analysis unit to decision scale.

Part D: Create a Sensor-Platform Recommendation

Each group selects one scenario and writes a recommendation. The recommendation must include: the management question, selected sensor/platform, reason, expected product, validation plan, and limitation.

Scenario A: Irrigated vegetable parcels

The university needs to compare potato, carrot, onion, cabbage, and tomato fields during the growing season.

Scenario B: Canal inspection

A local agency wants to identify erosion, vegetation blockage, and illegal dumping along a short canal reach.

Scenario C: Regional drought monitoring

A ministry needs repeated evidence of vegetation condition across several districts.

Scenario D: Flood response under clouds

A flood occurs after heavy rain, but optical satellite images are cloudy.

Scenario E: Salinity screening

Bright patches appear in an irrigated area, but it is unclear whether they are salt crusts, dry soil, roads, or construction materials.

Optional GIS Extension

1. Load a cloud-free Sentinel-2 or Landsat image for a study area.
2. Display true-color and false-color composites.
3. Load or create parcel boundaries or sample points.
4. Load a UAV orthomosaic or high-resolution reference image if available.
5. Compare satellite pixels and UAV details for the same fields.
6. Calculate an index such as NDVI or NDWI on the satellite image.
7. Use UAV data to interpret field-level variability or validate class labels.
8. Write a short report explaining how each dataset affected data quality.

Student Worksheet Package

Worksheet 1. Platform Comparison

Criterion	Satellite evidence	UAV evidence	Which is stronger for this task?	Reason

Worksheet 2. Data Quality Risks

Risk	Dataset affected	Why it matters	Mitigation

Worksheet 3. Final Recommendation

Item	Student answer
Management question	
Selected data	
Expected product	
Why this choice fits	
Validation evidence	
Main limitation	

Instructor Guide and Suggested Answers

A strong answer should not simply state that UAV data are more detailed. It should explain that UAV data are better for small objects, field validation, and local inspection, while satellite data are better for regional coverage, long archives, and repeated monitoring. A strong group may recommend a combined workflow: satellite time series for general monitoring and UAV flights for selected training/validation sites or detailed diagnosis.

Scenario	Suggested workflow	Reason
A. Vegetable parcels	Sentinel-2 time series + UAV field validation + parcel-based features	Crop types may be separated better by phenology and field-level evidence.
B. Canal inspection	UAV RGB/thermal/multispectral depending on target; satellite for context	Narrow canals need very high spatial detail.
C. Regional drought	Satellite optical time series, possibly thermal and climate data	Large-area repeat monitoring is required.
D. Flood under clouds	SAR satellite first, optical and UAV after conditions improve	Radar is more reliable during cloudy emergency conditions.
E. Salinity screening	Satellite optical/SWIR time series + field sampling + selected UAV checks	Brightness alone is not enough to confirm salinity.

Assessment Rubric

Criterion	Excellent	Satisfactory	Needs improvement
Platform comparison	Compares scale, timing, coverage, cost, and validation clearly	Mentions several differences but with limited explanation	Says one platform is simply better without reasoning
Data-quality reasoning	Links resolution and processing to specific errors	Mentions quality issues generally	No clear quality discussion
Application fit	Recommendation matches the scenario and target property	Recommendation partly fits but lacks detail	Dataset choice is random or unsuitable
Validation plan	Includes field/reference evidence and uncertainty	Mentions validation briefly	No validation or overclaims
Communication	Clear, concise, evidence-based explanation	Understandable but descriptive	Unclear or unsupported

References and Recommended Sources

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Note for instructors: mission specifications can change as agencies release new products and processing levels. When using real data, students should check the official data provider pages and the metadata of the exact product used.