ERASMUS-EDU-2023-CBHE
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LESLIE
LAND MANAGEMENT
ENVIRONMENT &
SOLID-WASTE

MICRO-CREDENTIAL

LAND MANAGEMENT IN CENTRAL ASIA

15.- Integrated Applications of Remote Sensing

Remote Sensing Applications Review

LM-W15-V105

Co-funded by
the European Union

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Remote Sensing Applications Review

Review focus

Connect remote sensing data to land management decisions
Compare application areas: land cover, crops, degradation, water, hazards and environment
Review how GIS, field data and accuracy assessment make satellite information usable

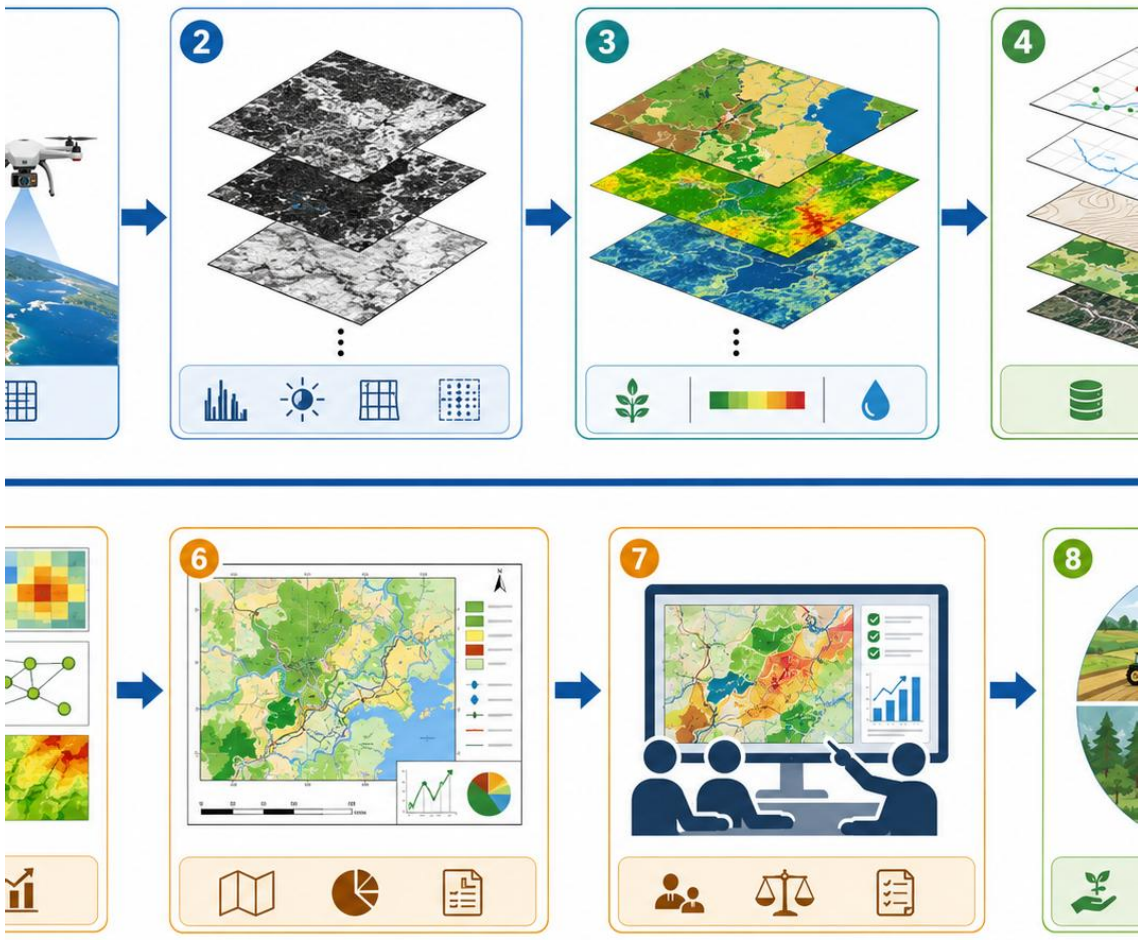
Main idea: remote sensing becomes valuable when images are transformed into reliable maps, indicators and decisions.

Why remote sensing applications matter

Remote sensing supports land managers because it can observe wide areas repeatedly and objectively.

Observe	Earth surface conditions from satellites, aircraft or UAVs
Measure	vegetation, water, soil, heat, roughness and elevation indicators
Compare	changes across seasons, years and management zones
Act	prioritize field checks, rehabilitation, irrigation, protection and policy decisions

> Application thinking asks: What is the land problem? Which sensor is suitable? What decision will the map support?



Application areas reviewed in Week 15

A review of applications should not be a list of tools. It should show how each application connects a land management question with data, analysis and action.

Land use / land cover

What covers the land?

Land degradation

Where is land quality declining?

Agriculture and crops

How are crops growing?

Water and wetlands

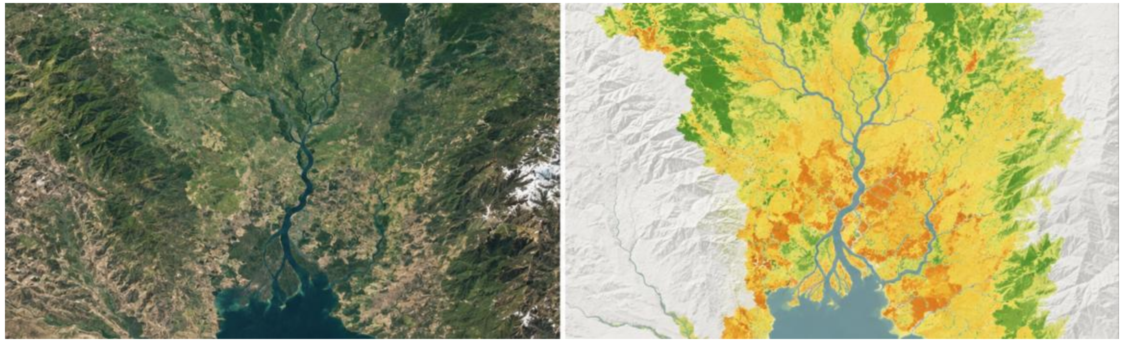
Where is water changing?

Hazards and risk

Where is exposure increasing?

Urban / infrastructure

Where is land conversion occurring?



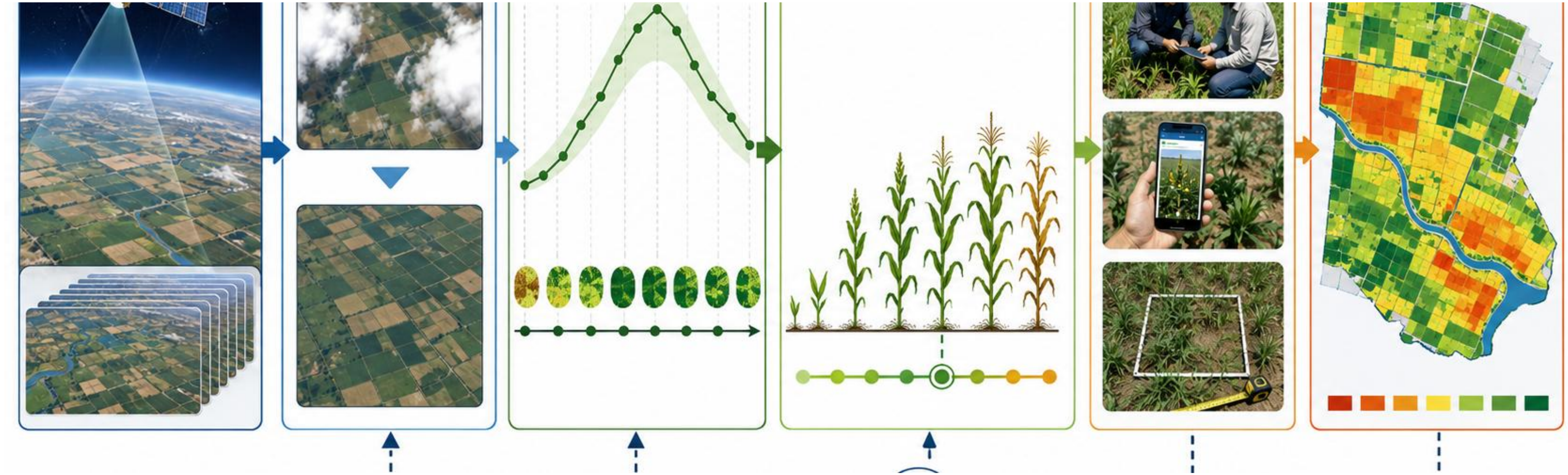
Data sources: choose the sensor for the problem

Different applications need different combinations of spatial detail, revisit time, spectral information and weather tolerance.

Source	Strength	Typical use
Landsat	30 m archive	long-term change, land cover history
Sentinel-2	10–20 m optical	crop condition, water, LULC, vegetation
Sentinel-1 SAR	radar signal	floods, soil moisture, cloudy seasons
MODIS/VIIRS	high temporal	regional drought and vegetation trends
UAV / LiDAR	very high detail	field validation, terrain and structure

Selection rule: do not start from the most attractive image; start from the land management question and required output.

General workflow: from image to decision



1 **Define objective**

What decision will the result support?

2 **Prepare data**

Cloud mask, correction, compositing, indices

3 **Analyze**

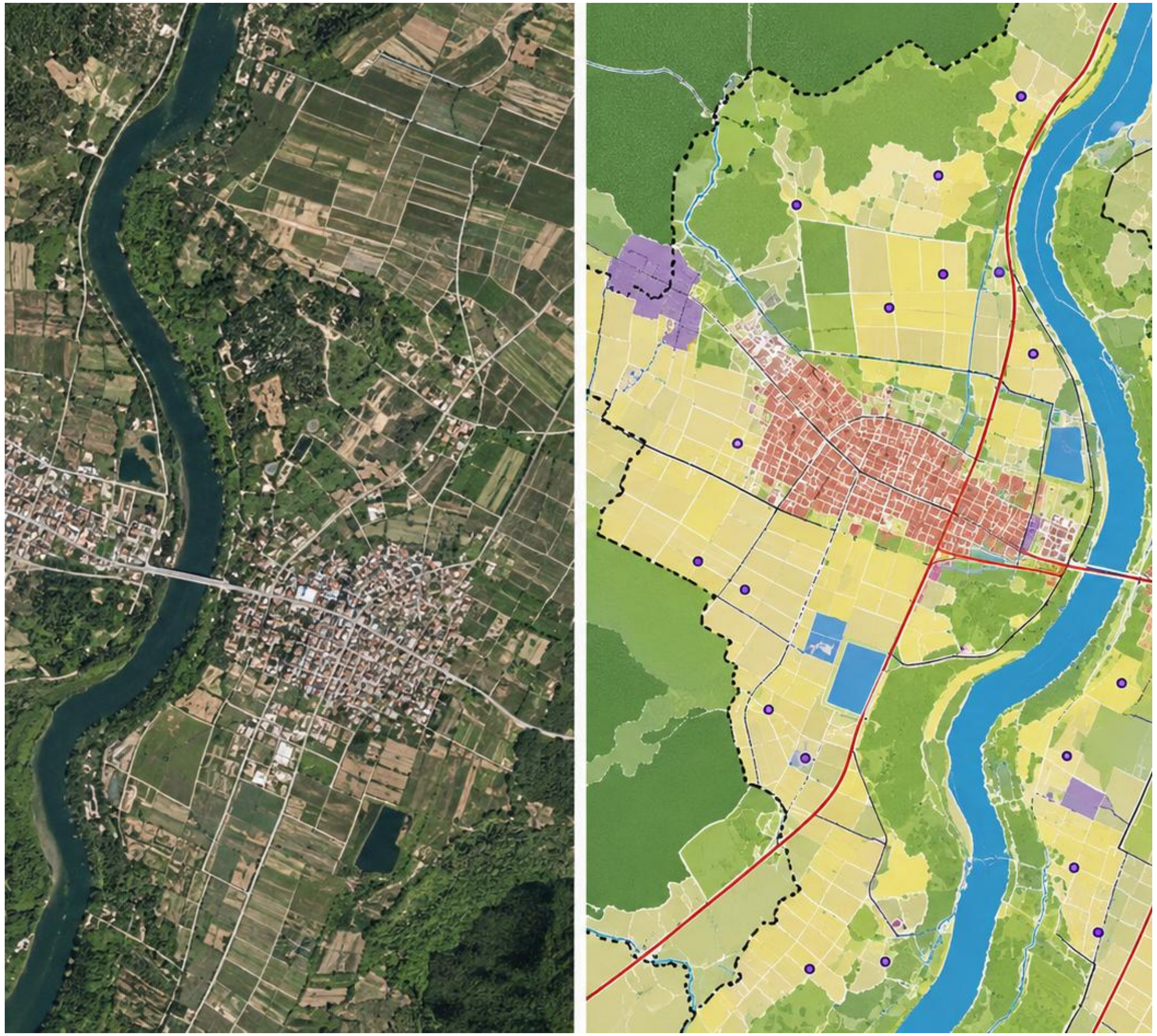
classification, change detection, risk modeling

4 **Validate and use**

field checks, accuracy assessment, map delivery

Good outputs are repeatable: methods, dates, classes, indices and validation rules must be documented.

Application 1: land use and land cover mapping



Land cover is what is physically present; land use explains how people use the land.

Maps forests, cropland, settlements, water, bare soil and wetlands
Supports cadastral planning, environmental monitoring and land-use policy
Accuracy assessment is essential before using the map for decisions

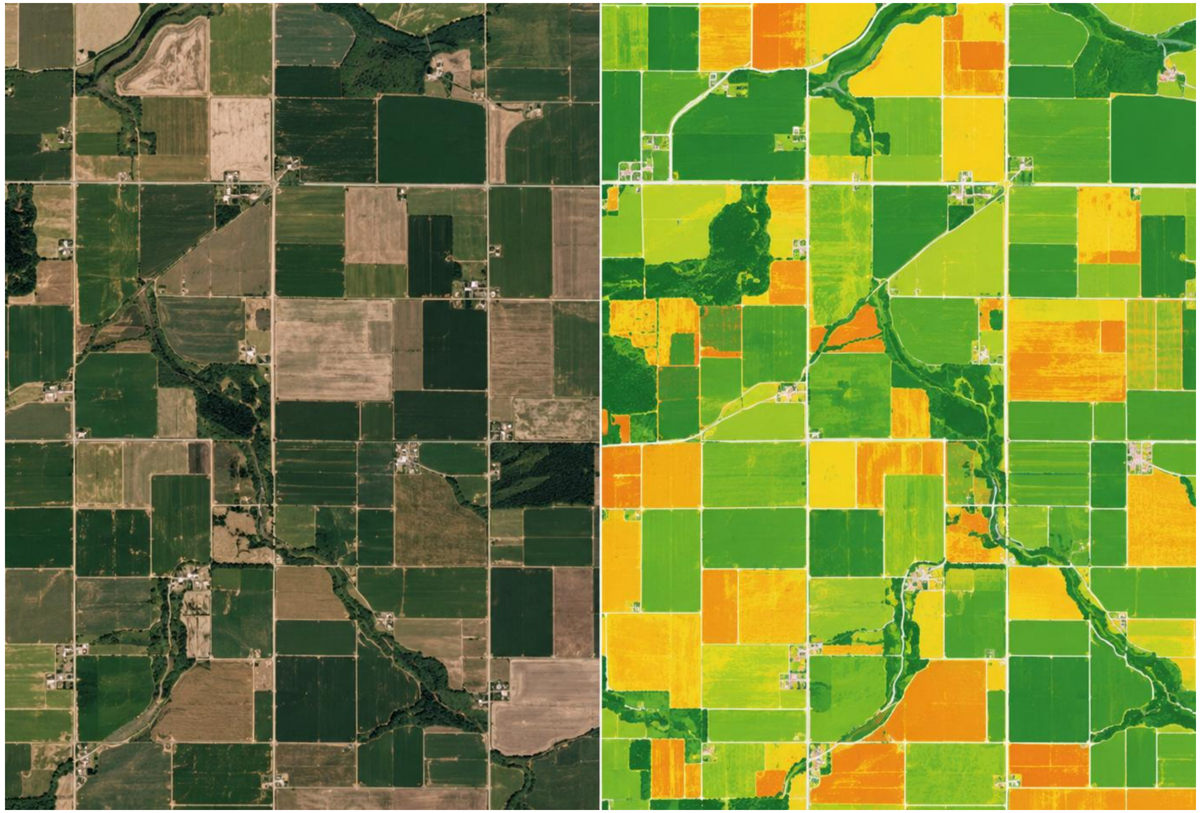
Typical methods: supervised classification, object-based mapping, time-series classification and visual interpretation.

Review question: Which class is most difficult to distinguish in irrigated landscapes: crop, bare soil, settlement or degraded land?

Application 2: agricultural and crop monitoring

Crop monitoring uses repeated observations to track growth, stress and harvest readiness.

NDVI, EVI and SAVI indicate vegetation condition
NDWI and thermal data help detect water stress
Time-series profiles show crop phenology and rotation patterns
Field data are required to distinguish crop types reliably



Uzbekistan link

Irrigated fields, crop calendars and canal networks make remote sensing useful for water-saving agriculture and field-level advisory services.

Land degradation is monitored through indicators that show declining vegetation, soil exposure, salinity, erosion risk and productivity loss.

Vegetation	NDVI/EVI trends, seasonal productivity
Soil / salinity	bare soil indices, brightness, salt-affected areas
Terrain	slope, erosion channels, drainage conditions
Pressure	grazing, land conversion, water stress

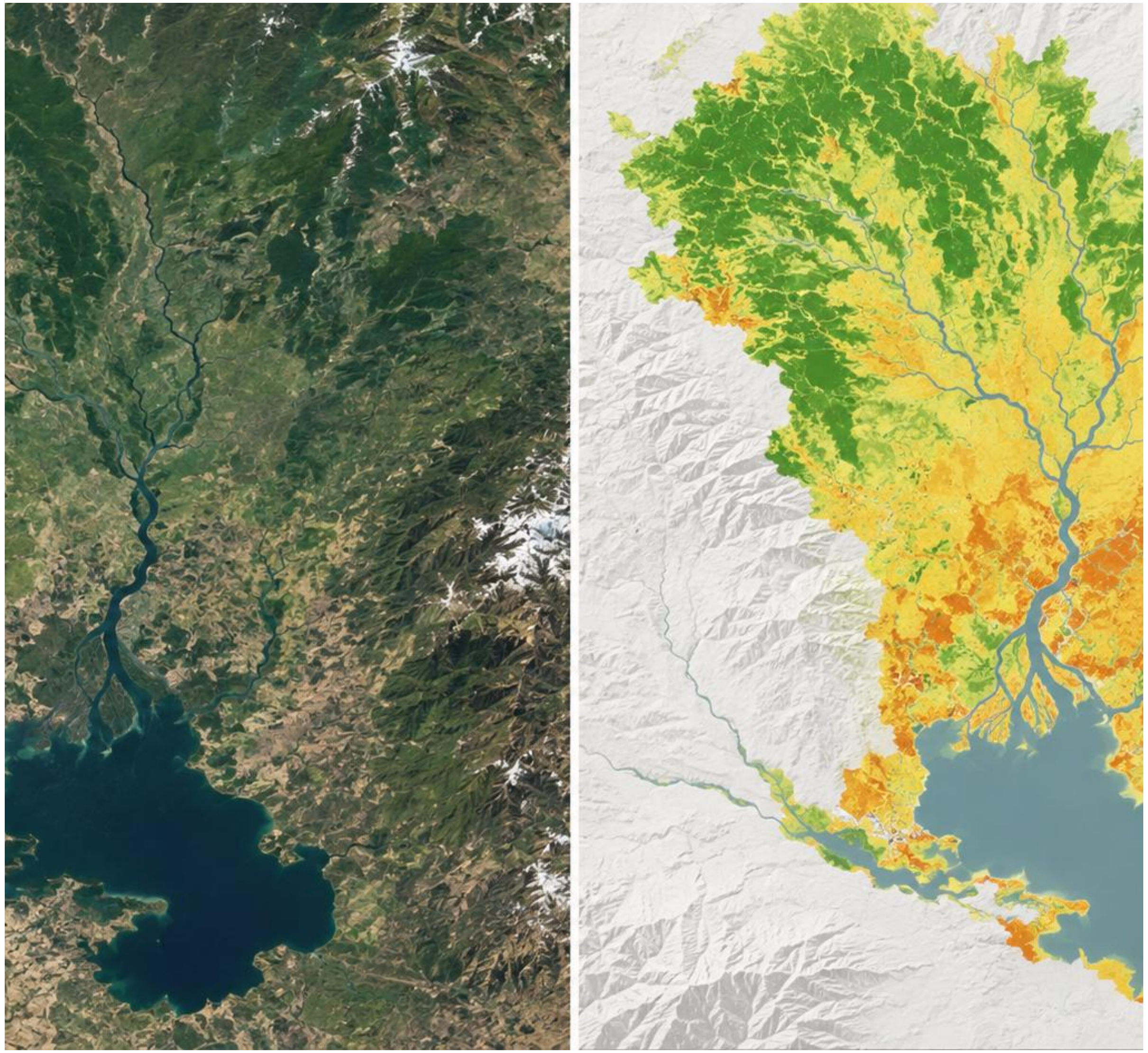
> For land management, the most useful question is not only “where is degradation?”, but also “what intervention should follow?”

Application 4: environmental monitoring and assessment

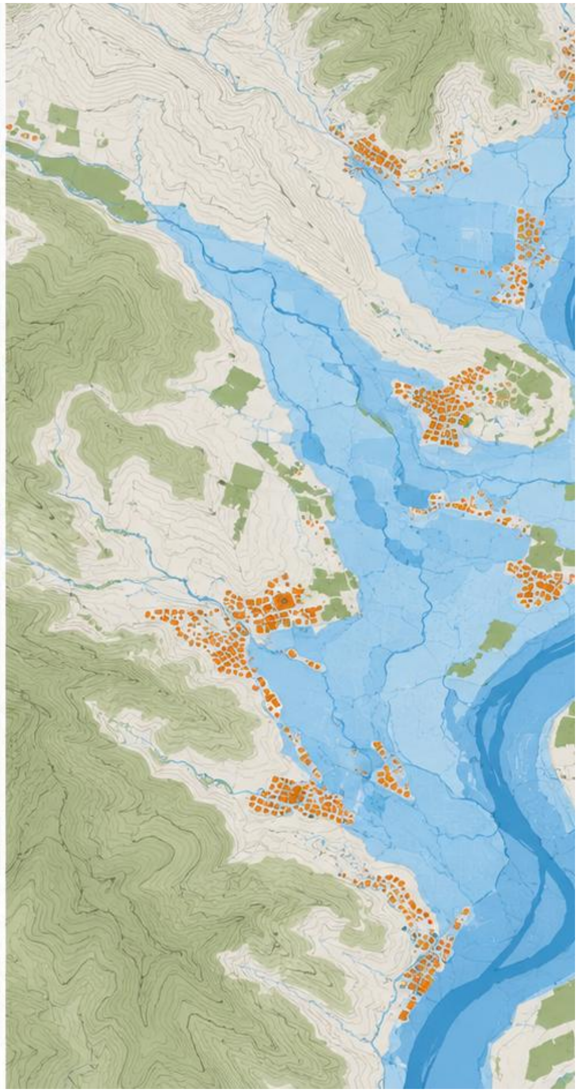
Environmental assessment connects satellite indicators with ecological condition and management priorities.

Water bodies and wetlands: extent, turbidity, shoreline change
Vegetation and habitat: cover, fragmentation, restoration progress
Urban environment: heat islands, impervious surfaces, green areas
Pollution risk: landfills, mining scars, disturbed surfaces

> Assessment should combine remote sensing with field observation, water/soil sampling and local land-use information.



Application 5: natural hazard monitoring



Remote sensing helps monitor hazards before, during and after damaging events.

Floods	water extent and damaged agricultural land
Landslides	slope failure, scars and risk zones
Drought	vegetation stress and water deficit
Wildfire	burned area and recovery mapping

SAR is especially useful for flood mapping when clouds limit optical imagery.

Integrated use: remote sensing + GIS + field data

The strongest applications are not image-only. They integrate observations, maps and local evidence.

Remote sensing indices, classifications, DEM, radar, thermal data

GIS layers parcels, canals, roads, soil maps, administrative units

Field data ground truth, GPS points, crop type, soil/water samples

Decision layer priority zones, monitoring reports, land-use recommendations

GIS integration allows results to be summarized by parcel, district, watershed or protected area.

Strengths and limitations: review table

Every application requires a balance between data availability, resolution, accuracy and interpretation limits.

Strengths	Large coverage, repeat observations, objective records, historical archive, cost-effective monitoring
Limitations	Clouds for optical imagery, mixed pixels, sensor noise, classification error, need for field validation
Good practice	Use time series, document methods, combine sensors, assess accuracy, explain uncertainty
Decision value	Prioritize zones, compare trends, support planning, monitor policy impact, communicate risk

A map should be treated as evidence with uncertainty, not as automatic truth.

Central Asia example: integrated monitoring for irrigated landscapes

In Central Asia, remote sensing is useful because land, water and agriculture are tightly connected.

Track crop growth and irrigation performance across fields
Detect salinity, waterlogging and vegetation decline in risk zones
Support land-use planning around settlements and canals
Combine satellite images with cadastre, canal networks and field checks

Practical output: a monitoring map that shows where to inspect, where to rehabilitate and where to protect productive land.

Discussion: Which application is most urgent for Uzbekistan—crop monitoring, salinity, water bodies, hazards or urban expansion?

Key messages and independent study

Key messages

Remote sensing applications begin with a management question, not only an image.
Application areas are connected: land cover, crops, degradation, water, hazards and environment influence one another.
GIS and field validation turn satellite observations into usable evidence.
Good maps communicate both results and uncertainty.

Reflection question

Choose one land management problem in your region. Which remote sensing data, GIS layers and field observations would you combine to support a decision?

Selected references

- NASA Earthdata. Earth Observation Data Basics and ARSET remote sensing training materials.
- USGS. Landsat and Annual National Land Cover Database resources.
- ESA / Copernicus. Sentinel-1 and Sentinel-2 mission documentation and Copernicus Data Space.
- Copernicus Land Monitoring Service. Land cover and land monitoring products.
- FAO Geospatial Unit. Ecosystem restoration and land degradation monitoring materials.
- Shokirov, S.S., Musaev, I.M., & Akbarov, M.S. Masofadan zondlash. Tashkent, 2015.

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