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

Environmental Monitoring and Assessment

LM-W15-V102

Co-funded by
the European Union

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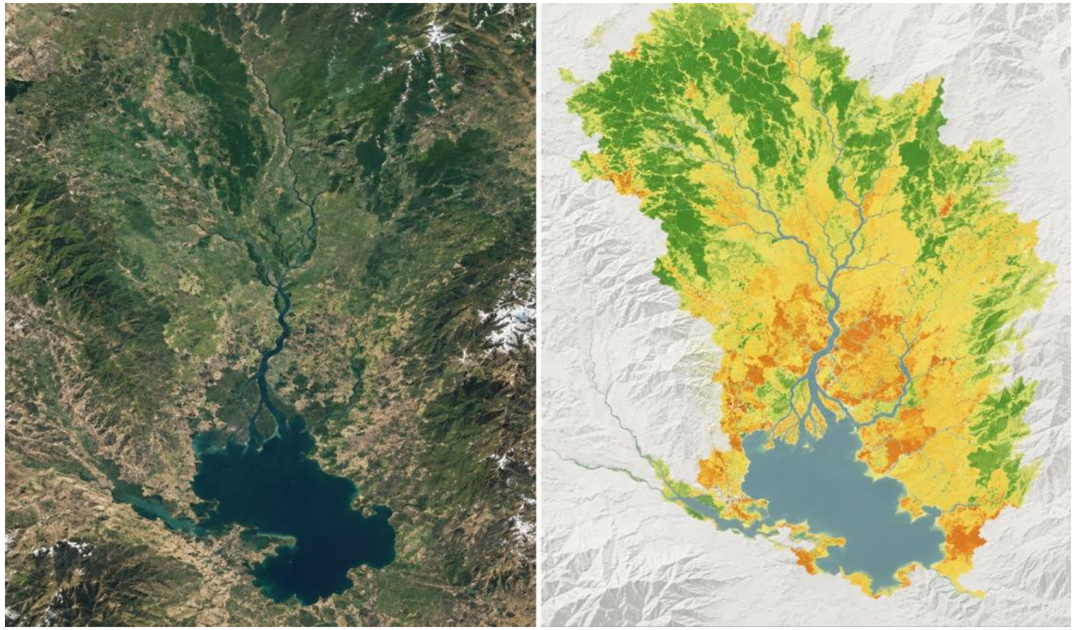
Learning objectives

Explain the role of remote sensing and GIS in environmental monitoring.

Identify key environmental indicators from optical, thermal, radar, and field data.

Describe how monitoring becomes assessment through comparison, thresholds, and validation.

Connect environmental assessment results with land management decisions in Central Asia.



Key idea: environmental monitoring observes change; environmental assessment explains whether that change creates risk, damage, recovery, or a need for action.

Why Environmental Monitoring Matters

Environmental conditions change across space and time: water, vegetation, soil, urban areas, and hazards.

Satellite observations provide repeated coverage over large territories where field surveys are costly.

GIS allows different evidence layers to be combined into practical assessment maps.

For land management, monitoring supports early warning, restoration planning, and policy evaluation.

Repeated

observations reveal trends, not only single events

Spatial

maps show where pressure is concentrated

Monitoring and Assessment: What Is the Difference?

Monitoring

Collects repeated observations

Tracks environmental variables

Detects change in time and space

Answers: What is happening?

Assessment

Interprets the meaning of change

Uses thresholds, baselines, and standards

Links evidence with risk or impact

Answers: Why does it matter?

Observe → **Compare** → **Validate** → **Interpret** → **Decide**

Main Data Sources

Environmental assessment improves when satellite evidence is combined with field knowledge and local context.

Satellite imagery

Landsat, Sentinel, MODIS and other Earth observation data provide repeated coverage for land, vegetation, water and temperature.

UAV and aerial data

Drones can capture very high-resolution information for local erosion, crops, waste sites, or restoration areas.

Field measurements

Water samples, GPS points, soil observations and photos are used for validation and interpretation.

GIS layers

Boundaries, land use, roads, canals, DEM, protected areas and settlements help explain exposure and vulnerability.

Important: remote sensing shows patterns, while field validation helps confirm causes and improve confidence.

Key Environmental Indicators from Remote Sensing

Indicator group	Typical data product	What it helps assess
Vegetation condition	NDVI, EVI, phenology curves	Biomass, crop stress, ecosystem change
Water condition	NDWI, MNDWI, water extent	Floods, wetlands, irrigation and surface water change
Soil and degradation	Bare soil index, salinity proxies, LST	Erosion risk, salinization, dryness and land degradation
Urban pressure	Built-up indices, impervious surface	Expansion, heat islands and land conversion
Hazards	Fire products, flood maps, drought indicators	Risk monitoring and emergency response

One indicator is rarely enough. Strong assessment combines several indicators and checks them against local observations.

Environmental Monitoring Workflow

Define problem → Select data → Preprocess → Calculate indicators → Validate → Assess risk

Water Environment Monitoring

Surface water extent can be mapped from optical indices such as NDWI and MNDWI.

Time-series images reveal seasonal changes in reservoirs, canals, wetlands, and floodplains.

Thermal and optical data can support assessment of water stress and evaporation-related patterns.

Assessment should include field checks for turbidity, salinity, pollution sources, and water-use pressure.

Typical outputs

- Water / no-water map
- Flood extent map
- Wetland change map
- Reservoir area trend
- Risk zones near settlements

In irrigated regions, water monitoring should be linked with land use, drainage, soil salinity, and agricultural demand.

Vegetation and Ecosystem Condition

What to monitor

Vegetation greenness and density

Phenological timing and seasonal curves

Forest, pasture, wetland and crop condition

Recovery after fire, drought, or restoration

How to assess

Compare with a baseline or previous years

Check changes against rainfall and temperature

Separate real degradation from seasonal variation

Validate with field photos and local knowledge

Interpretation warning: low vegetation index values may indicate drought, harvest, bare soil, salinity, overgrazing, or natural seasonal dormancy.

Urban and Industrial Environmental Pressure

Environmental monitoring is also important around cities, roads, industries, waste sites, and mining areas.

Satellite data can detect land conversion, impervious surface expansion, heat patterns, and disturbance zones.

GIS exposure analysis shows which communities, water bodies, or agricultural lands are near pressure sources.

Assessment should distinguish legal planned development from uncontrolled or environmentally risky expansion.

Assessment questions

What changed?

How fast did it change?

Which sensitive areas are affected?

Who or what is exposed?

What mitigation is needed?

Pressure → Exposure → Sensitivity → Risk → Response

Degradation, Salinity, Drought and Desertification

Drylands require careful monitoring because vegetation, soil moisture, and land cover can change rapidly under climate and land-use pressure.

Remote sensing can identify degradation signals such as declining productivity, expanding bare soil, erosion patterns, and salinity-related brightness.

Assessment must combine image evidence with rainfall, grazing pressure, irrigation history, soil data, and field observations.

For Central Asia, environmental assessment should connect land degradation with irrigation, drainage, water scarcity, pasture use, and settlement growth.

Central Asia and Uzbekistan Context

Environmental monitoring in Central Asia often focuses on water–land interactions.

Irrigation and drainage

Canals, water allocation, drainage condition, waterlogging and salinity are closely connected in irrigated landscapes.

Agricultural productivity

Crop condition maps help evaluate whether land remains productive and whether stress is seasonal or structural.

Dryland and pasture pressure

Vegetation trend analysis can support pasture management, rangeland restoration, and drought early warning.

Example classroom task: compare NDVI and water-index time series for an irrigated district and explain whether observed change is linked to crop cycles, water shortage, or land degradation.

From Assessment to Decision Support

A good assessment product should be understandable for both specialists and decision-makers.

Map → Classify risk → Prioritize sites → Recommend action → Monitor result

Planning

Where should restoration, drainage improvement, buffer zones, or inspections be prioritized?

Management

Which areas require irrigation adjustment, conservation action, or field verification?

Evaluation

Did an intervention reduce risk or improve environmental condition over time?

Remember these five principles:

1. Monitoring needs repeated data
2. Assessment needs interpretation
3. One indicator is not enough
4. Field validation improves confidence
5. Maps should support real decisions

Discussion question: Which environmental problem in your region could be monitored better with satellite data, and what field data would be needed to verify it?

References

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FAO. Ecosystem restoration and land degradation monitoring; geospatial technologies and remote sensing support mapping ecosystem conditions. https://www.fao.org/geospatial/our-focus/ecosystem-restoration---land-degradation-monitoring/en

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Students are encouraged to open the listed official sources and explore examples of environmental monitoring products independently.

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