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LAND MANAGEMENT
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LAND MANAGEMENT IN CENTRAL ASIA

15.- Integrated Applications of Remote Sensing

Monitoring Land Degradation

LM-W15-V100

Learning objectives

Explain what land degradation means in land management and environmental monitoring.

Identify main degradation signals visible in satellite and field data.

Describe how indices, time series, terrain data, and field observations are combined.

Interpret monitoring outputs for agricultural land, rangelands, water-stressed areas, and restoration planning.

Key message: remote sensing does not replace field knowledge; it helps identify where land condition is changing and where field verification is needed.

What Is Land Degradation?

Land degradation is a long-term decline in the biological, ecological, or economic productivity of land caused by natural pressures and human activities.

Physical degradation

erosion and gullies

soil compaction

loss of topsoil

Biological degradation

vegetation decline

loss of biomass

rangeland degradation

Chemical degradation

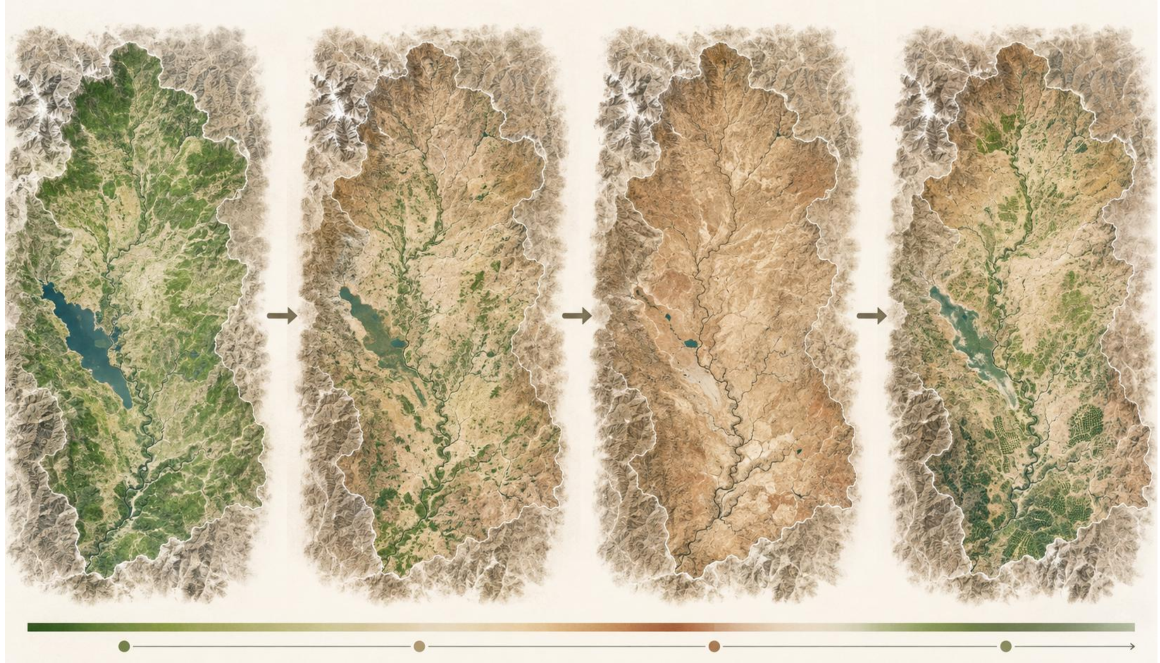
salinity

waterlogging

nutrient depletion

For Central Asian irrigated and semi-arid landscapes, degradation monitoring commonly focuses on vegetation productivity, salinity, soil moisture stress, erosion risk, and land-cover change.

Why Monitor Degradation with Remote Sensing?



Satellite observations provide repeated measurements across large areas.

Time series reveal gradual decline, sudden disturbance, or recovery after restoration.

Maps help prioritize field visits and management interventions.

Long archives, such as Landsat, support multi-decade comparison.

1972+
Landsat archive supports long-term land monitoring

10–30 m
common resolution for many land monitoring products

Main Indicators of Land Degradation

Land cover change → Land productivity → Soil condition → Water stress → Terrain risk

Remote sensing indicators

NDVI / EVI: vegetation greenness and productivity

SAVI: vegetation in sparse or bright-soil areas

NDWI / MNDWI: surface water and wetness

Bare soil and salinity-related indices

Supporting GIS indicators

DEM-derived slope, aspect, and drainage pattern

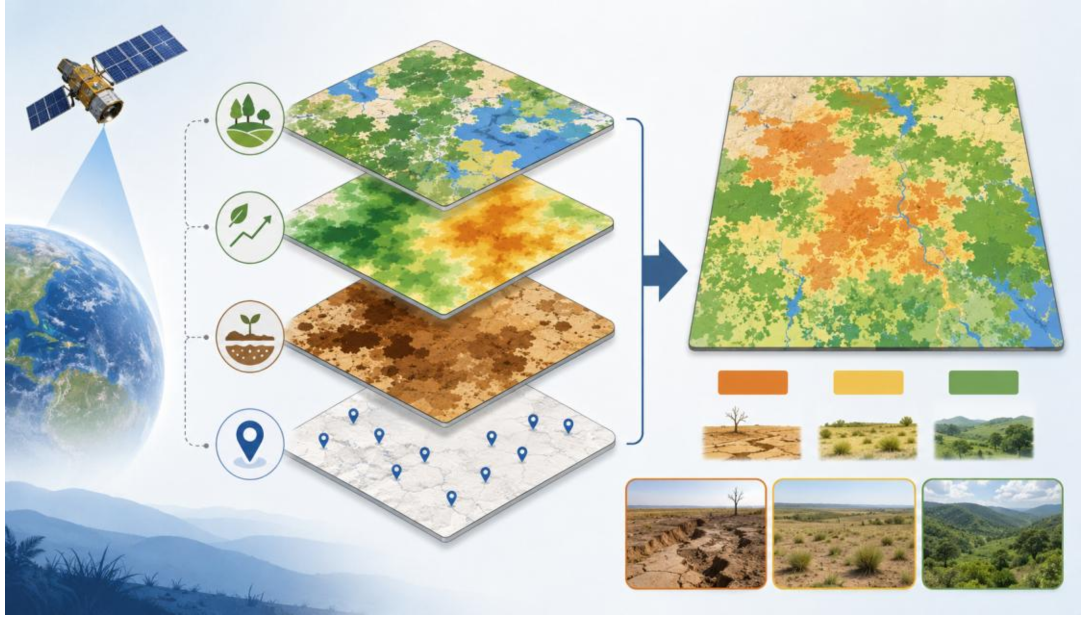
soil maps and irrigation/drainage networks

administrative boundaries and land parcels

field observations and laboratory results

A single indicator is rarely enough. Reliable monitoring usually combines spectral, temporal, terrain, and ground-based evidence.

Data Sources for Monitoring



Typical data combination

Optical satellite data: vegetation, bare soil, water, land cover

Radar data: soil moisture sensitivity and cloud-independent monitoring

DEM/LiDAR data: slope, gullies, terrain forms, drainage

Field data: calibration, interpretation, and accuracy assessment

Examples: Landsat, Sentinel-2, Sentinel-1 SAR, MODIS, GEDI LiDAR, national field surveys, cadastre and land-use records.

Monitoring Workflow

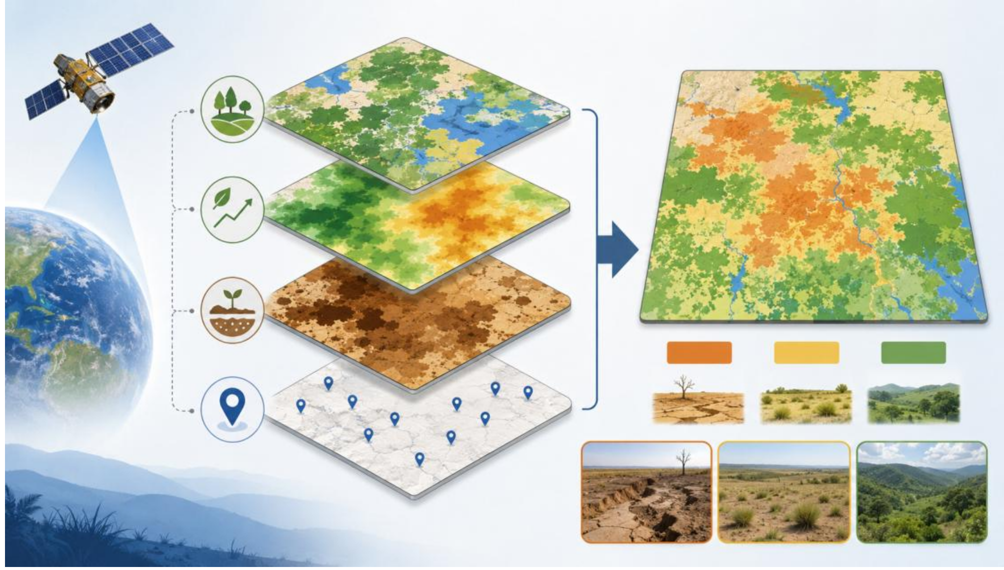
Define problem → Collect data → Preprocess → Calculate indicators → Detect change → Validate → Report

Define the degradation type: salinity, erosion, vegetation decline, waterlogging, or land-cover conversion.

Select the season and time period carefully; wrong timing can create false change signals.

Use cloud masking, atmospheric correction, mosaicking, and consistent projection.

Compare results with field observations and local land-use information before decision-making.



Vegetation Decline and Productivity Trends

What to observe

Lower NDVI/EVI over several seasons

Shorter growing period or delayed greening

Reduced biomass in rangelands or cropland

Spatial clustering near irrigation stress, salinity, or overgrazing

Interpretation caution

Low vegetation index does not automatically mean degradation.

It may also reflect crop rotation, harvest date, drought, clouds, or soil background.

Use multi-year seasonal averages and field verification.

Best practice: compare the same season across several years and include precipitation or irrigation information when available.

Soil Salinity and Bare Soil Signals

Salinity often appears as bright bare soil, white salt crusts, reduced vegetation cover, or patchy crop growth.

Optical images can help map surface salt expression, but subsurface salinity may remain hidden.

Combining seasonal vegetation decline, soil brightness, drainage data, and field EC measurements improves interpretation.

In irrigated landscapes, salinity analysis should consider groundwater level and drainage performance.

Central Asia link: irrigation and drainage conditions are important because salinization can reduce crop productivity even when water delivery continues.

Erosion and Terrain-Based Degradation Risk

Terrain factors

slope steepness and slope length

drainage density and flow accumulation

gully and channel formation

soil texture and vegetation cover

rainfall intensity and land-use pressure

Remote sensing contribution

DEM products help identify slope and drainage pattern.

High-resolution imagery helps detect gullies and bare soil expansion.

Change maps show where erosion risk becomes visible over time.

Output example: erosion risk zones for field inspection, soil conservation planning, and restoration priority mapping.

Water Stress, Drought, and Irrigation Pressure

Vegetation decline may be driven by drought, insufficient irrigation, salinity, waterlogging, or crop management changes.

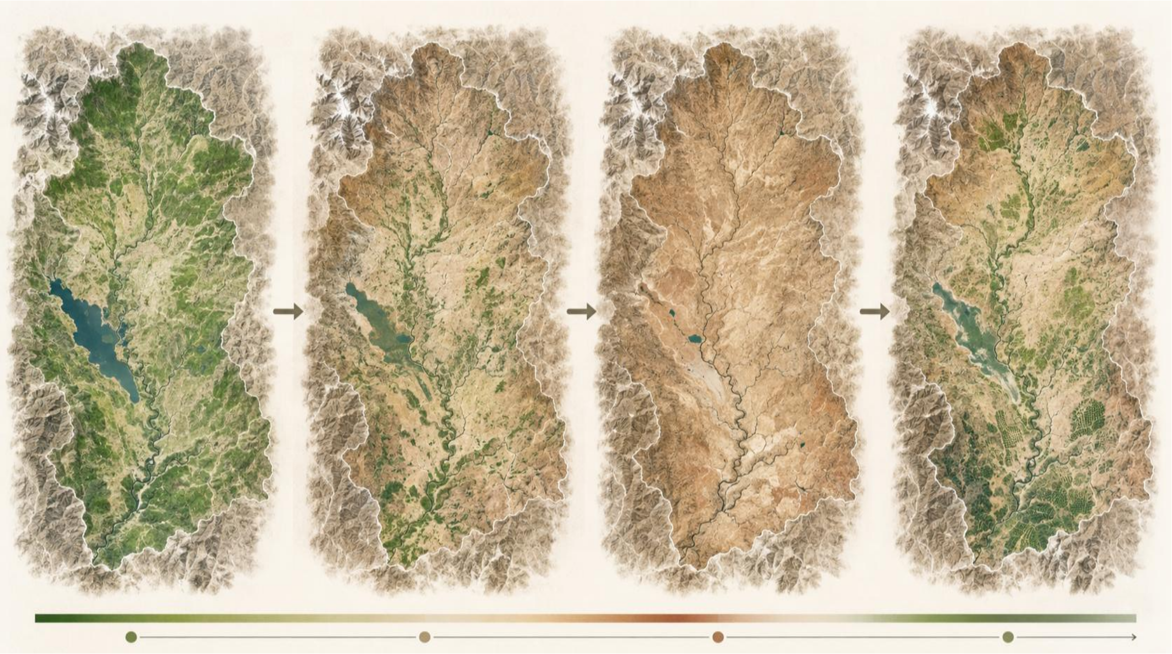
NDWI and surface water maps can show canals, reservoirs, wetlands, and seasonal water availability.

Thermal data can support crop water-stress analysis where suitable resolution is available.

Radar can add information when clouds limit optical observations or when moisture conditions are important.

Monitoring should connect satellite indicators with irrigation schedules, canal condition, field observations, and local agricultural knowledge.

Uzbekistan and Central Asia Context



Common monitoring needs

- irrigated cropland productivity
- salinity and drainage-related stress
- rangeland condition and overgrazing pressure
- riparian vegetation and wetland change
- land-cover change around settlements and infrastructure

In semi-arid regions, monitoring should not only identify degraded land; it should also help evaluate recovery, rehabilitation, and more sustainable land-use decisions.

Accuracy Assessment and Field Validation

Validation questions

Are the mapped degradation classes visible in the field?

Do the satellite dates match the field season?

Are reference points independent from training data?

Is the map accurate enough for the intended decision?

Simple accuracy outputs

confusion matrix

overall accuracy

producer’s and user’s accuracy

field photos and GPS points

short explanation of map limitations

A map without accuracy information should be treated as a preliminary interpretation, not as final evidence for management decisions.

From Monitoring to Land Management Decisions

Detect → Verify → Prioritize → Intervene → Monitor recovery

Planning

restoration zones

erosion control

irrigation improvement

Management

soil conservation

water saving

crop rotation support

Policy support

risk maps

targeted investments

monitoring reports

Effective monitoring connects technical products with decisions that land users, local authorities, and environmental institutions can apply.

Key Takeaways and References

Key takeaways

Land degradation is multidimensional and must be monitored through several indicators.

Remote sensing is strongest when used as a time-series and combined with field validation.

Central Asian applications should link vegetation, salinity, water, terrain, and land-use change.

References

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