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# MICRO-CREDENTIAL

# LAND MANAGEMENT IN CENTRAL ASIA

## 13.- Image Interpretation and Digital Image Processing

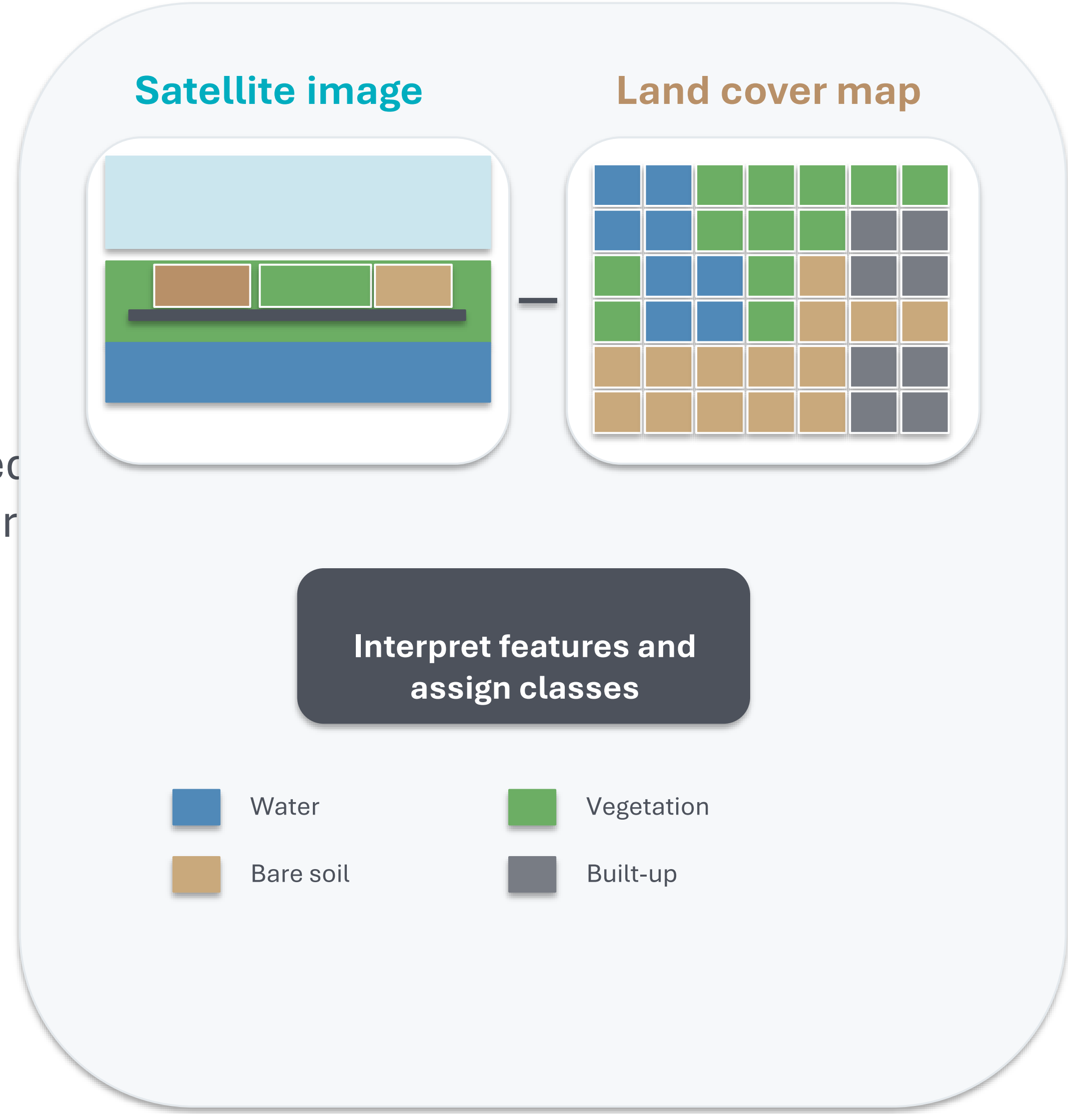
***Land Cover Mapping Using Satellite Images***

***LM-W13-V90***

# Land Cover Mapping Using Satellite Images

An introductory lesson on how satellite data are processed, classified, and interpreted to produce land cover maps for environmental and land management applications.

Focus: satellite sources, preprocessing, classification, validation, and practical map applications




Designed for undergraduate learners in remote sensing

# Learning objectives and lesson roadmap

## Learning objectives

Define land cover mapping and explain how satellite images support it.
Distinguish land cover from land use.
Recognize the main workflow from image selection to final map production.
Identify common satellite data sources and useful spectral bands.
Understand classification, accuracy assessment, and map applications.

## Roadmap

Concepts — Data — Processi ng — Mapping — Use

### Satellite sources

Landsat, Sentinel, MODIS, commercial imagery.

### Preprocessing

Correction, masking, and band preparation.

### Classification

Assign each pixel or segment to a class.

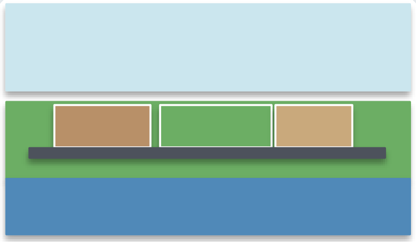
### Validation

Check accuracy using reference data.

Land cover mapping transforms satellite observations into a structured representation of the Earth's surface.

# Land cover and land use: what is the difference?

## Land cover



Physical material seen on the surface.
Examples: water, forest, crops, soil, buildings.

Satellite images directly observe land cover because they measure reflected or emitted energy from surface materials.

## Land use

Farm
Park
Road
Housing

Human purpose or function of the land.
Examples: agriculture, recreation, transport, residence.

Land use often requires interpretation beyond what is directly visible in the image.

Land cover describes what is on the ground, while land use describes how people use that land.

# Satellite data sources for land cover mapping

**Landsat**

30 m resolution, long historical archive, useful for multi-decadal mapping.

**Sentinel-2**

10–20 m resolution, frequent revisit, strong for vegetation and land cover studies.

**MODIS**

Coarser resolution but excellent temporal frequency for regional or global monitoring.

**Commercial /**

Very high resolution for local-scale mapping when detailed features are needed.

The best satellite source depends on the study area, class detail, time period, and required spatial resolution.

# Overall workflow for land cover mapping

Select satellite image → Preprocess image → Choose classes → Classify image → Assess accuracy → Create final map

| | |
|---|---|
| **Image selection** | Choose an image with suitable date, resolution, and cloud-free conditions. |
| **Preparation** | Correct, clip, and organize useful bands or indices. |
| **Mapping** | Apply a classification method and label the result. |
| **Quality check** | Use reference data and revise weak areas if necessary. |

A systematic workflow improves the reliability and reproducibility of land cover maps.

# Preprocessing satellite images

1

### Atmospheric correction

Reduce haze and convert image values to reflectance.

2

### Geometric correction

Ensure the image aligns with maps and coordinates.

3

### Cloud masking

Remove clouds and cloud shadows.

4

### Subsetting and mosaicking

Clip to the study area or merge scenes when needed.

Preprocessing makes the image more accurate, comparable, and ready for classification.

# Spectral bands and indices used in mapping

## Common spectral

**Visible bands**
Useful for natural color interpretation and built features.

**Near-infrared**
Strong for vegetation detection and biomass differences.

**Shortwave infrared**
Sensitive to moisture, soil, and burn conditions.

## Useful indices

**NDVI**
Highlights vegetation vigor.

**NDWI / MNDWI**
Improves water detection.

**SAVI**
Useful where vegetation cover is sparse.

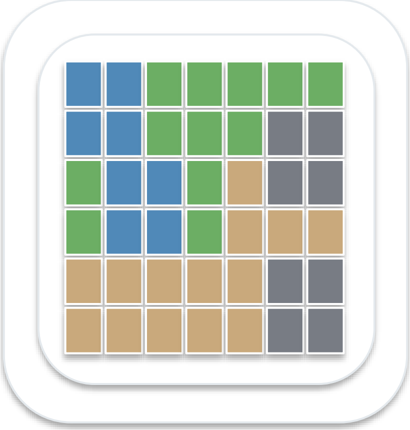
**NDBI**
Helps identify built-up surfaces.

Using suitable bands and indices helps improve class separation before mapping.

# Class scheme and reference data

## Example class

- Water
- Vegetation
- Cropland
- Bare soil
- Built-up



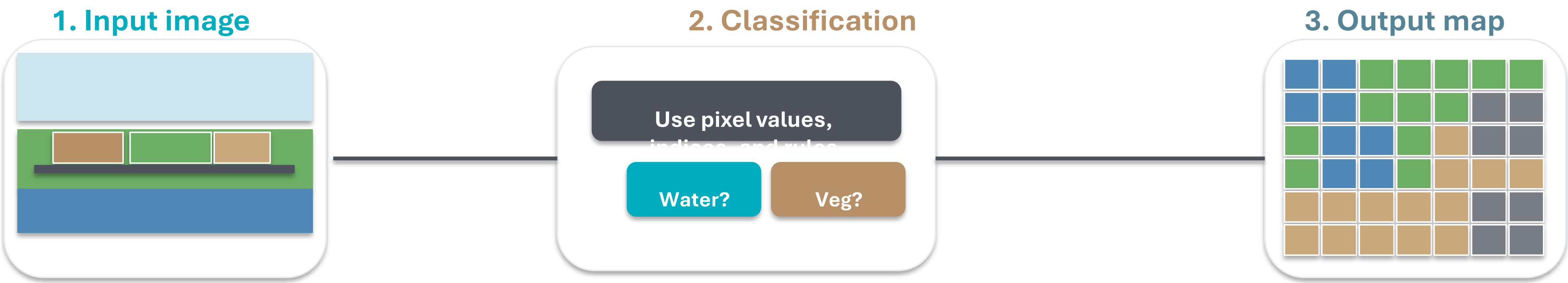
A clear class legend
improves interpretation.

## Reference data

Field observations collected with GPS.
Existing maps and official land cover products.
High-resolution images from Google Earth or UAV data.
Local expert knowledge and recent photographs.

A good class scheme and reliable reference data are essential foundations for a useful land cover map.

# From satellite image to classified land cover map




Classification may be supervised, unsupervised, or object-based depending on the data and mapping objective.

The central idea is to translate spectral patterns into map categories that represent real surface types.

# Accuracy assessment and map validation

## Simple confusion

| | Water | Veg. | Soil | Urban |
|---|---|---|---|---|
| **Water** | 15 | 1 | 0 | 1 |
| **Veg.** | 1 | 19 | 2 | 1 |
| **Soil** | 0 | 2 | 14 | 2 |
| **Urban** | 1 | 1 | 2 | 16 |

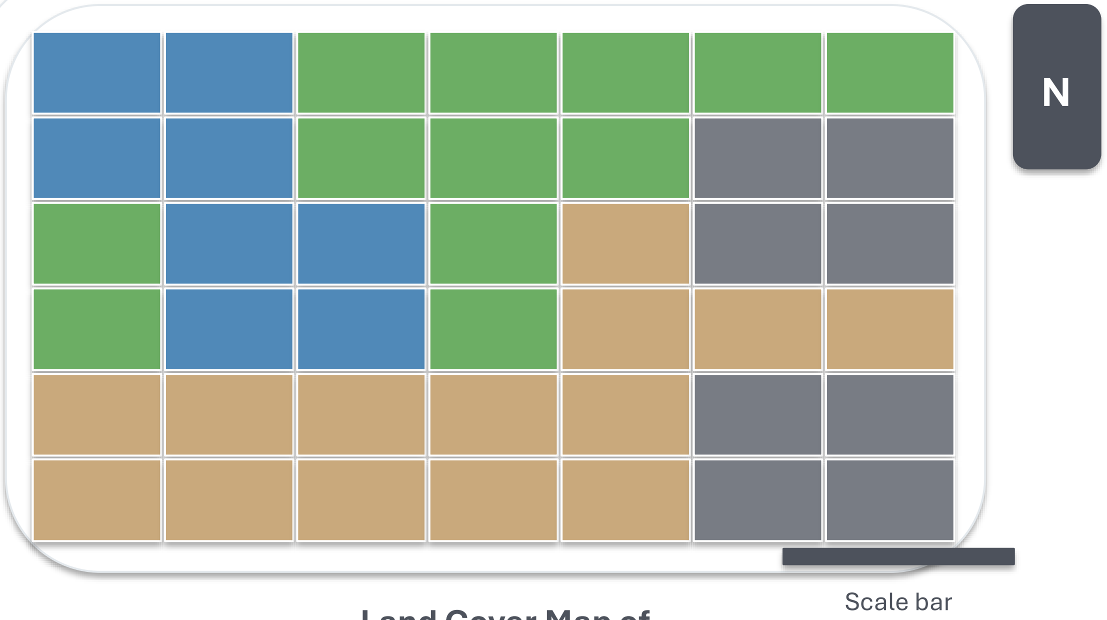
Rows = mapped class
Columns = reference class

## What to report

Overall accuracy of the entire map.
User's and producer's accuracy for each class.
Sources of error, such as mixed pixels or confusing classes.
Whether the result is suitable for the intended use.

Validation is necessary because a visually attractive map is not always an accurate map.

# Essential map elements in the final output




**Land Cover Map of Study Area**

## Legend

- Water
- Vegetation
- Cropland
- Bare soil
- Built-up

Include title, legend, scale, north arrow, source, and date.

A clear legend and map layout help users understand the meaning and quality of the land cover map.

# Applications of land cover maps

**Agriculture**

Monitor cropping patterns, field expansion, and land productivity.

**Water management**

Track reservoirs, rivers, wetlands, and irrigation areas.

**Urban planning**

Observe built-up growth and land conversion.

**Environment**

Assess forest change, degradation, erosion risk, and habitat fragmentation.

Land cover maps are useful in many sectors because they provide spatially explicit information about the Earth's surface.

# Common challenges in land cover mapping

**Mixed pixels**
A single pixel may contain more than one land cover type.

**Cloud cover**
Clouds and shadows can hide important features.

**Seasonal variability**
The same land cover may look different across dates.

**Spectral confusion**
Different classes may have similar spectral responses.

**Reference data gaps**
Insufficient field data can weaken validation.

Combining suitable imagery, well-defined classes, and careful validation helps reduce these challenges.

Understanding limitations allows analysts to produce more realistic and transparent land cover maps.

# Best practice for a successful mapping project

## Best practice

Use the most appropriate season for the classes you want to map.
Prepare the image carefully before classification.
Design a simple but meaningful class system.
Collect enough representative training and validation samples.
Review the output visually and statistically before finalizing the map.

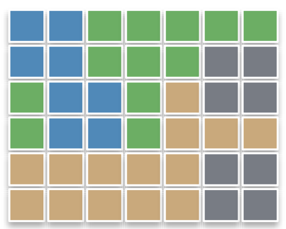
## Mini example

Sentinel-2 image

NDVI + bands

Random forest

Land cover map



Final product ready for analysis, reporting, and planning.

The strongest projects combine good data, a clear workflow, and critical evaluation of the results.

# References and further reading


Campbell, J. B., & Wynne, R. H. (2011). Introduction to Remote Sensing (5th ed.). Guilford Press.
Jensen, J. R. (2015). Introductory Digital Image Processing: A Remote Sensing Perspective (4th ed.). Pearson.
Lillesand, T., Kiefer, R. W., & Chipman, J. (2015). Remote Sensing and Image Interpretation (7th ed.). Wiley.
Richards, J. A. (2013). Remote Sensing Digital Image Analysis (5th ed.). Springer.
NASA Earth Observatory. Educational resources on satellite imagery, land cover, and environmental change.
USGS EROS Center and ESA Sentinel Online. Data guides and tutorials for land cover mapping workflows.


Suggested activity: select one satellite image, define five land cover classes, and sketch a simple workflow for producing a land cover map of your study area.

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