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Project number: 101129032

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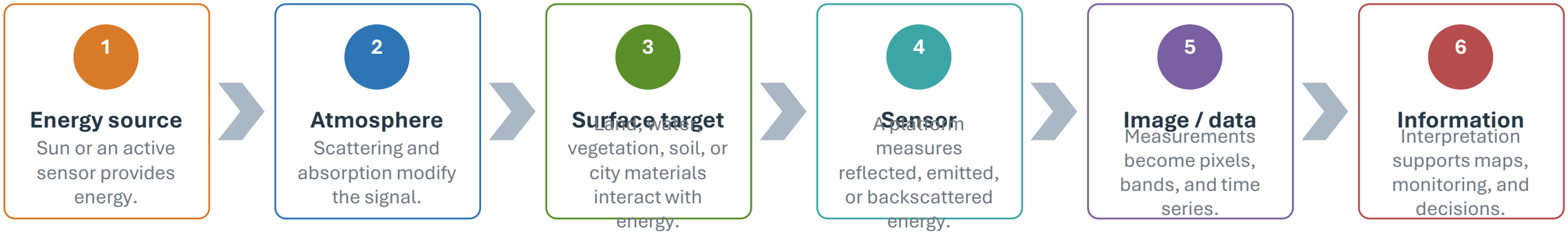
10.- Introduction to Remote Sensing

Introduction to Remote Sensing Review

LM-W10-V70

The Remote Sensing System at a Glance



Key idea

Remote sensing is not only image capture; it is a system of measurement, processing, interpretation, and application.

Why review this chain?

It explains why platform choice, sensor type, timing, and processing all affect the final map or analysis.

What Remote Sensing Means

Definition, scope, and the main ideas students should remember.

Core definition

Remote sensing is the acquisition of information about an object, area, or phenomenon without direct physical contact. In practice, sensors record reflected, emitted, or backscattered energy and convert it into usable data.

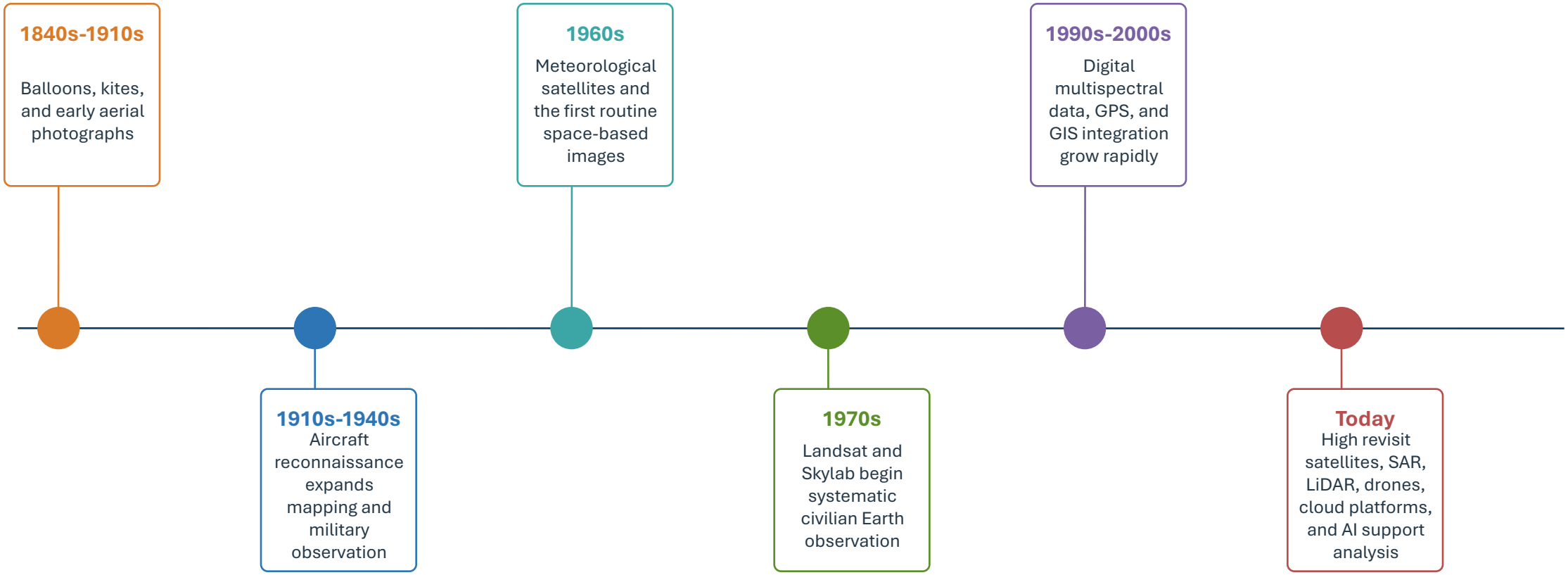
- It can be ground-based, airborne, or satellite-based.
- It includes both visual interpretation and digital analysis.
- It supports mapping, monitoring, and change detection across space and time.

Remote sensing combines a measurement principle with a practical interpretation framework.

Scope of review

Platforms
Sensors
Products
Use

Development of Remote Sensing Technologies



Review message

Technology changed from isolated photographs to continuous, multi-band, multi-date observation systems that support land, water, and environmental analysis.

Main Remote Sensing Data Sources and Platforms

Satellite
Regional to global coverage, repeated observation, many spectral options.

Aircraft
Flexible acquisition, high detail, useful for mapping projects.

UAV / drone
Very high detail for small areas and targeted monitoring.

Ground systems
Field spectrometers, cameras, and GPS for local measurement and validation.

Wider coverage
Lower local detail

Ground sources of data
Field observations, GPS points, and sample measurements are essential for training, validation, and interpretation.

Airborne sources
Aircraft and drones provide flexible scheduling and high spatial detail, but cover smaller areas than satellites.

Spaceborne sources
Satellites are best for repeated broad-area Earth observation and support land-cover, crop, water, and hazard monitoring.

Electromagnetic Radiation and Surface Interaction

Remote sensing depends on how different materials reflect, absorb, emit, or scatter energy.

Shorter wavelength

Longer wavelength

Reflection **Absorption** **Emission** **Scattering**

Vegetation

Strong absorption in red and strong reflection in near infrared help identify plant vigor.

Water

Water usually absorbs more energy, especially in near infrared and shortwave infrared bands.

Soil and built surfaces

Their spectral response changes with moisture, texture, mineral content, and material type.

Sensor Types: Passive and Active

Passive sensors

Source

Natural energy, mainly sunlight or thermal emission from the Earth.

Examples

Aerial photography, multispectral scanners, thermal sensors.

Strengths

Simple concept, rich spectral information, strong for land cover and vegetation analysis.

Limits

Depend on illumination; many optical systems are limited by cloud cover and haze.

Active sensors

Source

The sensor sends out energy and measures the returned signal.

Examples

Radar and LiDAR systems.

Strengths

Can work day or night; microwave radar can often observe through clouds.

Limits

Geometry and backscatter are more complex to interpret; processing can be demanding.

Resolution Review: Four Questions Every Student Should Ask

Spatial resolution

Question: How large is one pixel on the ground?

Example: 10 m pixels show more local detail than 30 m pixels.

Spectral resolution

Question: How many bands and how narrow are they?

Example: more bands can separate vegetation, water, soil, and minerals more clearly.

Radiometric resolution

Question: How finely can brightness be measured?

Example: 12-bit data record more gray levels than 8-bit data.

Temporal resolution

Question: How often can the same place be observed?

Example: frequent revisit improves change detection and crop monitoring.

Image Interpretation and Data Processing

Visual interpretation clues

Tone and color
Texture and pattern
Shape and size
Shadow and height clues
Site and association with nearby features

Acquisition → Correction → Enhancement → Classification → Map / product

Common products

True color and false color images, vegetation indices, classified maps, elevation models, and change detection layers.

Review message

Interpretation improves when image evidence is combined with field data, maps, and local knowledge.

Role of Remote Sensing in Earth Observation

Land

Land cover, land use, degradation, and urban growth can be monitored across large areas.

Vegetation

Seasonal behavior and crop condition become visible through repeated measurements.

Water

Rivers, reservoirs, wetlands, and flood extent can be measured through time.

Hazards

Drought, fire scars, dust, and other environmental changes can be tracked quickly.

Review message

Earth observation is powerful because the same place can be measured again and again, allowing trend analysis, early warning, and change detection.

Applications of Remote Sensing in Land Studies

Land cover mapping

Distinguish cropland, forest, grassland, bare soil, water, and built-up areas.

Crop condition

Track crop vigor, field differences, and seasonal development.

Soil and salinity clues

Spectral response can reveal surface condition, moisture, and salinity risk.

Urban growth

Support land planning and infrastructure analysis.

Waterlogging and irrigation

Identify wet fields, irrigation patterns, and drainage problems.

Forest and rangelands

Measure vegetation cover, disturbance, and seasonal stress.

Degradation and erosion

Repeated imagery helps identify exposed soil, gullying, and land decline.

Change detection

Compare dates to measure land transformation.

Regional Relevance: Why Remote Sensing Matters in Central Asia

Regional focus

Central Asia depends heavily on land, irrigation, snow and glacier-fed water, and dryland ecosystems. Remote sensing helps monitor conditions over large and often difficult-to-access areas.

Central Asia

Irrigated agriculture

Crop area, crop vigor, water stress, and field condition can be checked repeatedly during the season.

Rangelands

Vegetation cover and drought pressure can be mapped across wide pastoral landscapes.

Water resources

Reservoirs, rivers, snow cover, wetlands, and water distribution can be tracked through time.

Environmental change

Shoreline retreat, salinity effects, dust sources, and land degradation are visible in multi-date imagery.

Advantages of Remote Sensing

0

Large area coverage

One image can describe patterns across fields, districts, river basins, or entire countries.

1

Repeated observation

Revisit cycles allow change detection and monitoring through time.

2

Multiple spectral bands

Different wavelengths reveal vegetation, water, soil, and built surfaces differently.

3

Hard-to-reach areas

Remote sensing supports work in large, remote, hazardous, or politically difficult areas.

4

Efficient monitoring

Data collection can be faster than field-only surveys for broad regions.

5

Strong decision support

Remote sensing works well with GIS, field data, and models for planning and management.

Limitations and Practical Challenges

Main constraints

- Clouds and haze
- Mixed pixels
- Revisit and timing gaps
- Processing and calibration needs
- Need for field validation

How to respond to these limits

- Choose the sensor according to the problem, scale, and season.
- Use multi-date data to reduce timing and cloud problems.
- Combine remote sensing with field observations, maps, and GIS layers.
- Apply geometric and radiometric correction before analysis.
- Interpret results carefully, especially in complex or mixed landscapes.

Final Review

Key takeaways

1. Remote sensing collects information without direct contact by measuring energy from targets.

2. Platforms, sensor type, and resolution determine what can be observed and at what scale.

3. Interpretation and processing transform raw measurements into maps, indices, and decisions.

4. Earth observation and land studies rely on repeated data to detect patterns and change.

5. Compare theory with real image examples to deepen understanding.

Review keywords

Energy | Platform | Sensor | Resolution | Interpretation | Application

Study reminder

When reviewing images, always ask four questions: What energy is measured? From which platform? At what resolution? For which decision or interpretation task?

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