Satellite Images applications in natural resources

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Building International Cooperation on Arid Zones Research

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Remote Sensing

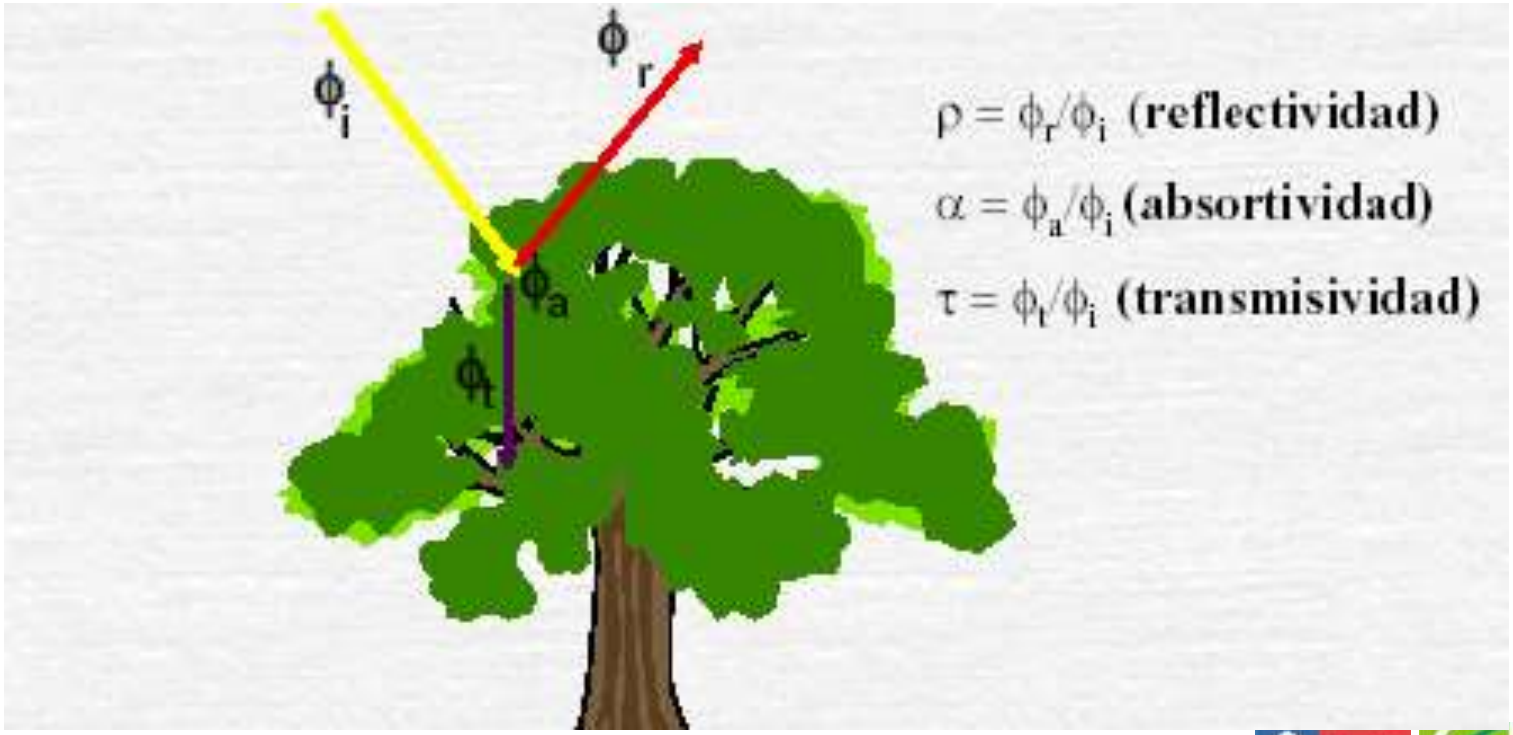
- Set of knowledge and techniques that are used to determine physical and biological characteristics of objects using measurements at a distance, without material contact.

Remote Sensing

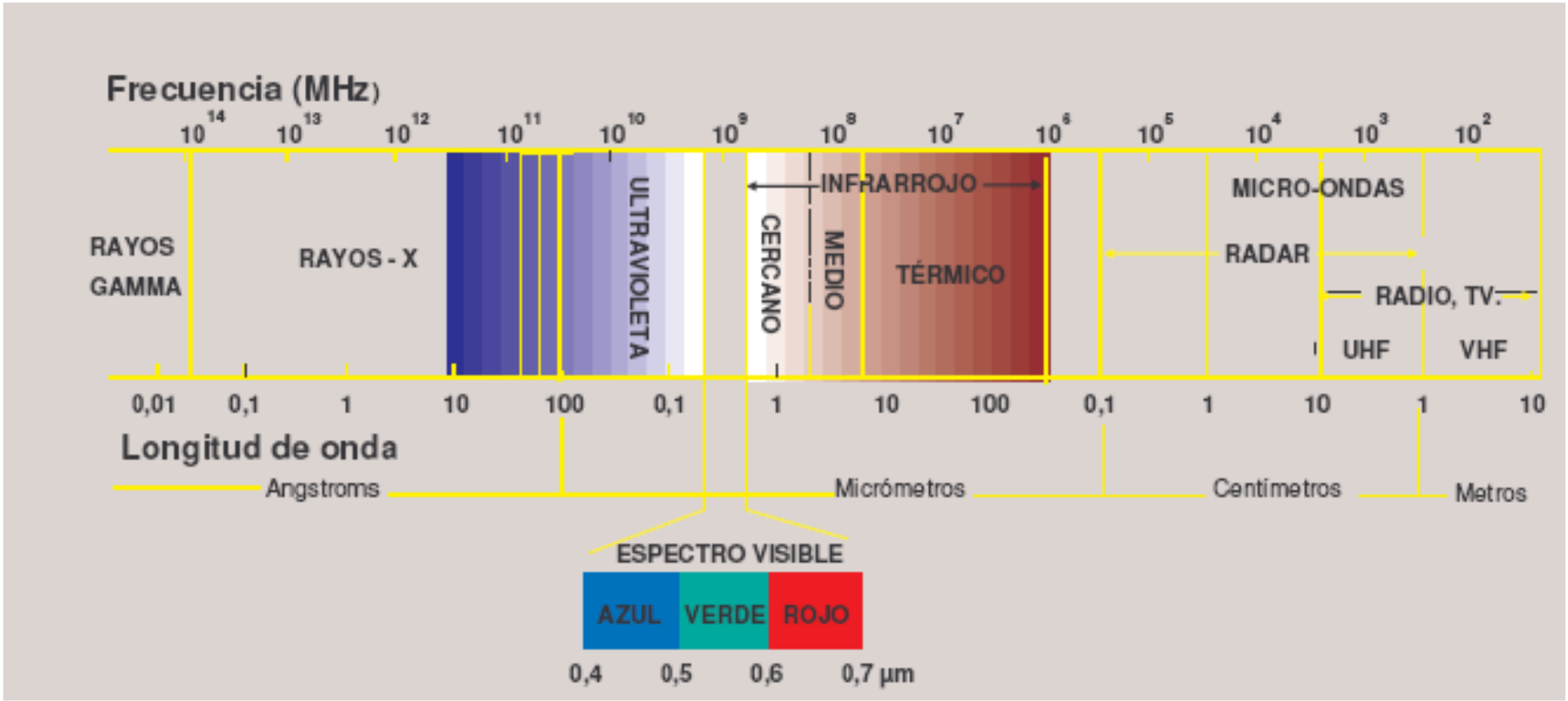
Obtaining information about an object or a surface without coming into physical contact with it.

- Basis: Interpretation of emitted or reflected electromagnetic radiation from a surface
- Requires knowledge of the physics behind the interaction of radiation at certain wavelengths with a surface
- Sensors and instruments
- Active and Passive Systems (microwave)

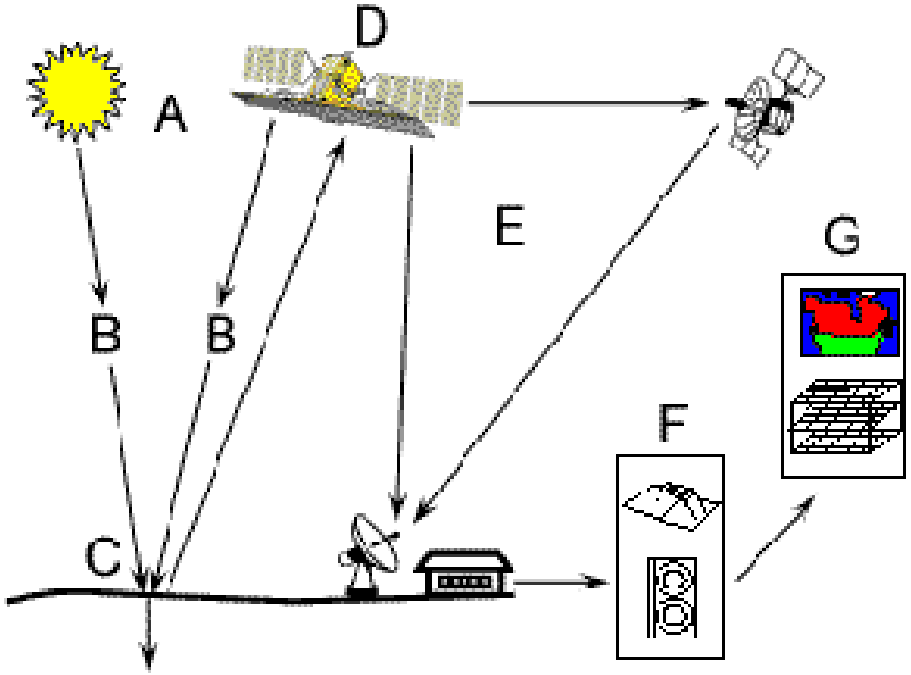
Physical principles of remote sensing



The Electromagnetic Spectrum



Elements involved in Remote sensing

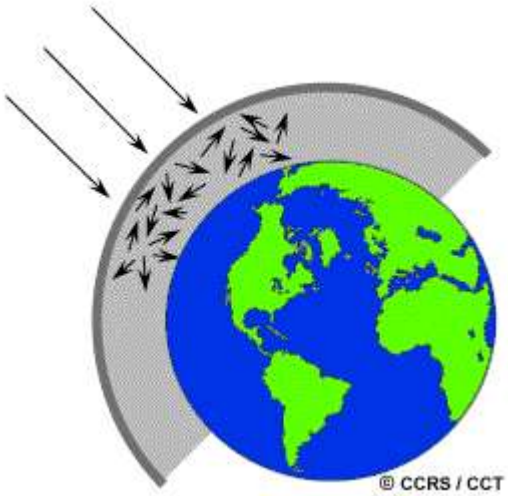


1. Energy Source or Illumination (A)
2. Radiation and the Atmosphere (B)
3. Interaction with the Object (C)
4. Recording of Energy by the Sensor (D)
5. Transmission, Reception and Processing (E)
6. Interpretation and Analysis (F)
7. Application (G)

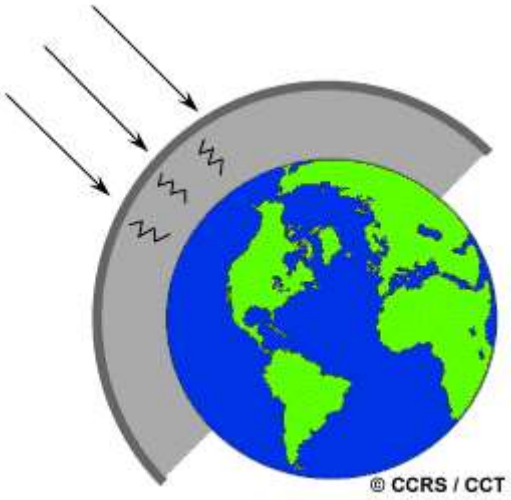
Interactions with the Atmosphere

- Particles and gases in the atmosphere can affect the incoming light and radiation

scattering



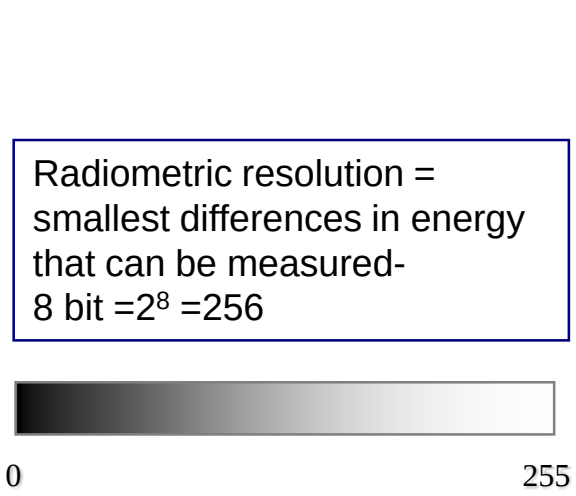
absorption

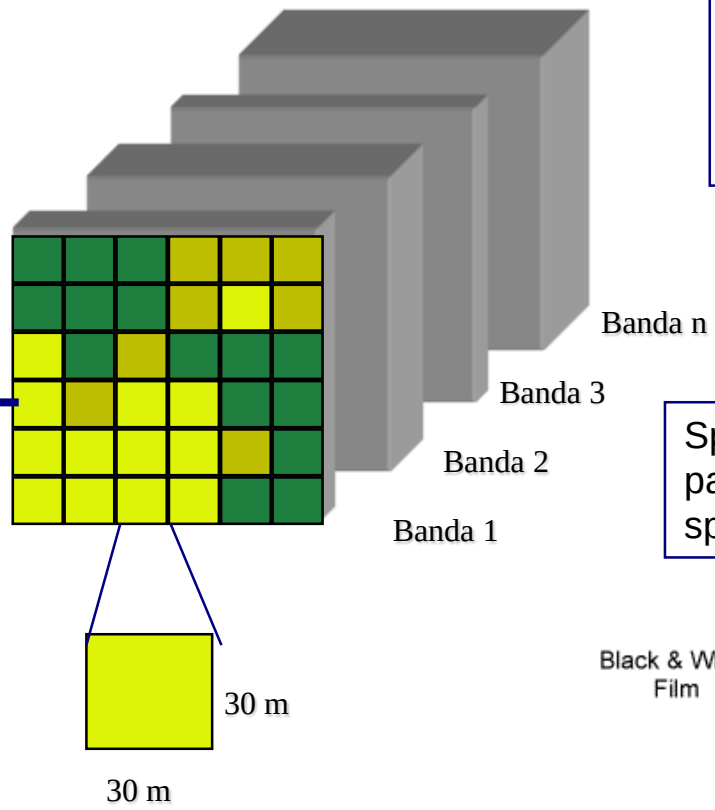


Sensor resolution

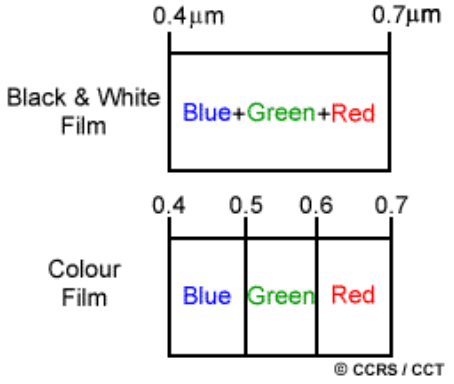
Revisit time (temporal resolution) = time between two successive image acquisitions over the same area

Radiometric resolution = smallest differences in energy that can be measured-
8 bit $=2^8=256$





Spectral resolution = part of the EM spectrum measured



Spatial resolution = smallest unit-area measured

Spectral and spatial Resolution

RADIOMETRO AVHRR

Banda		Rango Espectral (µm)
1	(1 km)	0.58 – 0.68
2	(1 km)	0.72 – 1.10
3	(1 km)	3.55 – 3.93
4	(1 km)	10.30 – 11.30
5	(1 km)	11.50 – 12.50

RADIOMETRO TM

Banda		Rango Espectral (µm)
1	(30m)	0.45 – 0.52
2	(30m)	0.52 – 0.60
3	(30m)	0.63 – 0.69
4	(30m)	0.76 – 0.90
5	(30m)	1.55 – 1.75
6	(60m)	10.40 – 12.50
7	(30m)	2.08 – 2.35

RADIOMETRO ASTER

Banda		Rango Espectral (µm)	
1	(15 m)	0.52 – 0.60	VNIR
2	(15 m)	0.63 – 0.69	
3 (N, B)	(15 m)	0.78 – 0.86	
4	(30 m)	1.600 – 1.700	SWIR
5	(30 m)	2.145 – 2.185	
6	(30 m)	2.185 – 2.225	
7	(30 m)	2.235 – 2.285	
8	(30 m)	2.295 – 2.365	
9	(30 m)	2.360 – 2.430	
10	(90 m)	8.125 – 8.475	TIR
11	(90 m)	8.475 – 8.825	
12	(90 m)	8.925 – 9.275	
13	(90 m)	10.25 – 10.95	
14	(90 m)	10.95 – 11.65	

Radiometric and temporal Resolution

Tipo de dato	Resolución radiométrica	Ejemplos de sensores remotos
8 bits	256	TM, MMRS, HRV.
10 bits	1024	AVHRR, SEAWIFS.
12 bits	4096	MODIS
16 bits	65536	ERS-1, ERS-2, RADARSAT, AVIRIS.

LANDSAT	16-18 Días
IKONOS	11 Días
NOAA	12 Horas
METEOSAT	30 Minutos

Satellite Images

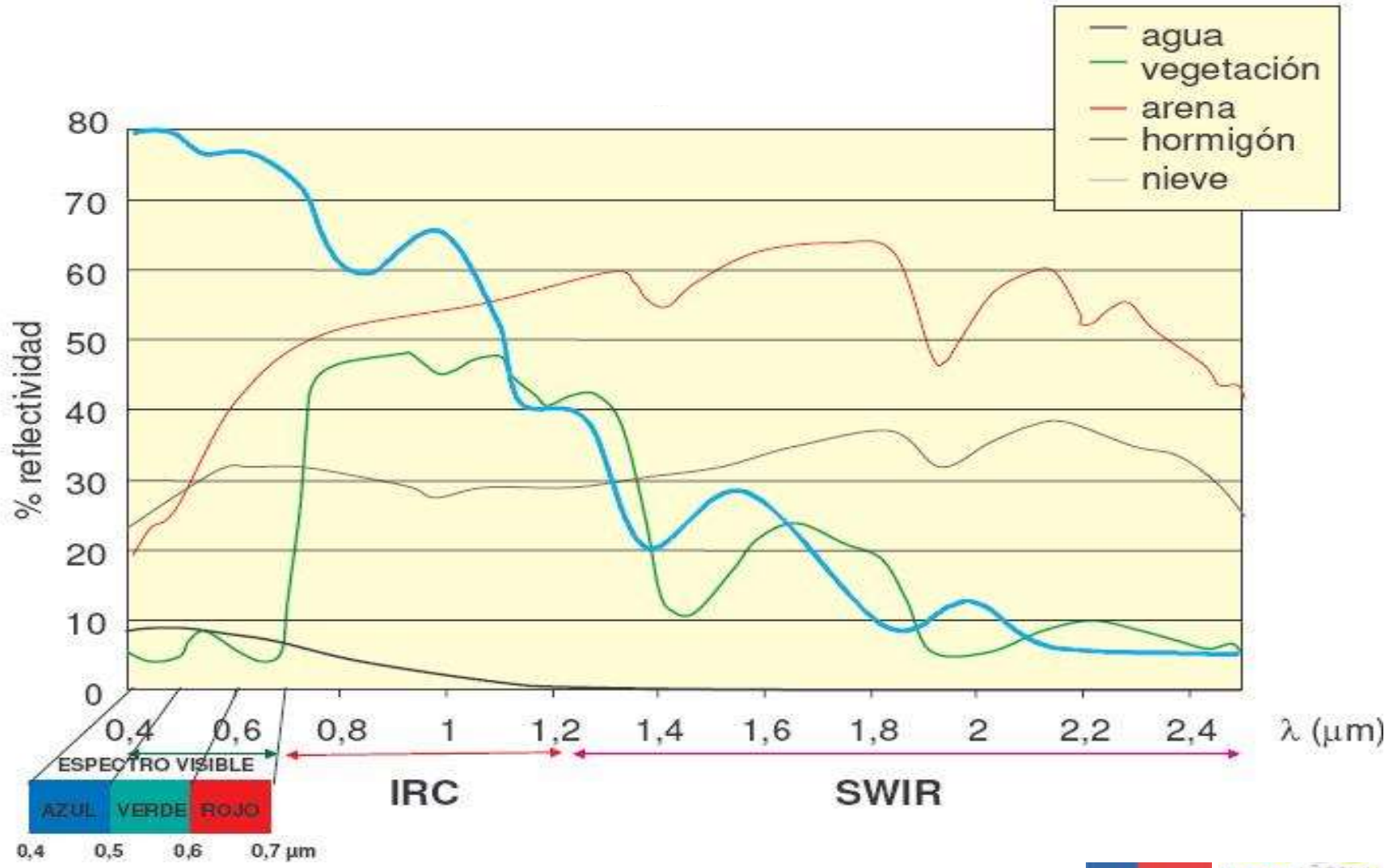
- Advantages
  - Covers large areas
  - Cost effective
  - Time efficient
  - Multi-temporal
  - Multi-sensor
  - Multi-spectral
  - Overcomes inaccessibility
  - Faster extraction of GIS-ready data

- Disadvantages
  - Needs ground verification
  - Doesn't offer details
  - Not the best tool for small areas
  - Needs expert system to extract data

Spectral signature

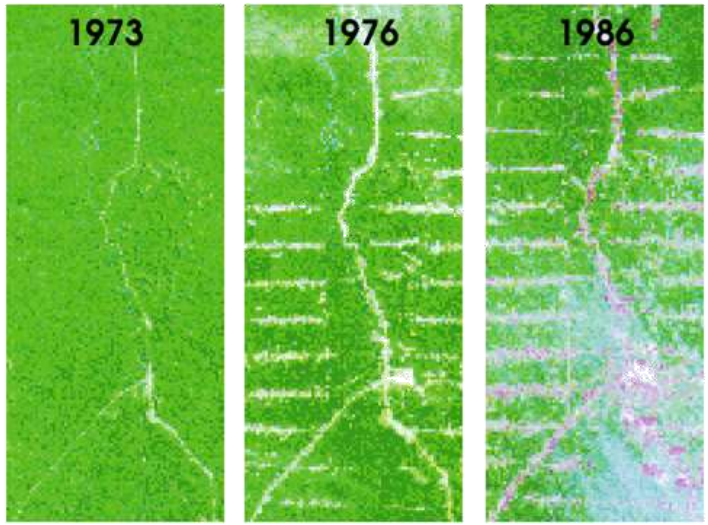
- The spectral signature, offers information about the surface that emits or reflects radiation.
- Every object that exists on Earth has its unique spectral signature or reflectance when exposed to light.
- The pattern of response spectral or spectral signature allows us to interpret the different States of an object.

Spectral signatures



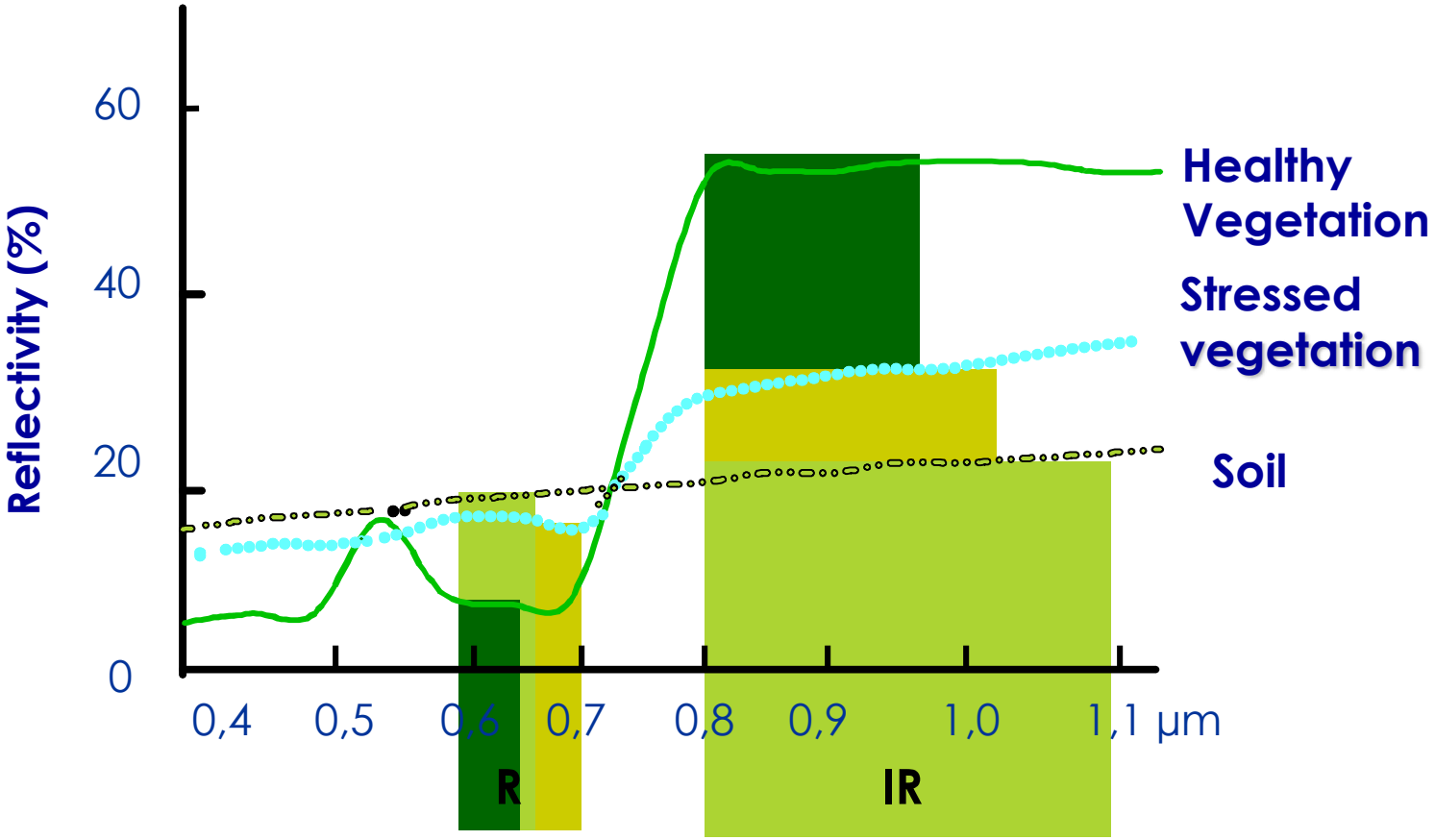
Application of Remote sensing

- Natural Resource Management
  - Habitat analysis
  - Environmental assessment
  - Pest/disease outbreaks
  - Impervious surface mapping
  - Lake monitoring
  - Hydrology
  - Landuse-Landcover monitoring
  - Mineral province
  - Geomorphology
  - Geology

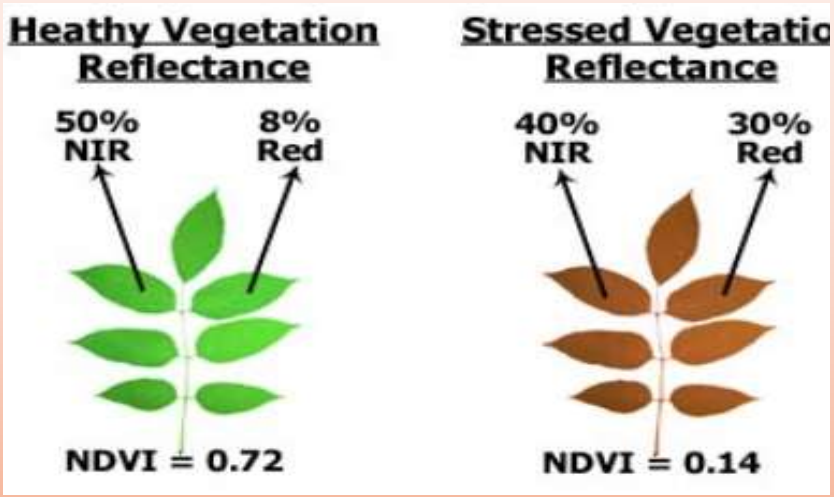


- Agriculture
  - Crop health analysis
  - Precision agriculture
  - Yield estimation

Vegetation Index

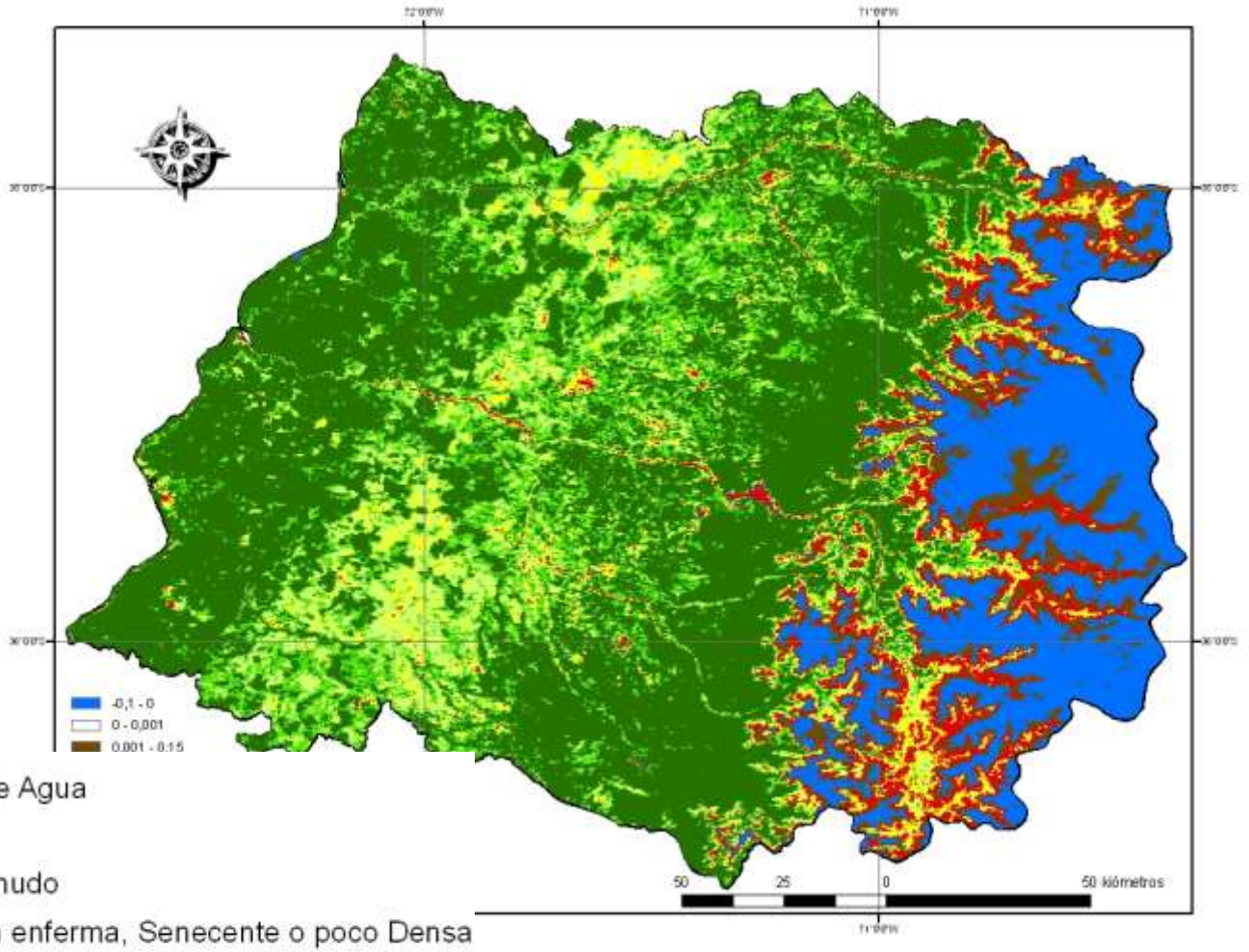


Normalized Difference Vegetation Index (NDVI)



$$NDVI = \frac{NIR - Red}{NIR + Red}$$

NDVI IN MAULE REGION



-0,2 - 0	Cuerpos de Agua
0 - 0,001	Nieve
0,001 - 0,15	Suelo Desnudo
0,15 - 0,3	Vegetación enferma, Senecente o poco Densa
0,3 - 0,4	
0,4 - 0,5	
0,5 - 0,6	
0,6 - 0,7	Vegetación Sana y Densa

Ministerio de Agricultura
Gobierno de Chile
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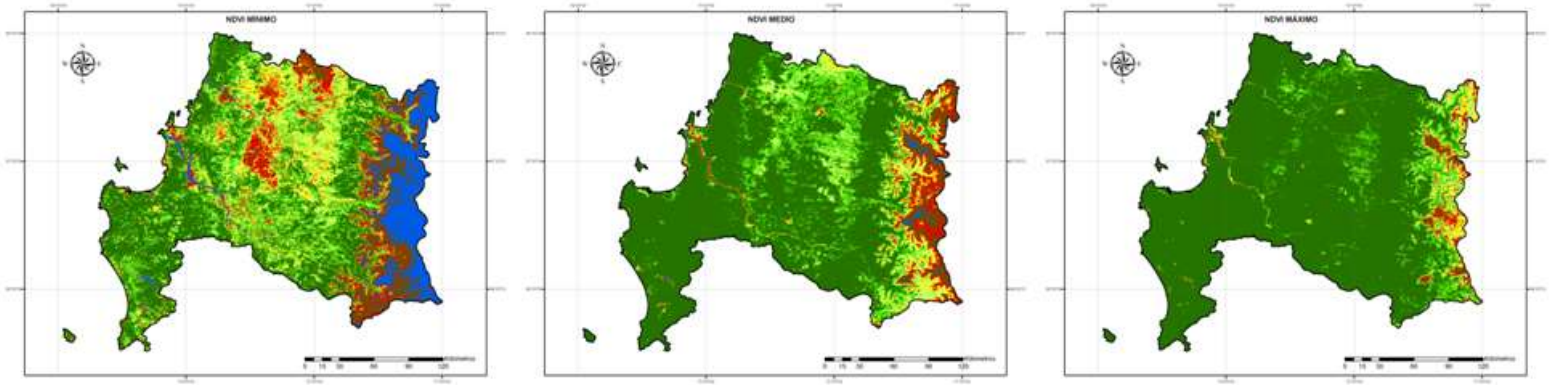
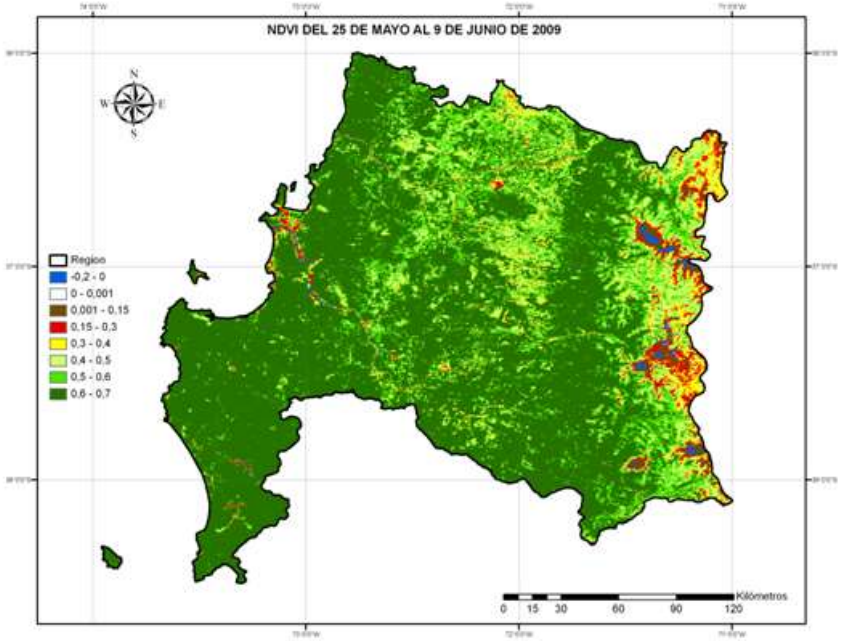
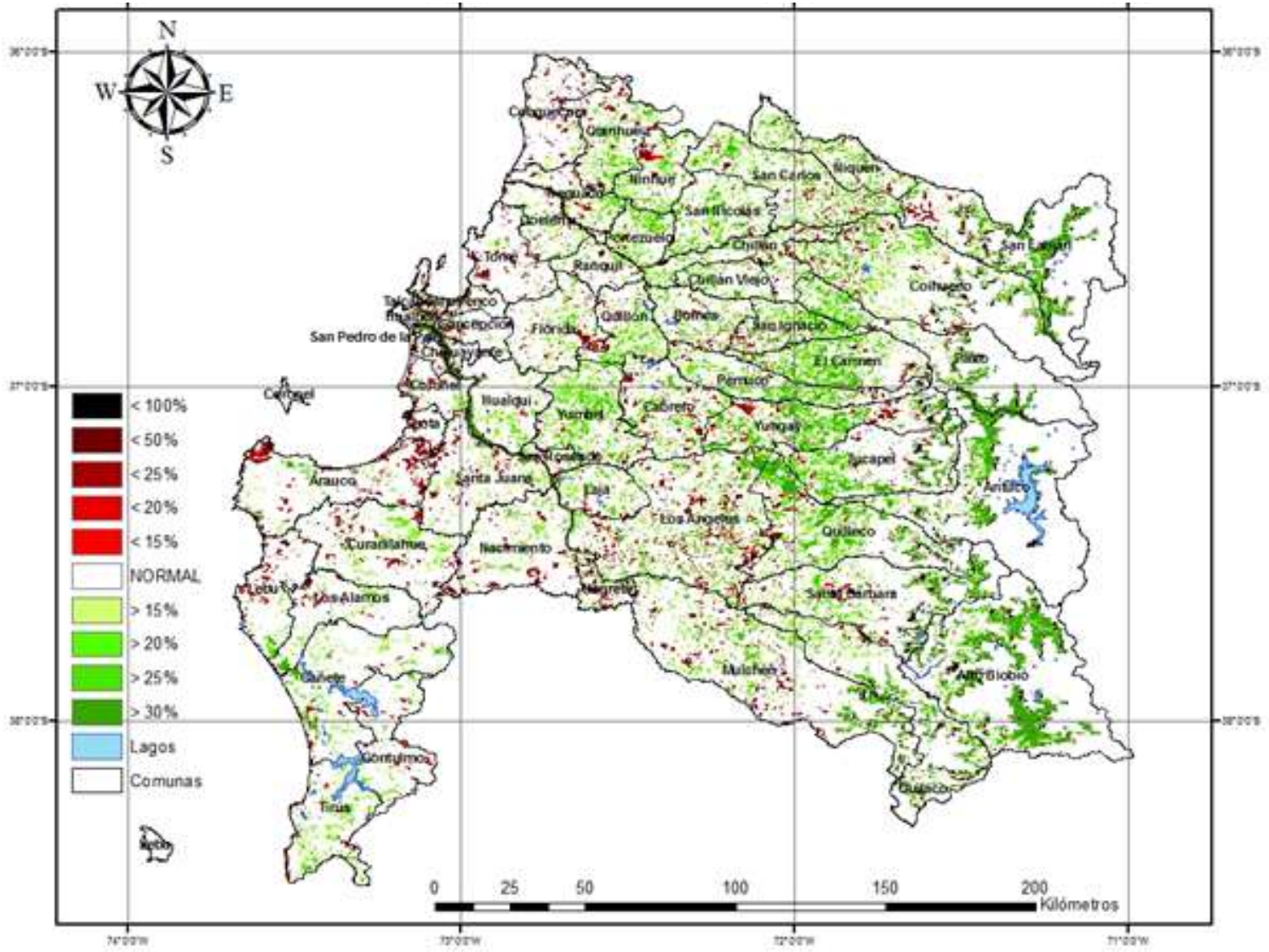
VISUAL COMPARISON

NDVI OCTAVA REGIÓN, 25 MAYO - 9 JUNIO

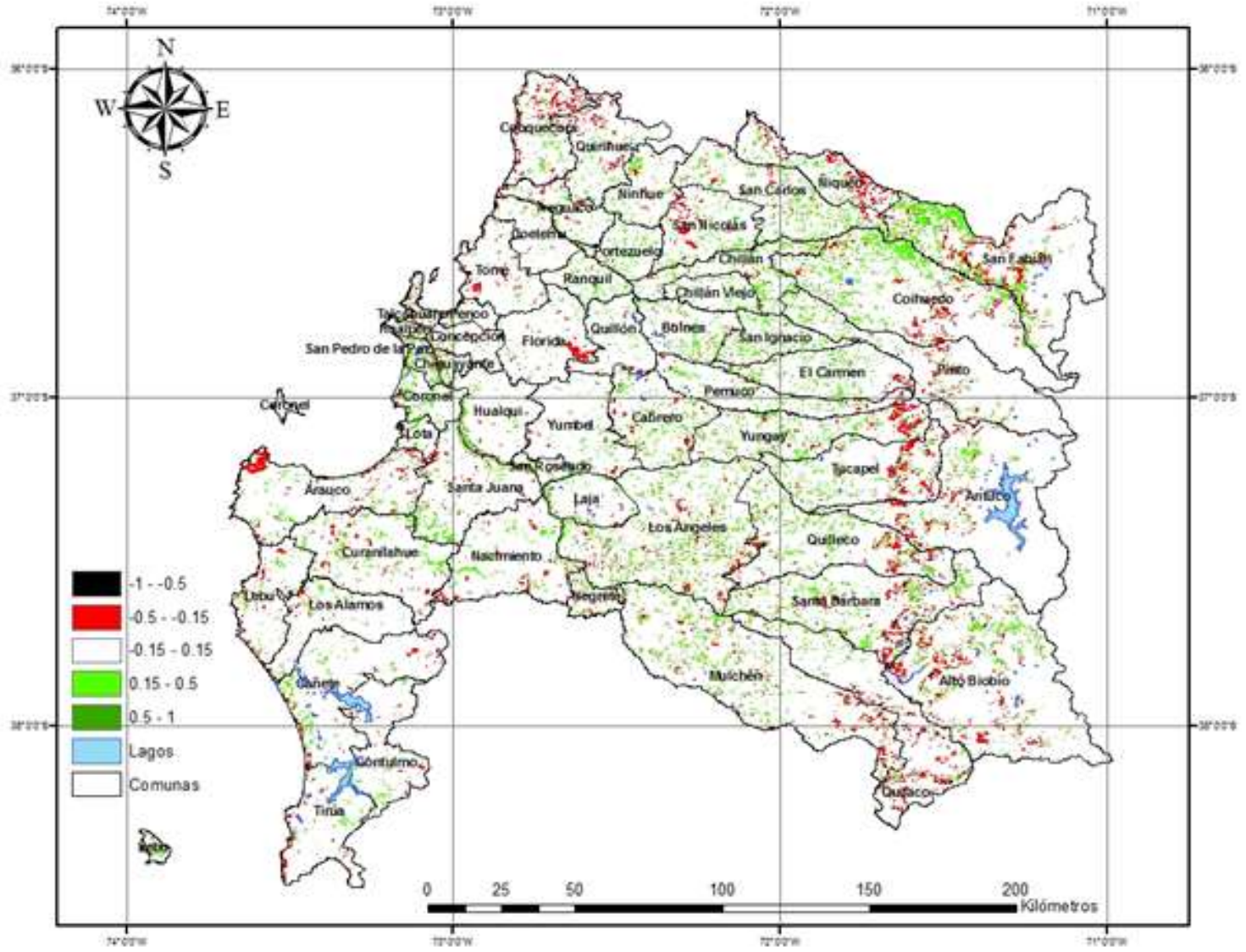




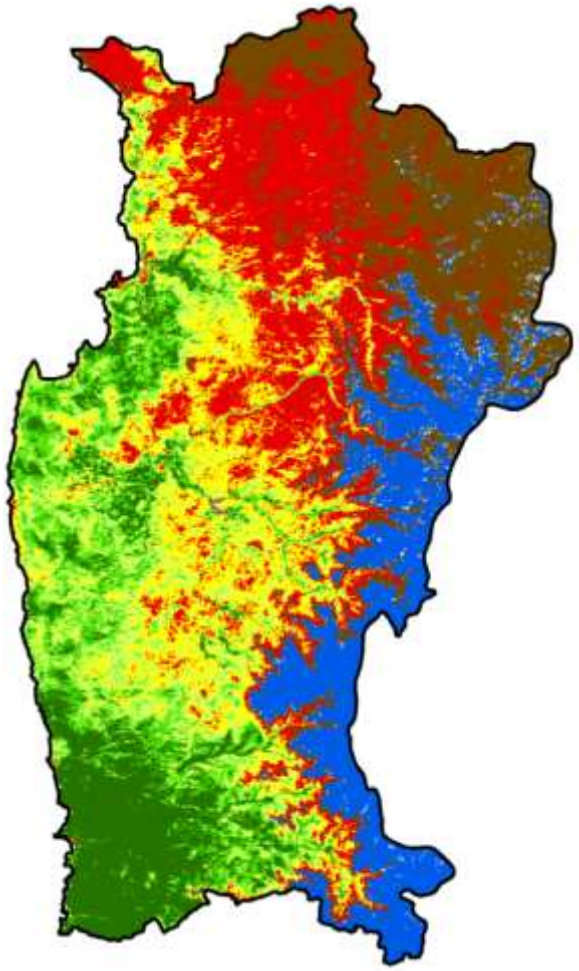
NDVI deviation (Ago 29-Sep 13 BIO BIO)



NDVI diference (Ago 29-Sep 13 BIO BIO)



Soil-adjusted Vegetation Index (SAVI)



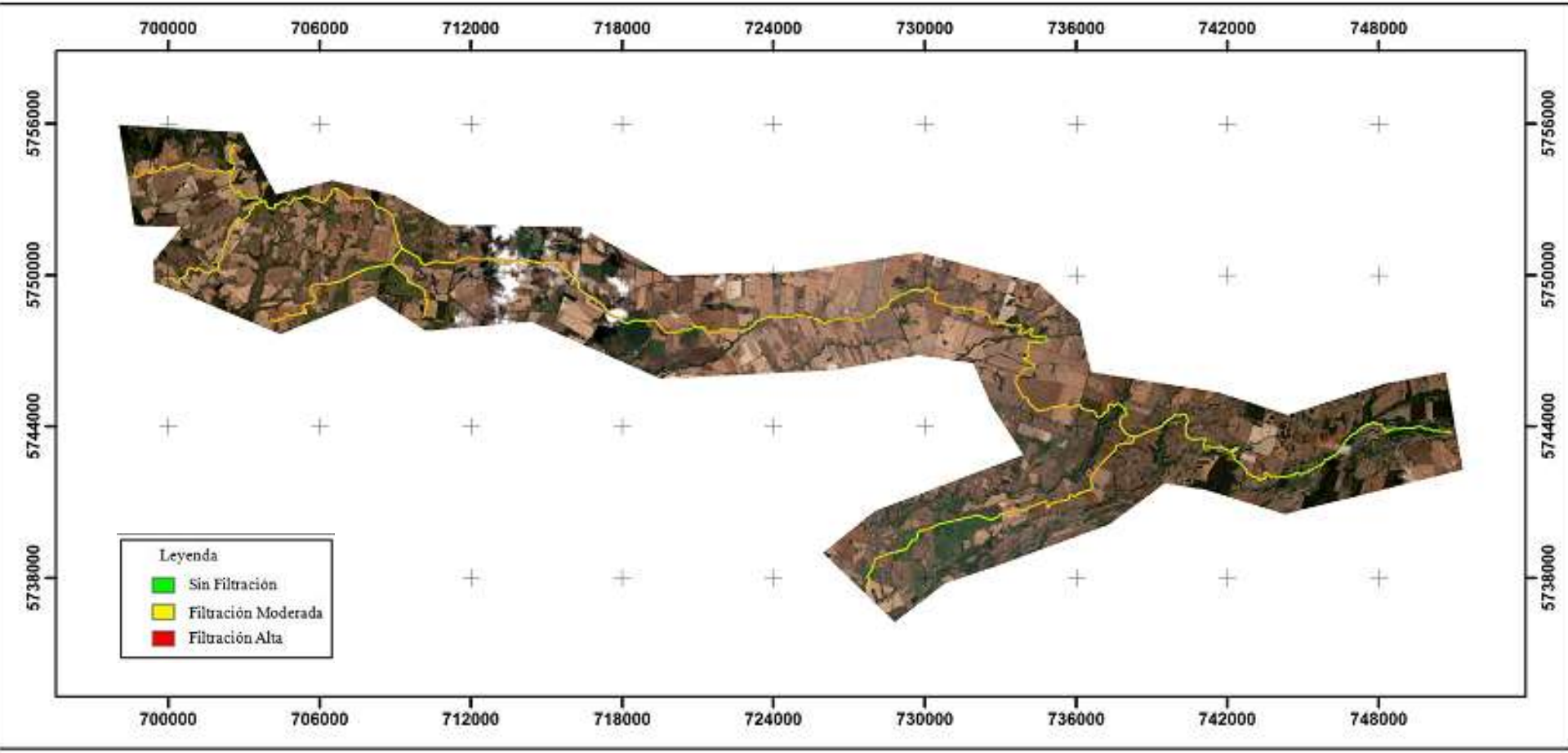
In areas where vegetative cover is low (i.e., < 40%) and the soil surface is exposed, the reflectance of light in the red and near-infrared spectra can influence vegetation index values.

The SAVI is structured similar to the NDVI but with the addition of a "soil brightness correction factor.

$$SAVI = (1+L)\cdot\frac{\rho_{NIR}-\rho_{red}}{\rho_{NIR}+\rho_{red}+L}$$

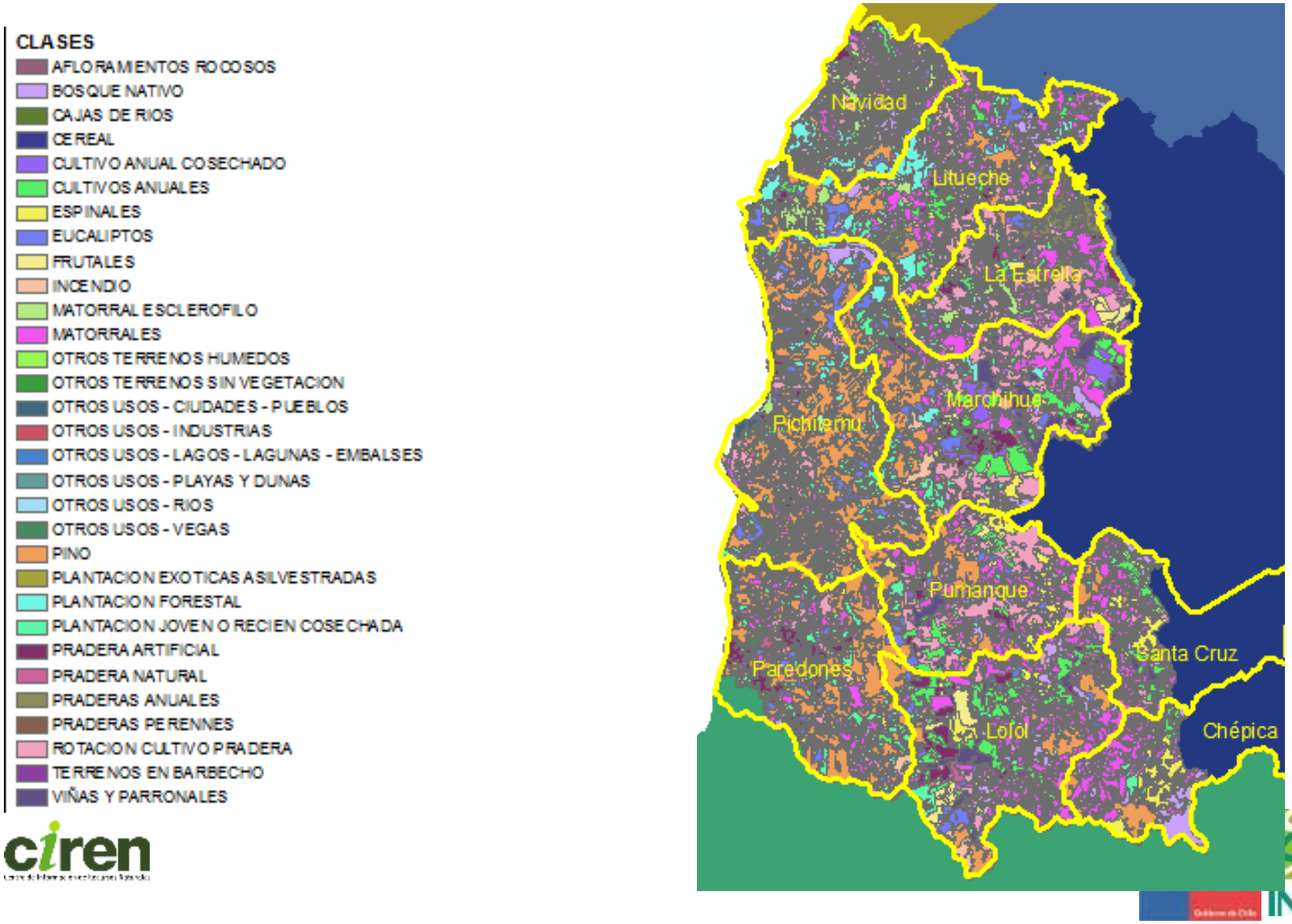
L = 0.5

Seepage losses in irrigation canals

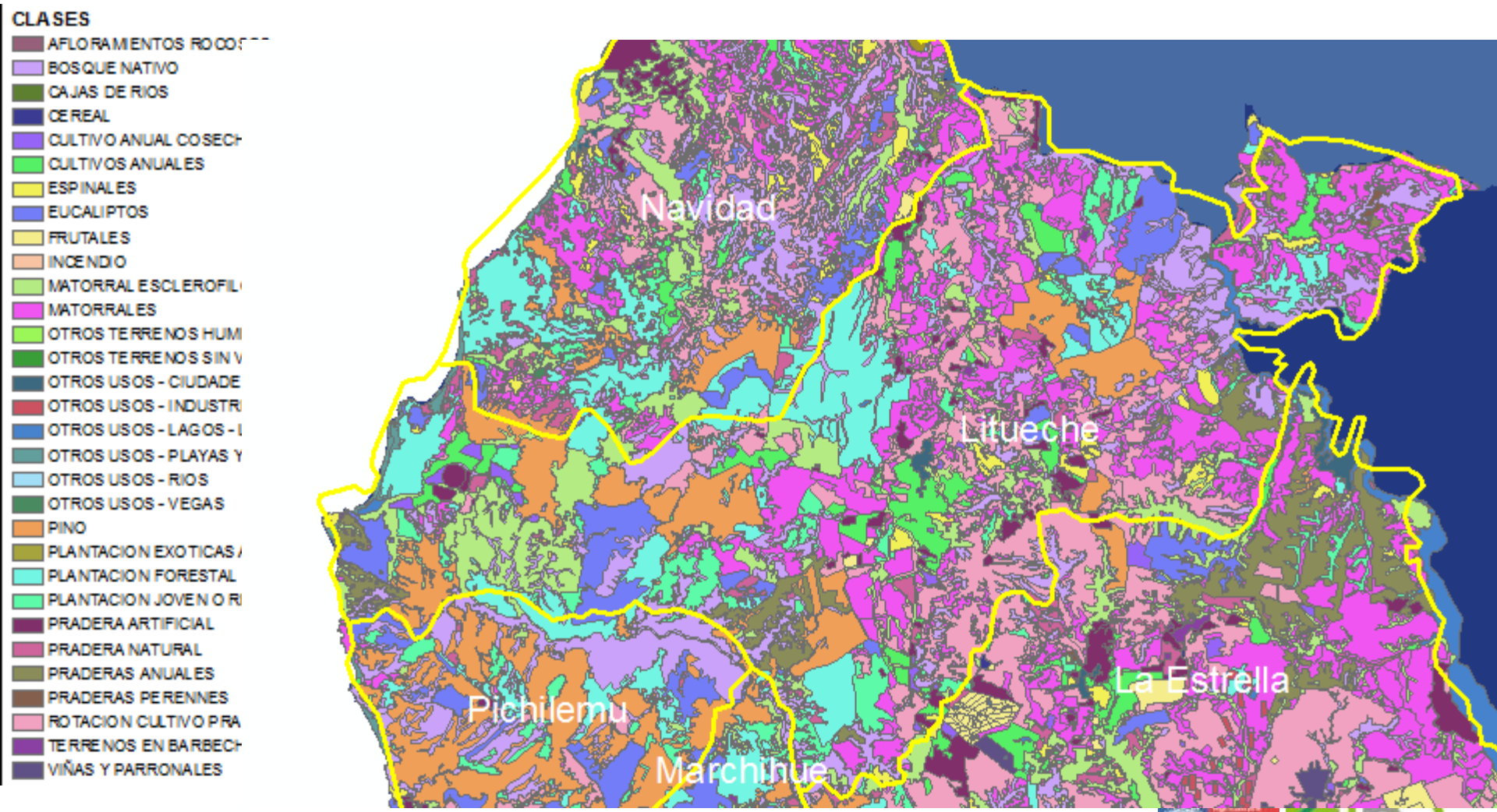


WORLDVIEW-2 : Multiespectral 4-bandas (RGB + NIR).
PANCROMATICA : 0.5 m
MULTIESPECTRAL 2.0 m

Land use clasification



Land use clasification



Thank you