

Análisis de imágenes  
para ciencias de la vida

# Imágenes satelitales



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  - \* Aplicaciones
- \* Procesamiento de imágenes
  - \* Introducción
  - \* Intensidad
  - \* Filtrado
  - \* Segmentación
  - \* **Georeferenciación**

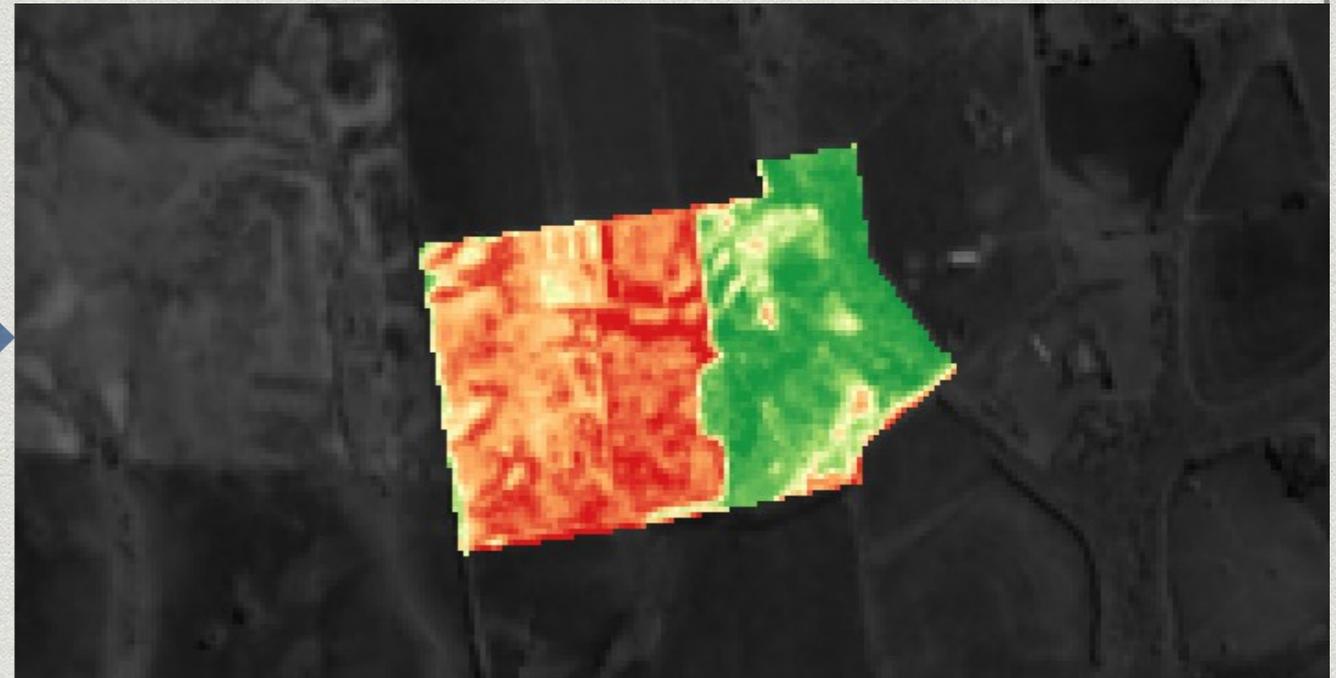
# Objetivo

## Analizar NDVI:

- Calcular NDVI
- Identificar zonas de rendimiento uniforme

# Objetivo

## Calcular NDVI



# Objetivo



ROI Manager

0266-0150  
0171-0361  
0411-0282

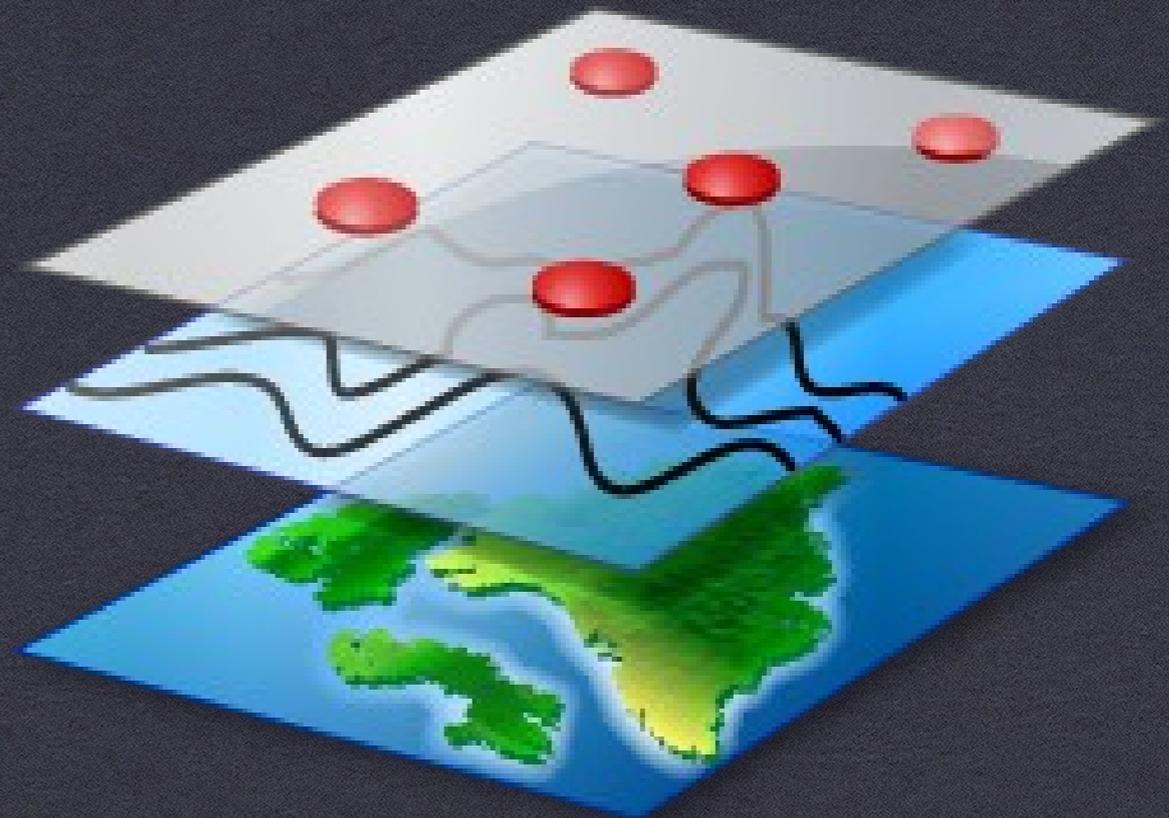
Add [t]  
Update  
Delete  
Rename...  
Measure  
Deselect  
Properties...  
Flatten [F]  
More »  
 Show All  
 Labels

## Results

Label	Area	Mean	Min	Max	X	Y	XM	YM	BX	BY	Width	Height	Circ.	AR	Round	Solidity
1 contraste_bn_base.png:0266-0150	6817	54.111	46	85	145.462	269.272	145.530	268.252	115	178	61	181	0.456	4.672	0.214	1.000
2 contraste_bn_base.png:0171-0361	4959	82.906	33	109	362.520	170.814	362.155	170.626	321	131	80	80	0.769	1.127	0.887	1.000
3 contraste_bn_base.png:0411-0282	15839	42.389	9	98	286.279	419.540	285.341	417.965	202	341	161	141	0.623	1.131	0.884	0.880

# Georeferenciación

- Cálculo de NDVI
- Imágenes satelitales
- Flujo de trabajo
- Software
- Ejemplo



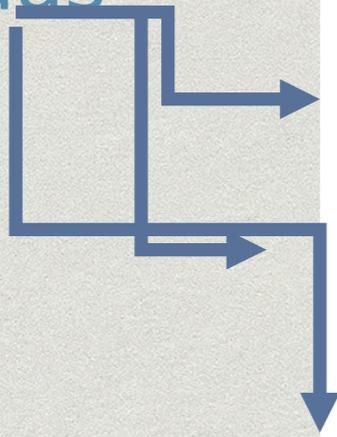
# NDVI

- \* Normalized Difference Vegetation Index
- \* Indicador:
  - \* estado de un cultivo
  - \* Presencia o ausencia de plantas
- \*  $NDVI = (NIR - RED) / (NIR + RED)$
- \* Absorción energética debido a la fotosíntesis

# NDVI

## ✱ Espectro Visible

Bandas



Color	Wavelength	Frequency	Photon energy
Violet	380–450 nm	668–789 THz	2.75–3.26 eV
Blue	450–495 nm	606–668 THz	2.50–2.75 eV
Green	495–570 nm	526–606 THz	2.17–2.50 eV
Yellow	570–590 nm	508–526 THz	2.10–2.17 eV
Orange	590–620 nm	484–508 THz	2.00–2.10 eV
Red	620–750 nm	400–484 THz	1.65–2.00 eV

A horizontal color bar representing the visible spectrum. It shows a gradient from violet on the left to red on the right, with a black section at the far right. Wavelength markers in nanometers (nm) are placed above the bar: 380, 450, 495, 570, 590, 620, and 750. The corresponding color names are placed above the markers: V (Violet) between 380 and 450, B (Blue) between 450 and 495, G (Green) between 495 and 570, Y (Yellow) between 570 and 590, O (Orange) between 590 and 620, and R (Red) between 620 and 750.

# NDVI

## \* Relación con los colores

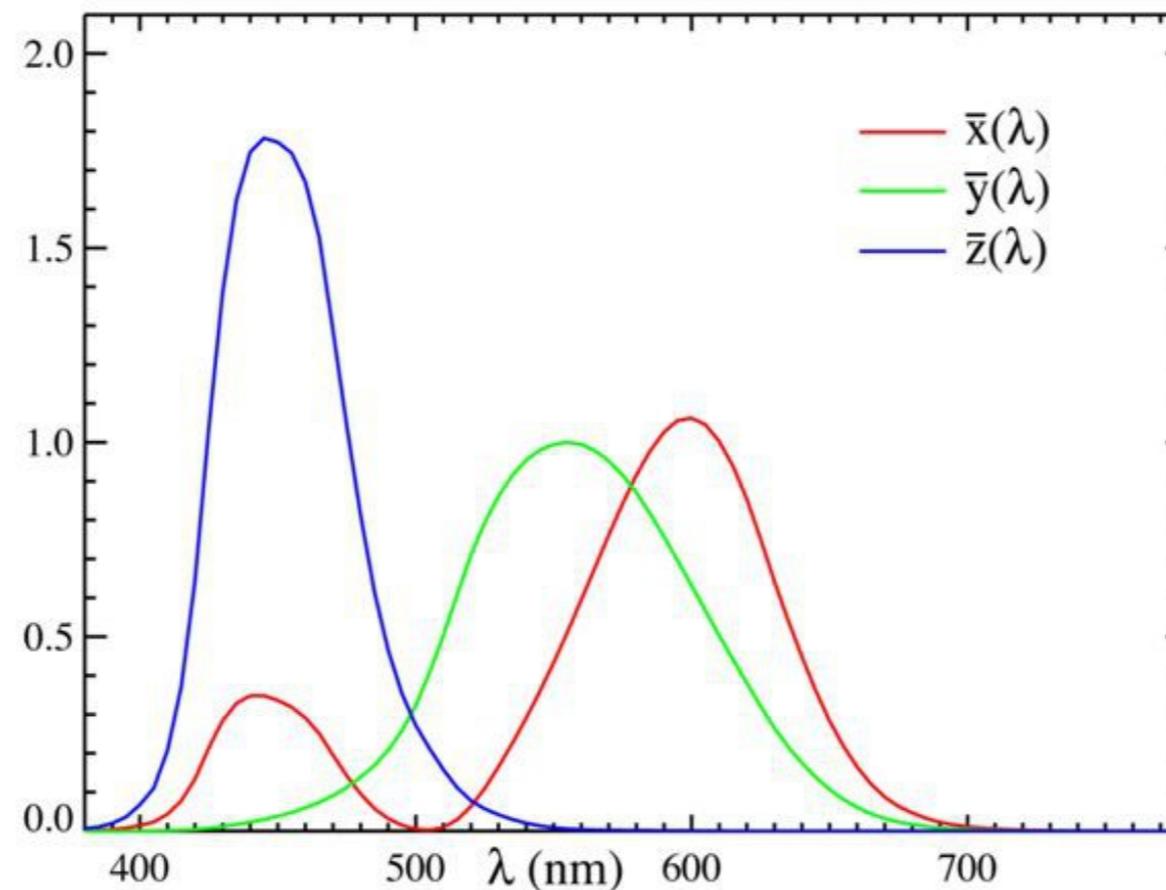
### The CIE standard observer color-matching functions

Tristimulus values

$$X = \int_0^{\infty} I(\lambda) \bar{x}(\lambda) d\lambda$$

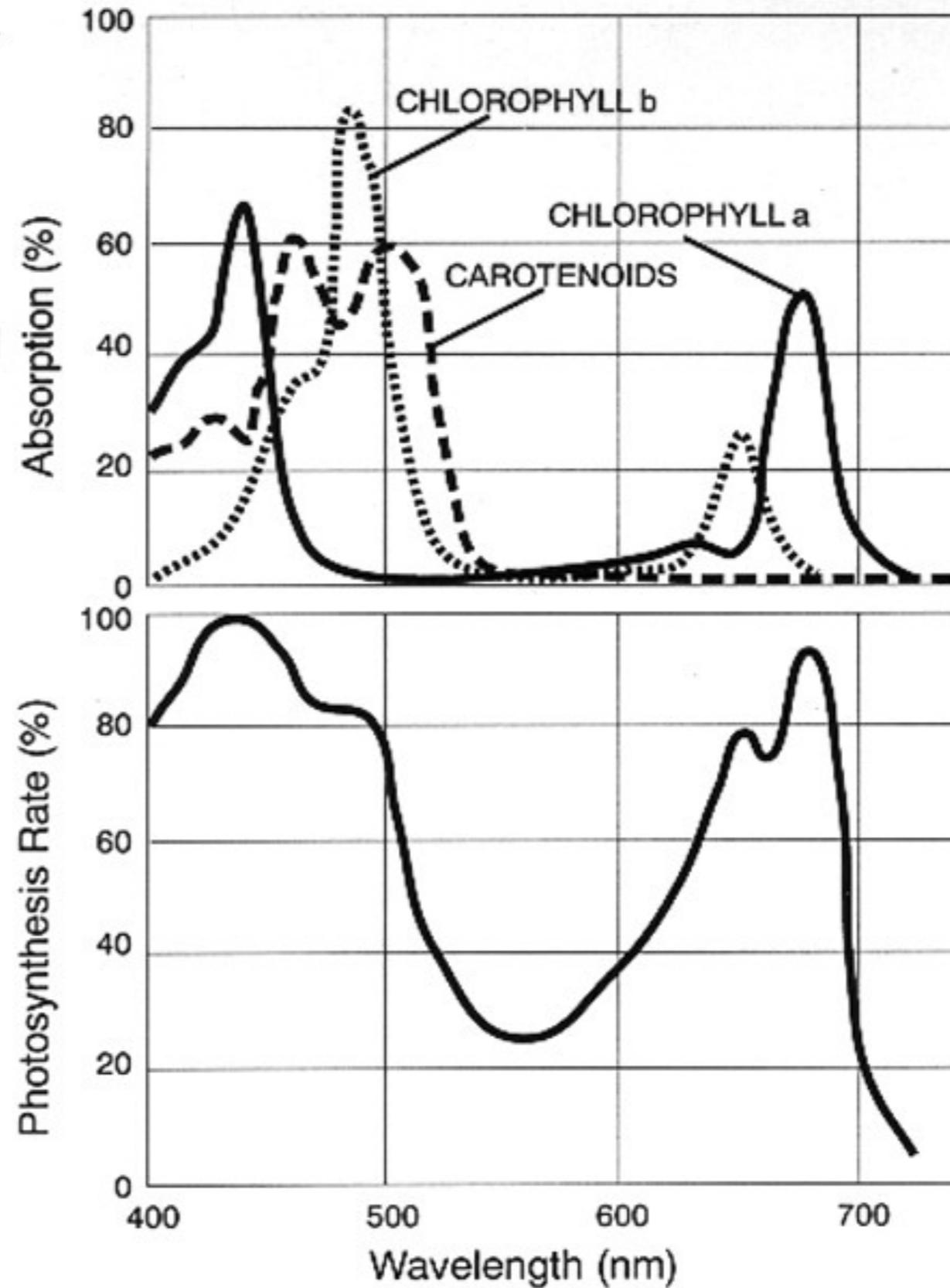
$$Y = \int_0^{\infty} I(\lambda) \bar{y}(\lambda) d\lambda$$

$$Z = \int_0^{\infty} I(\lambda) \bar{z}(\lambda) d\lambda$$



Other observers, such as for the CIEXYZ space or other [RGB color spaces](#), are defined by other sets of three color-matching functions, and lead to tristimulus values in those other spaces

# NDVI



Radiación fotosintéticamente activa: 400-700nm

# Imágenes satelitales



- \* Multi-banda: permiten ver la absorción de energía en otros rangos
- \* Alta densidad, poca frecuencia temporal, poca resolución espacial
  - \* Diferentes tipos de satélites

# LandSat 8



✳ Resolución espacial: 15 o 30

✳ Área de cobertura: 185x185

✳ Frecuencia temporal: Cada 16 días, separado 8 del LandSat 7

✳ 8 bandas

<b>Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensor (TIRS)</b>	<b>Bands</b>	<b>Wavelength (micrometers)</b>	<b>Resolution (meters)</b>
	Band 1 - Ultra Blue (coastal/aerosol)	0.435 - 0.451	30
	Band 2 - Blue	0.452 - 0.512	30
	Band 3 - Green	0.533 - 0.590	30
	Band 4 - Red	0.636 - 0.673	30
	Band 5 - Near Infrared (NIR)	0.851 - 0.879	30
	Band 6 - Shortwave Infrared (SWIR) 1	1.566 - 1.651	30
	Band 7 - Shortwave Infrared (SWIR) 2	2.107 - 2.294	30
	Band 8 - Panchromatic	0.503 - 0.676	15
	Band 9 - Cirrus	1.363 - 1.384	30
	Band 10 - Thermal Infrared (TIRS) 1	10.60 - 11.19	100 * (30)
	Band 11 - Thermal Infrared (TIRS) 2	11.50 - 12.51	100 * (30)

# LandSat 8



\* Tamaño en pixeles (por imagen): 6000x6000 o 12000x12000

\* Tamaño en bytes:  $2.3 \times 10^9$  ~ 2Gb

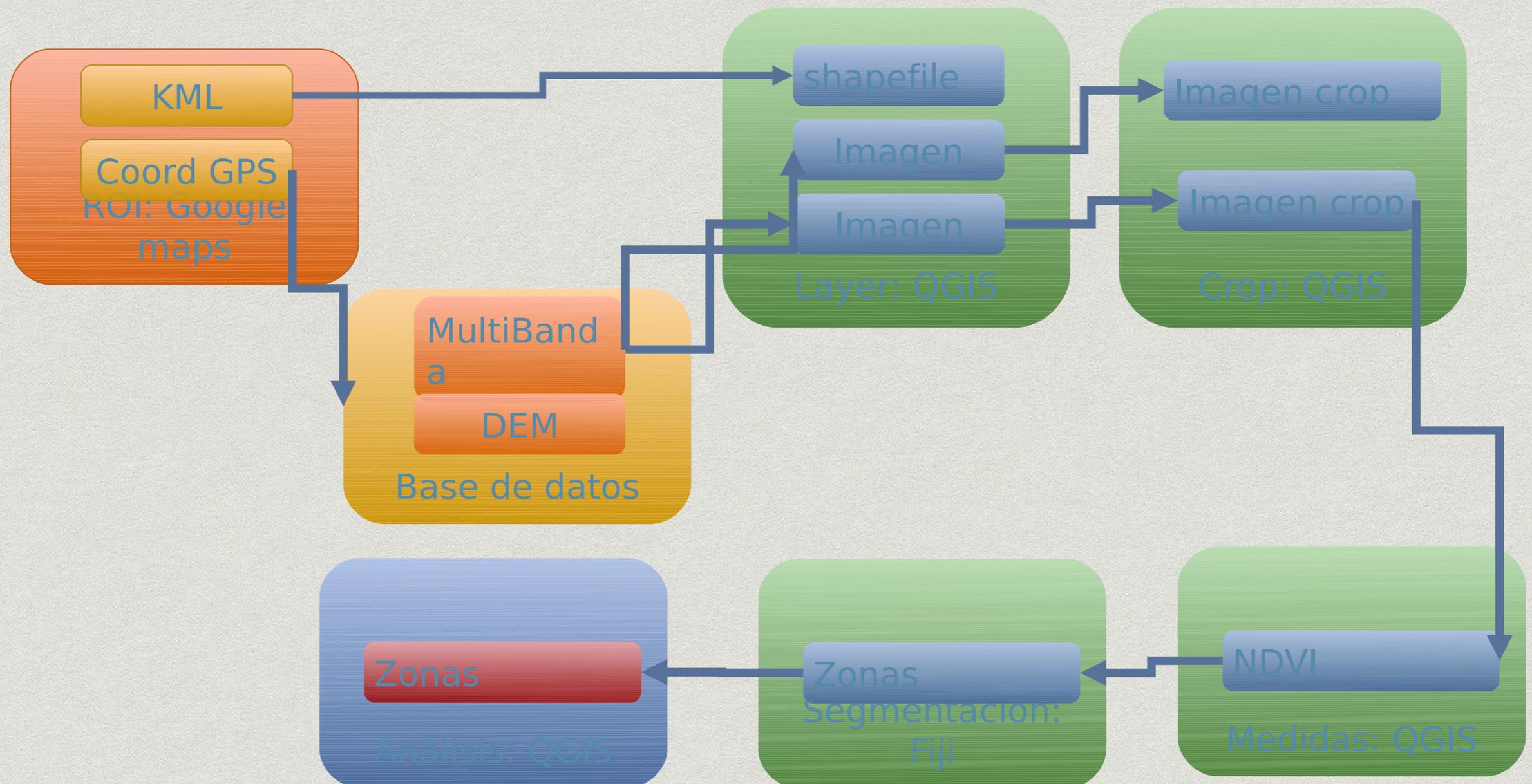
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# Imágenes satelitales



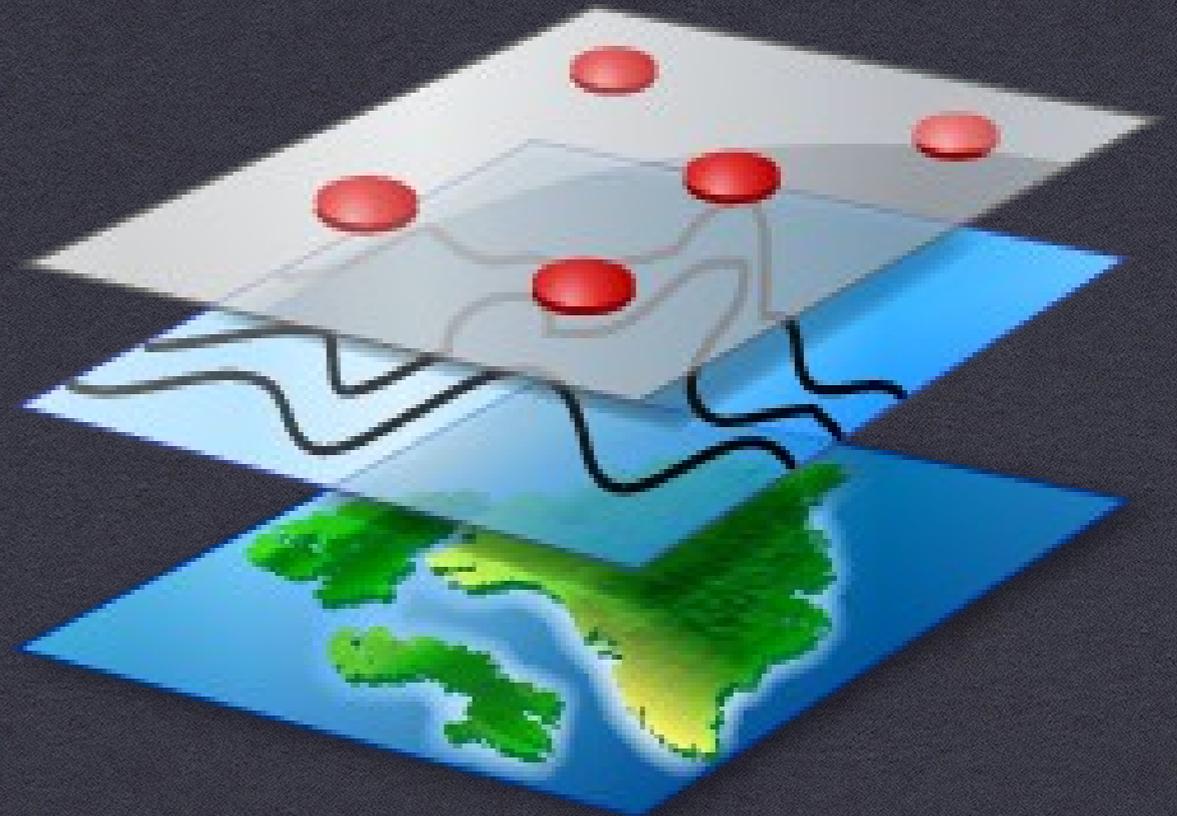
- \* Se organizan en bases de datos publicas:
- \* Copernicus (Europa): <http://www.copernicus.eu/>
- \* Earth Explorer (USA): <https://earthexplorer.usgs.gov/>
- \* Uruguay:
- \* Topografía

# Flujo de trabajo



# Ejemplo

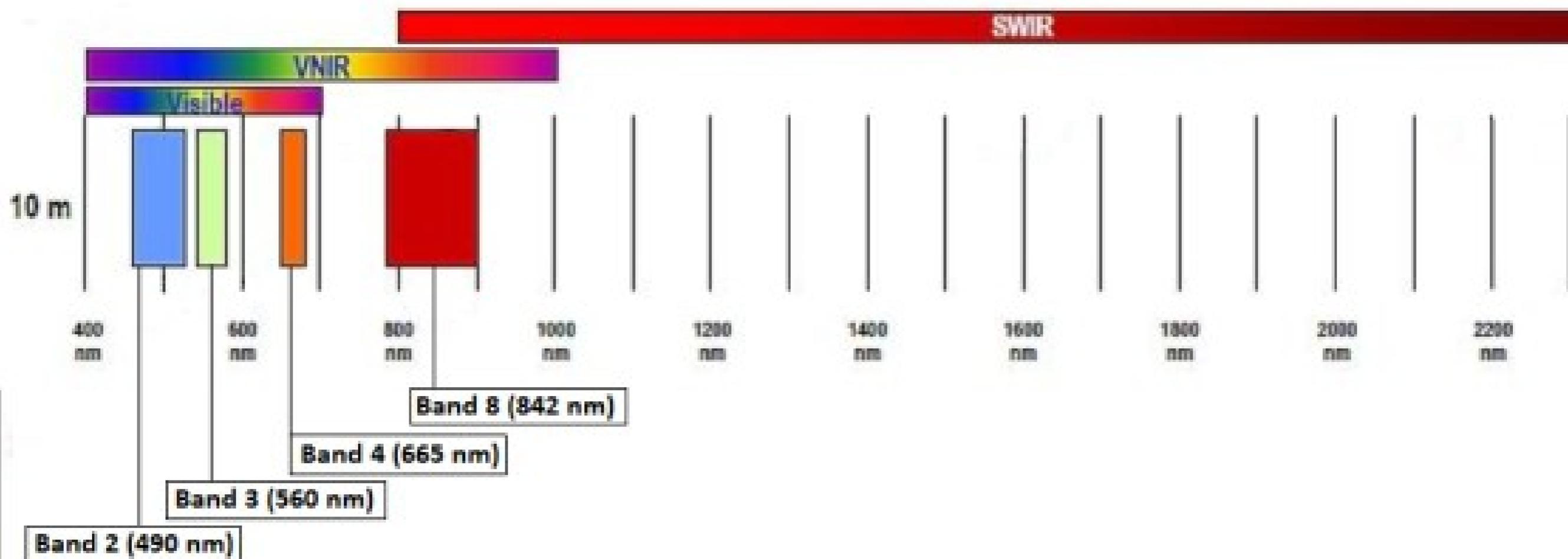
- Cálculo de NDVI
- Sentinel-2
- Copernicus
- QGIS



# Sentinel 2



- \* Resolución espacial: 10 m
- \* Área de cobertura: 290 km<sup>2</sup>
- \* 8 bandas, 10k × 10k pixels/imagen
- \* Frec. temporal: Cada 10 días, separado 8 del LandSat 7



# Sentinel 2



## Que se puede ver?

- \* all continental land surfaces (including inland waters) between latitudes  $56^{\circ}$  south and  $84^{\circ}$  north
- \* all coastal waters up to 20 km from the shore
  - \* all islands greater than 100 km<sup>2</sup>
    - \* all EU islands
    - \* the Mediterranean Sea
  - \* all closed seas (e.g. Caspian Sea).

# Sentinel 2

Que se puede ver?



Spatial Resolution (m)	Band Number	S2A		S2B	
		Central Wavelength (nm)	Bandwidth (nm)	Central Wavelength (nm)	Bandwidth (nm)
10	2	496.6	98	492.1	98
	3	560.0	45	559	46
	4	664.5	38	665	39
	8	835.1	145	833	133
20	5	703.9	19	703.8	20
	6	740.2	18	739.1	18
	7	782.5	28	779.7	28
	8a	864.8	33	864	32
	11	1613.7	143	1610.4	141
	12	2202.4	242	2185.7	238
60	1	443.9	27	442.3	45
	9	945.0	26	943.2	27
	10	1373.5	75	1376.9	76