UNIVERSIDAD
NACIONAL
DE COLOMBIA

PROYECTO **CULTURAL, CIENTÍFICO Y COLECTIVO** DE NACIÓN

Detection of land cover change using remote sensing

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Detection of land cover change using remote sensing

Land cover

Biophysical description of the land surface

Vegetation

Plants and natural ecosystems

Bodies of Water

Rivers, lakes, and oceans

Urban Areas

Cities and man-made structures

Agricultural Zones

Cropland and farms

Detection of land cover change using remote sensing

Importance

Unmonitored ecosystems

Untracked land cover transformations

Mapping of land cover

Mapping of land cover and monitoring

Impact assessment

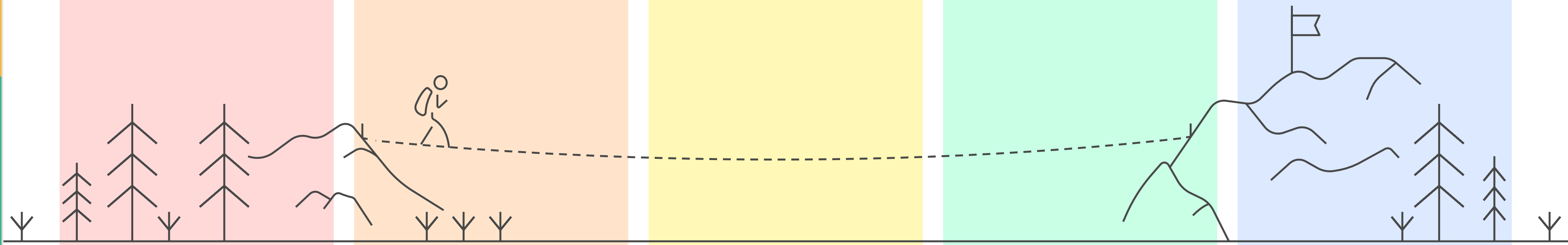
Assessment of impact on global climate

Identification of vulnerable areas

Identification of vulnerable areas and prediction of impacts

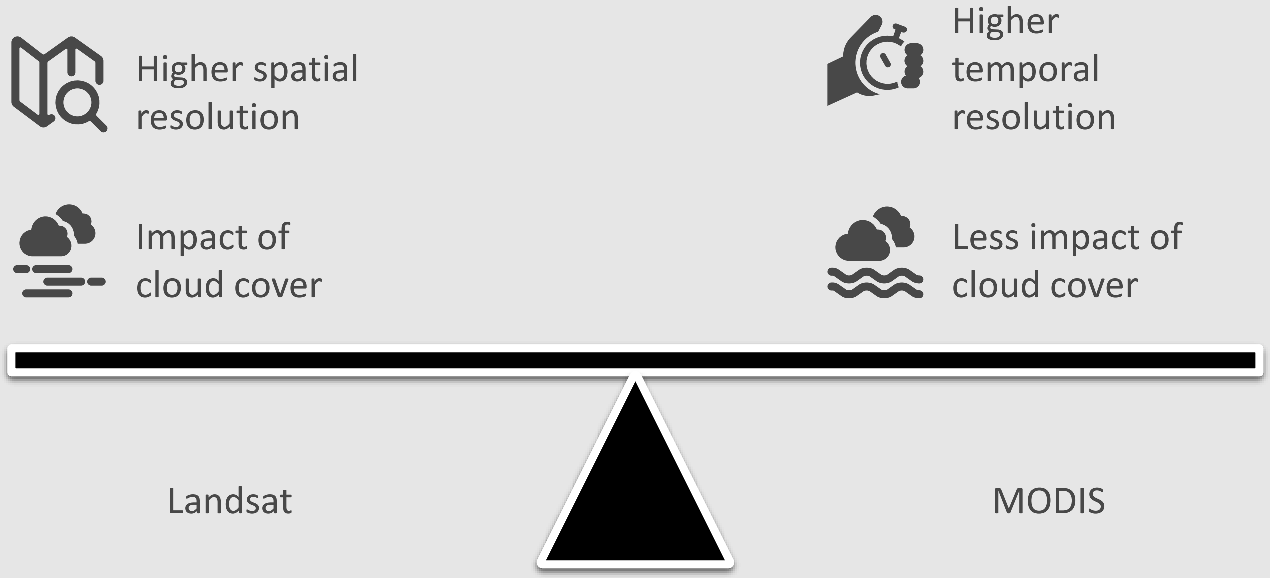
Resilient ecosystems

Mitigation and adaptation strategies implemented



Detection of land cover change using remote sensing

Advances in change detection



Detection of land cover change using remote sensing

Algorithms for change detection

Algorithm	Description	Advantages	Limitations	Sources
CCDC	Harmonic model that uses all available Landsat images to detect changes continuously	High temporal and spatial accuracy, does not require thresholds.	High computational cost.	Zhu & Woodcock, 2014
CCDC-SMA	Combines CCDC with spectral analysis (SMA) to detect gradual and subtle degradation.	Detects sub-pixel changes and progressive degradation.	Requires high-quality spectral mixture data.	Chen et al., 2021
LandTrendr	Segments annual Landsat time series with straight lines to identify disturbances and recovery.	Ideal for abrupt changes; validated with field data.	It may not adequately capture very short-term events or anomalies if there is insufficient temporal data density.	Kennedy et al., 2010
MDDI	Index based on NIR and SWIR bands with LandTrendr to detect tropical deforestation.	Accuracy >80% in humid forests.	Low accuracy in dry areas due to exposed soils.	Hurtado & Lizarazo, 2021

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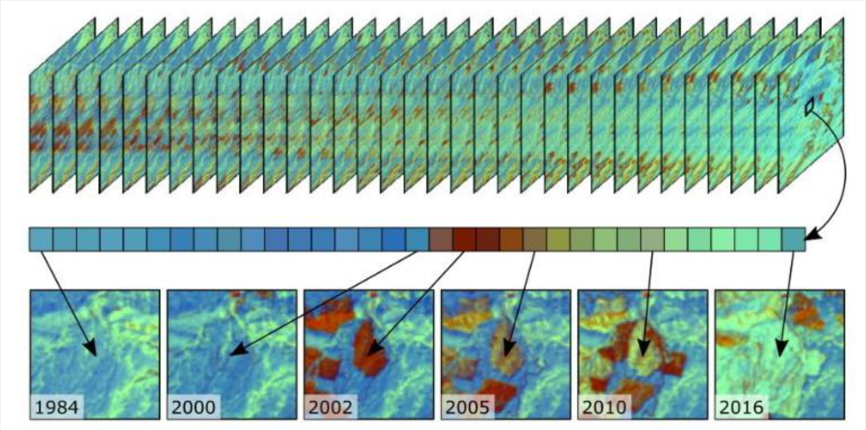
LandTrendr

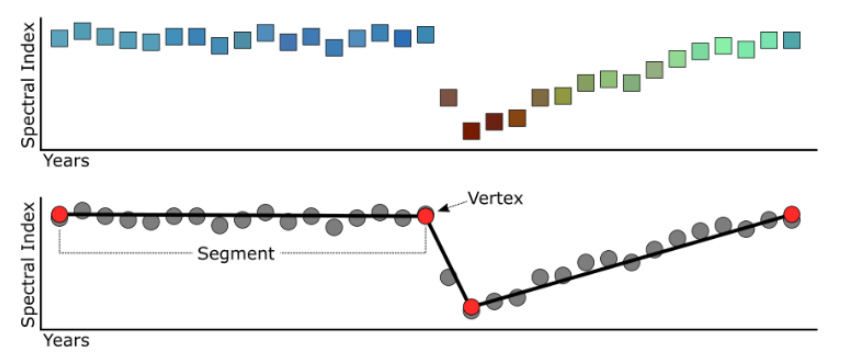
Input

Annual time series of an index.



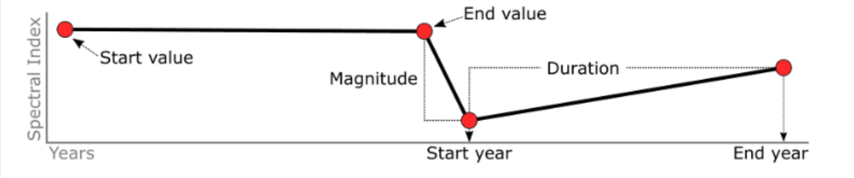
Process

Detects change vertices and allows interpolation.



Output

Simplified trajectory + temporal metrics.



More information

Detection of land cover change using remote sensing

Methodology

- Exploratory analysis
  - MODIS
- Preprocessing
  - Annual maximum NDVI
  - Annual total precipitation
  - Simple linear regression per pixel
  - Calculate residuals
- Temporal segmentation
  - NDVI residual
  - Segmentation using fitted values
- Unsupervised classification
  - K-means
  - Classify pixels

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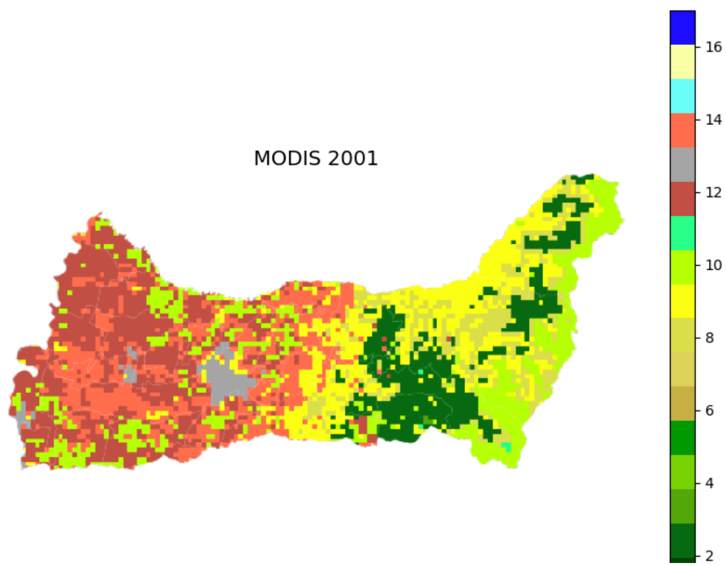
Methodology: exploratory analysis

Exploratory analysis

MODIS

Atributo	MCD12Q1 - Cobertura de Suelo	MOD13Q1 - Vegetación (NDVI/EVI)
Producto	Clasificación global de cobertura de suelo	Índices de vegetación NDVI y EVI
Resolución Espacial	500 m a 1 km (según versión)	250 m
Resolución Temporal	Anual	Cada 16 días
Periodo Disponible	Desde 2001 hasta la actualidad	Desde 2000 hasta la actualidad
Bandas/Variables	`LC_Type1` a `LC_Type5` (Categorías de uso/cobertura)	NDVI, EVI, Ángulos de visión, Calidad (QA)
Cobertura Geográfica	Global	Global
Detección de Cambio	Cambios anuales en el uso/cobertura del suelo	Cambios estacionales o intra-anuales en la vegetación



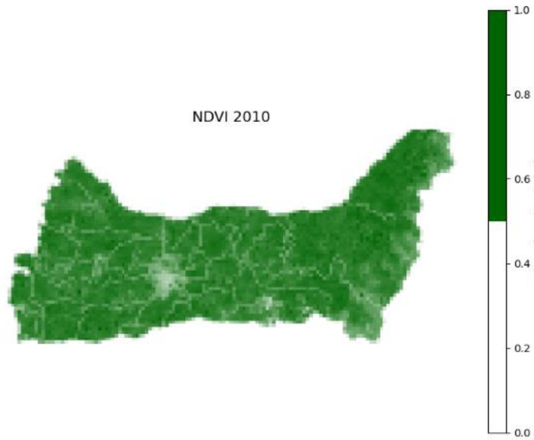
Clase	Color Hex	Descripción
0	`#05450a`	Sin asignar
1	`#086a10`	Bosque de hoja perenne de coníferas
2	`#54a708`	Bosque de hoja perenne de latifoliadas
3	`#78d203`	Bosque de hoja caduca de coníferas
4	`#009900`	Bosque de hoja caduca de latifoliadas
5	`#c6b044`	Bosque mixto
6	`#dcd159`	Matorral cerrado
7	`#dade48`	Matorral abierto (leñosas 1-2 m, 10-60% cobertura)

Detection of land cover change using remote sensing

Methodology: preprocessing

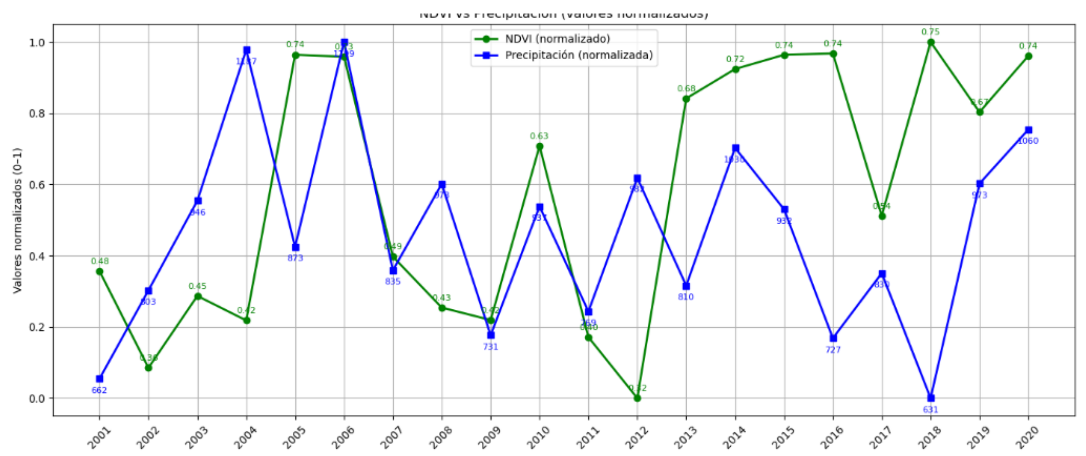
Preprocessing

- Annual maximum NDVI
- Annual total precipitation
- Simple linear regression per pixel
- Calculate residuals



CHIRPS

- **Cobertura:** Cuasi-global (50°N a 50°S)
- **Resolución espacial:** 0.05° (~5 km)
- **Resolución temporal:** Diario, 10 días, Mensual
- **Período:** 1981 - Actualidad
- **Fuente:** Satélite + Estaciones meteorológicas
- **Acceso en Earth Engine:** `UCSB-CHG/CHIRPS/DAILY`



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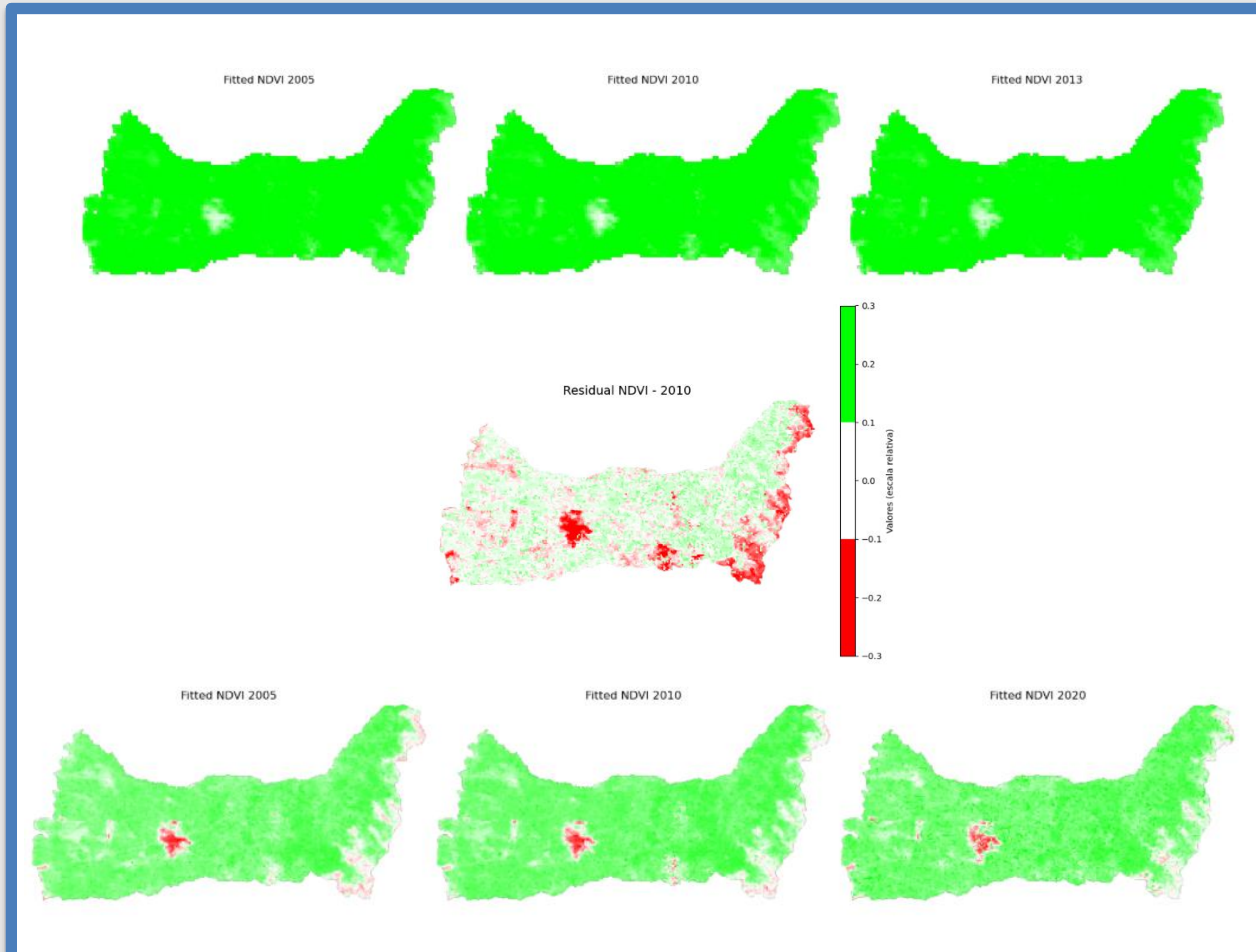
Methodology: temporal segmentation

Temporal segmentation

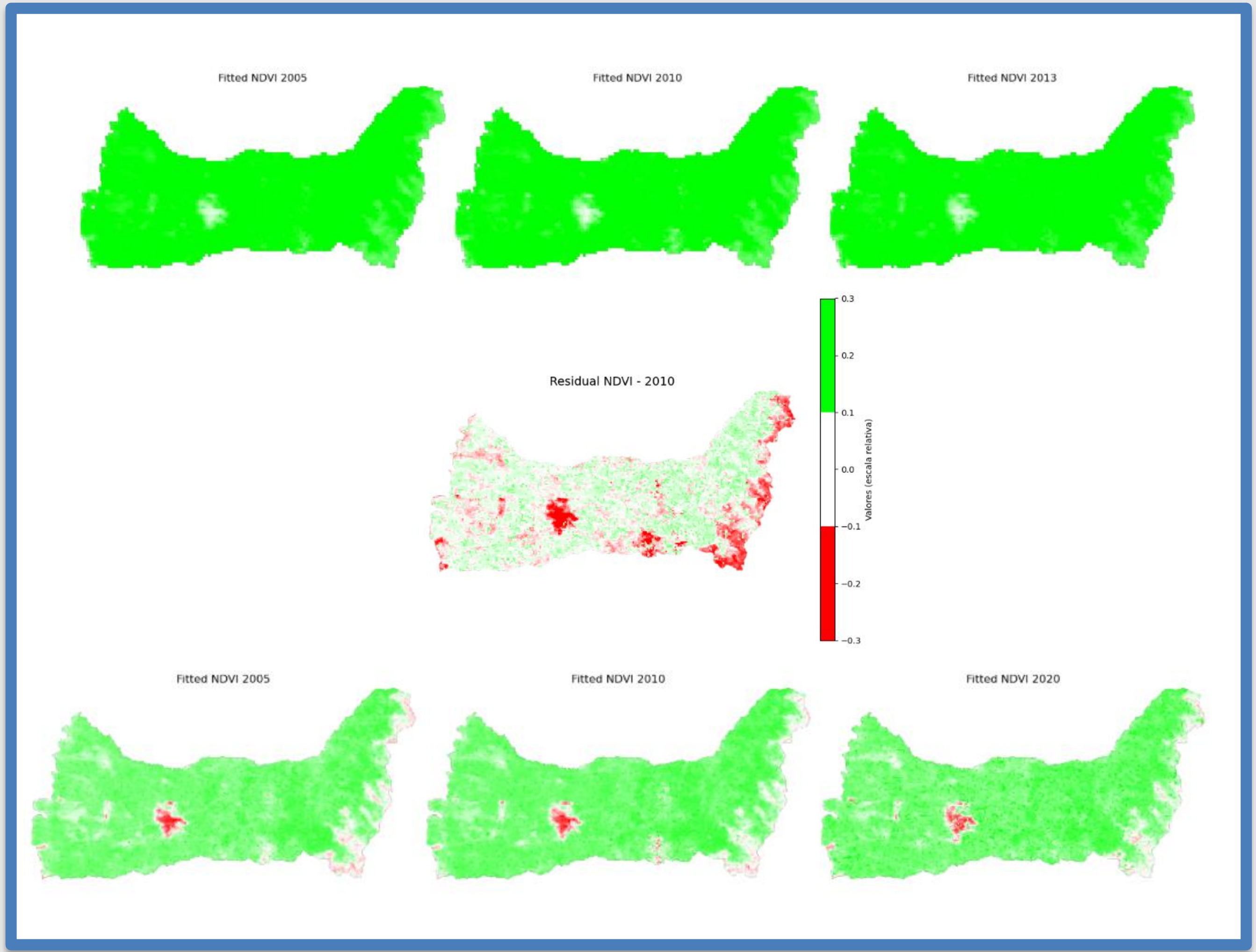
- NDVI residual
- Segmentation using fitted values



Detection of land cover change using remote sensing

Methodology: temporal segmentation

- Temporal segmentation
  - NDVI residual
  - Segmentation using fitted values

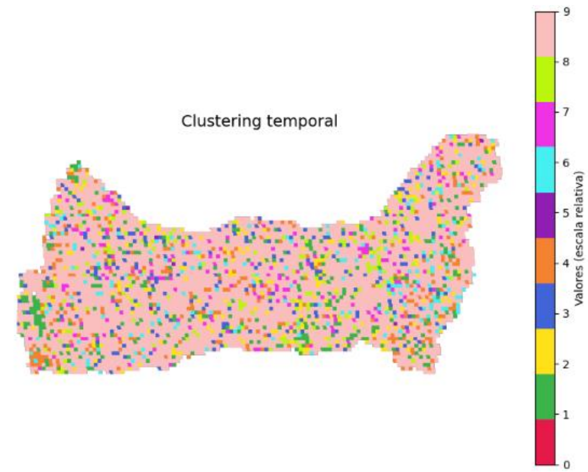


Detection of land cover change using remote sensing

Methodology: temporal segmentation

Unsupervised classification
- K-means
- Classify pixels

1. **Extraer vértices (vertex_stack):** Se generan 20 bandas (una por año) que indican si hubo un cambio (vértice) en cada píxel entre 2001 y 2020 (valor 0 o 1).
2. **Muestrear datos de entrenamiento:** Se extraen 5000 píxeles aleatorios con su historial de cambio (secuencia de 0s y 1s).
3. **Entrenar K-means:** Se agrupan los píxeles en 10 clusters según similitud en su historial de cambios temporales.



Detection of land cover change using remote sensing

Conclusion

Temporal analysis of residual NDVI, combined with segmentation and unsupervised clustering, enables the detection of vegetation change patterns that are not visible with traditional methods. This methodology enhances the monitoring of dynamic ecosystems such as grasslands, allowing for more accurate environmental management.

References

Cardille, J. A., Crowley, M. A., Saah, D., & Clinton, N. E. (Eds.). (2023). *Cloud-based Remote Sensing with Google Earth Engine: Fundamentals and Applications*. Springer Nature.

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Thanks

GitHub