

PhenChile

Un proyecto I+D para el monitoreo satelital de los efectos
del cambio climático sobre la vegetación

Roberto O. Chávez; Diego Valencia; Ignacio Díaz-Hormazábal; Jorge Herreros; José Lastra; Javiera Aguayo; Pablo Stuardo; Francisca Díaz; Sebastián Bruna; Matías Pérez; Marcela Riquelme-Solar

www.labgrs.pucv.cl

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Jun 2025

Viña del Mar, Chile



AndesPeat
Núcleo Milenio en
Turberas Andinas



- 1) **Fenología** según GEO-BON
- 2) Innovación para la toma de decisiones: **npphen R package**
- 3) **PhenChile**: sistema integrado satelital y red Phenocam
- 4) **Próximos pasos**: sistema de monitoreo fenológico nacional



Outline

- 1) Fenología
- 2) npphen R package
- 3) PhenChile
- 4) Próximos pasos

Essential biodiversity variables

21 EBV candidatas, agrupadas en 6 clases



1. Genetic composition

e.g. EBV=allelic diversity



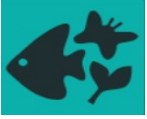
2. Species population

e.g. EBV=species distribution



3. Species traits

e.g. EBV=Phenology



4. Community composition

e.g. EBV=Taxonomic diversity



5. Ecosystem function

e.g. EBV= NPP



6. Ecosystem structure

e.g. Habitat structure

<https://geobon.org/>



Outline

Fenología

npphen R package

PhenChile

Próximos pasos

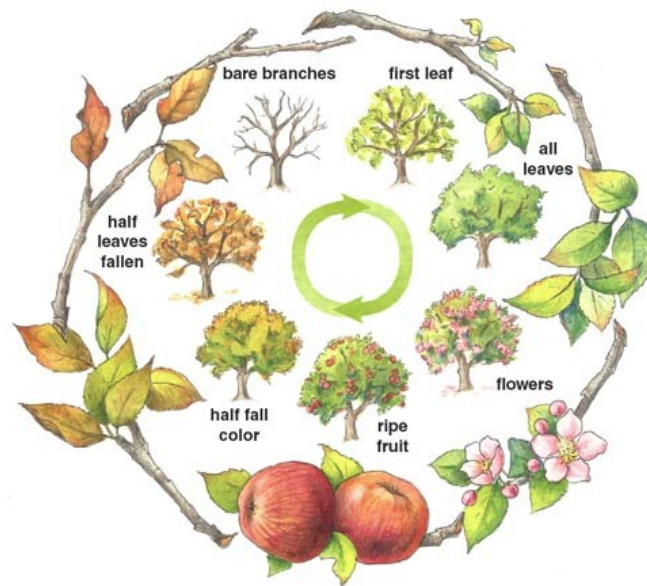
Definición de Fenología según

GEO-BON:

“Presencia, ausencia, abundancia o duración estacional de actividades de los organismos”

Ejemplo:

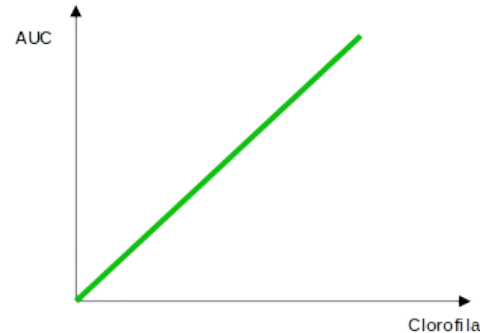
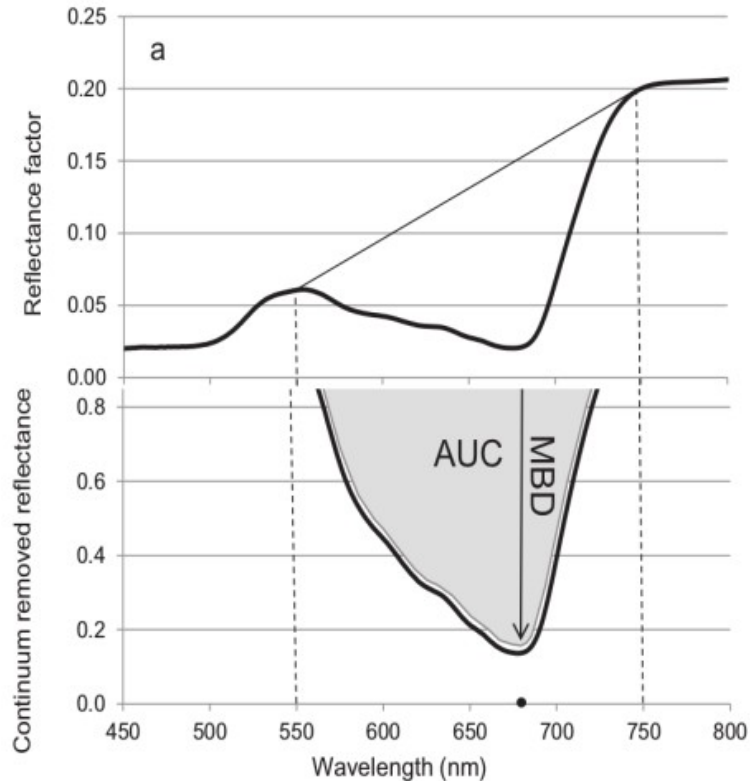
Momento y magnitud del desarrollo de hojas en la vegetación (fenología foliar)



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- 
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Principio de absorción de luz solar por las hojas



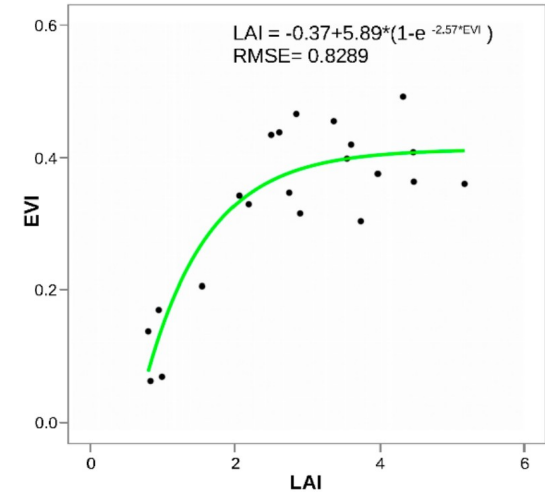
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Qué medimos desde el espacio? = green leaf area index



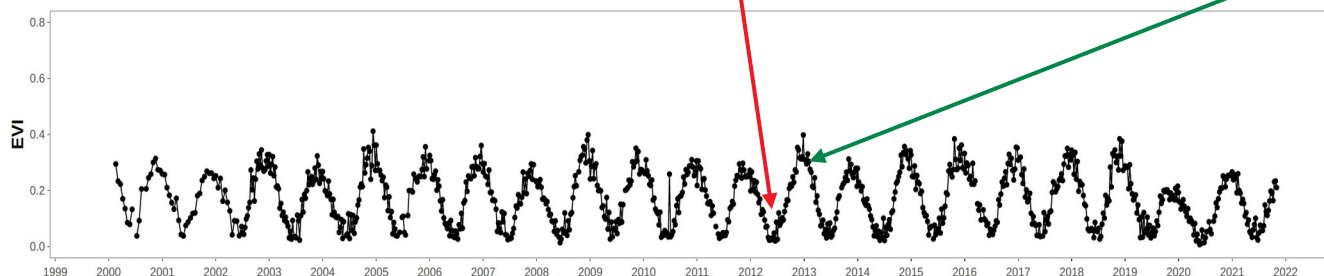
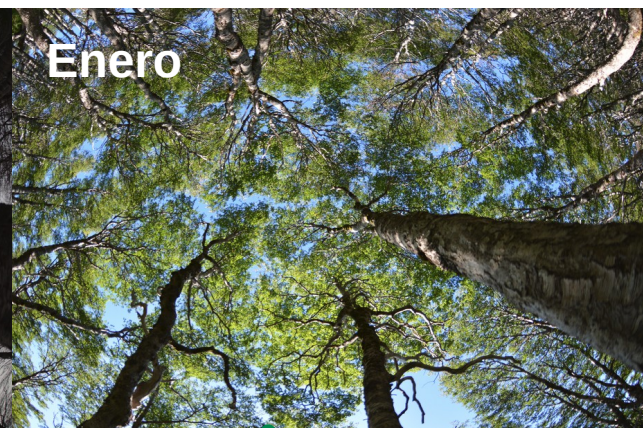
Fotos hemisféricas de bosques deciduos de Lenga (*N. pumilio*) en Patagonia



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Fenología = electrocardiograma de la **vegetation**

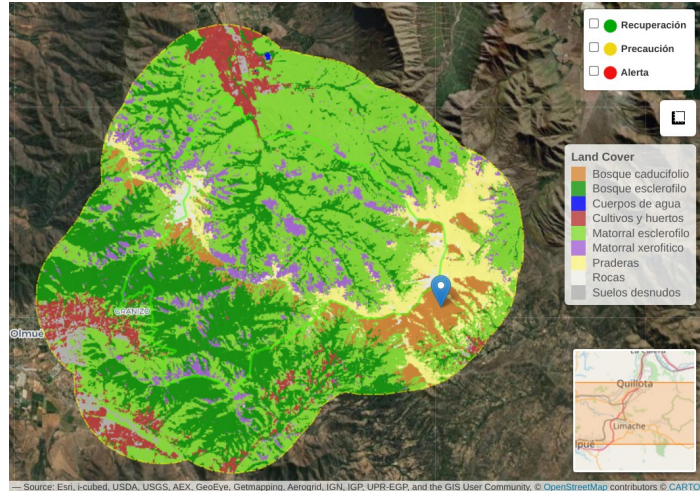


Enhanced Vegetation Index (EVI) time series from the MODIS NASA sensor

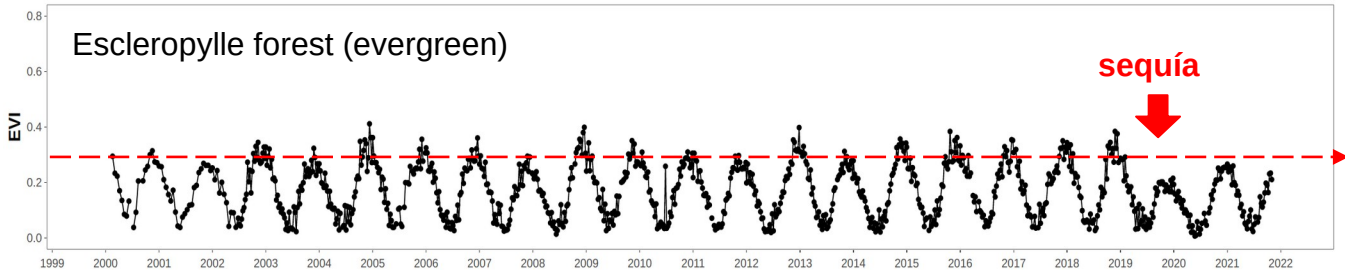
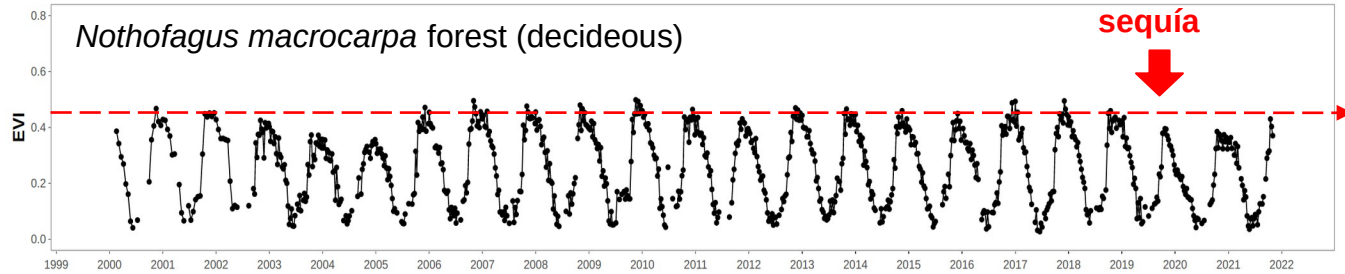
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Cambios en la fenología ¿cuánto es grave?



Parque Nacional La Campana, Chile Central



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npphen R-package

Usted está en: Portada | Labgrs | Proyectos

Introduction to npphen in R

Authors: Matías Olea, José A. Lastra, Roberto O. Chávez (May 30, 2022)

Preamble

The R package npphen has been developed primarily to enable land surface phenology reconstruction and extreme anomaly detection by using remote sensing time series. Nevertheless, npphen includes functions to analyze any type of numerical time series. Examples of remote sensing time series that can be tackled using npphen are different time series (e.g. NDVI, EVI, Temperature, Precipitation, Soil Moisture) from different datasets as [GIMMS project](#), the [U.S. MODIS Program](#), [Landsat Program](#) the [E.S.A. Sentinel 2 Program](#) or the [CR2MET](#) products for Chilean climate. Examples of numerical time series can be the [NPP \(Net Primary Productivity\)](#) from a [FluxNet Tower](#) or the [GI \(Green Index\)](#) from the Phenocams Networks.

In this document we want to facilitate the use of this package by demonstrating in detail what the individual functions do and how they can be applied. For this task we will use a demo dataset of 16-day MODIS Enhanced Vegetation Index (EVI) composites, though generally the package can be used to process a wide range of remotely-sensed products such as Landsat, MODIS, Sentinel-2 or AVHRR.

1 Set up your system

All necessary R packages (such as *raster* & *rgdal*) are automatically installed together with *npphen* by typing and running in an active R session:

```
install.packages("npphen")
library(npphen)
```

<https://www.pucv.cl/uuaa/labgrs/proyectos/introduction-to-npphen-in-r>

✓ Otros Temas

- ▷ AVOCADO
- ▷ Validation Data Collection for Dynamic Land Cover Product
- ▷ Remote sensing EBV for assessing the spatial distribution and intensity of insect outbreaks in broadleaf Nothofagus forests



Technical Note

npphen: An R-Package for Detecting and Mapping Extreme Vegetation Anomalies Based on Remotely Sensed Phenological Variability

Roberto O. Chávez ^{1,2,3,*}, Sergio A. Estay ^{4,5}, José A. Lastra ¹, Carlos G. Riquelme ⁵, Matías Olea ¹, Javiera Aguayo ¹ and Mathieu Decuyper ⁶

- ¹ Laboratorio de Geo-Información y Percepción Remota, Instituto de Geografía, Pontificia Universidad Católica de Valparaíso, Valparaíso 2362807, Chile
 - ² Millennium Nucleus in Andean Pastlands (AndesPast), Avenida 18 de Septiembre 2222, Atica 1000965, Chile
 - ³ Institute of Ecology and Biodiversity, Las Palmeras 3425, Nuiño, Santiago 7800003, Chile
 - ⁴ Instituto de Ciencias Ambientales y Evolutivas, Facultad de Ciencias, Universidad Austral de Chile, Valdivia 5090000, Chile
 - ⁵ Center of Applied Ecology and Sustainability, Facultad de Ciencias Biológicas, Pontificia Universidad Católica de Chile, Santiago 7810177, Chile
 - ⁶ Forest Ecology and Management Group, Wageningen University, Droevendaalsesteeg 3, 6708 PB Wageningen, The Netherlands
- * Correspondence: roberto.chavez@pucv.cl

Abstract: Monitoring vegetation disturbances using long remote sensing time series is crucial to support environmental management, biodiversity conservation, and adaptation strategies to climate change from global to local scales. However, it is difficult to assess whether a remotely detected vegetation disturbance is critical or not, since available operational remote sensing methods deliver only maps of the vegetation anomalies but not maps of how “uncommon” or “extreme” the detected anomalies are based on the available records of the reference period. In this technical note, we present a new release of the probabilistic method and its implementation, the npphen R package, designed to detect not only vegetation anomalies from remotely sensed vegetation indices, but also to quantify the position of the anomalous observations within the historical frequency distribution of the phenological annual records. This version of the R package includes two new key functions to detect and map extreme vegetation anomalies: *ExtremeAnom* and *ExtremeAnoMap*. The npphen package allows remote sensing users to detect vegetation changes for a wide range of ecosystems, taking advantage of the flexibility of kernel density estimations to account for any shape of annual phenology and its variability through time. It provides a uniform statistical framework to study all types of vegetation dynamics, contributing to global monitoring efforts such as the GEO-BON Essential Biodiversity Variables.

Keywords: disturbance; remote sensing; time series; climate change; EBV; GEO-BON



Citation: Chávez, R.O.; Estay, S.A.; Lastra, J.A.; Riquelme, C.G.; Olea, M.; Aguayo, J.; Decuyper, M. npphen: An R-Package for Detecting and Mapping Extreme Vegetation Anomalies Based on Remotely Sensed Phenological Variability. *Remote Sens.* **2022**, *15*, 73. <https://doi.org/10.3390/rs1510073>

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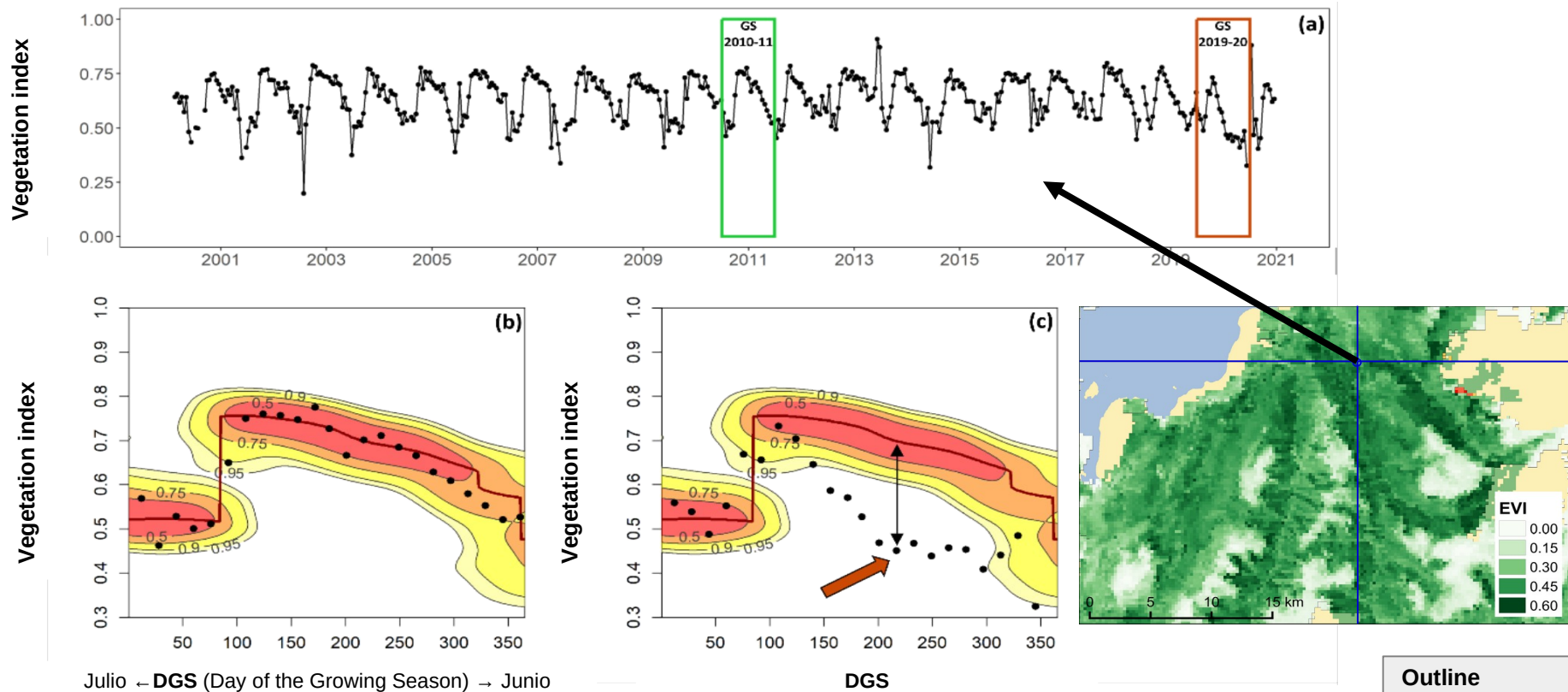
<https://www.mdpi.com/2072-4292/15/1/73>

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npphen R-package, cómo funciona?



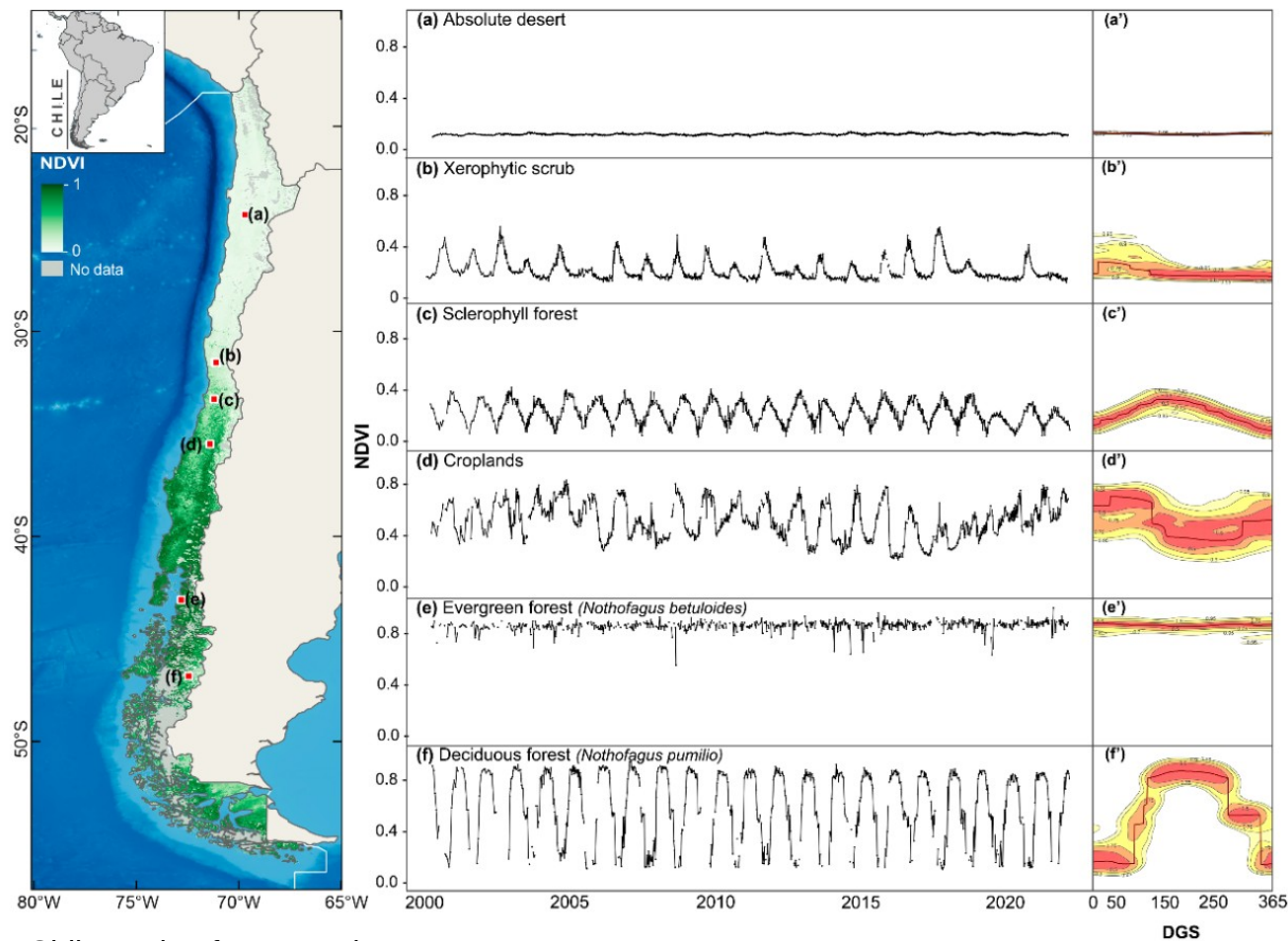
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“npphen” aplicable a todo tipo de vegetación

Atacama Desert

Patagonia

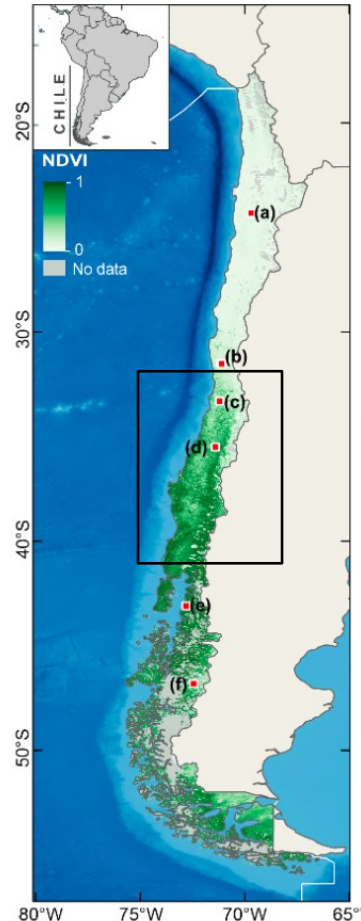


Chile seeing from EVI data

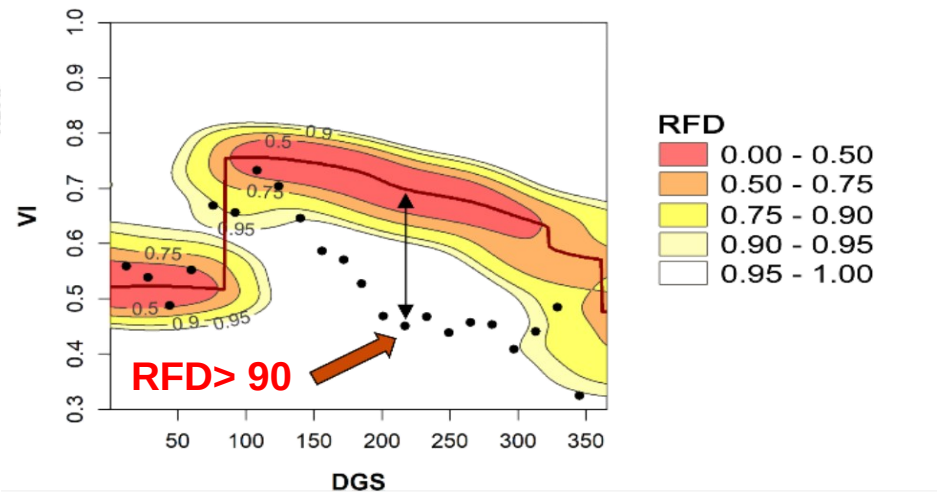
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Mapa de la hiper-sequía 2019 usando “npphen”



Chile seeing from EVI data



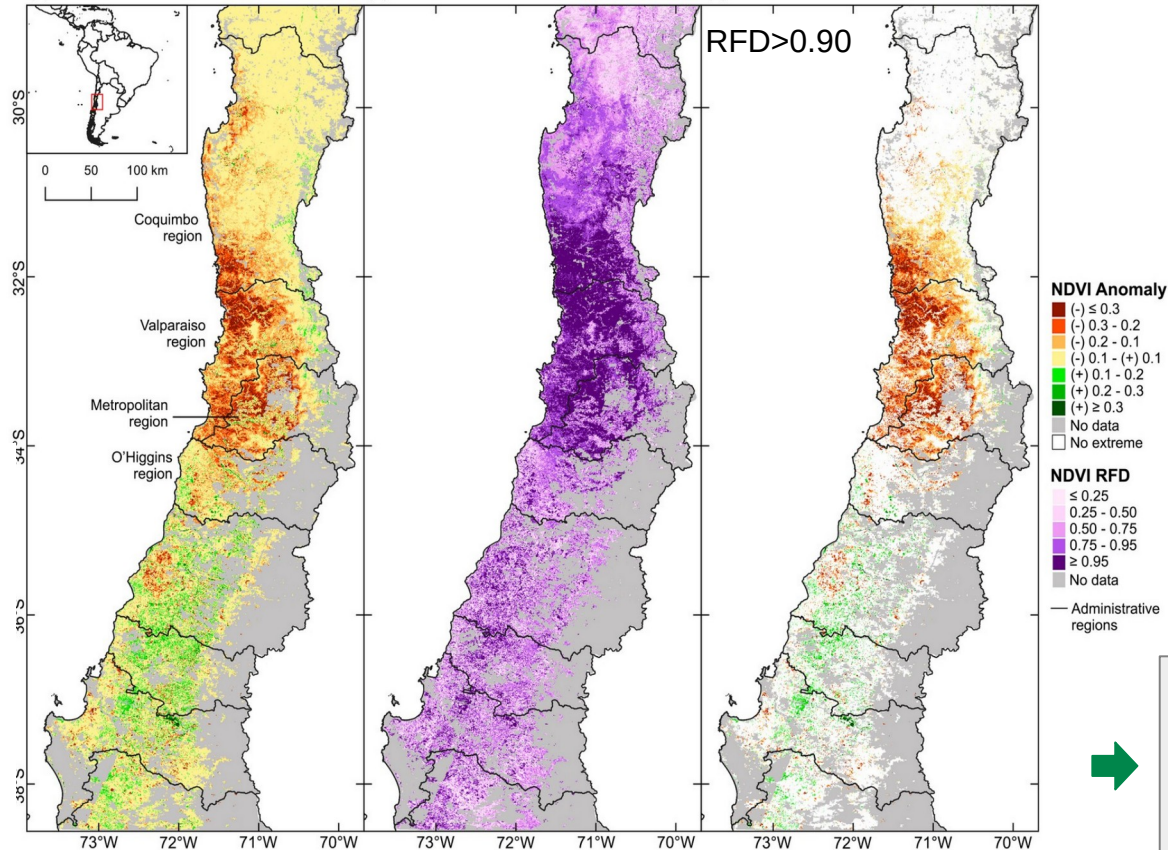
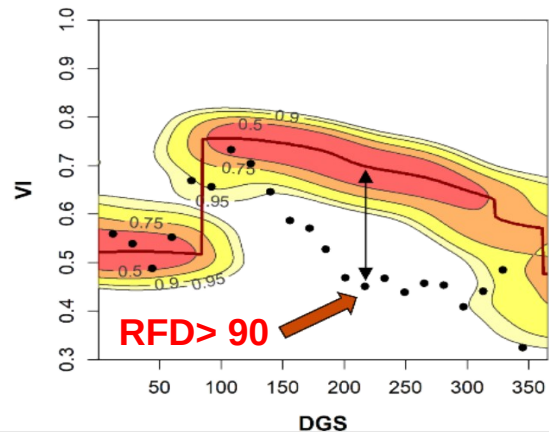
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Mapa de la hiper-sequía 2019 usando “npphen”

VI anomaly + extreme = Extreme anomaly

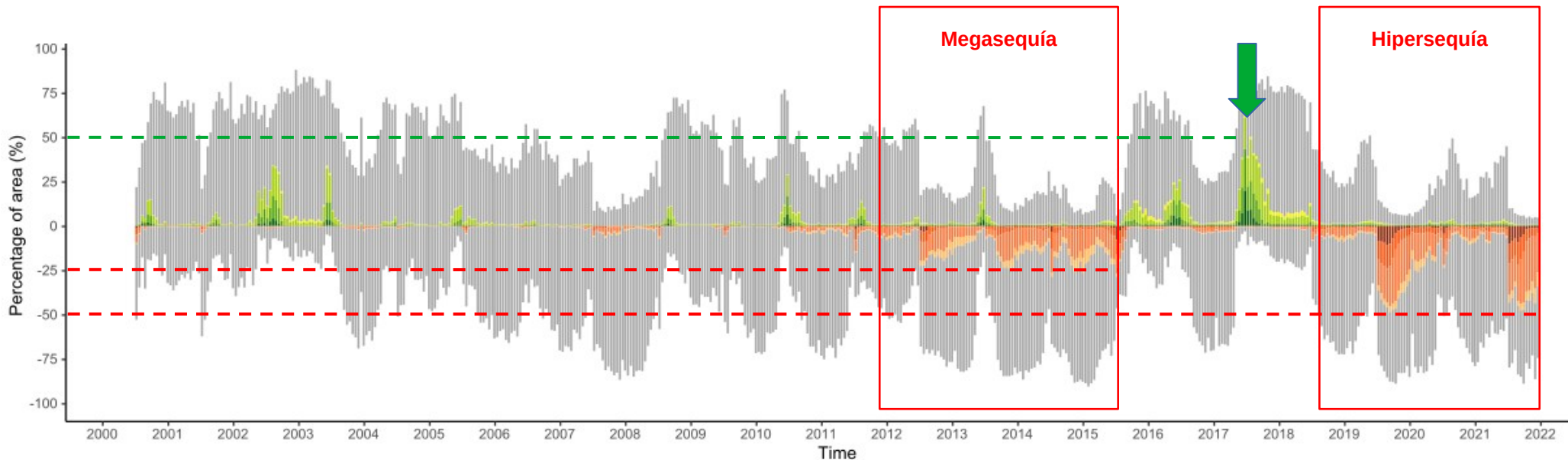


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Porcentaje de Chile Central bajo hipersequía (RFD>0.9)



Región de Atacama

"Desierto florido" 2017 podría ser el más grande en la historia de la región de Atacama

por Emilio Lara

Miércoles 12 julio de 2017 | 13:56

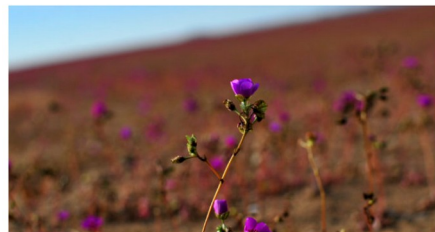


Foto: Pablo Vera | Agencia UNO | Imagen referencial.

visitas



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PhenChile: sistema de monitoreo fenológico nacional



Datos satelitales MODIS NASA

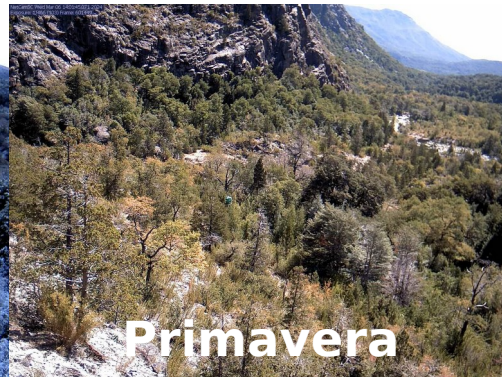
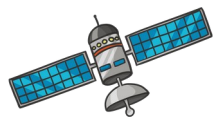


Vegetación: Reserva Nacional

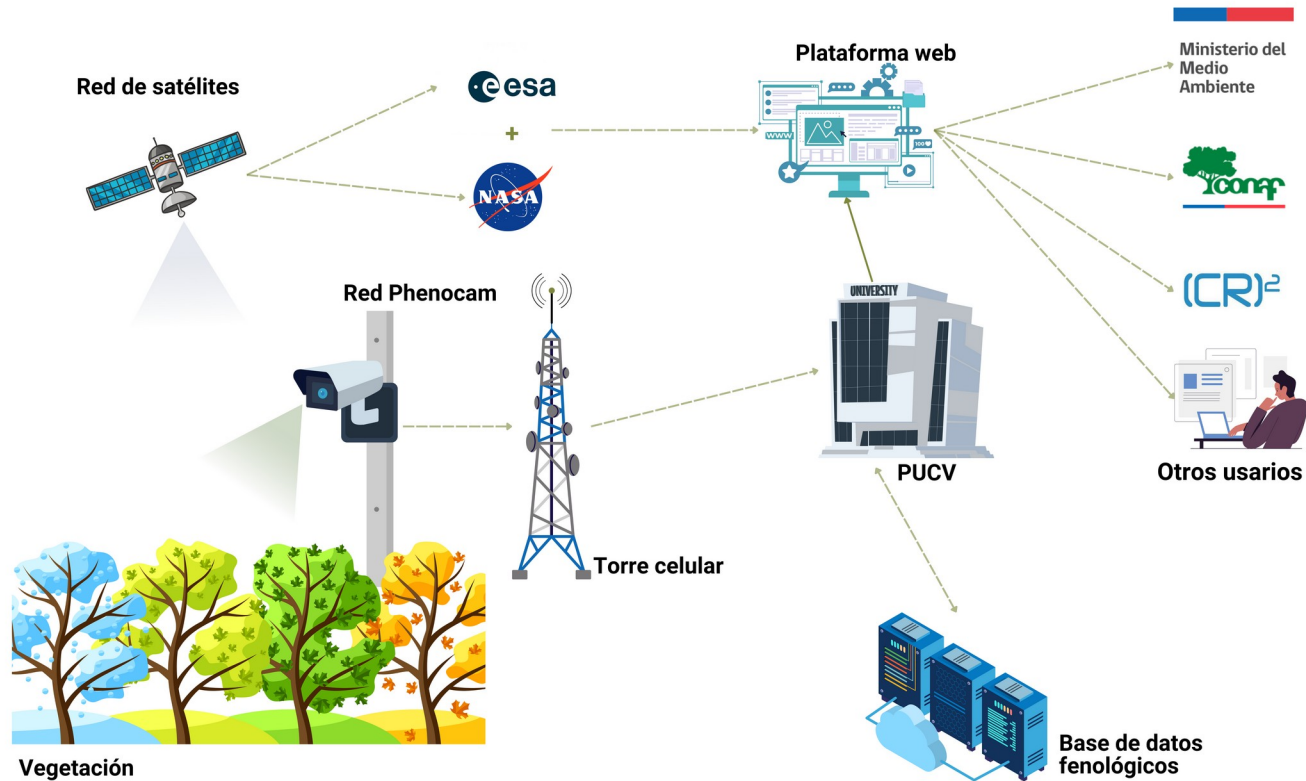


Red Phenocam

PhenChile: sistema de monitoreo fenológico nacional



PhenChile: sistema de monitoreo fenológico nacional



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PhenChile: sistema de monitoreo fenológico nacional



<http://phenchile.pucv.cl/>



[https://labgrs.github.io/
PhenChile_mobile/](https://labgrs.github.io/PhenChile_mobile/)

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PhenChile

SISTEMA DE MONITOREO FENOLÓGICO NACIONAL



Financiado por:
Proyecto FONDEF ID21/10249

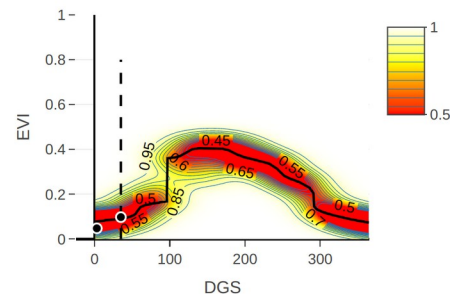
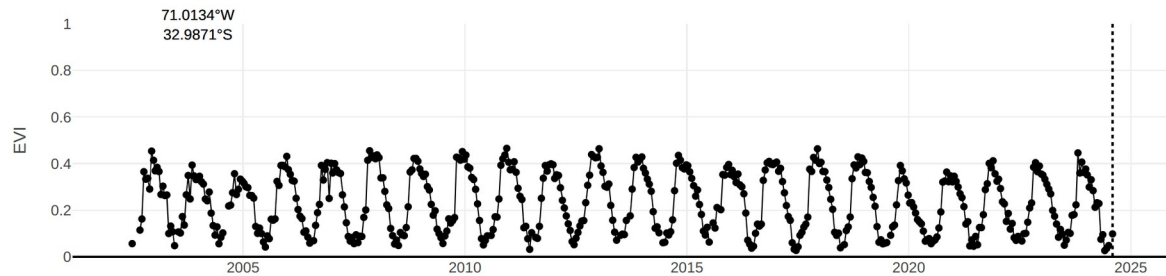
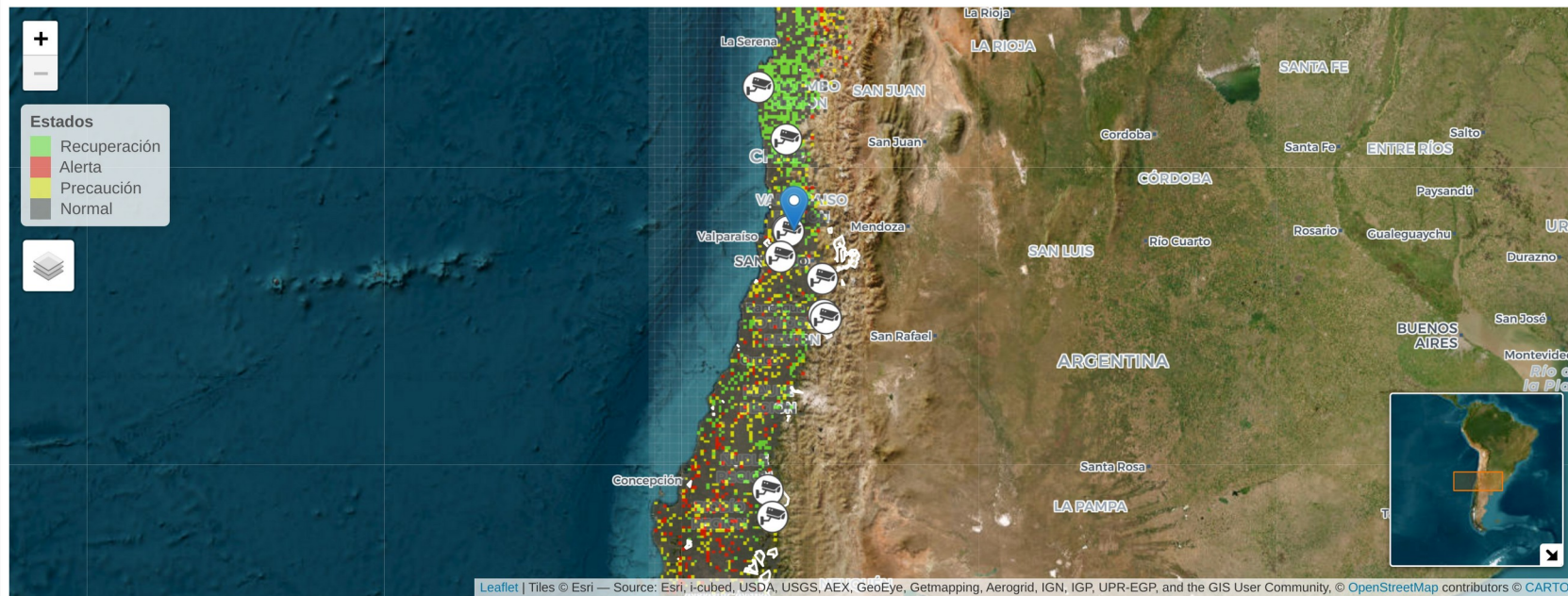
SISTEMA DE MONITOREO
FENOLOGICO NACIONAL

Seleccione una fecha:

2024-08-04

Capa a desplegar

Alertas

[i Acerca de la Info. Satelital](#)

Financiado por:

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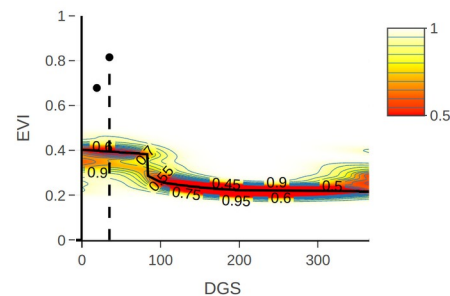
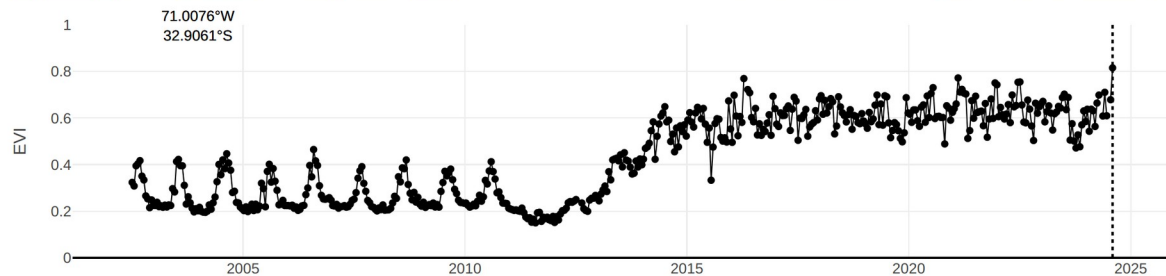
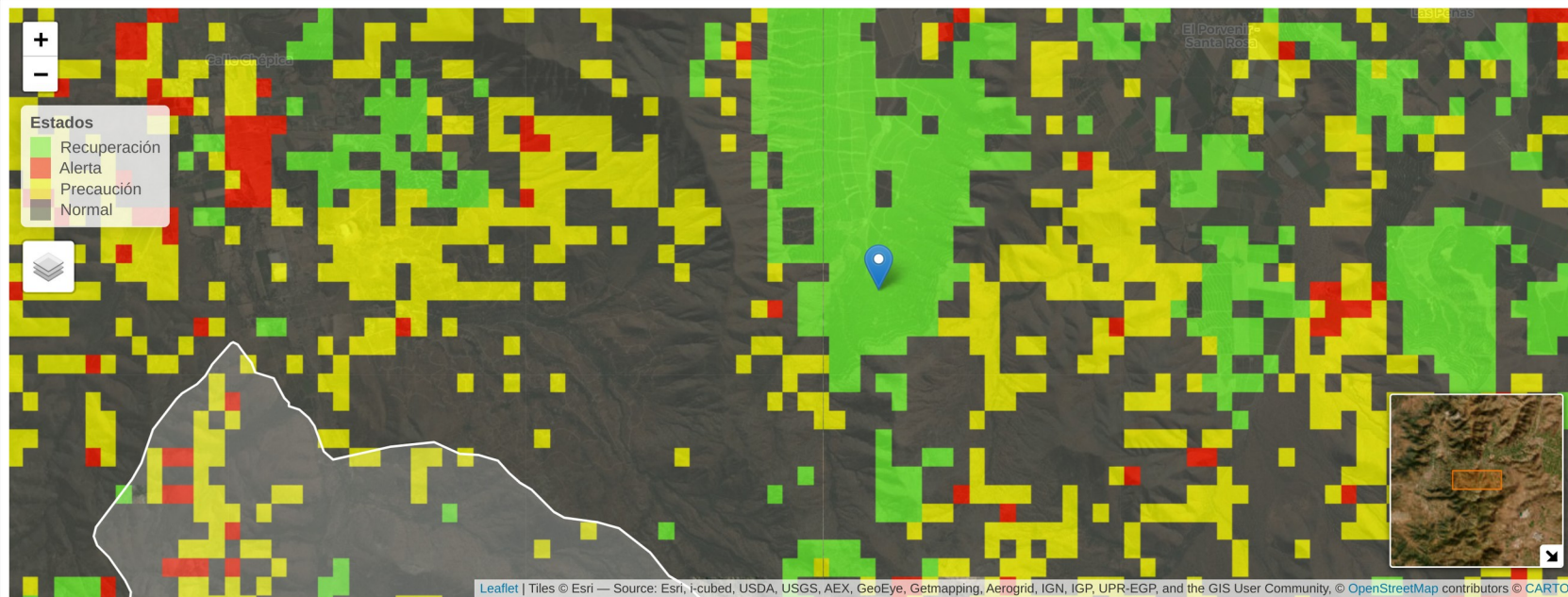
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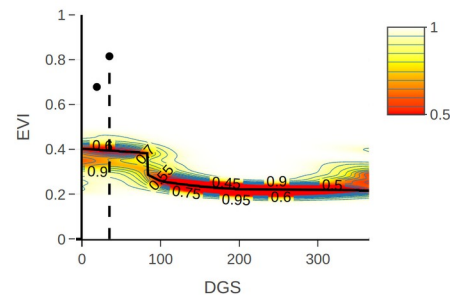
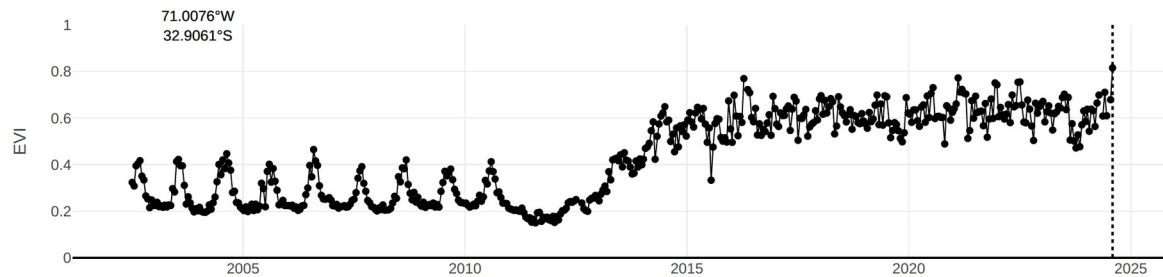
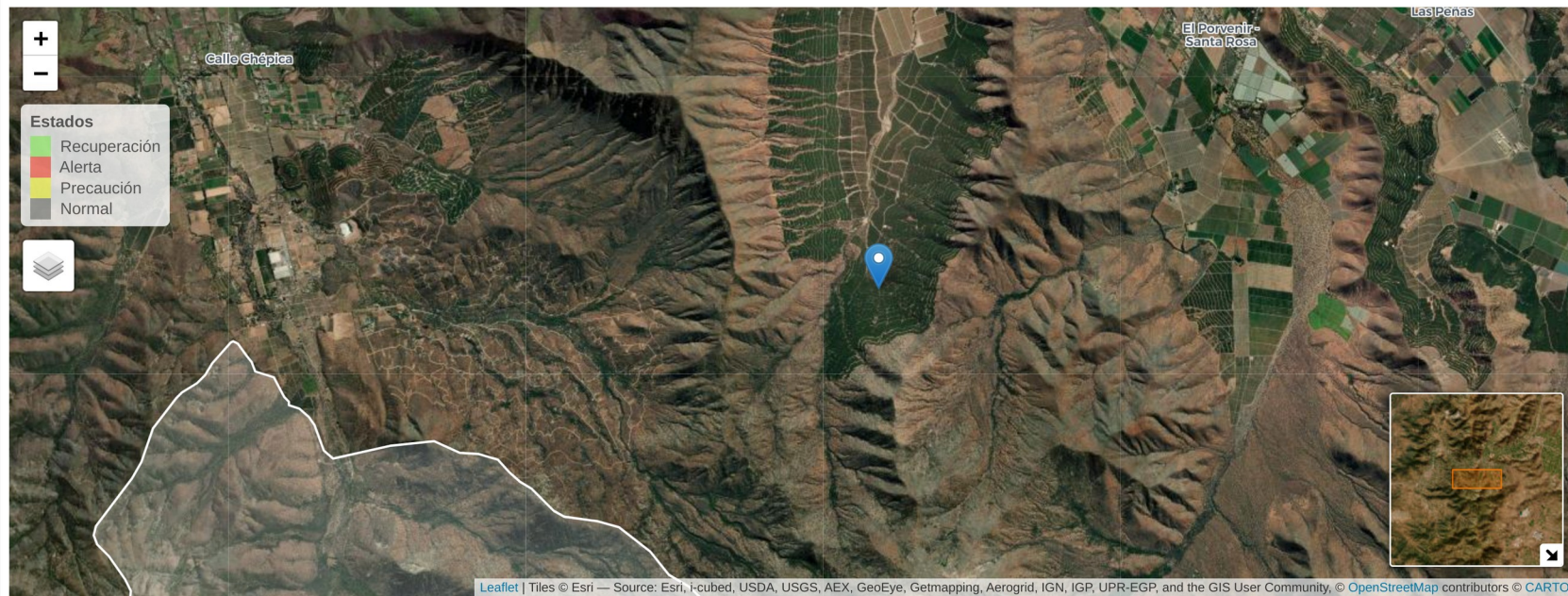
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SISTEMA DE MONITOREO
FENOLOGICO NACIONAL

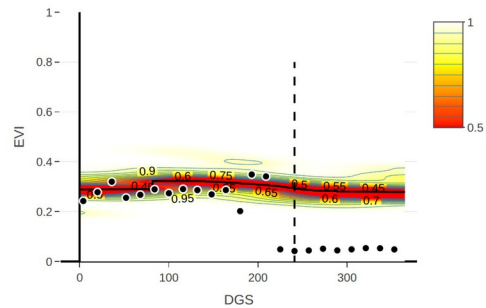
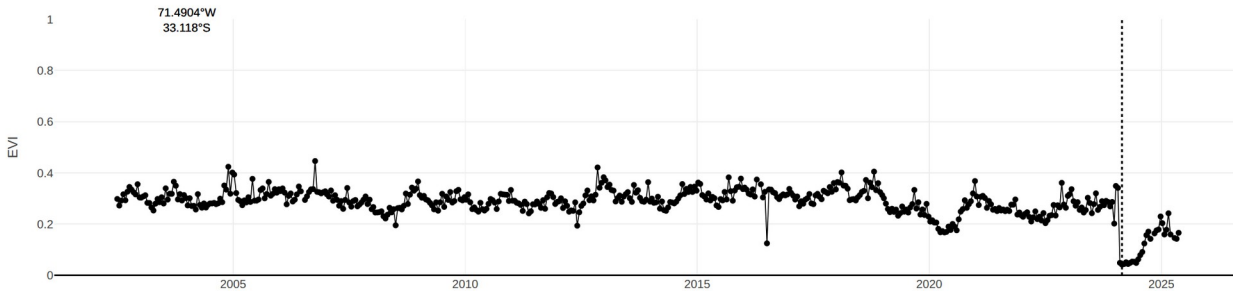
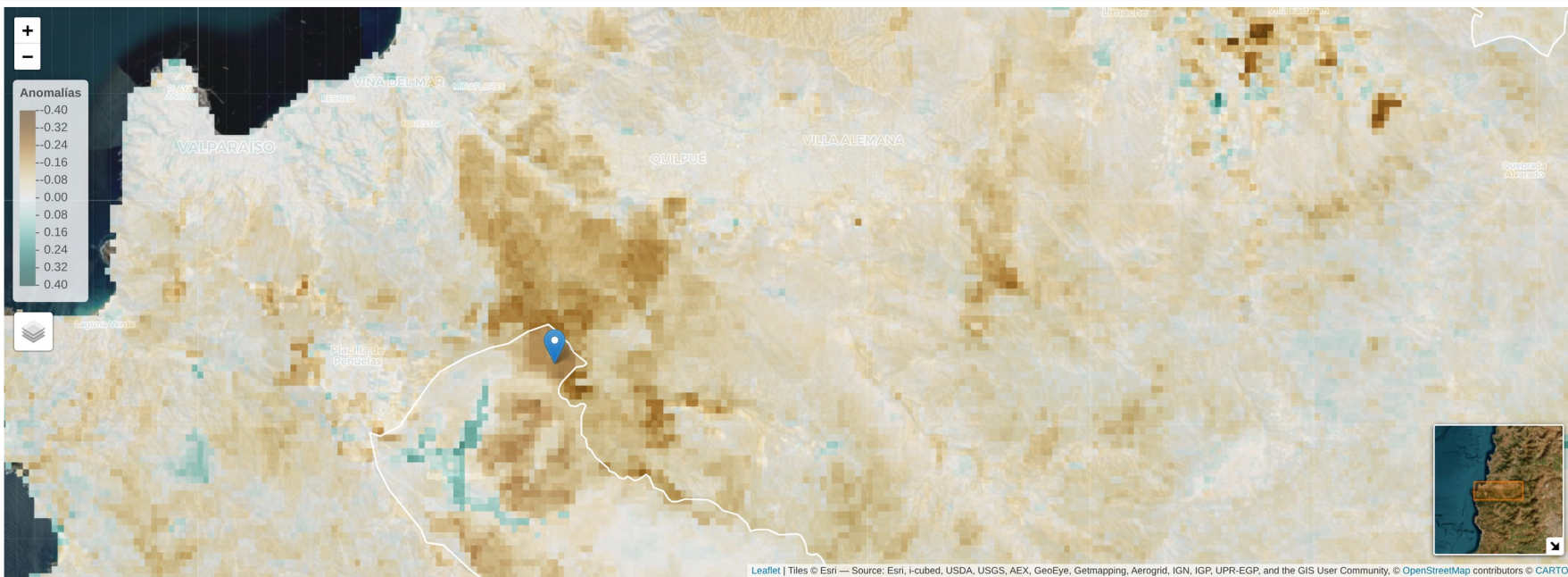
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Capa a desplegar

Anomalías

[Acerca de la Info. Satelital](#)



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SISTEMA DE MONITOREO
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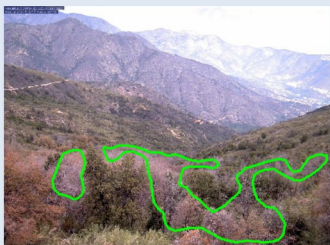
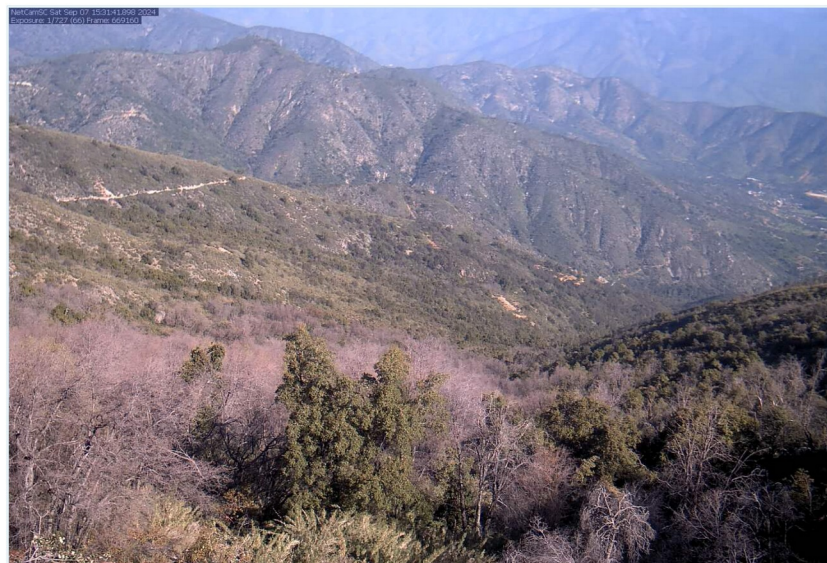
Phenocams

P.N. LA CAMPANA PHEN 001

Seleccione una fecha:

2024-09-07

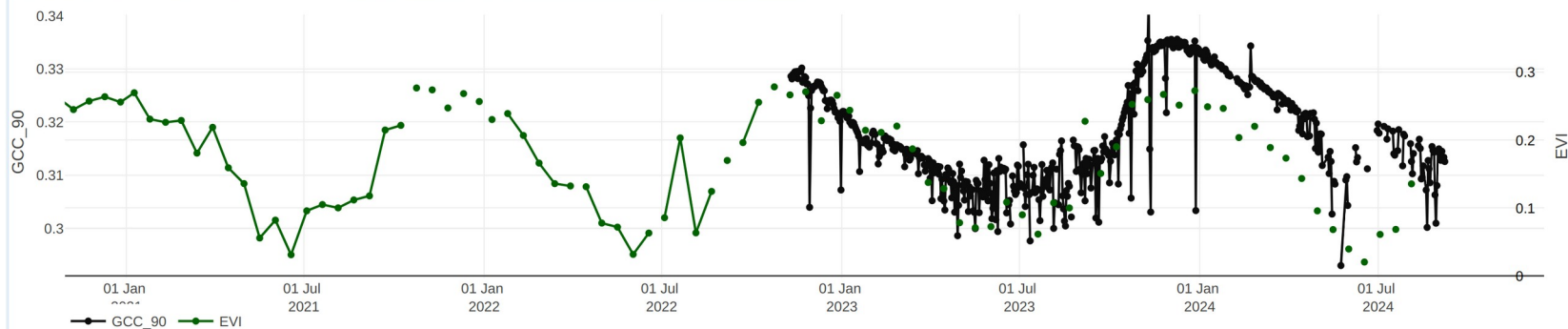
Imagen referencial del ROI

[Acerca de las Phenocams](#)

Características de la Phenocam:

SITIO:	P.N. LA CAMPANA
LONG:	-71.12514
LAT:	-32.96065
ELEVACION:	1277 m.s.n.m.
VEGETACION:	BOSQUE DE ROBLE

Seleccione gráfica a desplegar:

☐ GCC ☒ GCC + EVI MODIS

Financiado por:

FONDEF IdeA I+D ID21110249



Red Phenocam



PHEN 001 – P.N. LA CAMPANA



PHEN 002 – R.N. LAS CHINCHILLAS



PHEN 003 – P.N. RÍO CLARILLO



PHEN 004 – P.N. LA CAMPANA



PHEN 005 – R.N. ÑUBLE



PHEN 006 – P.N. LAGUNA DEL LAJA



PHEN 007 – R.N. RÍO CIPRESES



PHEN 008 – R.N. RÍO CIPRESES



PHEN 009 – VIÑA VERAMONTE



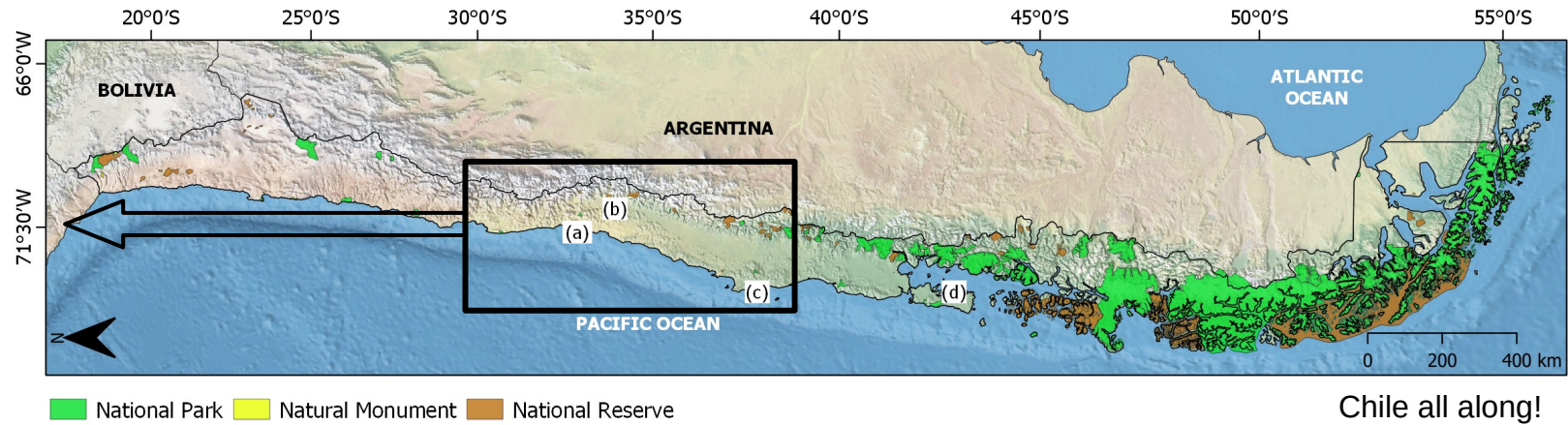
PHEN 010 – P.N. FRAY JORGE

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Proyecto actual: IT23I0099



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Proyecto actual: IT23I0099



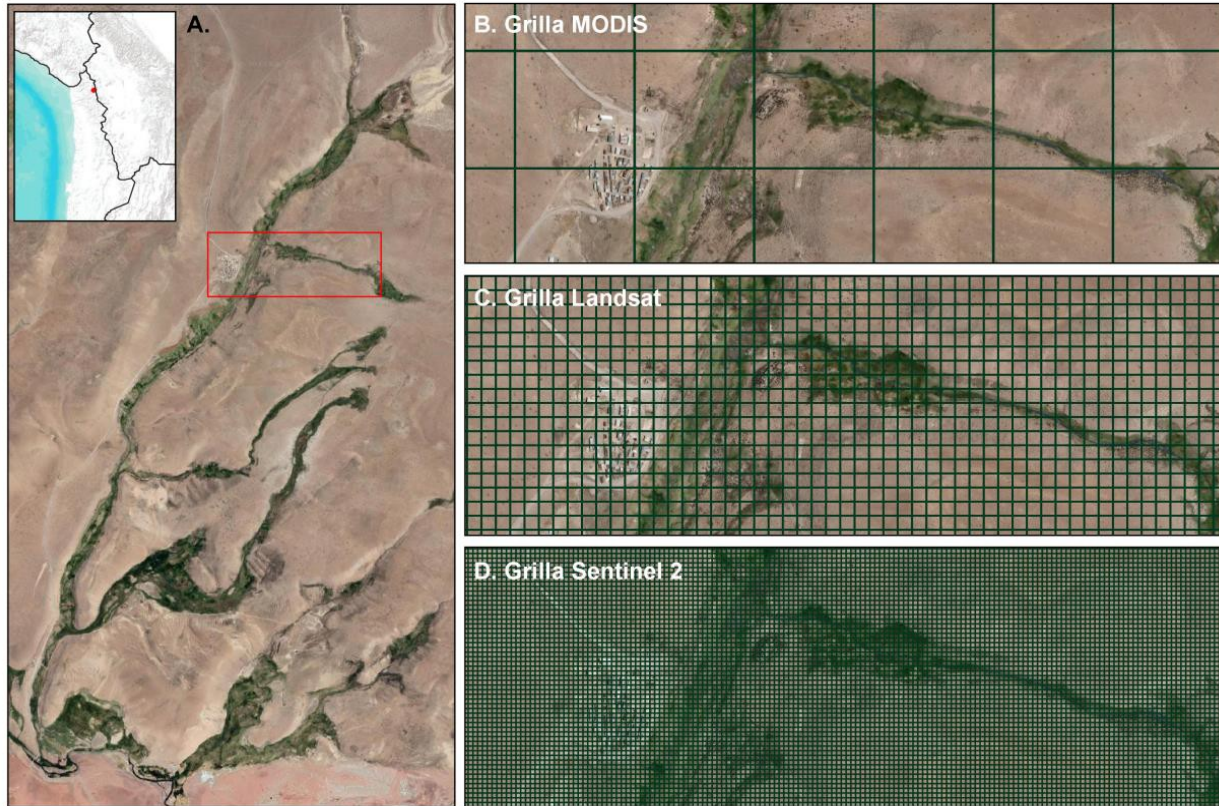
Bofedal Guallatire, Reserva Nacional Las Vicuñas.

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Próximos pasos: moderada + alta resolución

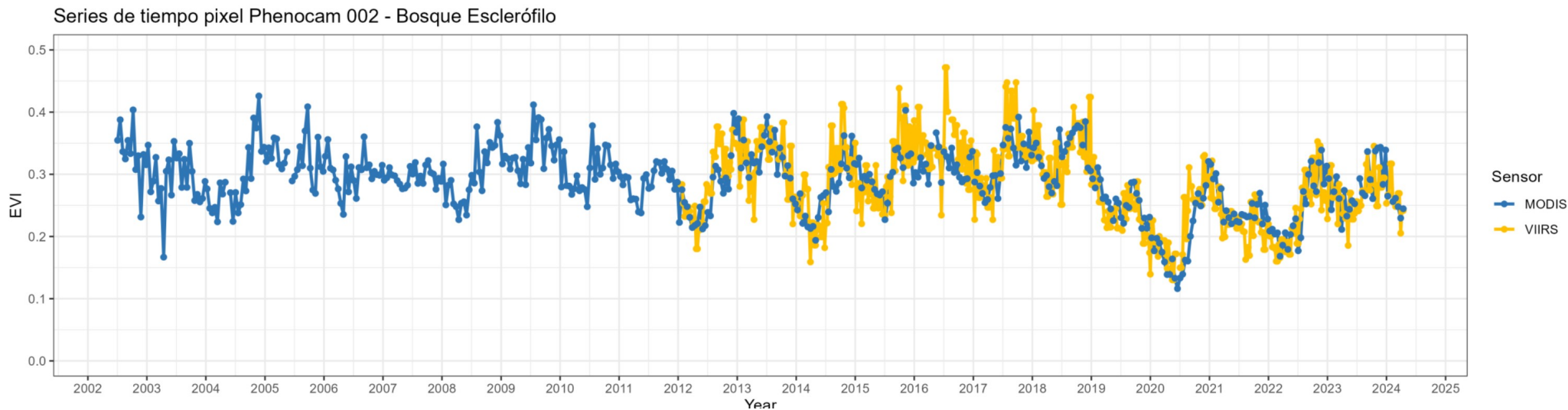


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Próximos pasos: VIIRS continuación a escala moderada



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LabGRS

Bienvenidas y bienvenidos



Muchas gracias

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- Fondecyt Regular N°1201714
- Fondecyt Regular N°1211924
- Fondef IdeA I+D ID2110249
- Investigación tecnológica IT23I0099

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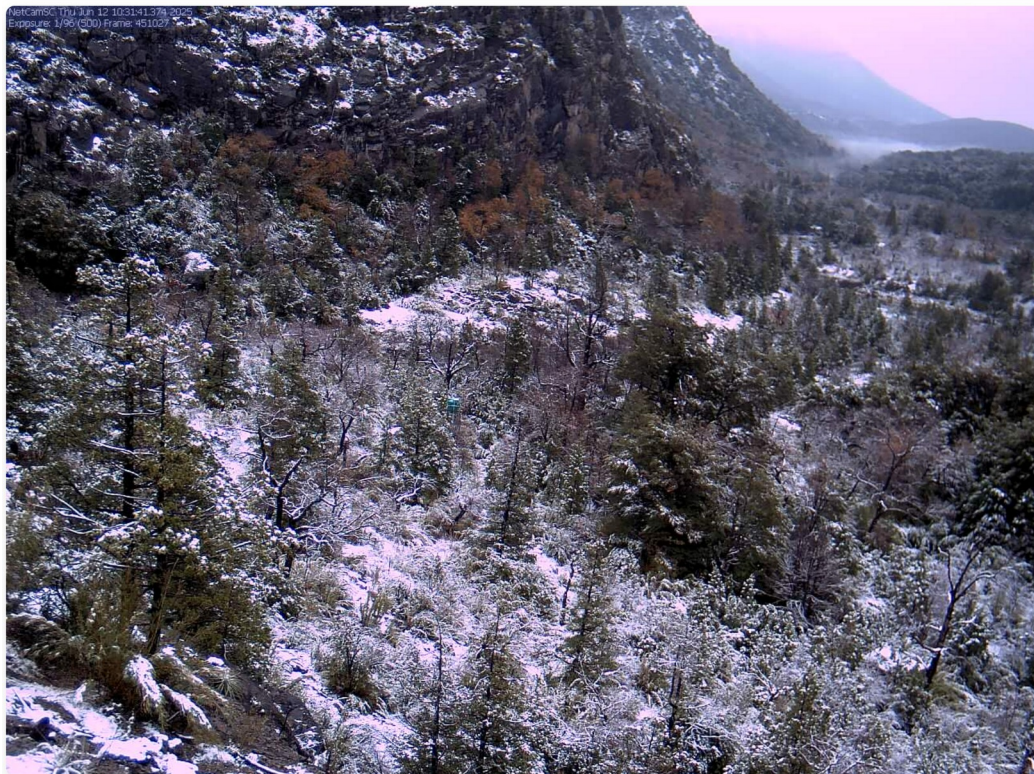
Jun 2025

Viña del Mar, Chile



AndesPeat
Núcleo Milenio en
Turberas Andinas





R.N. ÑUBLE

12/6/2025 10:31:00 AM

10:31 AM



10:01 AM



09:31 AM



09:01 AM



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Jun 2025

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