MIND THE GAP

The importance of paleoecological analyses to address ecological systems beyond the instrumental record

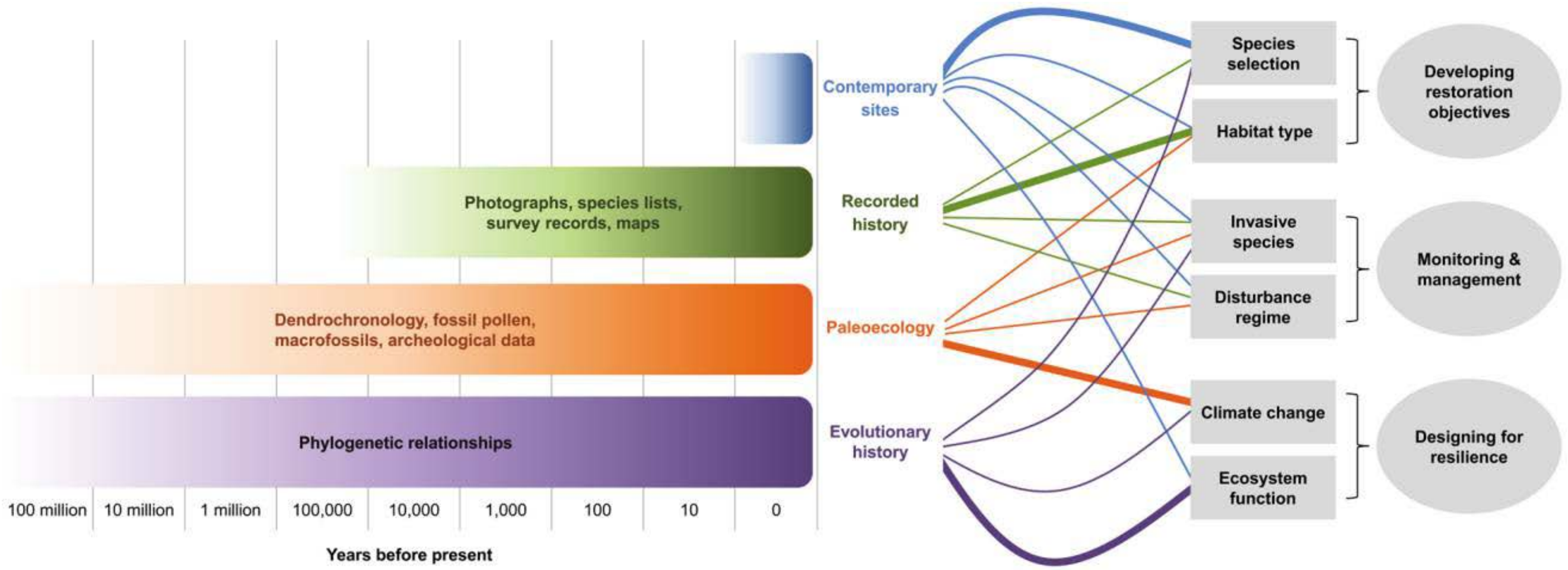
Catalina González Arango
Departamento de Ciencias Biológicas
Universidad de los Andes

ESO Symposium, Medellín 22.11.2016

Why paleoecology?

TEMPORAL dimension

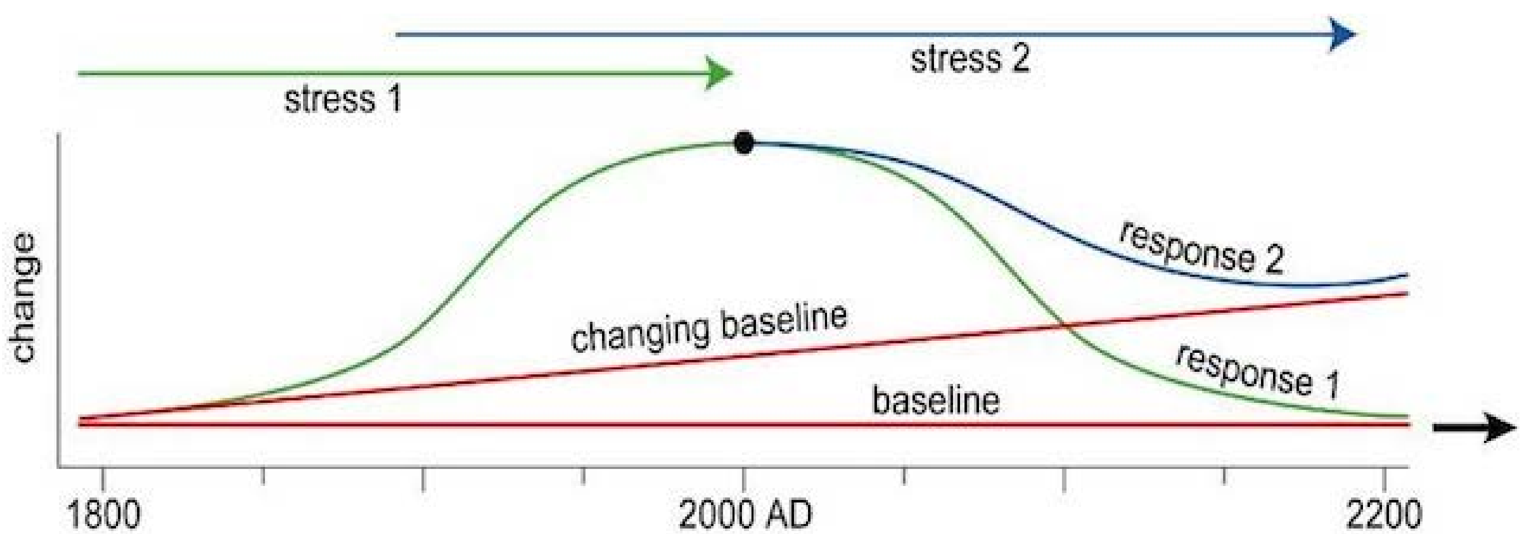
- Lack of long, complete, reliable data sets (climate, vegetation)
- Long & slow processes underrepresented or missed in short time series
- Past as natural experiment (analogs, non-analogs, hypothesis testing)



Photographs, species lists, survey records, maps
Dendrochronology, fossil pollen, macrofossils, archeological data
Phylogenetic relationships
100 million
10 million
1 million
100,000
10,000
1,000
100
10
0
Years before present
Contemporary sites
Recorded history
Paleoecology
Evolutionary history
Species selection
Habitat type
Invasive species
Disturbance regime
Climate change
Ecosystem function
Developing restoration objectives
Monitoring & management
Designing for resilience

Barak, 2016

- Dynamic systems (interactions, feedbacks)
- Complex and nonlinear systems (steady states, attractors)
- Memory of the system
- Natural boundaries
- Stressors (single, multiple, interactions)
- What builds resilience?



Battarbee et al. 2005

Example 1. Climate & Vegetation SA during the last 2000 yr.

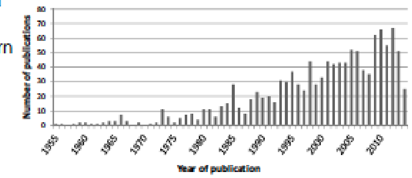
- Can we extract climate information from pollen records?
- Spatial/temporal patterns
- Anthropogenic impact
- How clean, reliable are the climate signals
- How do we compare sites?

Updated site compilation of the Latin American Pollen Database (LAPD) 2014

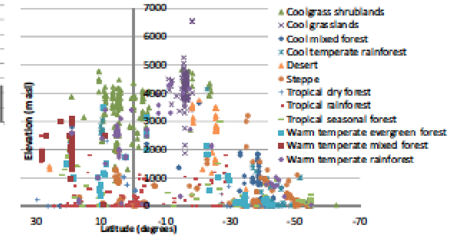
Compiled by Suzette G.A. Flantua and collaborators**

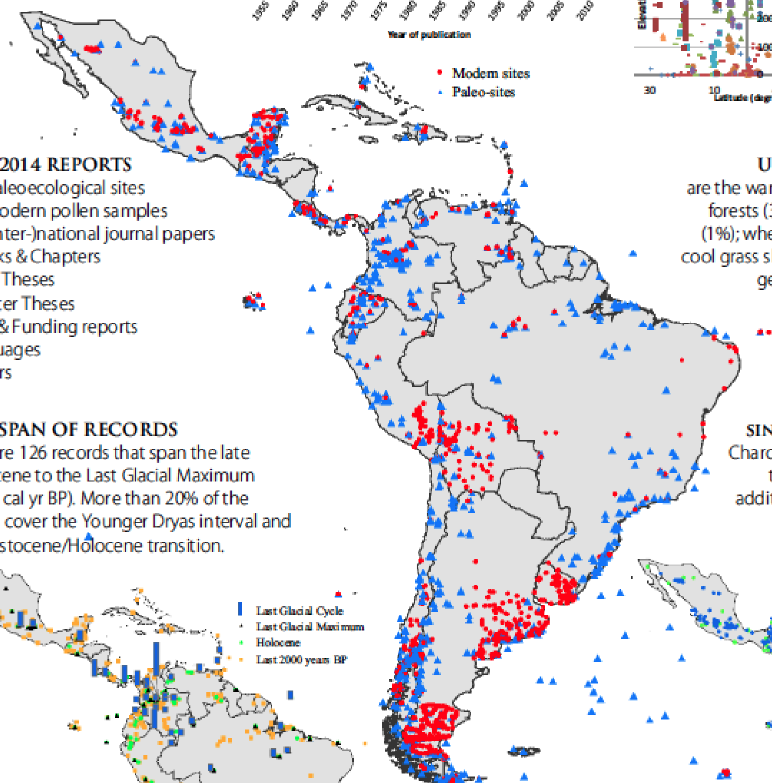
>1200 STUDIES
in peer-reviewed and grey literature have been reviewed. Latin America shows a major expansion of paleoecological studies and modern pollen rain samples in the last decades. The LAPD Literature Database is increasing every day.

Year of publication of paleoecological and modern pollen rain studies in the LAPD 2014



12 BIOMES IN 30 COUNTRIES
are found in an altitudinal range from 0 to 6300 m asl.



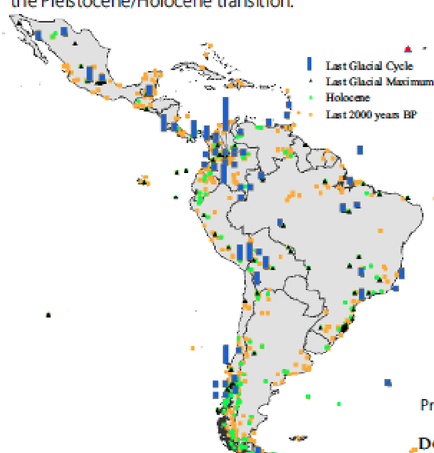


LAPD 2014 REPORTS
1380 Paleoecological sites
4800 Modern pollen samples
1110 (inter-)national journal papers
81 Books & Chapters
42 PhD Theses
26 Master Theses
7 Field & Funding reports
6 Languages
4 Posters

UNDERREPRESENTED BIOMES
are the warm temperate mixed forest (3%), dry forests (3%), and warm temperate rainforest (1%); whereas steppe, tropical rainforest, and cool grass shrublands, such as the páramos, are generally well represented (all >17%).

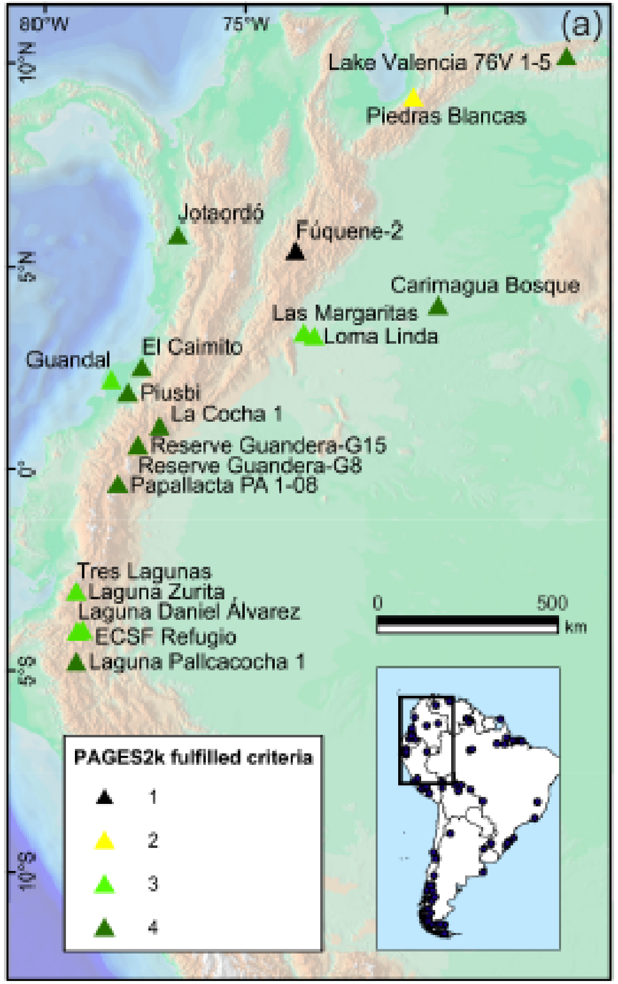
TIME SPAN OF RECORDS
There are 126 records that span the late Pleistocene to the Last Glacial Maximum (21,000 cal yr BP). More than 20% of the records cover the Younger Dryas interval and the Pleistocene/Holocene transition.

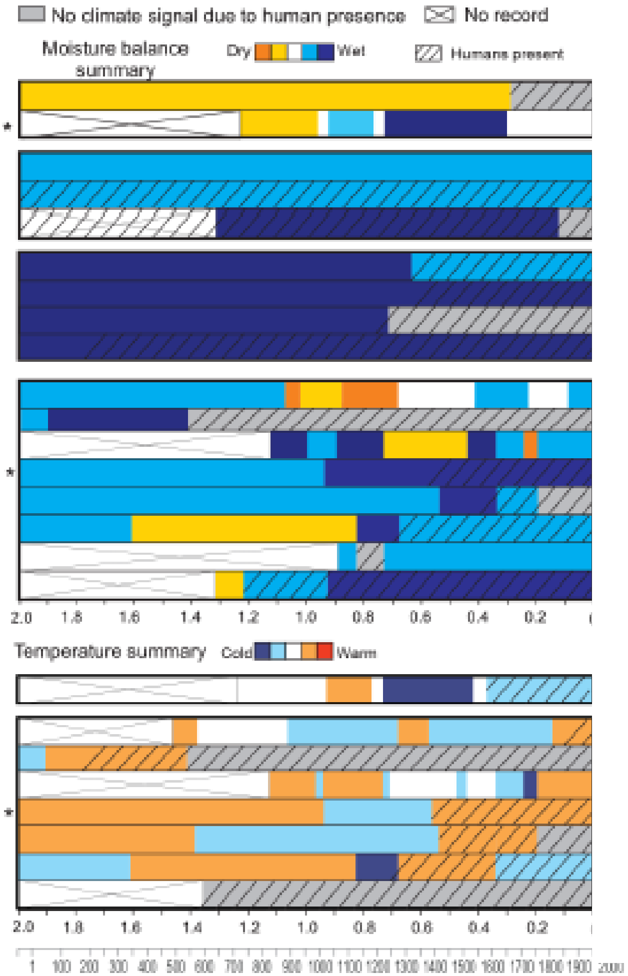
SINCE 2000, 50% IS MULTIPROXY
Charcoal and physical sedimentology are the most commonly used proxies in addition to pollen; Studies of 3-4 proxies are nowadays frequent.

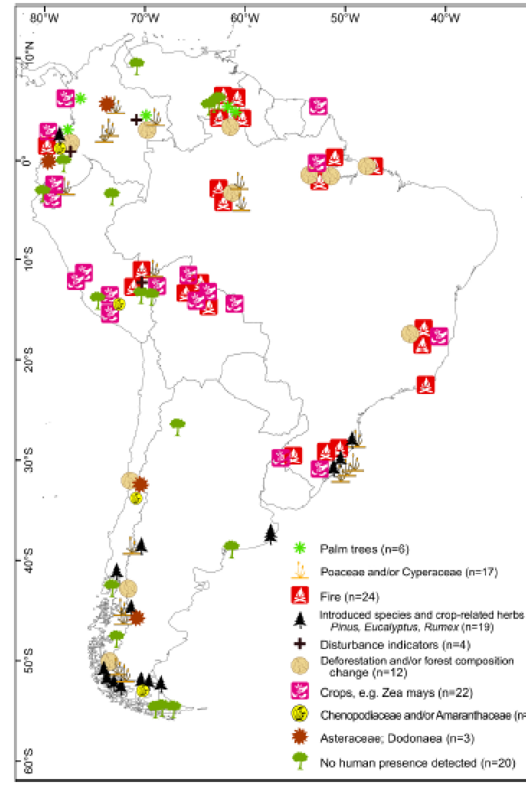


WHY IS THE LAPD RELEVANT FOR YOU?
DO YOU WANT MORE PEOPLE TO SEE YOUR STUDY AND INCREASE CITATIONS?
Provide your coordinates to the LAPD and your study will show up on the map for everyone to find!
DO YOU WANT TO COMPARE YOUR DATA WITH OTHERS?
Become part of the running LAPD projects and expand your network!
ARE YOU CURIOUS AND WANT TO KNOW MORE?
Contact the current LAPD data steward at s.g.a.flantua@uva.nl

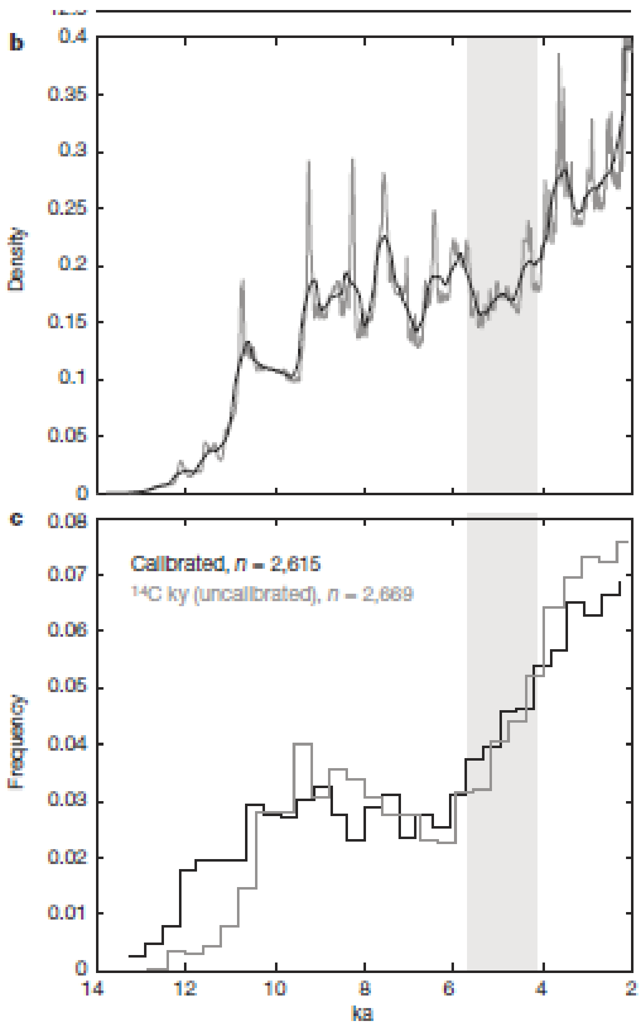
uniandes



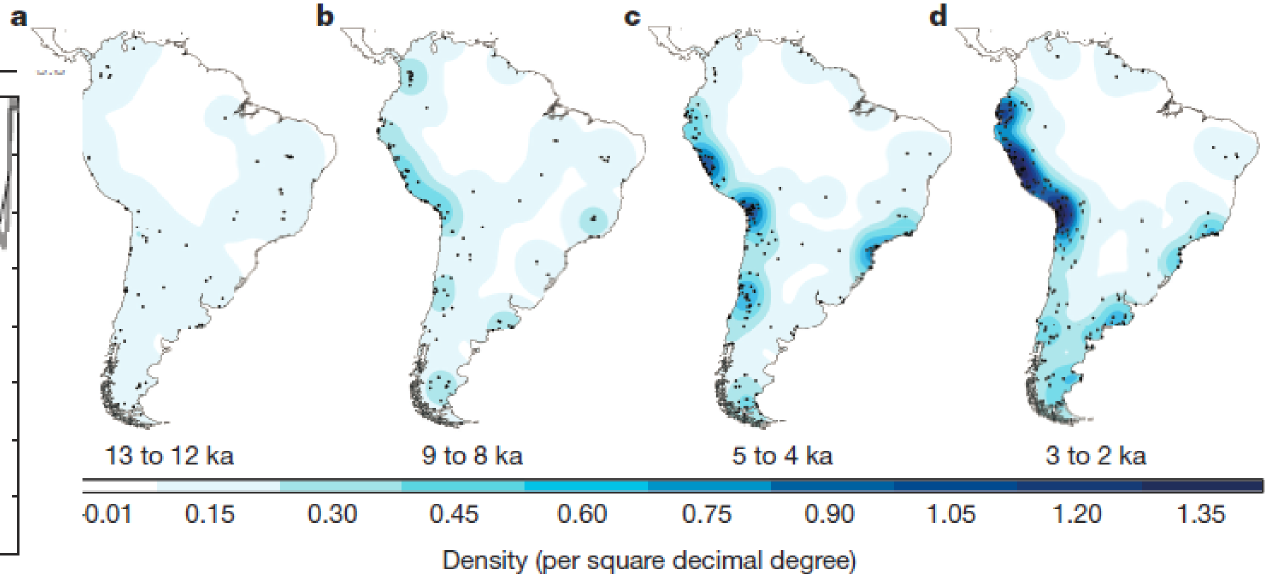




Flantua et al. 2016



Goldberg et al. 2016



GLOBAL PALEOFIRE
WORKING GROUP 2

Atlas arqueológico Colombiano

Example 2. PaleoENSO dynamics

- PaleoENSO amplitude and frequency during different climatic states

- Response of vegetation to extremes (composition, Carbon,)

- Proxy vs. Instrumental calibration (isotopes in wood and cactus spines)

La historia climática de la Tatacoa contada por espinas de cactus columnares

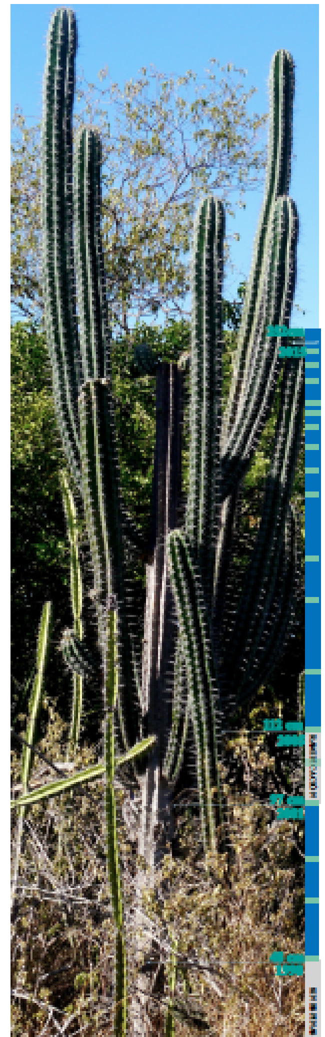
Juanita Moreno Millán[1], Eloisa Lasso[2], Catalina González Arango[1]

[1]Laboratorio de Palinología y Paleoecología Tropical, Departamento de Ciencias Biológicas, Universidad de los Andes

[2]Laboratorio de Ecología y Fisiología Vegetal, Departamento de Ciencias Biológicas, Universidad de los Andes

Contacto: j.moreno624@uniandes.edu.co

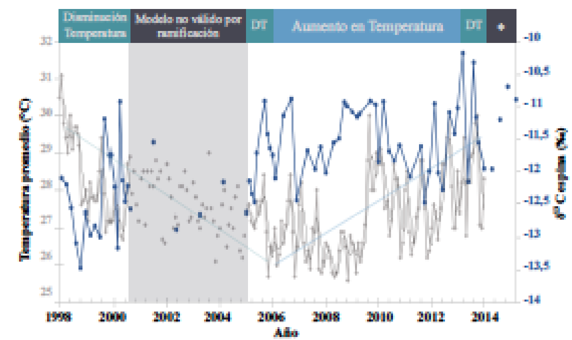
Resultados



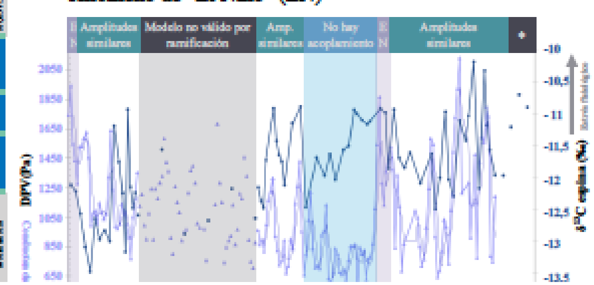
- 18 Dataciones con $F^{14}C$ permiten saber que:
  - La **edad** de este cactus es de c.a. **20 años.**
  - La tasa de crecimiento promedio es de 15 cm/año
  - En la ramificación la tasa disminuye a 3 cm/año

Temperatura y DPV son las variables que más se relacionan con la señal isotópica:

- La señal isotópica tiene la misma tendencia que la temperatura: descendente desde 1999 hasta 2005 y ascendente desde 2006 hasta 2013.

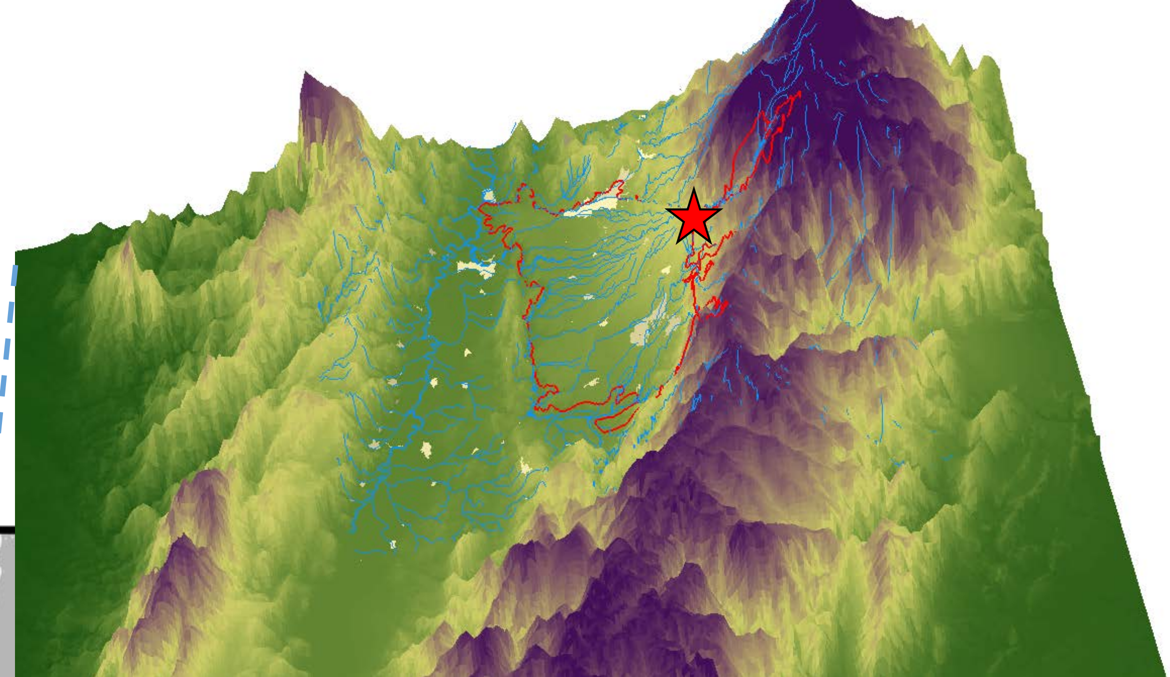


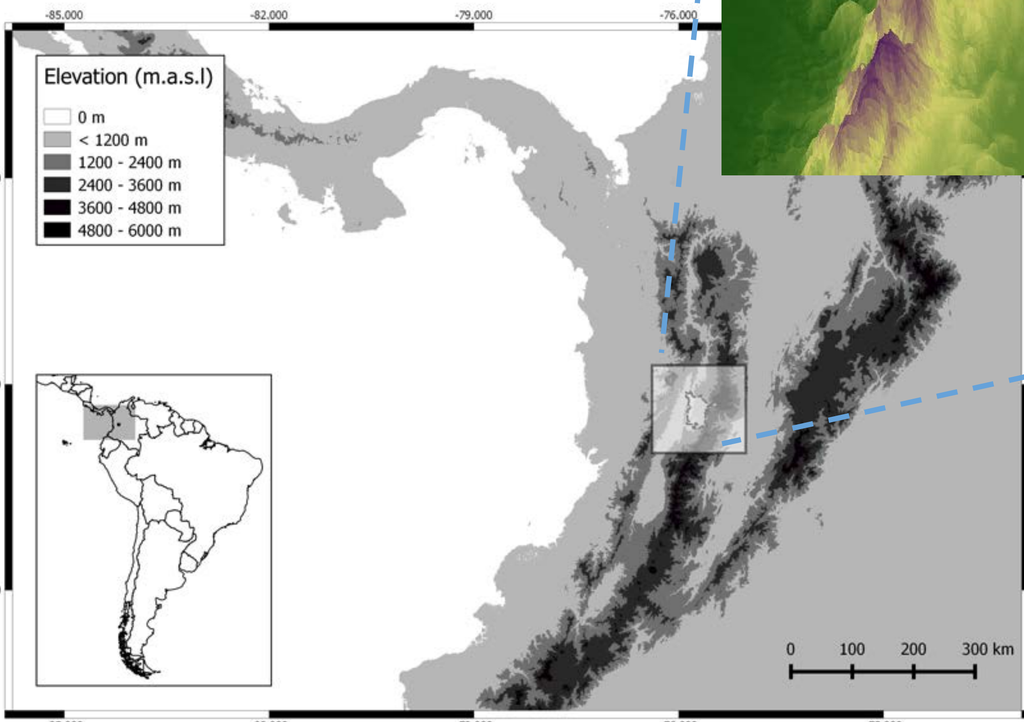
- $\delta^{13}C$ es más sensible a las amplitudes del parámetro DPV y a los períodos de sequía: acoplamiento con fenómeno de "El Niño" (EN)

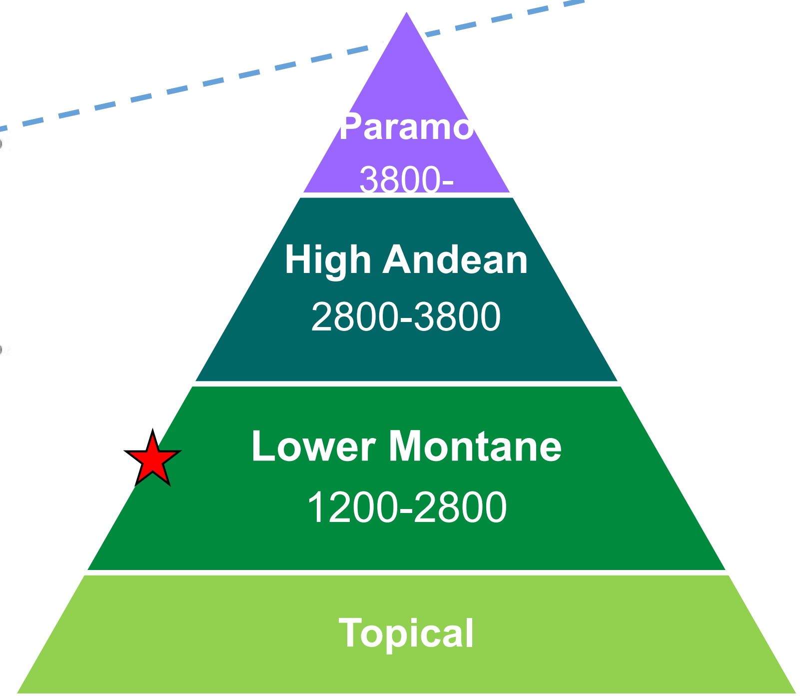


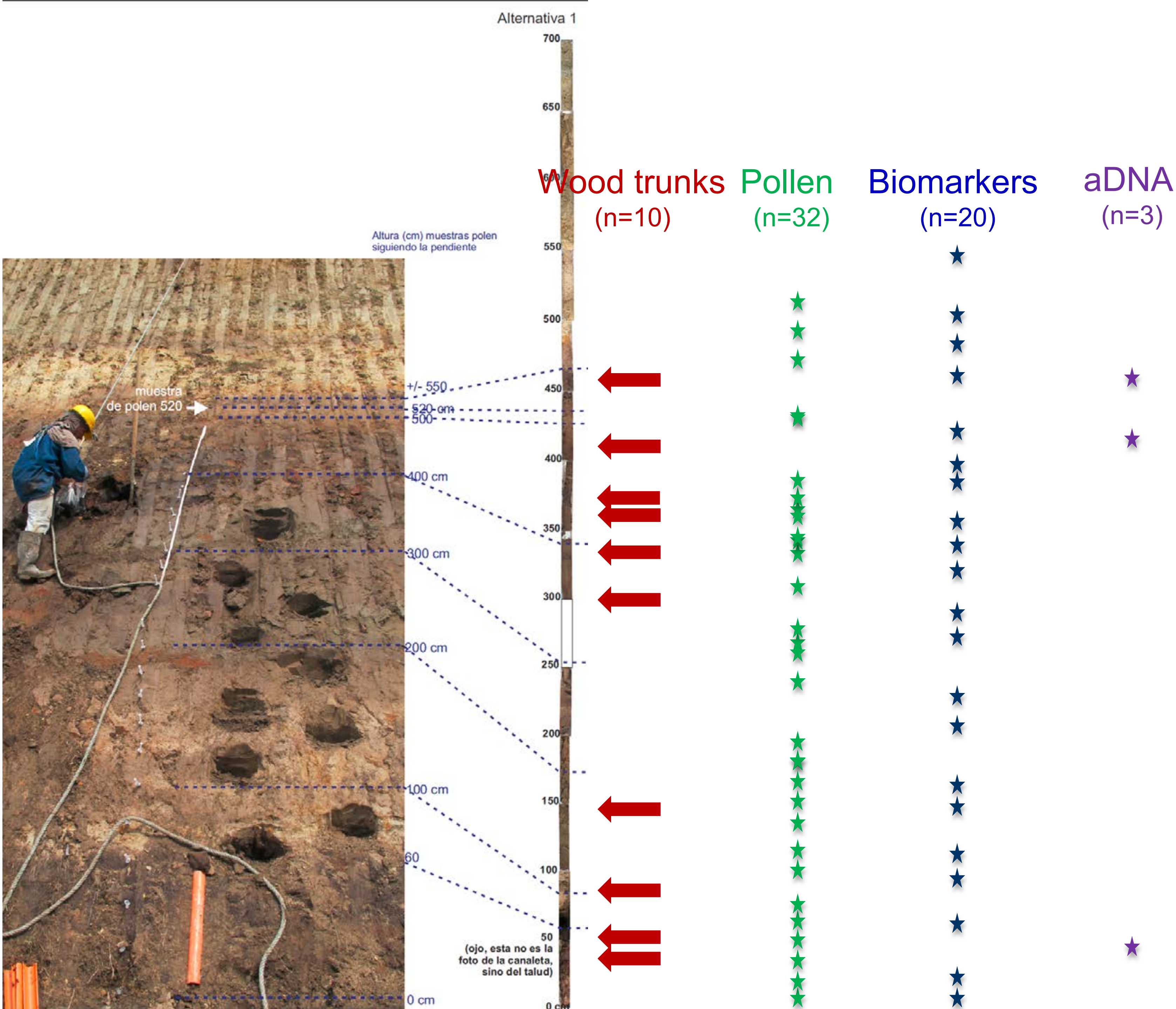
Plio-Pleistocene
Pereira Volcanodetritic Fan

2014 masl
3000 mm/yr









Alternativa 1
Wood trunks
(n=10)
Pollen
(n=32)
Biomarkers
(n=20)
aDNA
(n=3)
Altura (cm) muestras polen siguiendo la pendiente
muestra de polen 520
+/- 550
520 cm
500
400 cm
300 cm
200 cm
100 cm
60
0 cm
700
650
600
550
500
450
400
350
300
250
200
150
100
50
(ojo, esta no es la foto de la canaleta, sino del talud)
0 cm

Stable isotopes in subfossil woods: first insights into an ultra-high resolution paleoclimatic record of an Andean forest during the Late Pleistocene.

David Andrés Ayala Usma[1] and Catalina González Arango[1*]

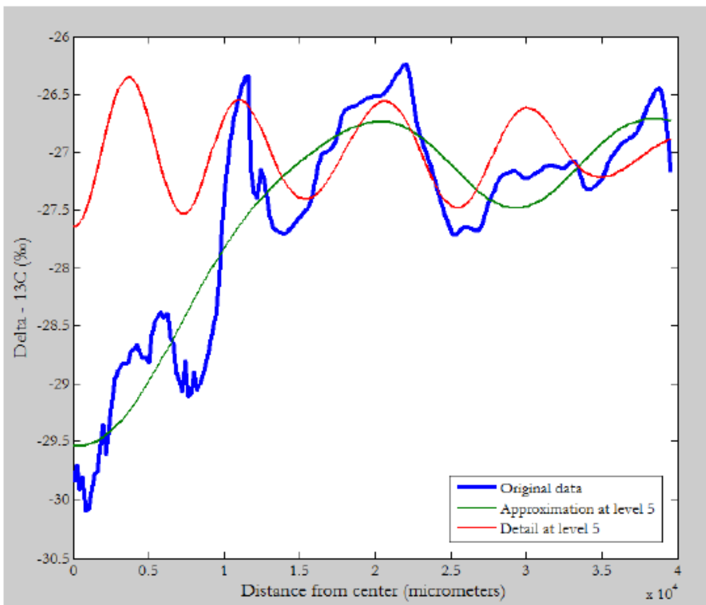
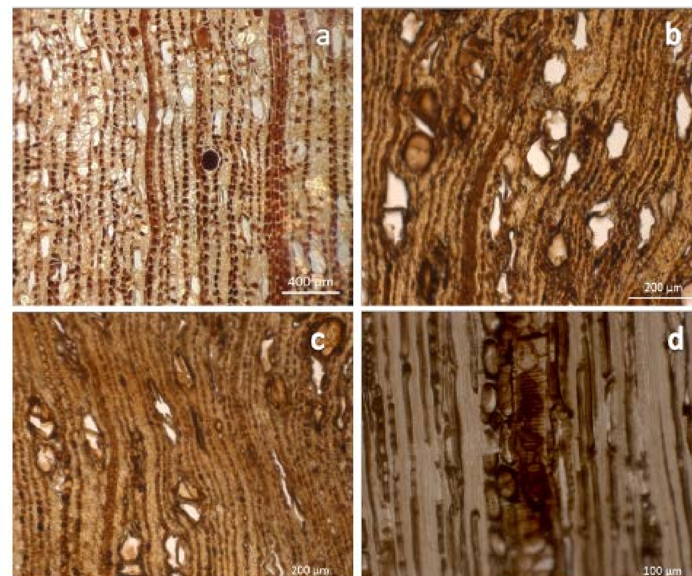
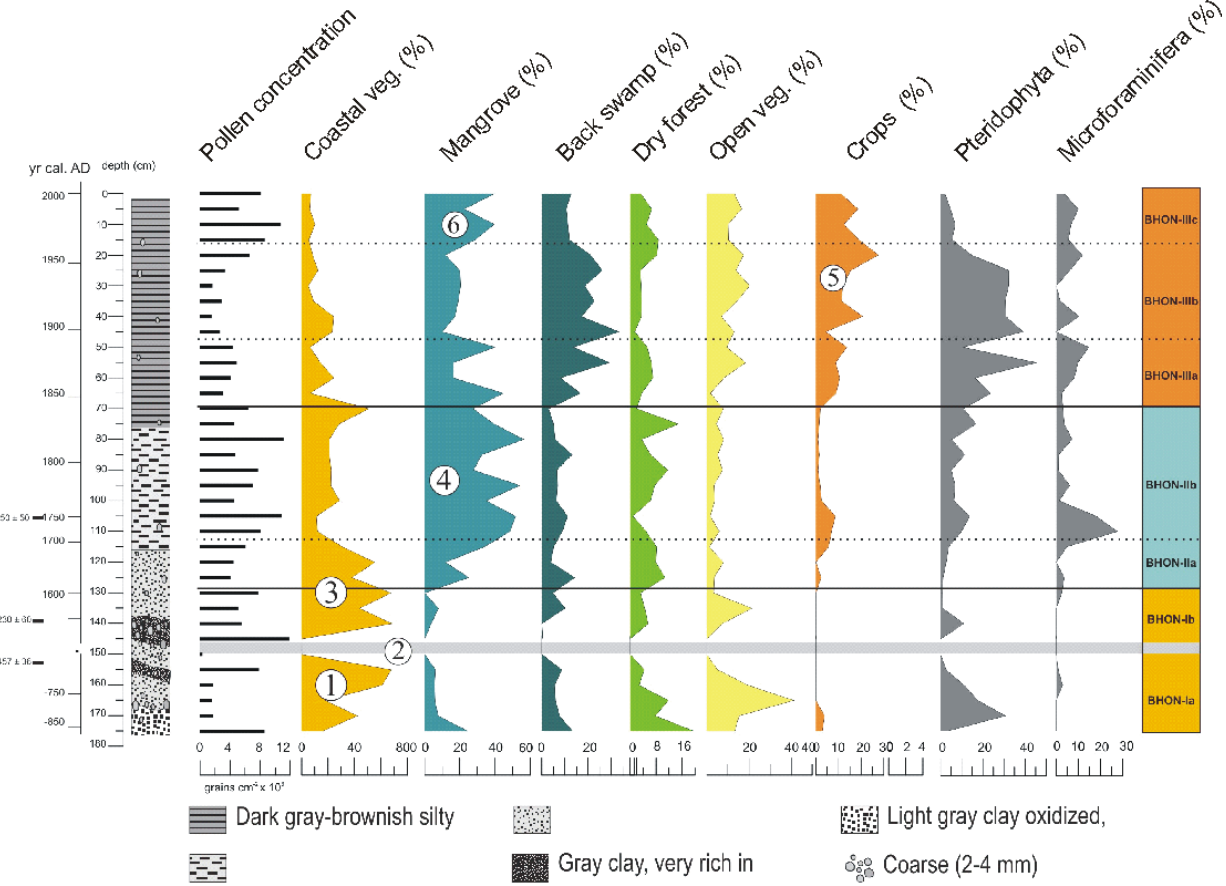


Figure 7: Superposition of the approximation at 5 level and the detail at the 5 level w
data.



Example 3. Mangroves

- Response to sea-level change, climate, humans
- Response, trajectories, recovery after extreme events
- Heterogeneity of responses to the same stressor

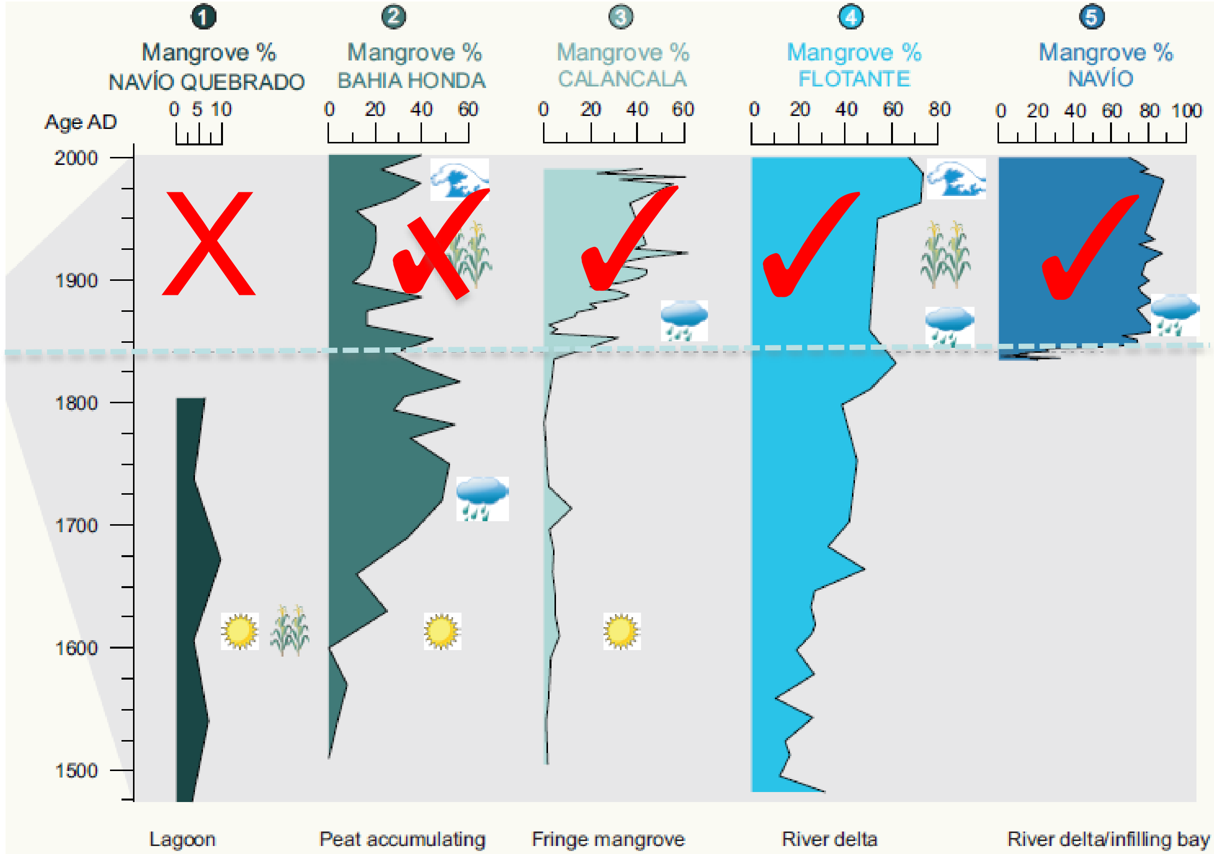


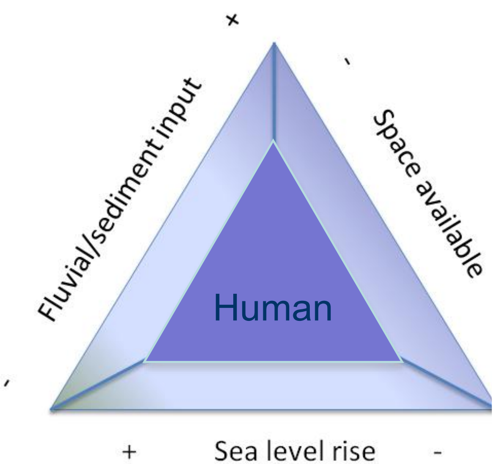
- Resilience?
- Succession trajectories?
- Time of recovery?

- Hurricane at 1605 AD, which destroyed completely the forest and promoted the displacement of the shoreline. Supported by historical documents.

- The mangrove started to recover after 50-70 years.

- Anthropogenic impact





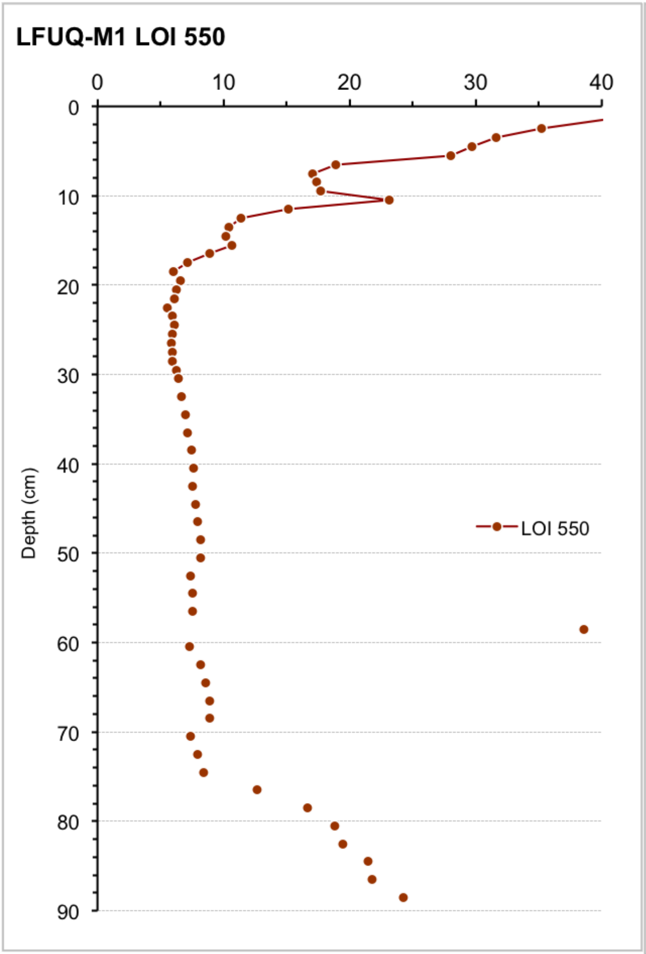
No single location follows the global average of climate estimates

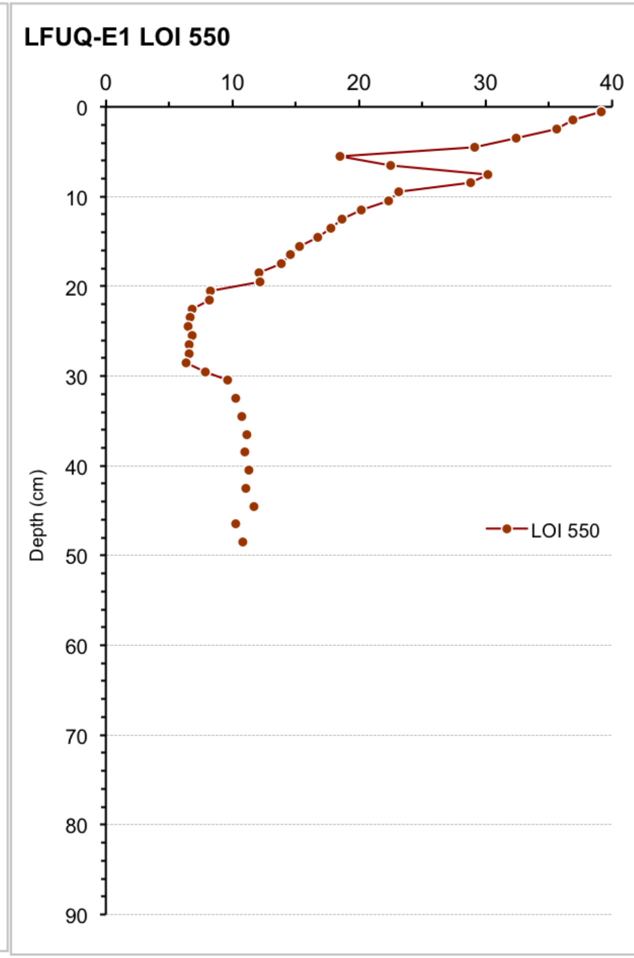
Urrego et al. 2012

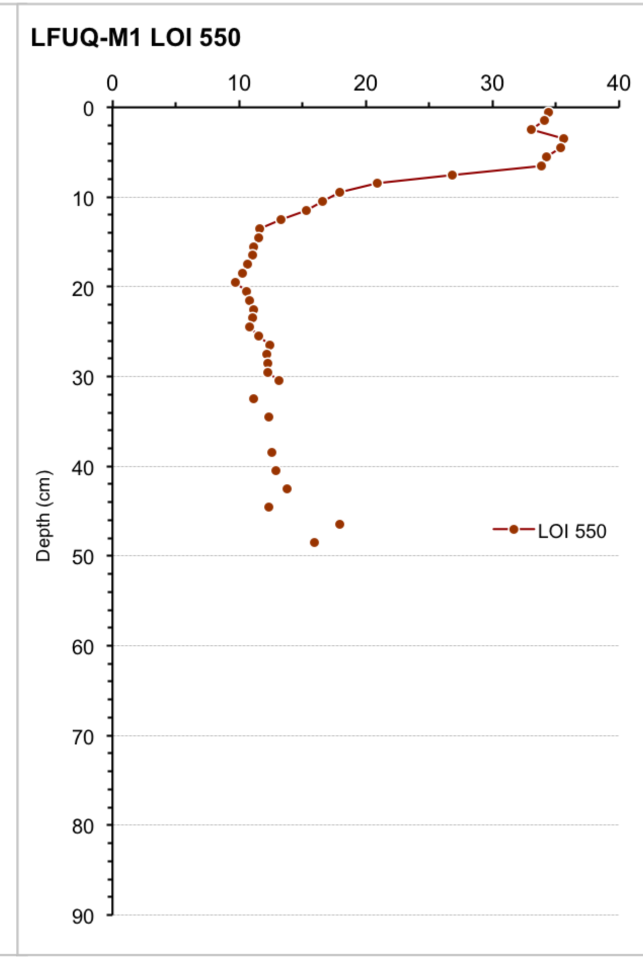
Example 4. Monitoring and paleolimnology of Andean lakes

Superimposed Anthropogenic impacts

- Invasive species
- Climate change
- Mining
- Agriculture, cattle







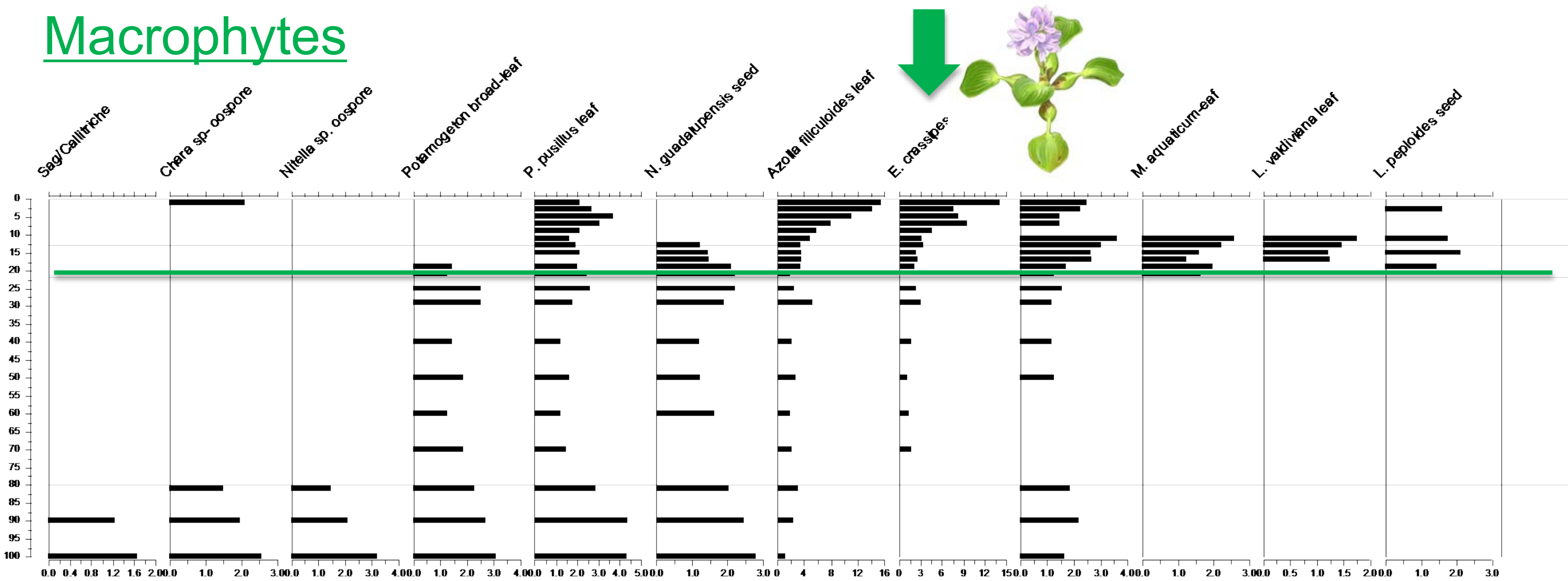
M1

E1

B1

Salgado et al. In prep

Macrophytes



Invertebrates

Salgado et al. In prep

Diatoms

Pollen

Biomarkers

Charcoal

Geochemistry

Variables

Vegetation composition

Trophic networks (lakes)

Diversity *

Moisture availability

Temperature (atitude)

Sedimentation rates

Soil erosion

Human presence

Salinity

Fire occurence

DPV Deficit de presión de vapor

Nutrients and minerals, (C, N, P, Ca,

Scales

Interannual

Decadal

Centuries-millennia

Millions

By integrating the long term perspective, we expand the possibities of understanding our knowledge on the functioning of ecosystems.