

# Human impact: Niche construction: examples from multiple disciplines, outlook to the future



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ARCHON CONFERENCE: Pathways to the Present – 3 June 2022

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- Human impact
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  - Human Niche Construction
  - TERRANOVA: a landscape-based response
    - Example Agrarian Transition NW Spain
    - Example Industrial Transition Spain
  - Concluding remarks

# Problem Human Impact (1)

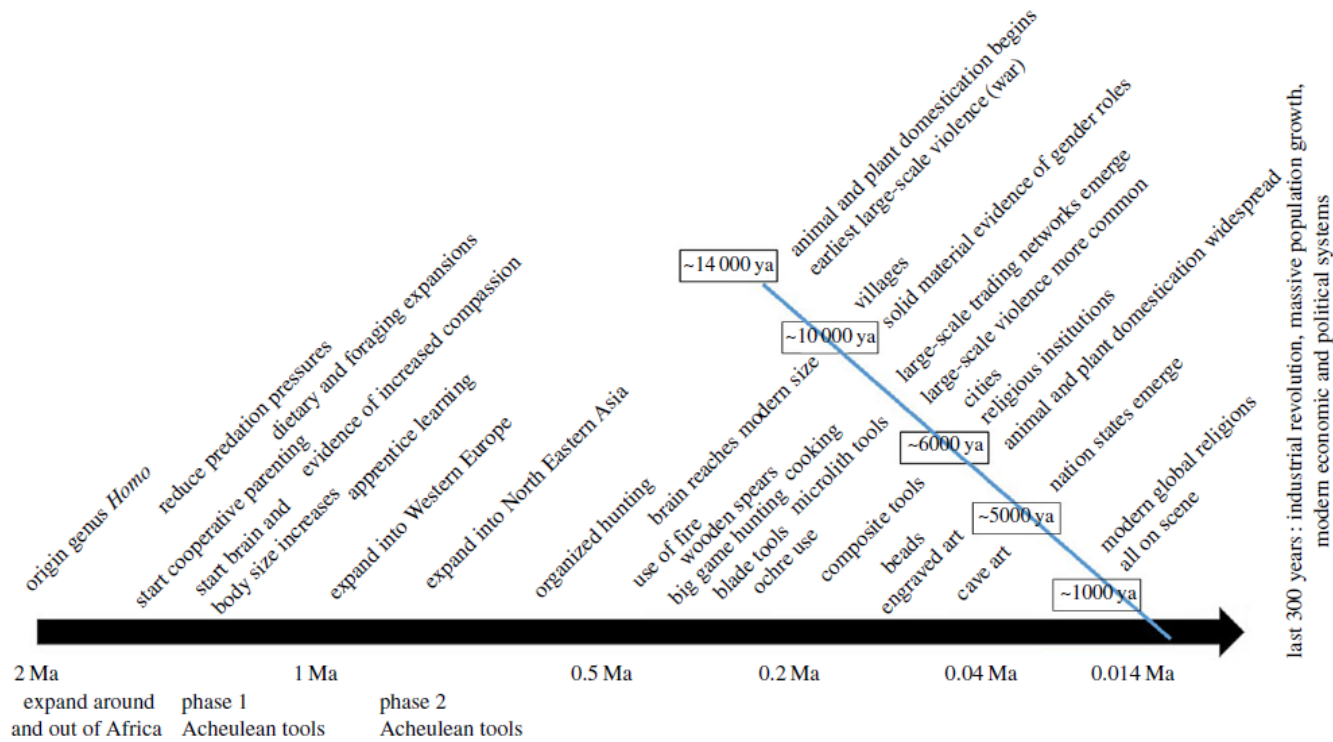
- Human impact today:
  - We have by now transformed more than half of the ice-free land of the earth, and indirectly half of what remains
  - We have dammed or diverted most of the world's major rivers
  - Fertilizer plants and legume crops fix more nitrogen than all terrestrial ecosystems combined
  - Planes, cars and power stations emit a hundred times more CO<sub>2</sub> than volcanoes do
  - We now routinely cause earthquakes

# Problem Human Impact (2)

- In terms of biomass:
  - Today people outweigh wild animals by more than eight to one,
  - Add to that the weight of domesticated animals (mostly cows and pigs) the ratio climbs to twenty-two to one.
  - We have become the major driver of extinction, and also of speciation
  - Human impact is so pervasive: Welcome to the Anthropocene

Source: E. Kolbert (2021) Under a White Sky- Can we save the natural world in time?

# Key events in Pleistocene and Holocene human evolution



# Human Niche Construction (part 1)

1. Maurits W. Ertsen, Christof Mauch, Edmund Russel, *Editors 2016* Molding the Planet: Human Niche Construction at Work, no. 5, Rachel Carson Center for Environment and Society,

2. Kluiving, SJ & Hamel, A 2016, How Can Archaeology Help Us Unravel the Anthropocene? RCC Perspectives: Transformations in Environment and Society. in *Molding the Planet: Human Niche Construction at Work: Editors: Maurits W. Ertsen, Christof Mauch, Edmund Russel.*, no. 5, Rachel Carson Center for Environment and Society, pp. 55–62.

3. Kluiving, SJ 2015, 'How geoarchaeology and landscape archaeology contribute to niche construction theory (NCT)' *Water History*, vol. 7, no.

4. <https://doi.org/10.1007/s12685-015-0144-8>

4. van den Biggelaar, DFAM & Kluiving, SJ 2015, 'A niche construction approach on the central Netherlands covering the last 220,000 years' *Water History*. <https://doi.org/10.1007/s12685-015-0141-1>



Both have  
similar  
activities...

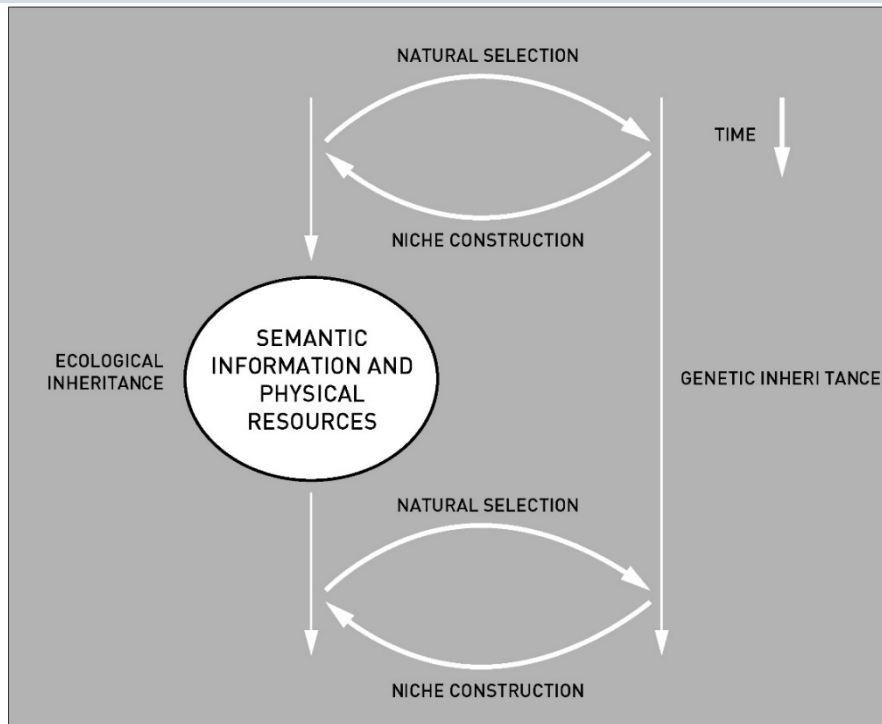


# Niche Construction Theory

Capacity of organisms to modify their environment and thereby influence their own and other species' evolution (Odling-Smee et al, 2003).

Relations between natural selection and niche construction through time has 2 outcomes.

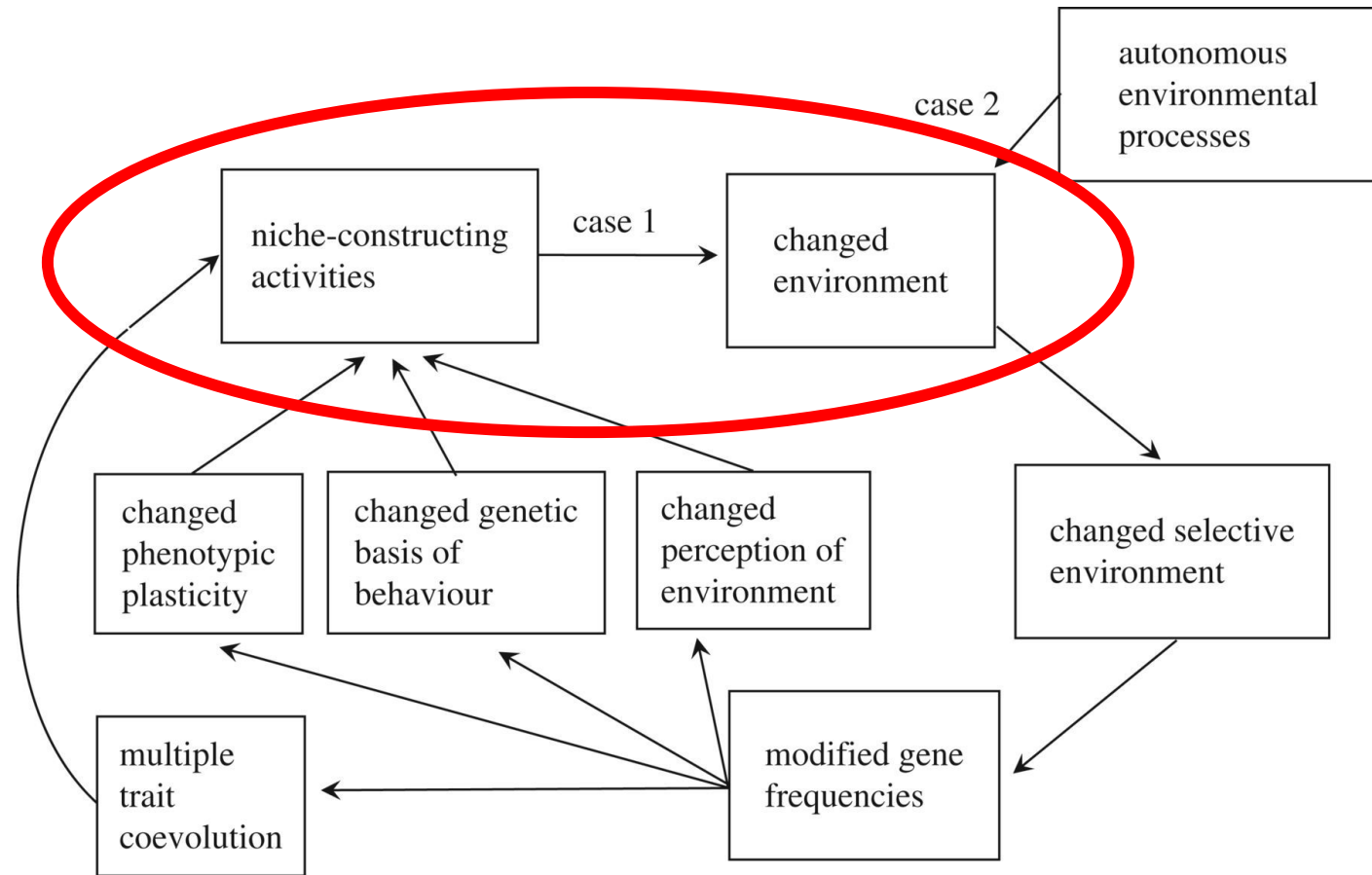
Human interference will add an **ecological inheritance** through *social learning and physical elements* to the next cycle.



After: Kendal et al, 2012



# NCT discussion



Laland et al 2017

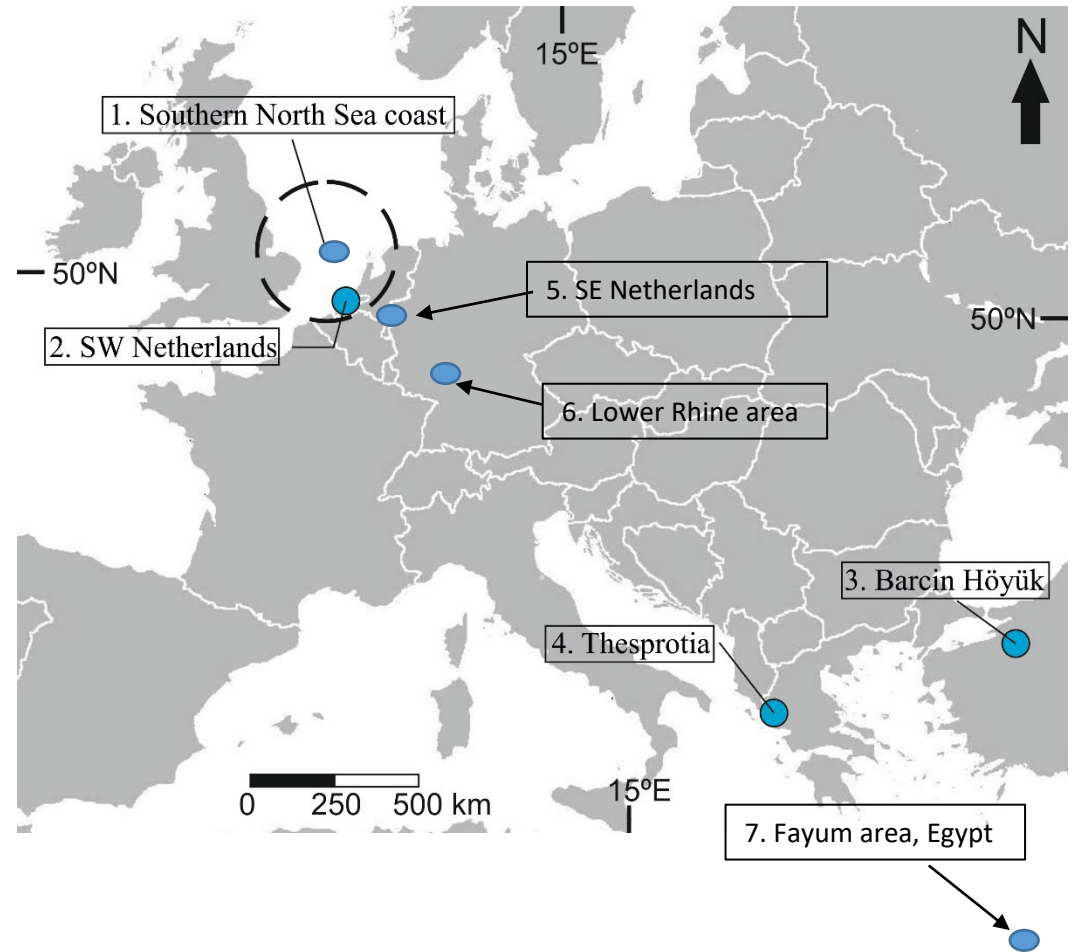
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# Research design

Hypothesis: modification of environments is an important condition for organism-induced changes in selection procedures.

Approach: Testing several examples of past human occupation in geoarchaeology and landscape archaeology on HNC.

→ Important landscape gradients that affect human activity are transitions between: land and water, high and low altitudes, different soil properties, salt- vs. freshwater environments etc.





CS6

Buried dark soil horizons and archaeological features in the Neolithic settlement region of the Lower Rhine area, NW Germany: Formation, geochemistry and chronostratigraphy

R. Gerlach<sup>a,\*</sup>, P. Fischer<sup>b</sup>, E. Eckmeier<sup>c</sup>, A. Hilgers<sup>b</sup>

Loess-covered landscape of Lower Rhine Basin with their arable soils has been exposed to human impact during most of the Holocene.

Assumed that Chernozems existed as naturally formed soils at the onset of the Neolithic (5300 BC).

Palynology did not find evidence for steppe or forest-steppe vegetation prior to Neolithic.

chernozem





Buried dark soil horizons and archaeological features in the Neolithic settlement region of the Lower Rhine area, NW Germany: Formation, geochemistry and chronostratigraphy

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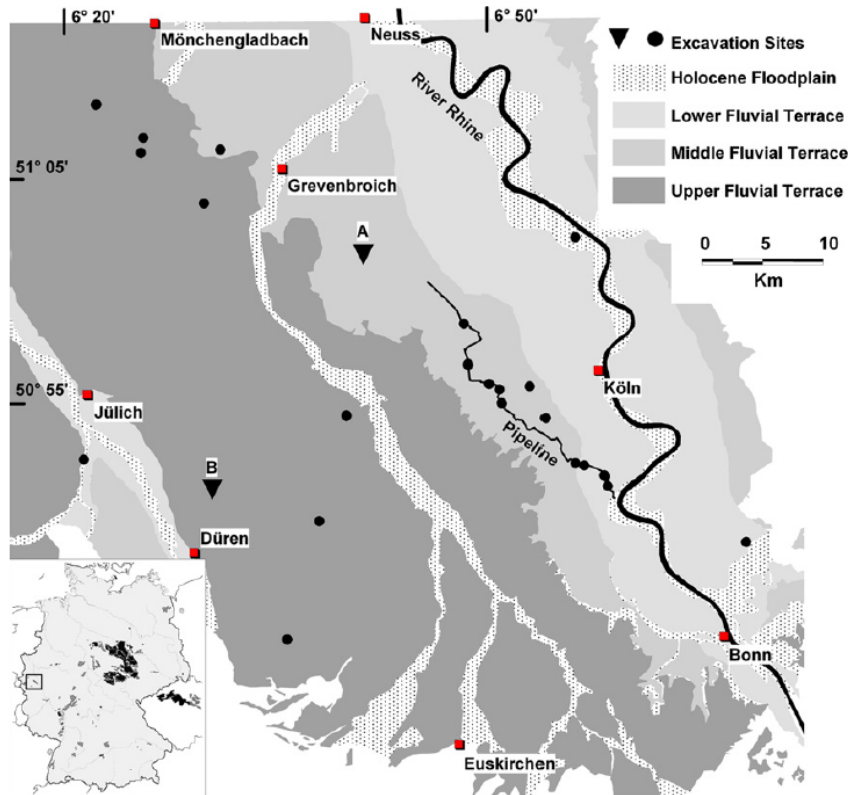


Fig. 1. The study area including the main geomorphological units, the investigated archaeological excavation sites (triangle = OSL dated sites, A: Rommerskirchen–Gillbach, B: Arnoldsweiler–Ellebach) and the pipeline trench (supplemented after Gerlach et al., 2006). The inset map shows the distribution of Chernozems (black) and degraded chernozemic soils (grey) in Germany (modified after Eckmeier et al., 2007a).

1 No natural Luvisc Phaeozems or Chernozemic soil but an archaeological feature  
2. No Loess, but a (human induced) colluvial parent material



chernozem

# Conclusion Gerlach et al. 2012

CS6

- Strong human impact on soil-forming processes since the onset of agriculture
- Dark fossil Bht-horizons and pits are archaeological off-site features, deeply influenced by charred organic matter derived from fires ignited by humans.
- Parent material of soils enriched in pyrogenic carbon is of colluvial origin
- Revise conventional wisdom for many Central European soils which were strongly influenced during the Holocene by enduring agricultural activities
- **Human impact can be considered as the main soil forming factor in early settled regions, not only for black soils.**



# TERRANOVA: a landscape-based response to one of the greatest challenges of our time.

*Sjoerd Kluiving, coordinator; Funded by European Union: MARIE SKŁODOWSKA-CURIE ACTIONS - Innovative Training Networks (ITN)*

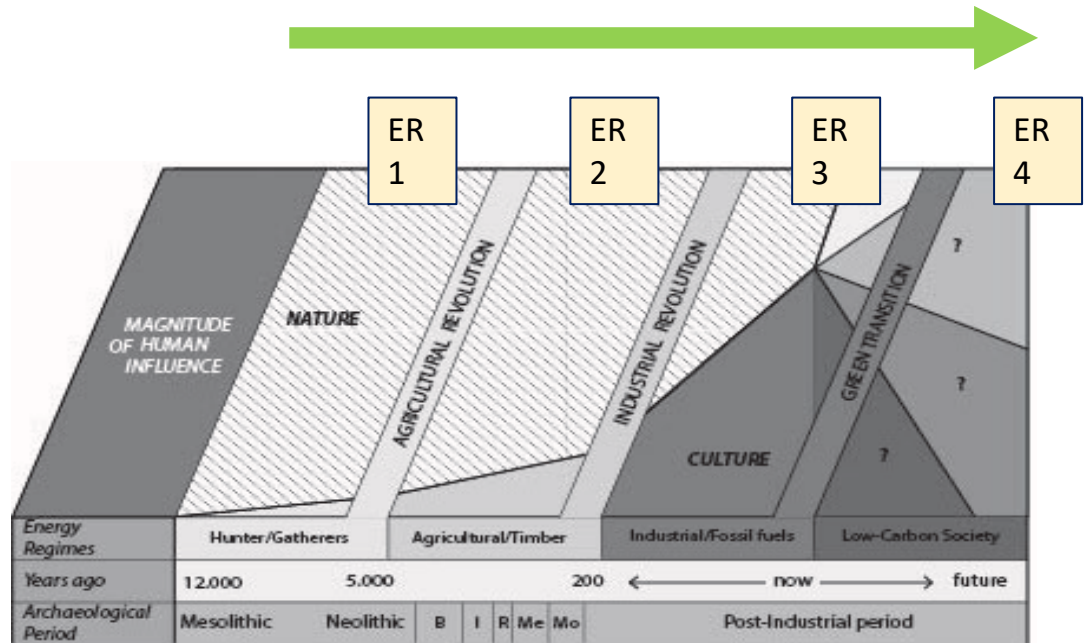
*Call: H2020-MSCA-ITN-2018, TerraNova will run 2019 – 2023*



**TERRANOVA Academy Field School 6: transition to the Low Carbon Society, Brussels (IUCN, ELO)**

# Concept of energy regimes through time

- And the increasing magnitude of human influence and changing balance between nature and culture.
- Training researchers to understand and negotiate the uncertain “future of nature” is a major focus of TerraNova.



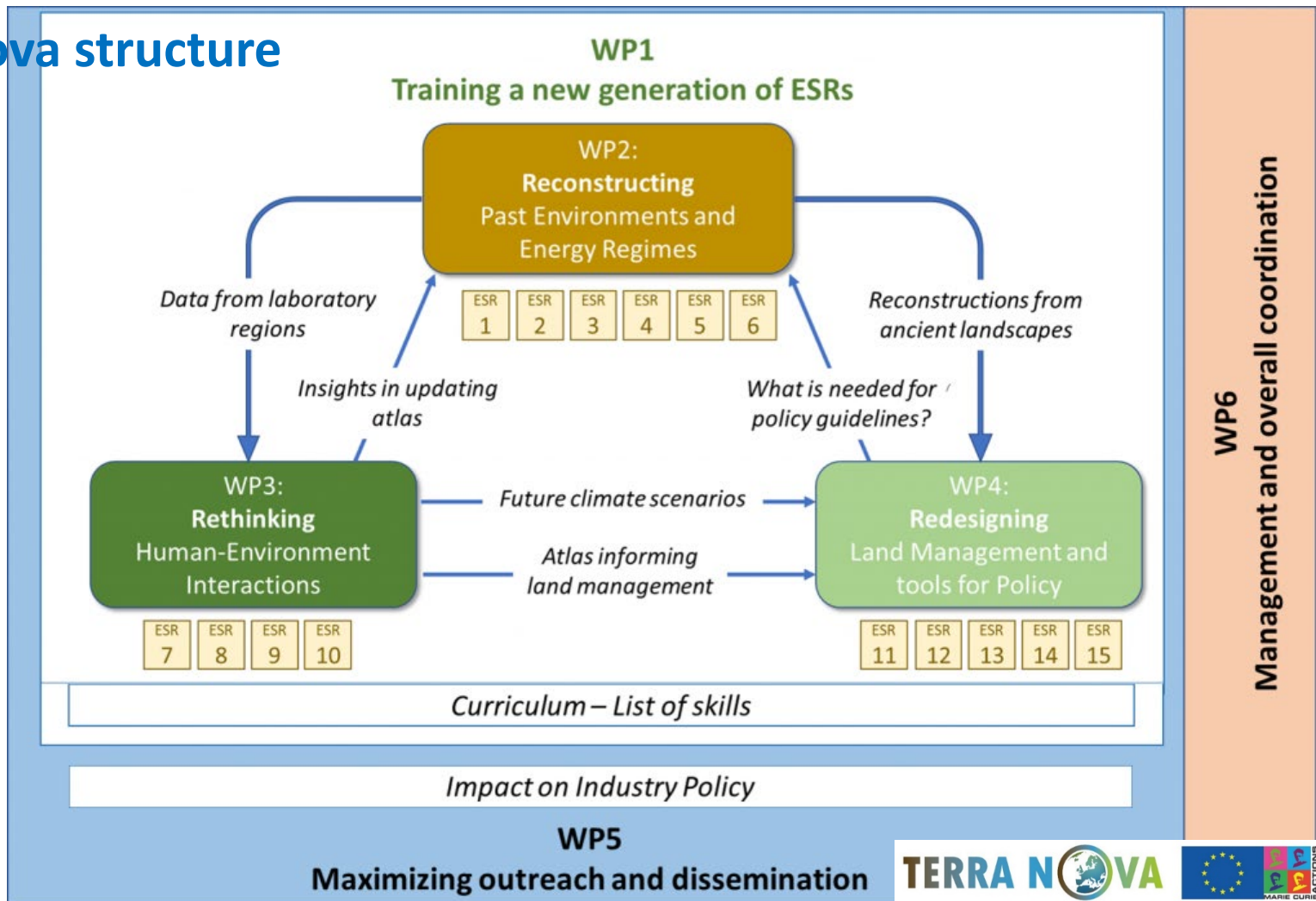
# Biodiversity and landscape change

- Over the last decades **biodiversity has declined sharply** due to land-use intensification, urban development and climate change.
- In addition to biodiversity loss, **intensive land use** has resulted in *soil subsidence, eutrophication, land, water and air-pollution and increased greenhouse gas emissions*.
- **Landscape transitions** can only be achieved via a close *collaboration of scientists, landowners (nature managers and farmers), citizens and other stakeholders*, with the aim **to apply interventions in the landscape that are effective to restore biodiversity and essential ecosystem functions and services, including rewilding.**

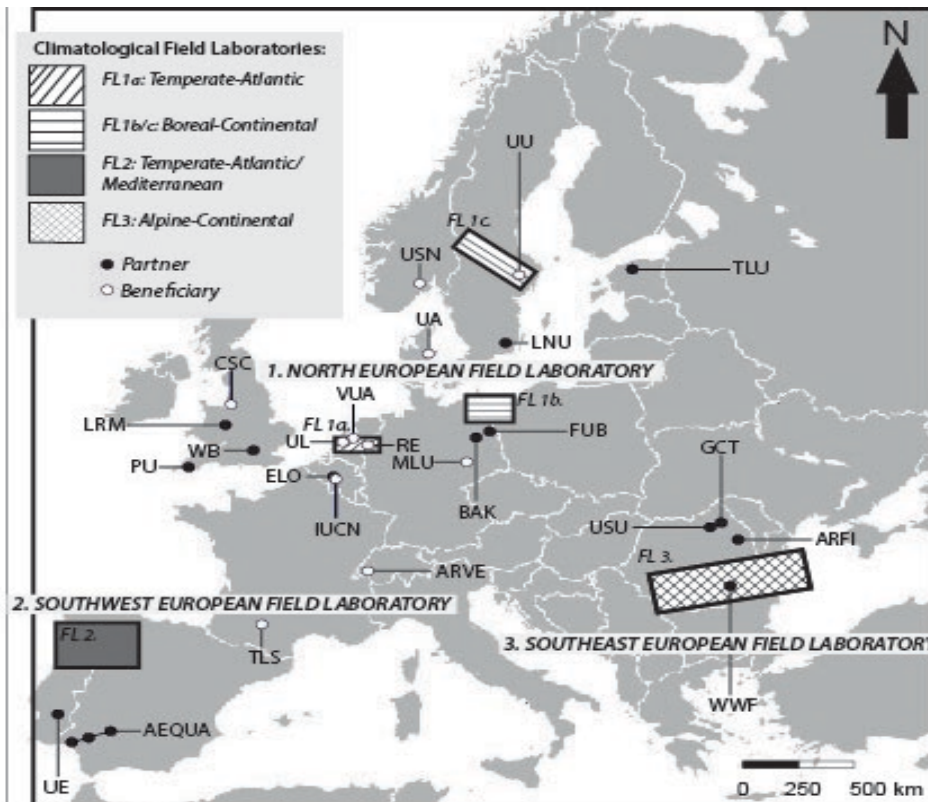




# TerraNova structure



# TERRANOVA Beneficiaries, Partners and Field laboratories

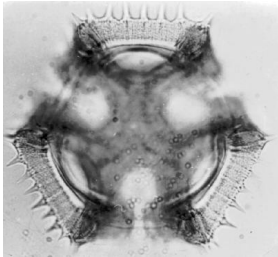
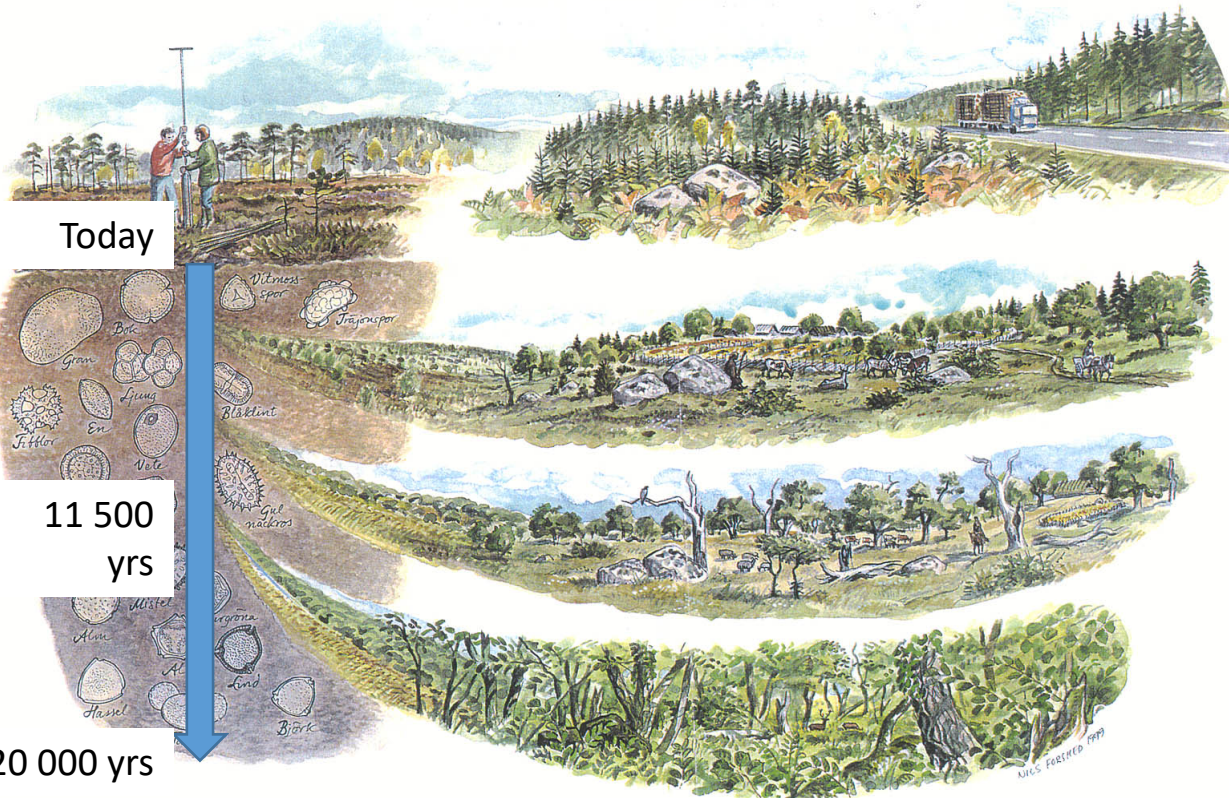


- 11 beneficiaries
- 14 partners
- 13 Universities
- 11 European countries
- 7 traditional disciplines
- Local expertise in field laboratory areas



# LEARNING FROM THE PAST TO PROMOTE A SUSTAINABLE FUTURE

## lessons from the deep history of Europe's cultural landscapes

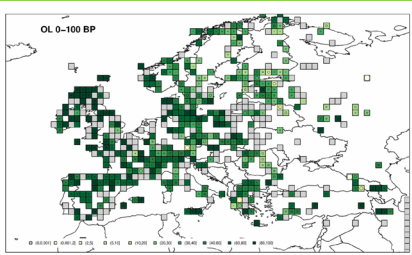


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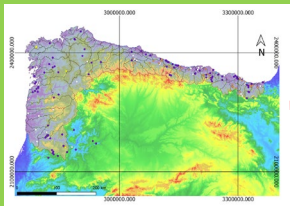


**A common goal: A digital atlas of the history and potential future of land cover and land use change in Europe and the role of human-environment interactions in this change**

**WP2 inputs**



Reconstructions of the past

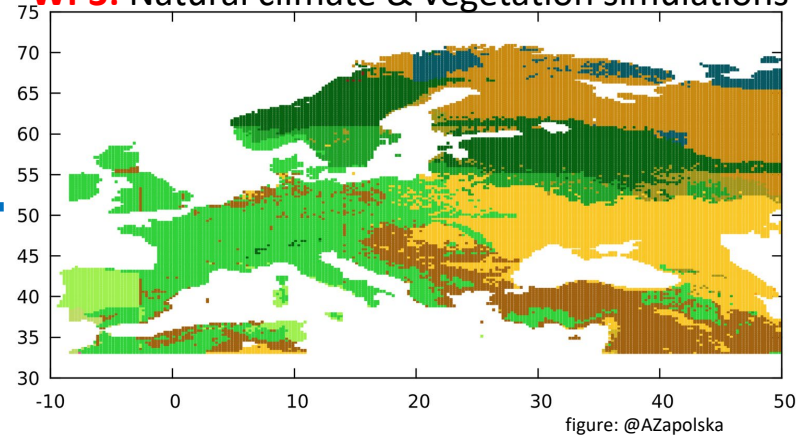


Human impacts

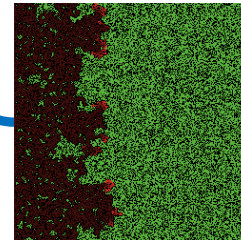
**Digital Atlas**  
(integration step)

**WP4: land management and tools for policy**

**WP3: Natural climate & vegetation simulations**

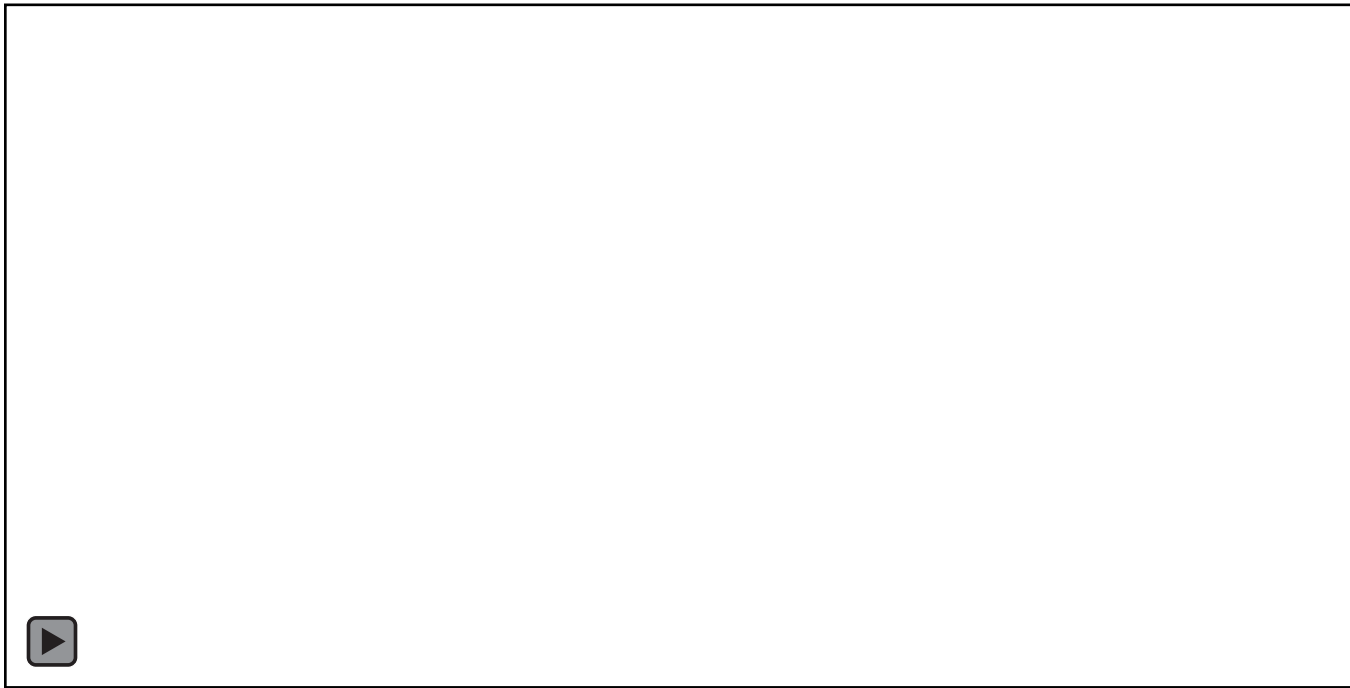


Human disturbances modelling  
(e.g. fire, wood harvest)



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# Sneak preview of Atlas deliverable



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# Production in publications within TERRANOVA

Paper production: **24 papers -March 2022**

- Published: 10 (including 2 white papers)
- Submitted: 3
- In preparation: 11





- **Understand deep history of European landscapes** and past changes in human-environment interactions
- **Apply reservoirs of knowledge and experience** that landscapes encompass, for nature conservation, **landscape planning and sustainable livelihoods, which now remain unexplored.**
- **Shift academic curricula to demonstrate intelligent and innovative solutions** for problems of land abandonment, landscape management and stewardship, rewilding and the process of transitioning to a low carbon society.

For download, go to [www.terranovaltn.eu](http://www.terranovaltn.eu) -> Discover -> Publications

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# RESULTS – MEETING LOCAL AND REGIONAL STAKEHOLDERS (White paper 2):

For download, go to [www.terranovalab.eu](http://www.terranovalab.eu) -> Discover -> Publications

- **Engage with stakeholders** and TERRANOVA's current actions on **participatory scenarios** .
- **Co-produce knowledge** is becoming common practice in academic research
- **Account for land use changes and trajectories, at various spatial and temporal scales.**
- **Involve** local and regional stakeholders in the early stage of a research is vital to deeply understand the complexity of the different case studies



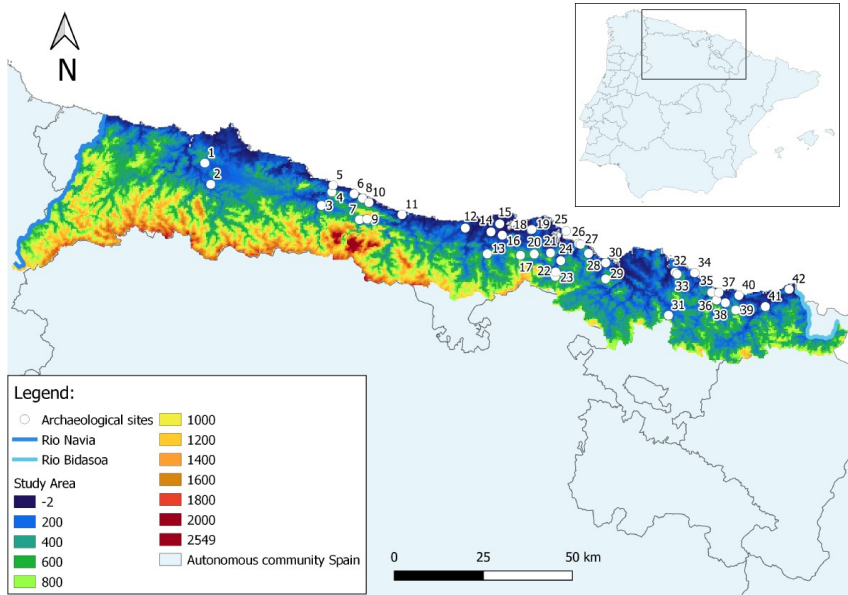


# Rethinking the Agrarian Transition through the lens of long-term history of subsistence strategies and use of energy and resources in Cantabrian Spain

*This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 813904. This output reflects the views only of the author(s), and the European Union cannot be held responsible for any use which may be made of the information contained therein.*

*May 27, 2022.*

# 1. Limitations of cultural phases



*Study area: Cantabrian Spain (Martinez et al., in press).  
Temporal settings: From the Last Glacial Maximum (24,000 cal BP) to the Mid-Holocene (5,300 cal BP).*

## Aim

Connect traditional cultural phases with Energy Regimes.

## Prehistoric chronology

- Cultural phases: Upper Paleolithic, Epipaleolithic, Mesolithic, Neolithic.
- Classification based on technological typologies of stone tools.
- No much societal information → need complementary approach: Energy Regimes.



## Energy Regimes (ER)

- Describe Human-environment interactions based on energy sources.
- Independent from cultural entities.
- Allow comparison with past societies, ethnographic studies, and current societies.

## 2. Methodology

### Data acquisition

- Dataset with 336 entries (archaeological remains).

### Connection with Energy Regimes

- *Immediate Return societies*: Little planning and specific strategies, e.g. following the migration pattern of big mammals.
- *Delayed Return societies*: Planning of the exploitation of the environment, e.g. forest burning for a profitable future.
- *Transition to Agrarian regime*: First appearance of sedentary economies.

Proxies		Indicators
Variance of site elevation		Logistical/Residential continuum
First appearances of ceramics		Reduction of mobility
Marine mollusk MNI	Ungulate MNI	Foraging economy
Domestic plants and fauna		Sedentary Economy
Marine mollusk size		Overexploitation
Marine mollusk age		
Young ungulate proportion		
Burials		Societal complexity
Megalithic structures		

## 4. Economy

Time line (k cal BP)



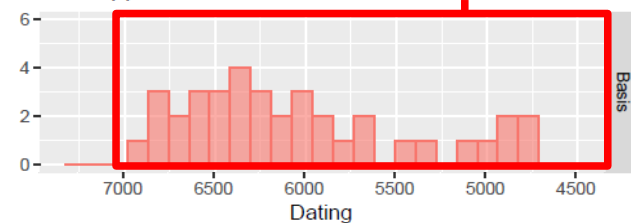
Decrease of ungulate MNIs per stratigraphic level

	Ungulate				Mollusk				
	Entries in database	MNI	Level	MNI/Level	Entries in database	MNI	Level	MNI/Level	
Solutrean	43	1081	48	22.52	5	7601	18	422.28	
Magdalenian	58	1988	72	27.61	24	41820	50	836.40	
Epipaleolithic	15	382	31	12.32	15	30875	22	1403.41	
Mesolithic	10	156	12	13.00	23	75234	38	1979.84	
Neolithic	5	78	7	11.14	9	36343	14	2595.93	

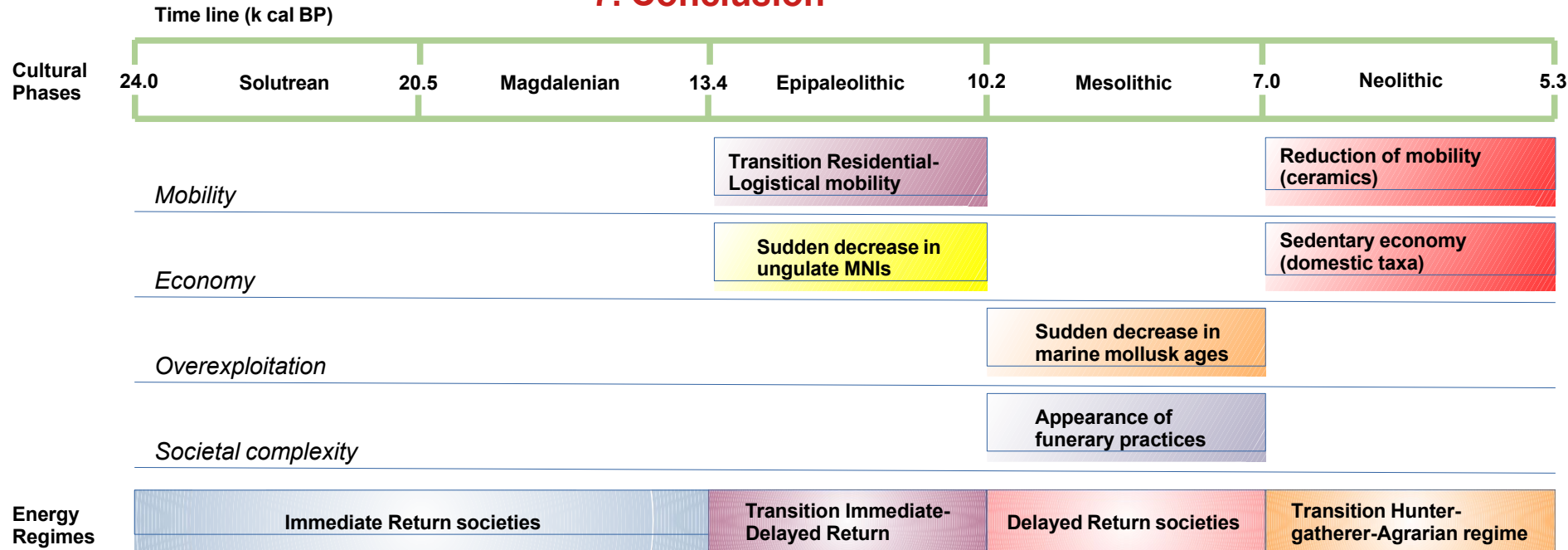
*MNIs of ungulate and marine mollusks per stratigraphic level*

Appearance of domestic taxa

First appearances of domestic taxa



## 7. Conclusion



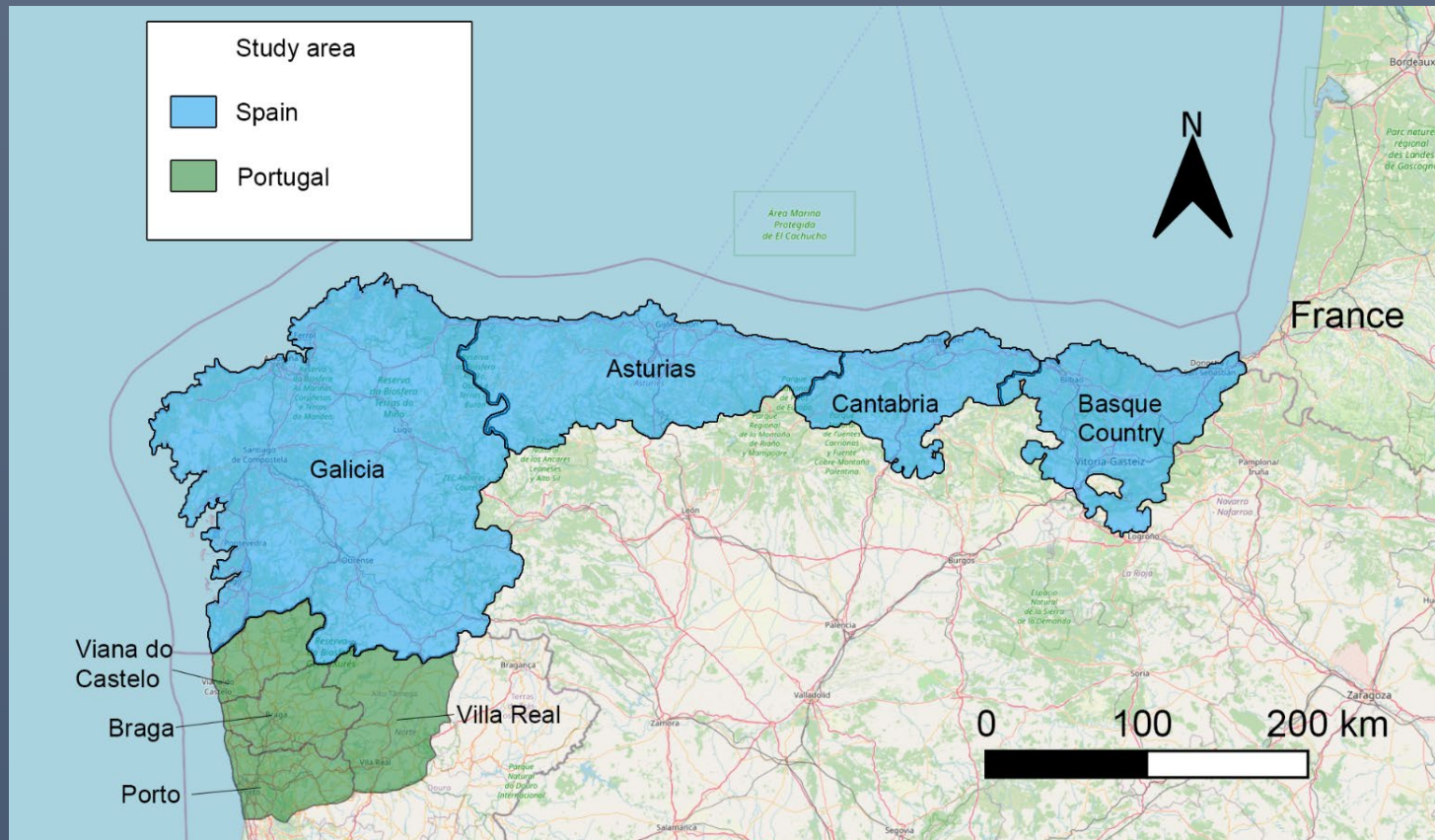
### Concluding remarks

- Connection of cultural phases with Energy Regimes.
- Open ways to quantification of past energy systems.
- Make possible comparison with archaeological and ethnographic studies, as well as current societies.

# Introduction – Objectives

- Can we quantify the societal energy changes during the Industrial Revolution in northwest Iberia?
- What were the controlling factors in energy changes?
- What can we learn from this past energy transition?

# Introduction – Study area



# History –

- Colonialism a
- Treaty of Tor

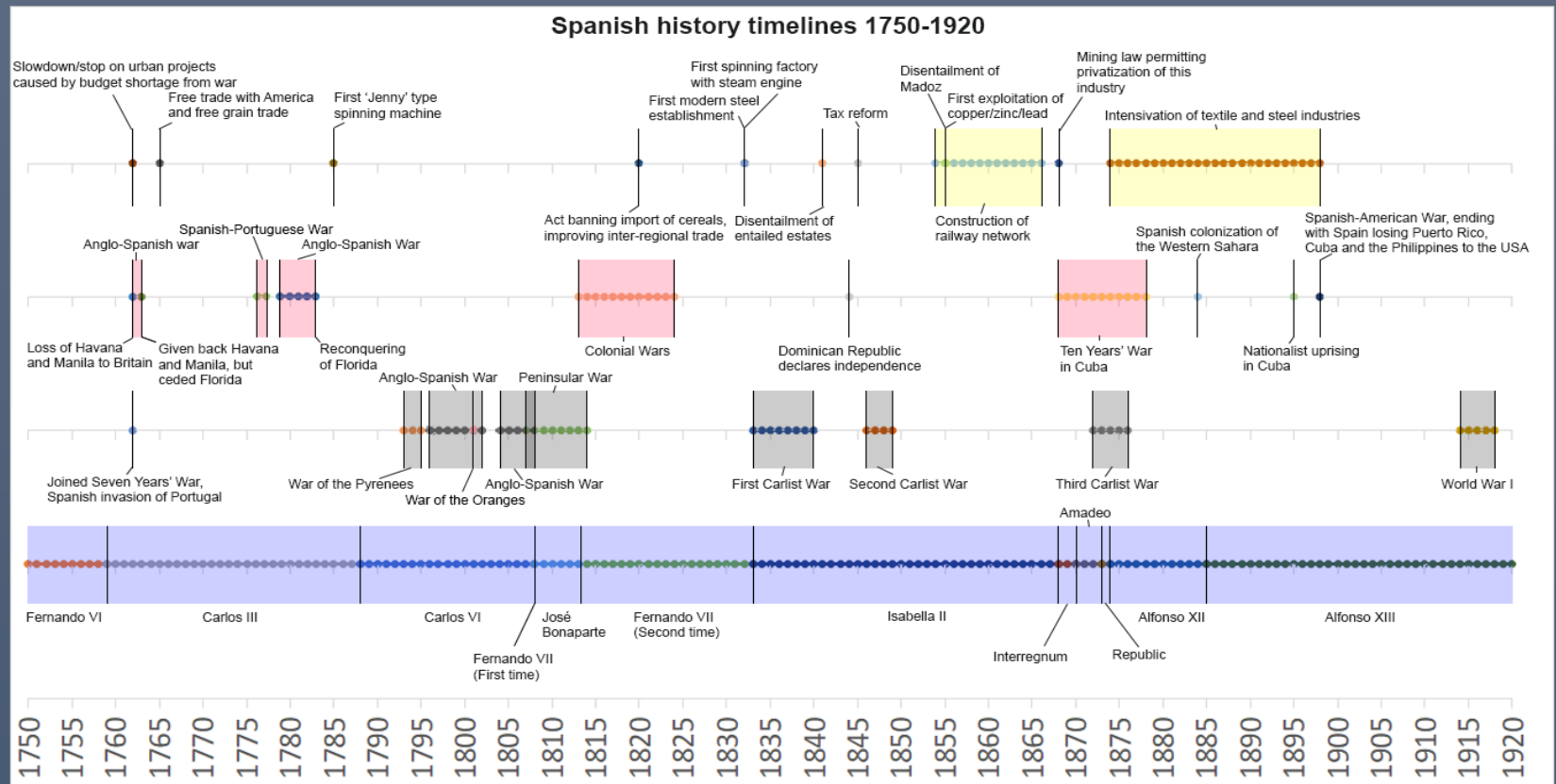


750)

Map by Nagihuin, 2018.  
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# History – Spain (1750-1920)



# Conclusions

- Data availability biggest obstacle
- Over time period 1802-1920, energy consumption grew from ~40 PJ to ~129 PJ in study area
  - ~79% of this growth from Spain, ~21% from Portugal
  - Spanish part showed growth above country average, Portuguese part below country average
  - Basque Country and Porto most important industrial centres
- 'Replacement' effect of traditional with modern energy consumption
- Transitions require extended periods of time, investments and internal stability



## Summary and conclusion

# The classic nature story...

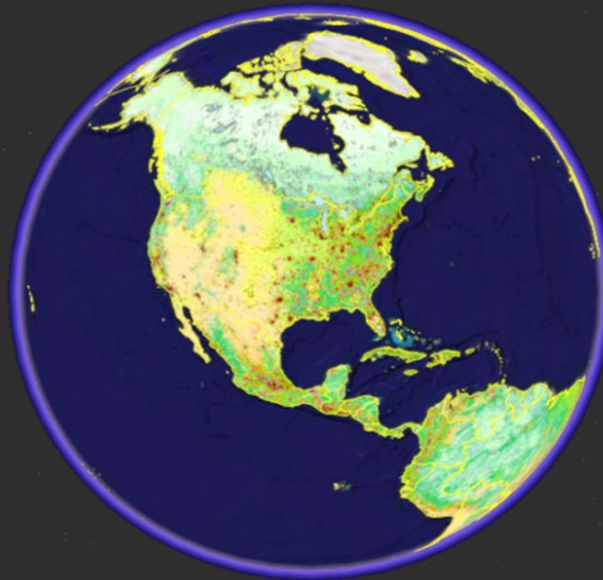
“An ecology disturbed by humanity”



Source: Erle Ellis, Univ.  
Baltimore, USA

# A narrative for the Anthropocene...

“Ecologies embedded within human systems”



Source: Erle Ellis, Univ.  
Baltimore, USA

# Ecologies of the Anthropocene

## Ancestral

value the biosphere we've created (it makes us possible)

## Mosaic

work **across** anthrome mosaics: **Used|Novel|Wild**

## Global

include **global context** in research & teaching

## Permanent

human stewardship **can** sustain the biosphere

# Engaging landscapes towards a better Anthropocene

## Anthropogenic Landscapes

Sustaining Humanity

Sustaining Nature

Producing

∞

Conserving

Restoring

Observing

Structures | Tradeoffs | Opportunities

Negotiating

Stewardship | Engineering | Design | Emergence

Engaging

Stakeholders | Resources | Natures

Scaling

Local ∞ Global

# Human impact: Niche construction: examples from multiple disciplines, outlook to the future



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Thank you for your attention