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Living labs for systemic innovations in silvopastoral systems: opportunities and challenges

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Outline

- The nature of the issues
- Hypotheses
- The Living Lab concept
- The SALAM-MED living lab
- Opportunities and challenges
- Stories of change
- Take home messages





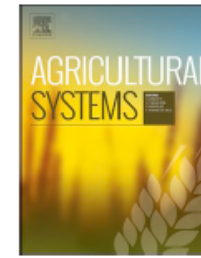


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Patchy landscapes support more plant diversity and ecosystem services than wood grasslands in Mediterranean silvopastoral agroforestry systems

Simonetta Bagella^{a,b,*}, Maria Carmela Caria^b, Giovanna Seddaiu^{b,c}, Laura Leites^d, Pier Paolo Roggero^{b,c}



Land uses	Standardized diversity and ES indices	Sample illustration
WL		
WG Dehesa type		
OG		

S. Bagella, et al.

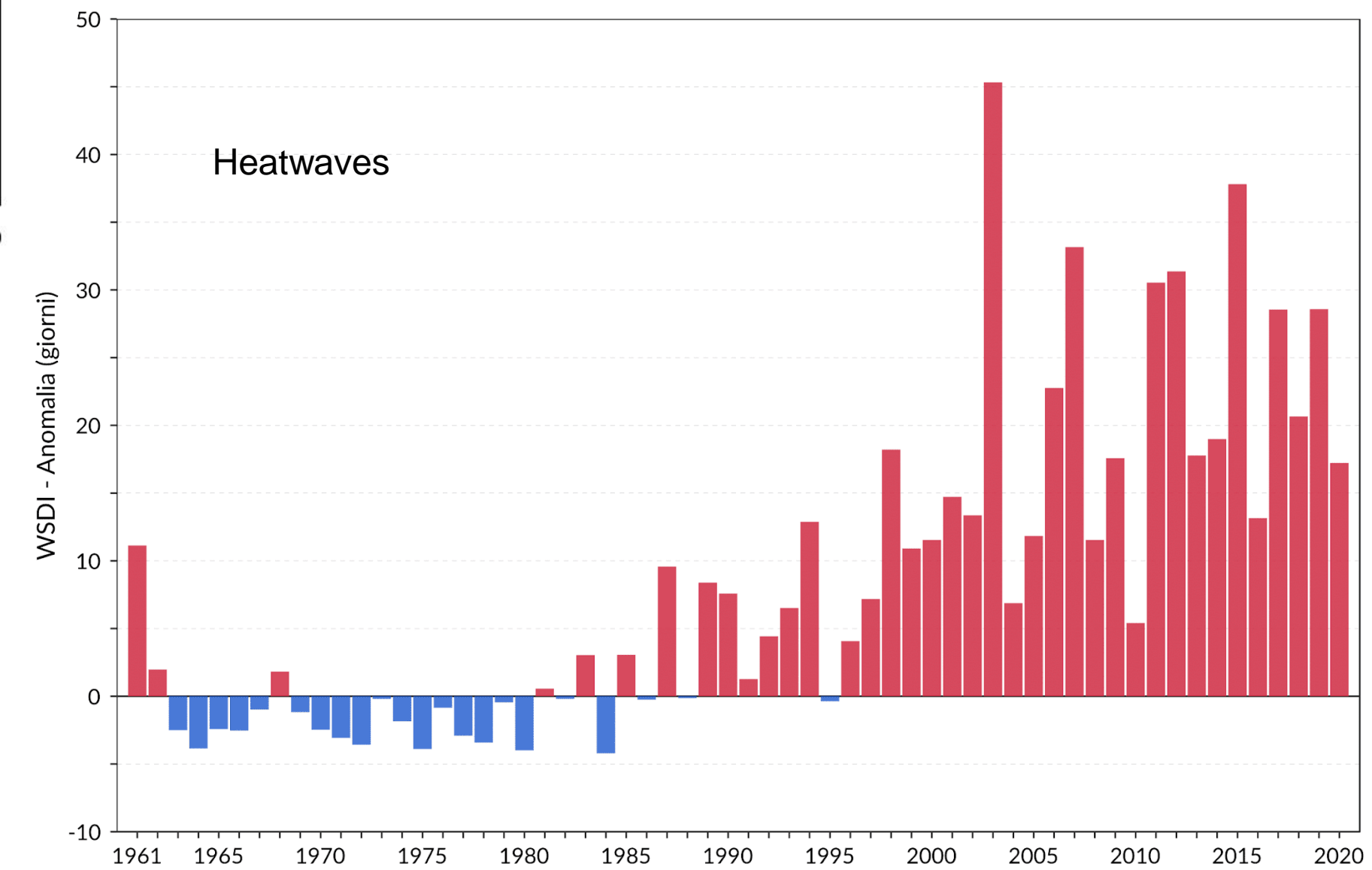
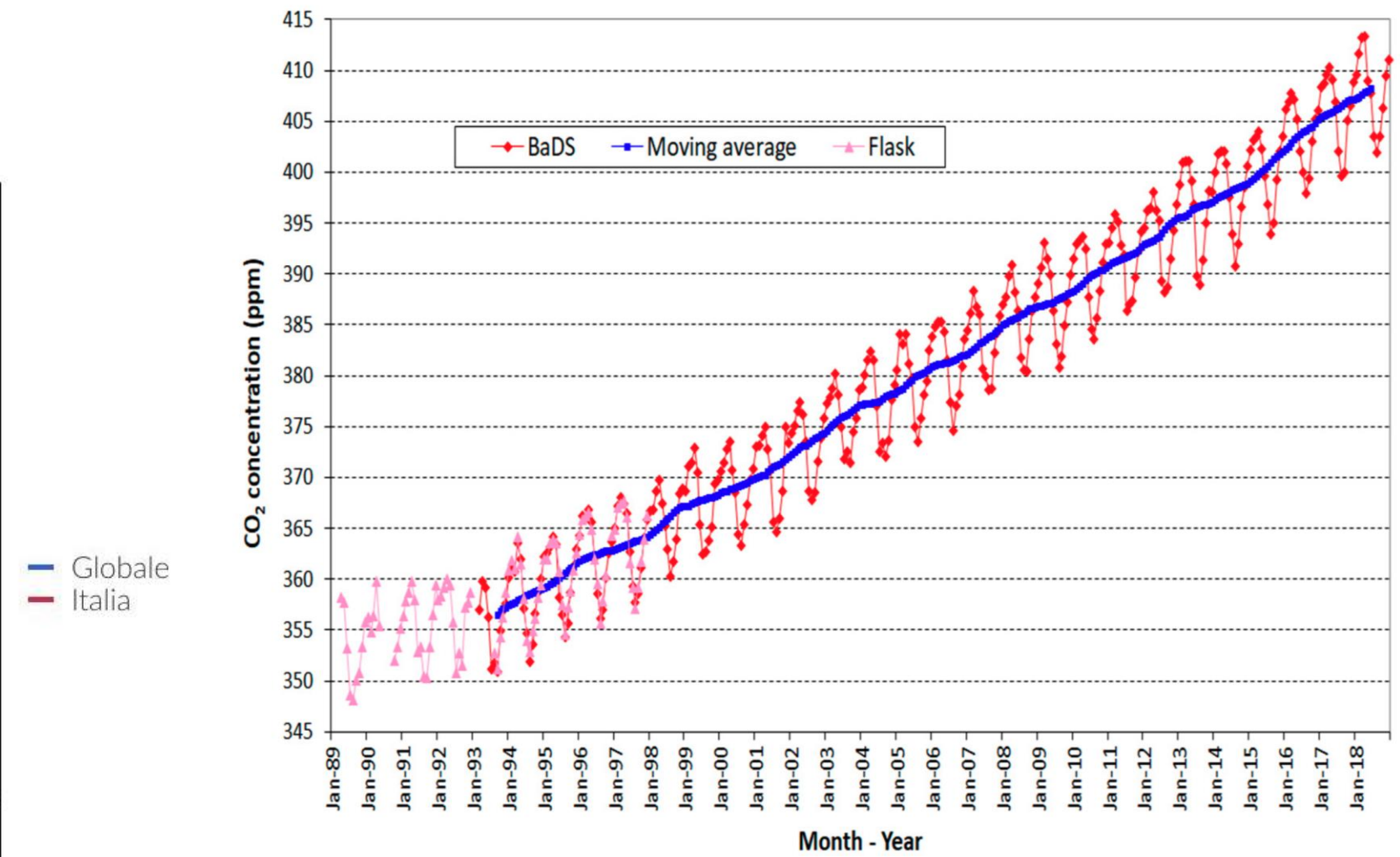
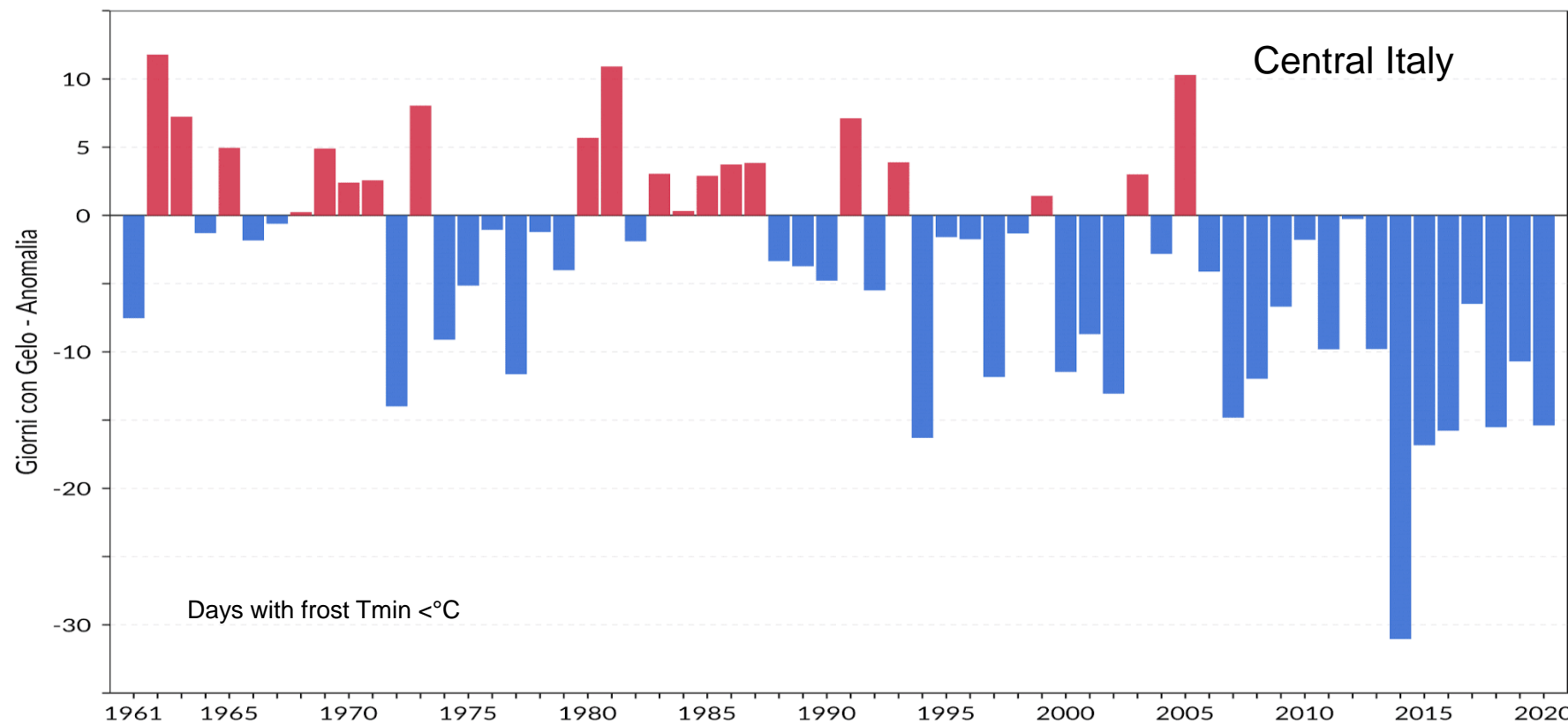
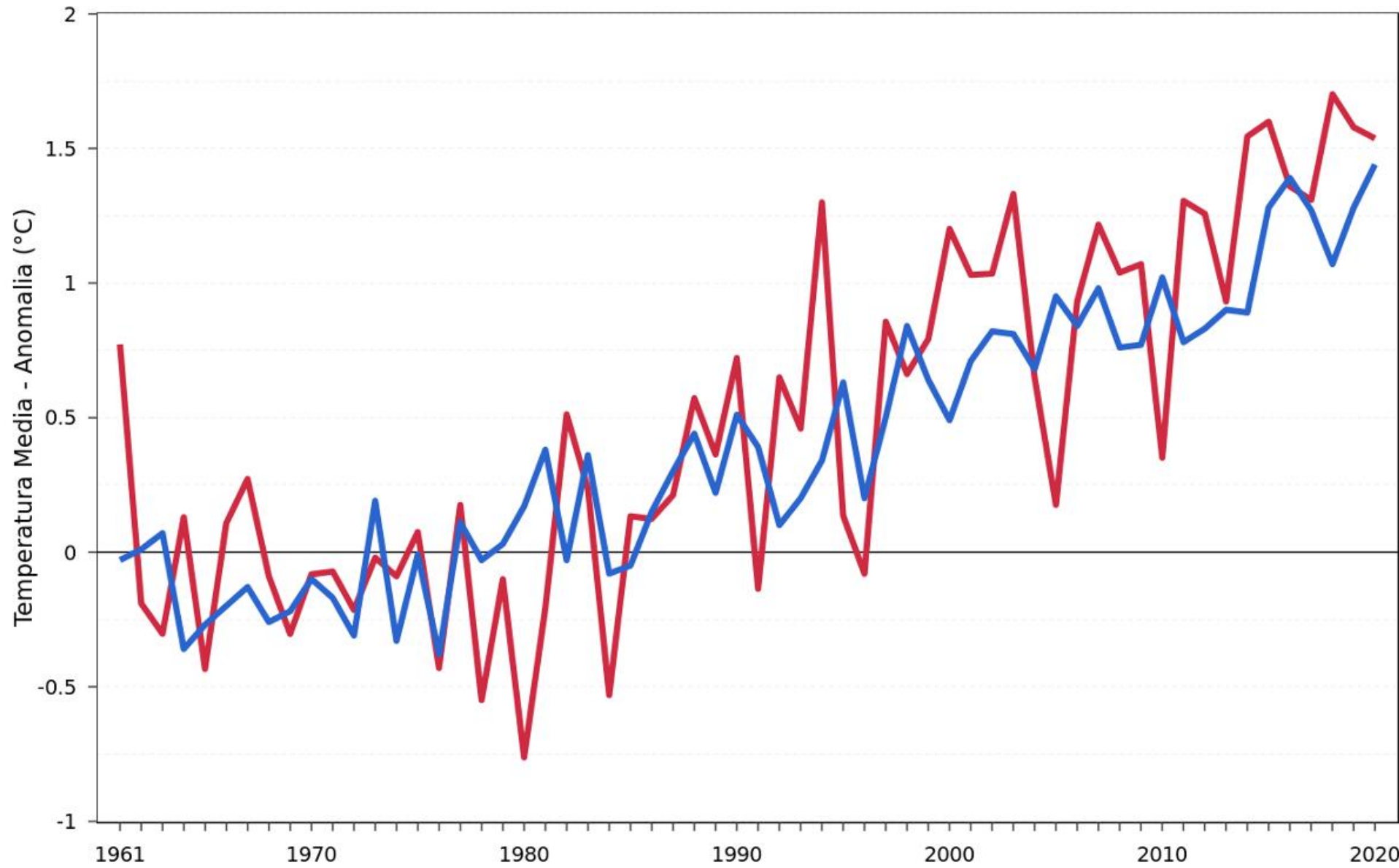
Land uses	Standardized diversity and ES indices	Sample illustration
Specialized		
Patchy		

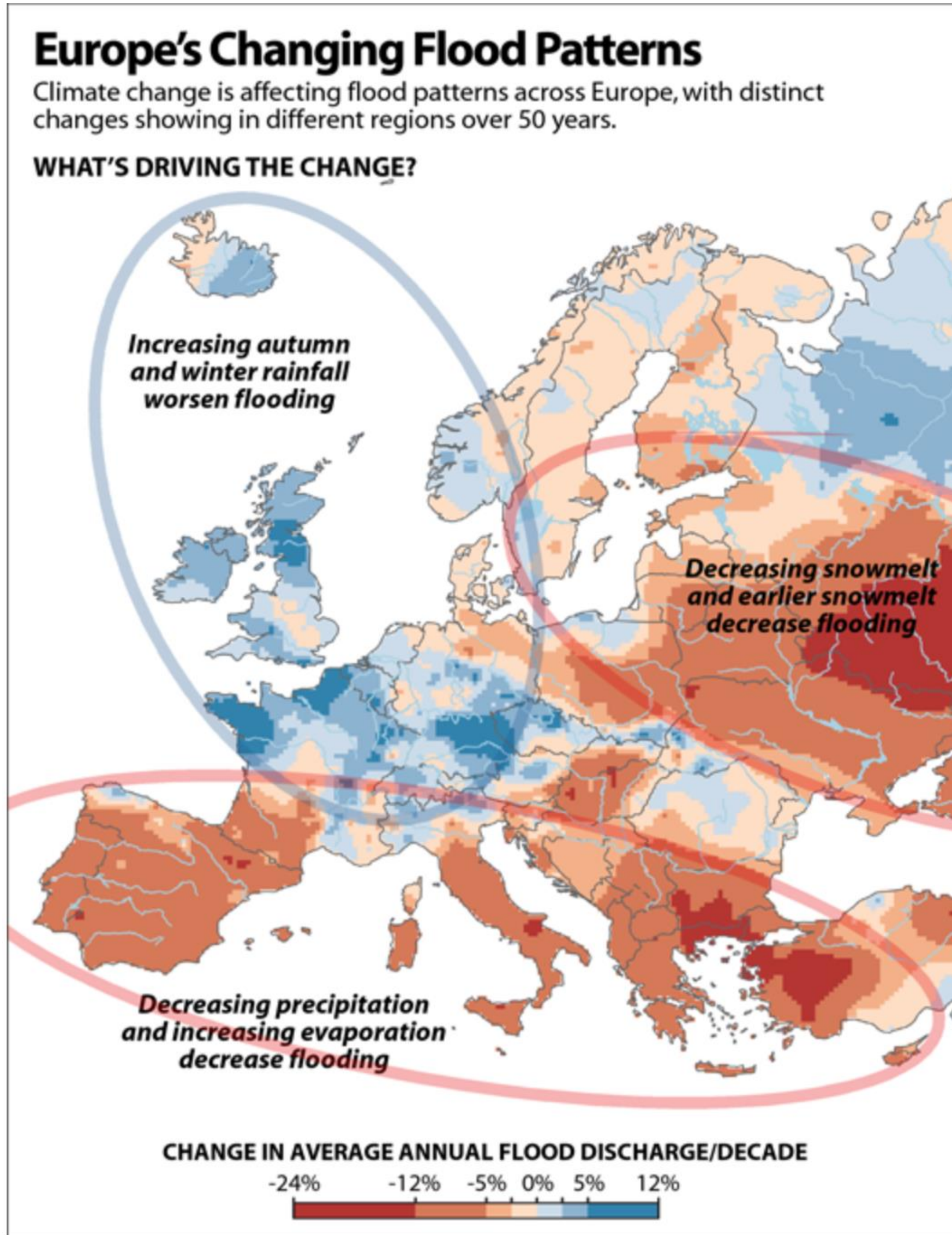
Fig. 6. Spider diagrams of the standardized values of plant diversity indicators and ecosystem service proxy indicators in relation to land uses and the different scenarios. OG = 100% open grassland; WL = 100% Woodlands; WG (“dehesa type”) = 100% wood grasslands with 27% tree cover; “specialized” = 27% WL and 73% OG; “patchy” = 50% WL with 27% tree cover, 13,5% WL and 36.5% OG. The scale of the diagram expresses the deviation from the average value of the three land uses.

Abbreviations: gamma = γ diversity; alpha = average α diversity; beta = β diversity; unique = Total no. of species unique to a land use type; PV = Pastoral Value; Excel = Excellent and very good forage plant cover %; Leg = Legumes cover%; Nectar = Nectariferous value; Hem = Hemicryptophyte cover; Acorns = annual acorn production; Cork = annual cork production; SOC = Soil organic Carbon stock; LTC = Live tree Carbon stock; TOC = Total organic C stock.



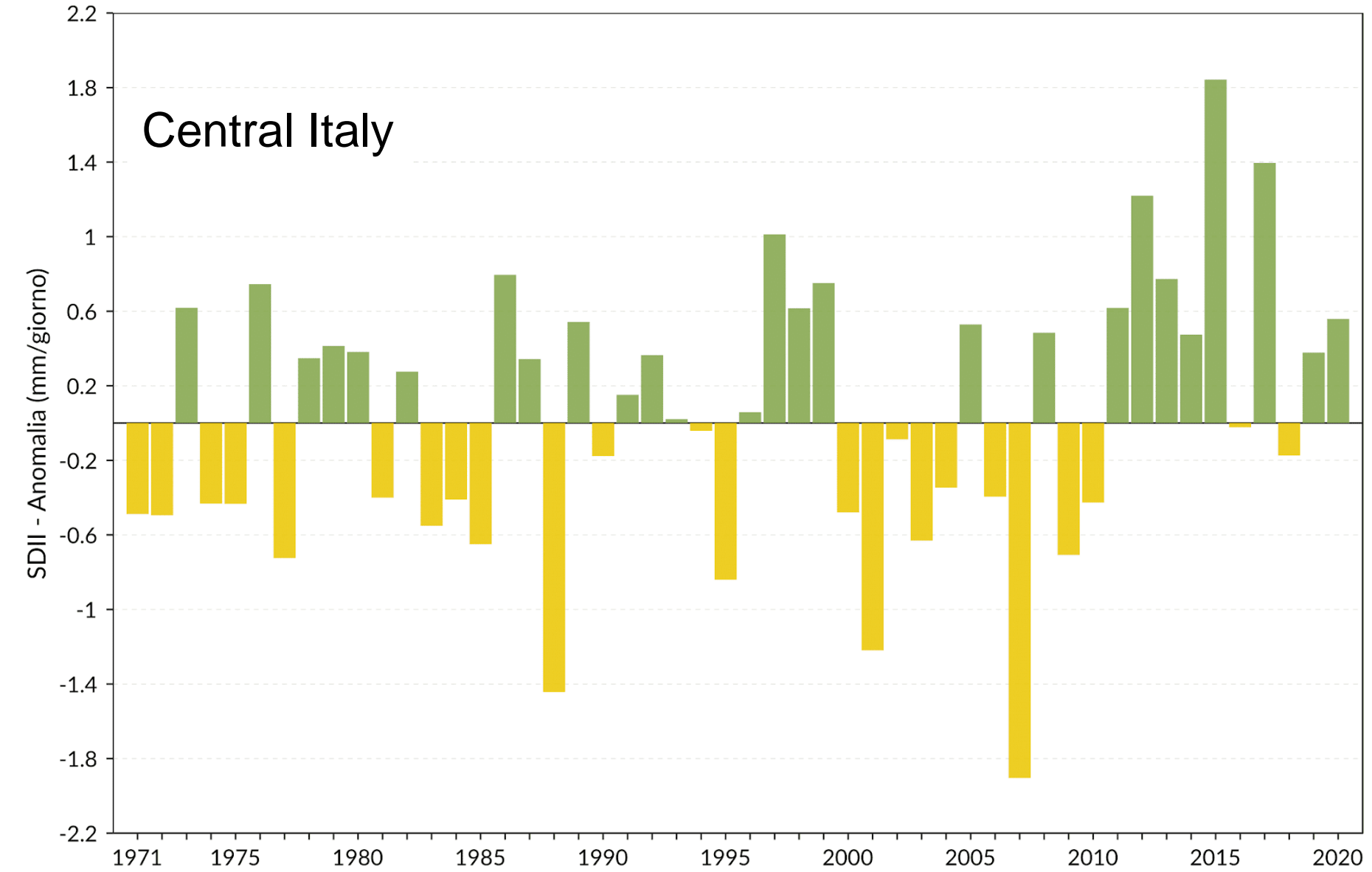
Climate pressure

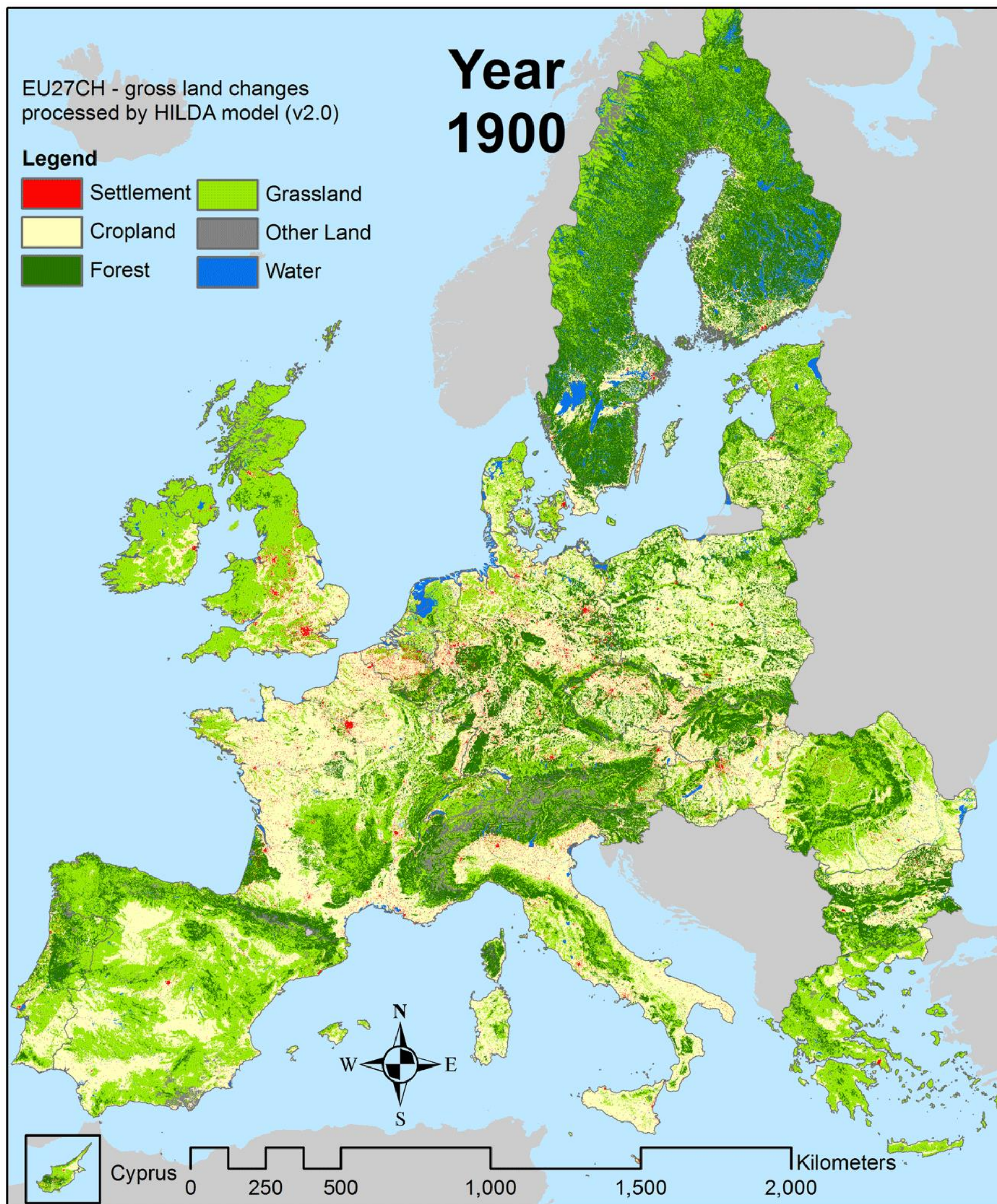




SOURCE: Gunther Blöschl, et al.

InsideClimate News





Diverging trends

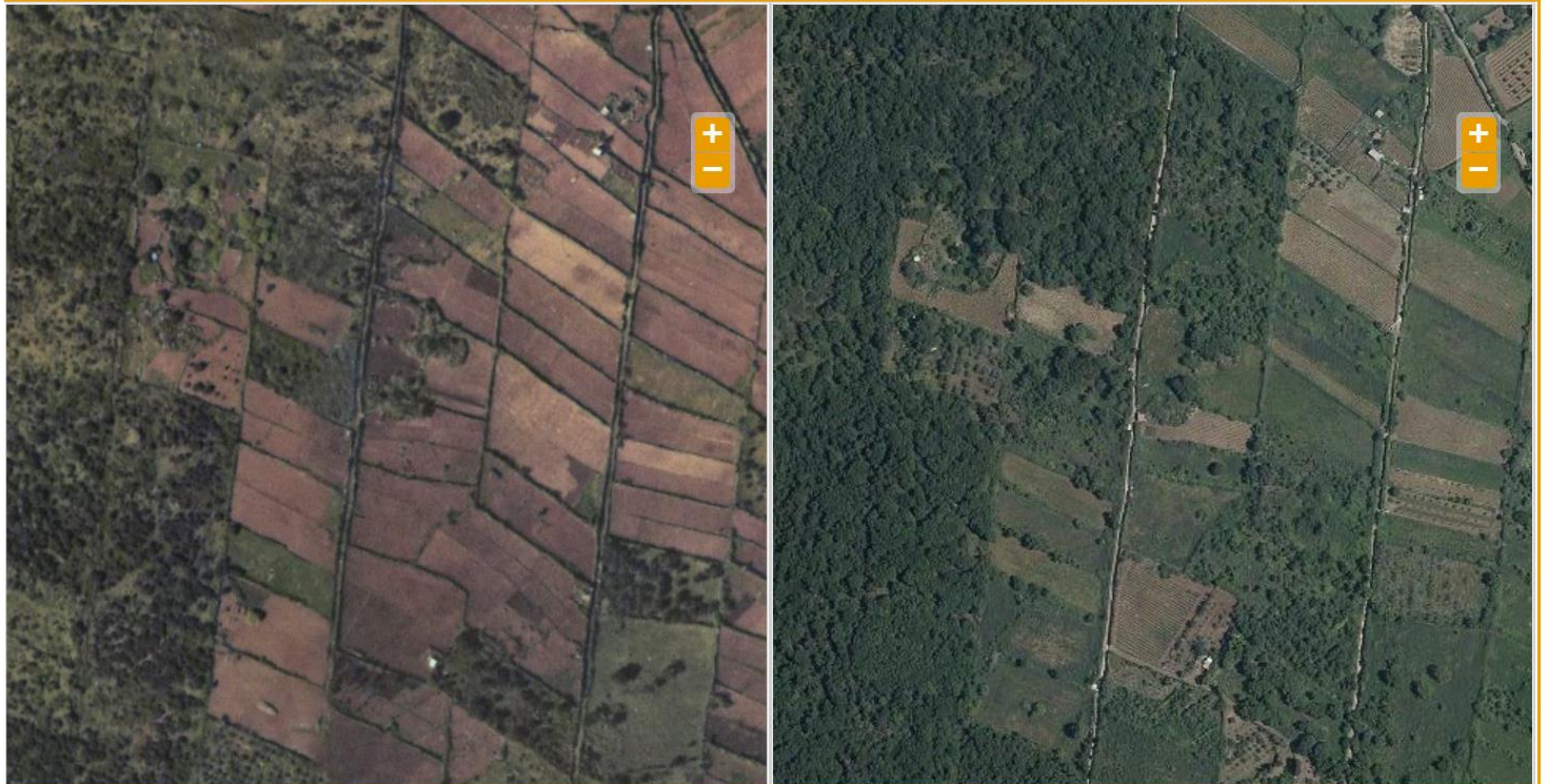
Abandonment

- Cropland → grassland → forest
- Access, security, *wildlife*
- Fewer, larger farms
- Depopulation
- Fewer social services in rural areas
- Increased risks of natural disasters
- Land tenure change

Intensification

- Increased risks of water pollution
- Soil erosion
- Urbanization, land consumption
- GHG emissions
- Loss of rural landscape and culture
- Gap between rural and urban society

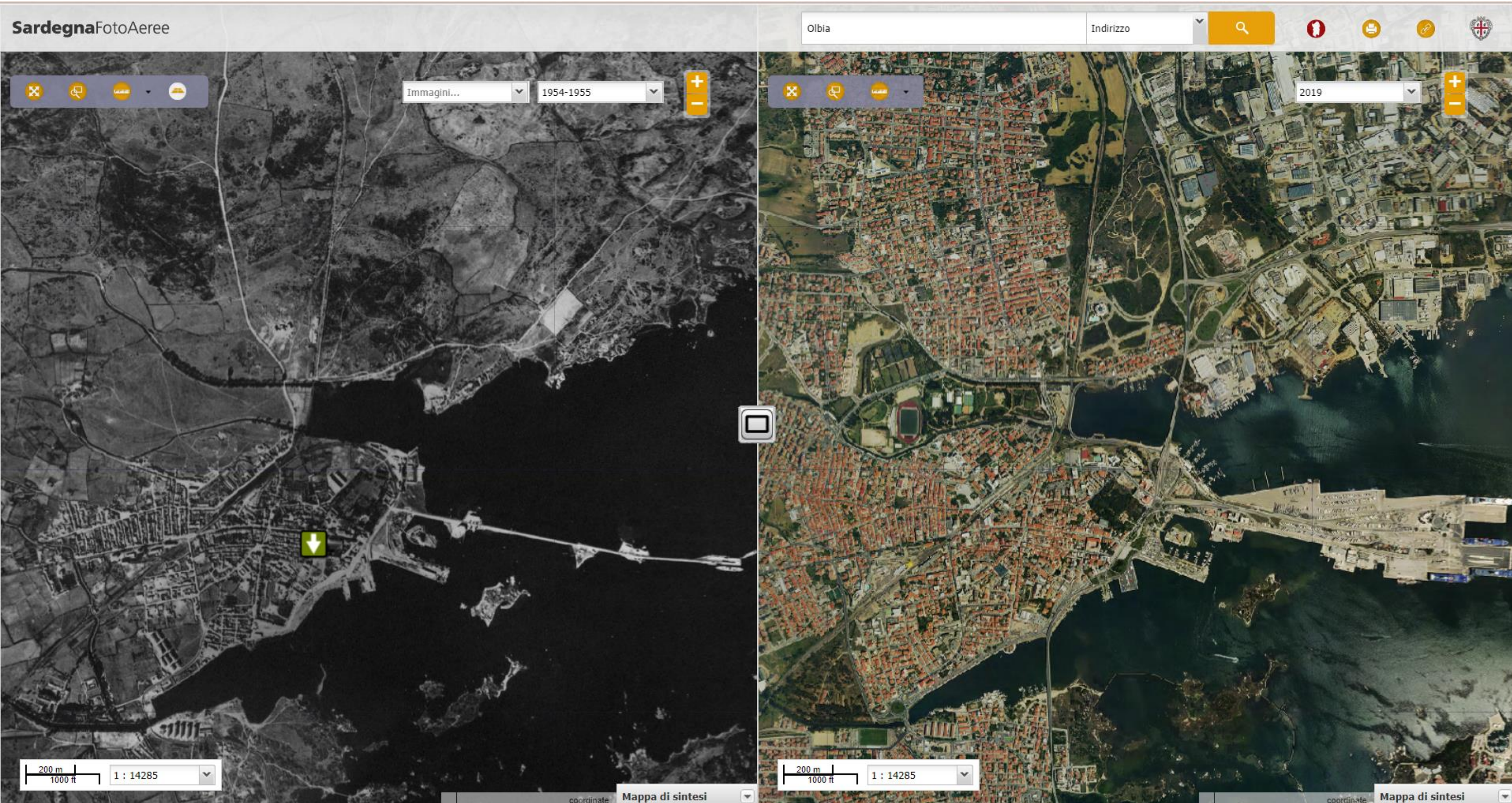
SardegnaFotoAeree





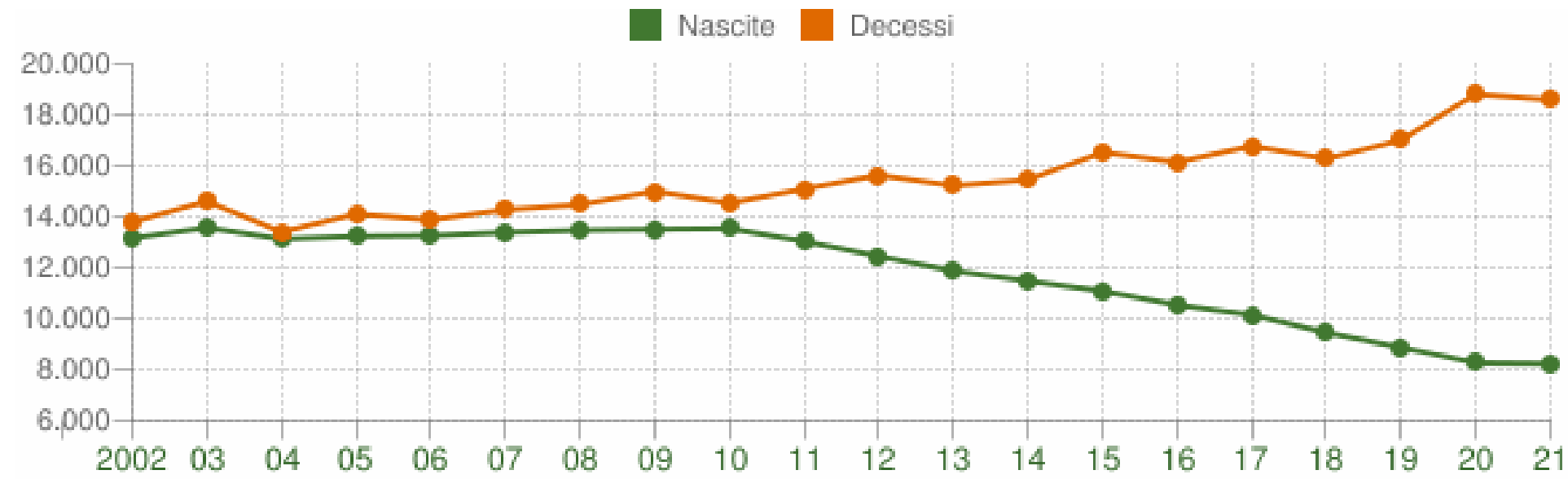
Santulussurgiu summer 2020





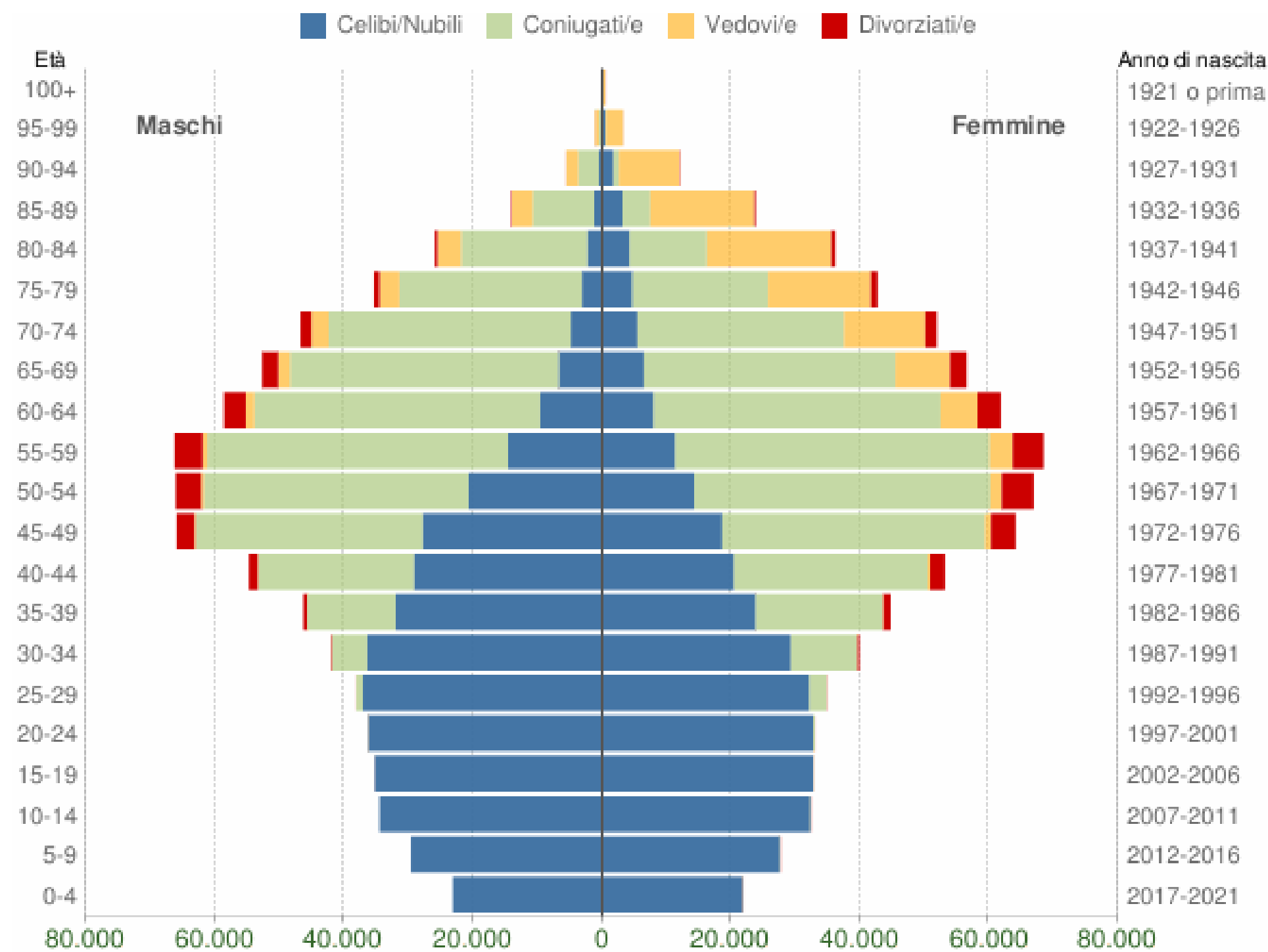
Olbia 1954

Olbia 2019



Movimento naturale della popolazione

SARDEGNA - Dati ISTAT (bilancio demografico 1 gen-31 dic) - Elaborazione TUTTITALIA.IT

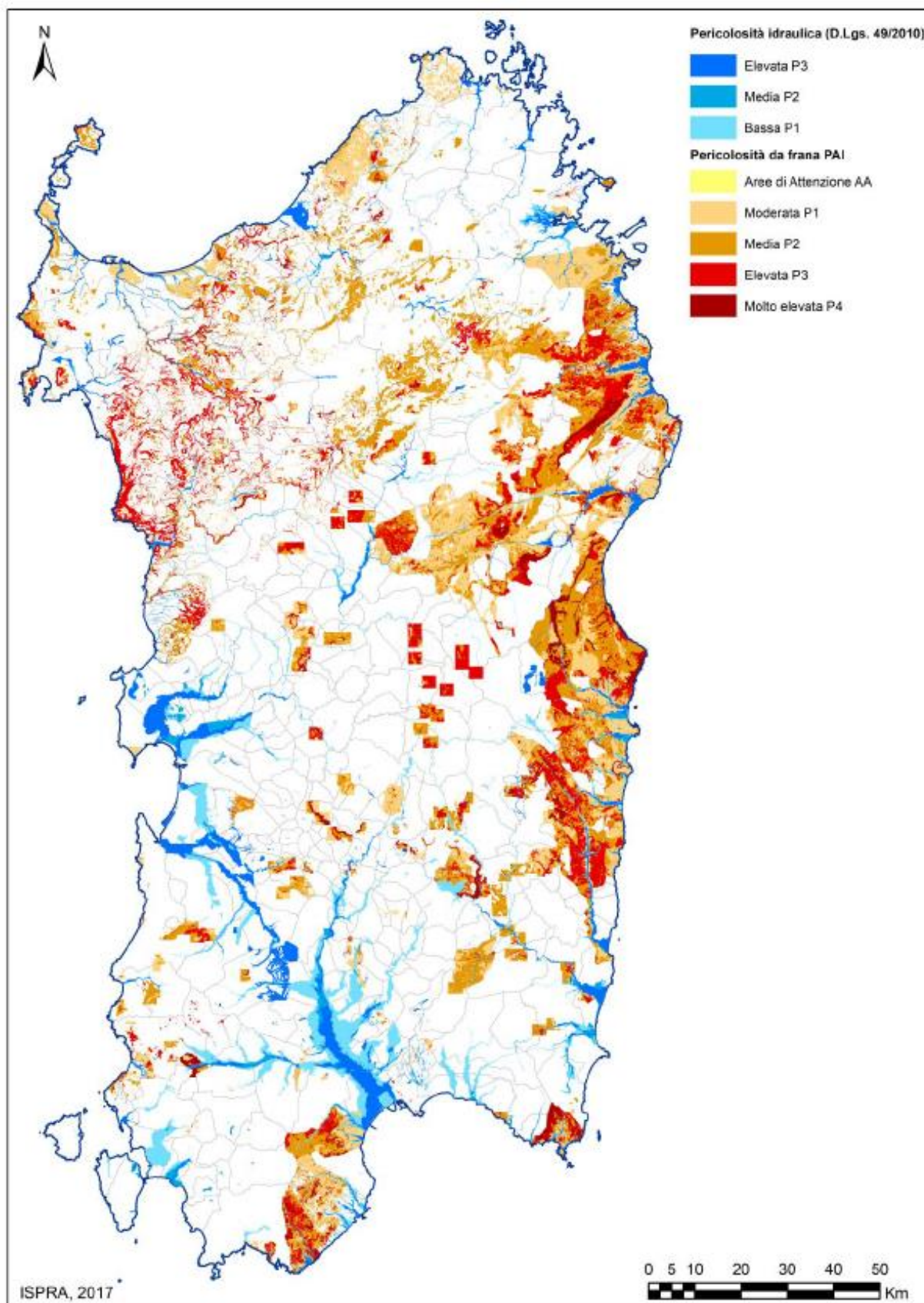


Popolazione per età, sesso e stato civile - 2022

SARDEGNA - Dati ISTAT 1° gennaio 2022 - Elaborazione TUTTITALIA.IT



- 90% municipalities at hydraulic and landslide hazard



ero
tre

Figura 59 Mosaicature degli involucri delle aree a pericolosità idraulica, secondo il D-Lgs 49/2010, e delle aree a pericolosità frana PAI (Fonte ISPRA 2017, adattato per la Sardegna, informazioni spaziali in sitografia).

Climate change impacts on the Alpine, Continental and Mediterranean grassland systems of Italy: A review

Camilla Dibari,¹ Antonio Pulina,² Giovanni Argenti,¹ Chiara Aglietti,¹ Marco Bindi,¹ Marco Moriondo,³ Laura Mula,² Massimiliano Pasqui,³ Giovanna Seddaiu,² Pier Paolo Roggero²

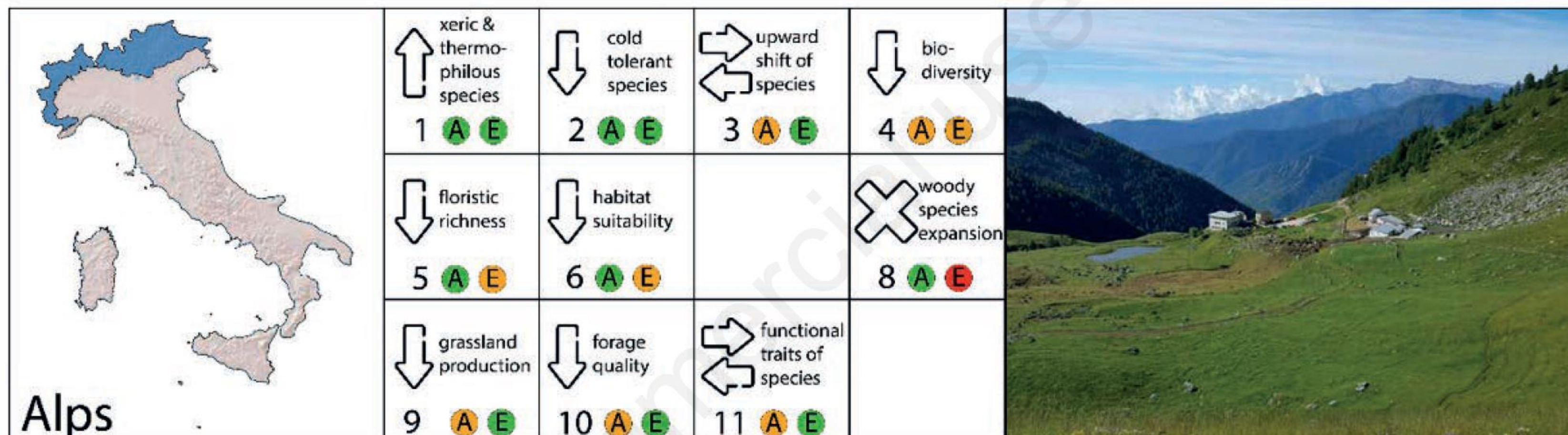


Figure 1. Agreement (level of agreement in the literature) and Evidence (frequency of a given impact) of the main climate change impacts as resulting from the literature review. Upward arrow: increases, downward arrow: decreases, two arrows: changes, cross: loss. (A): agreement, green colour: high, orange colour: medium. (E): evidence, green colour: high, orange colour: medium, red colour: low.

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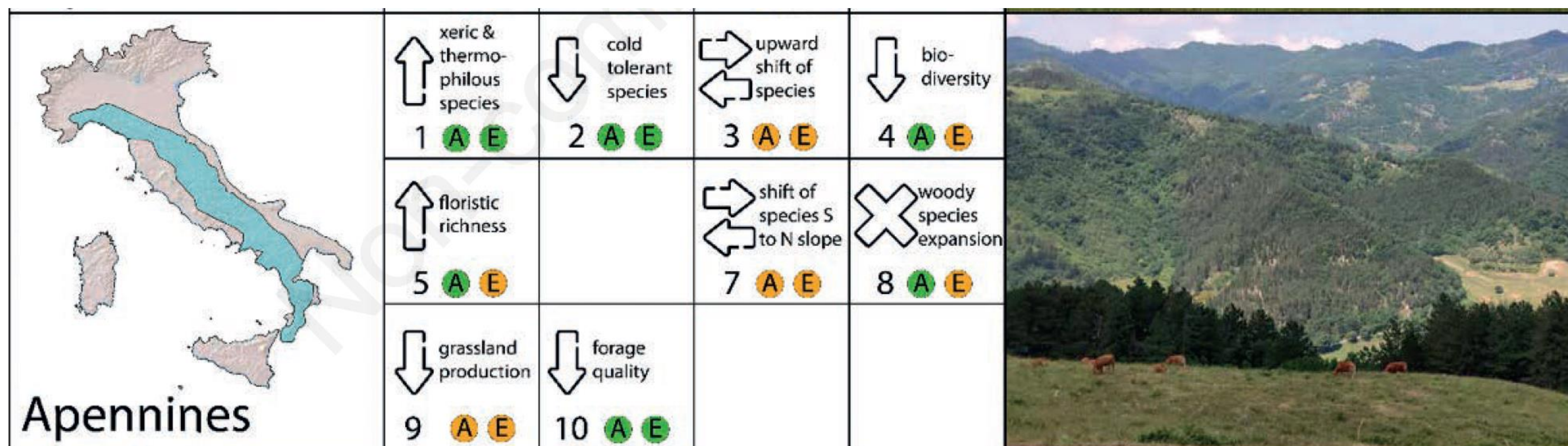


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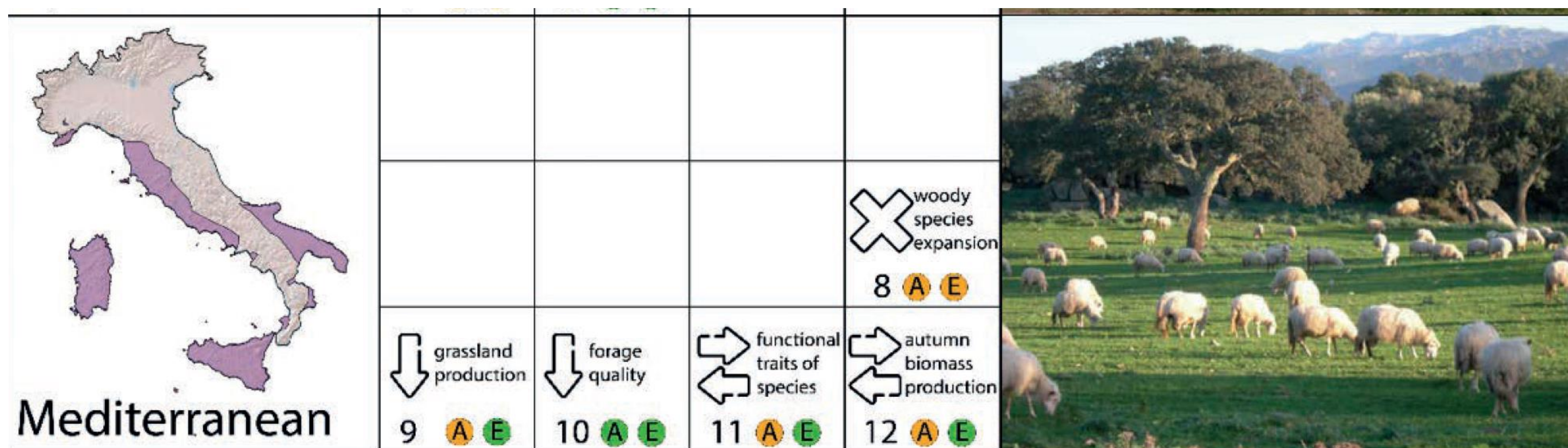


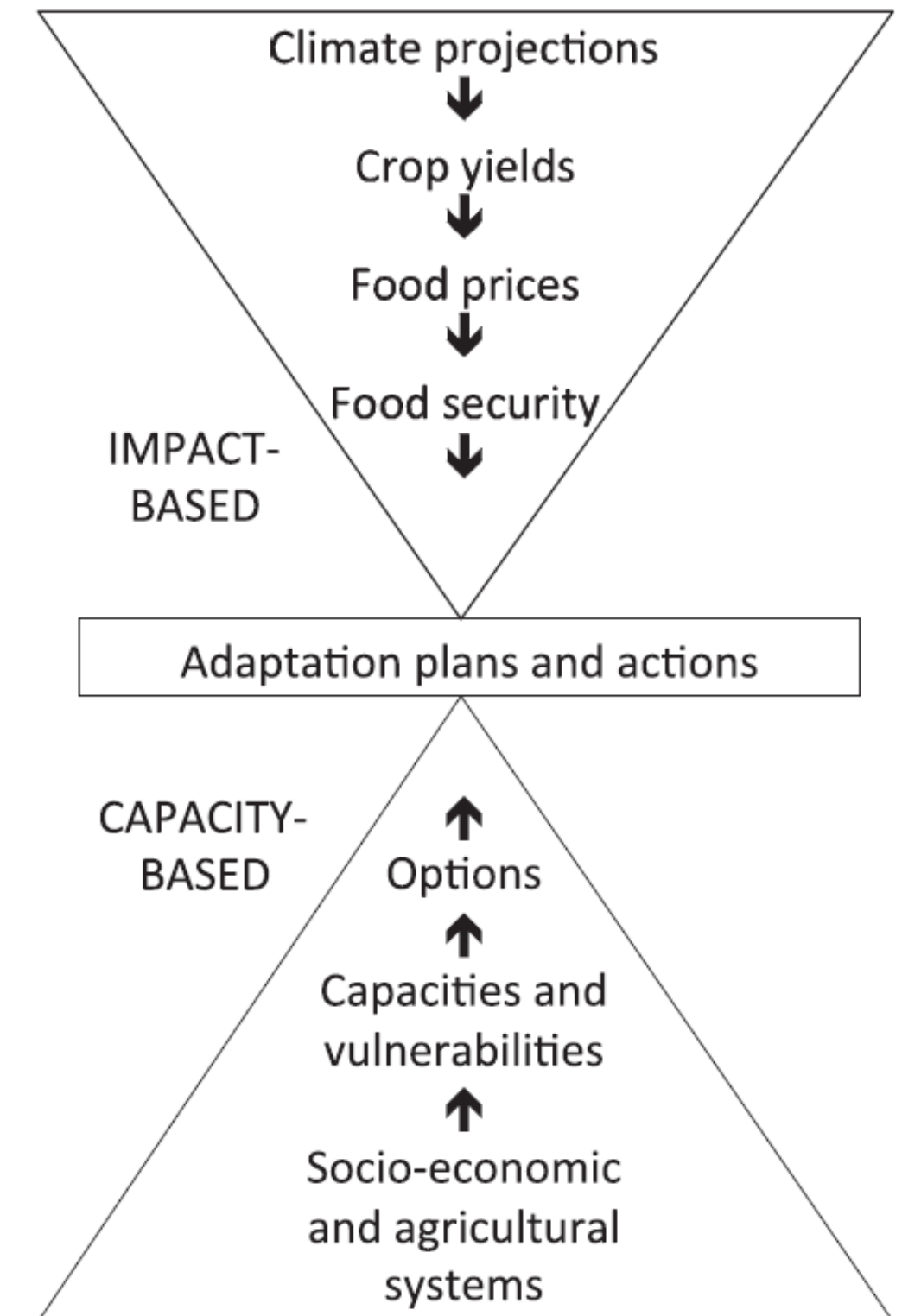
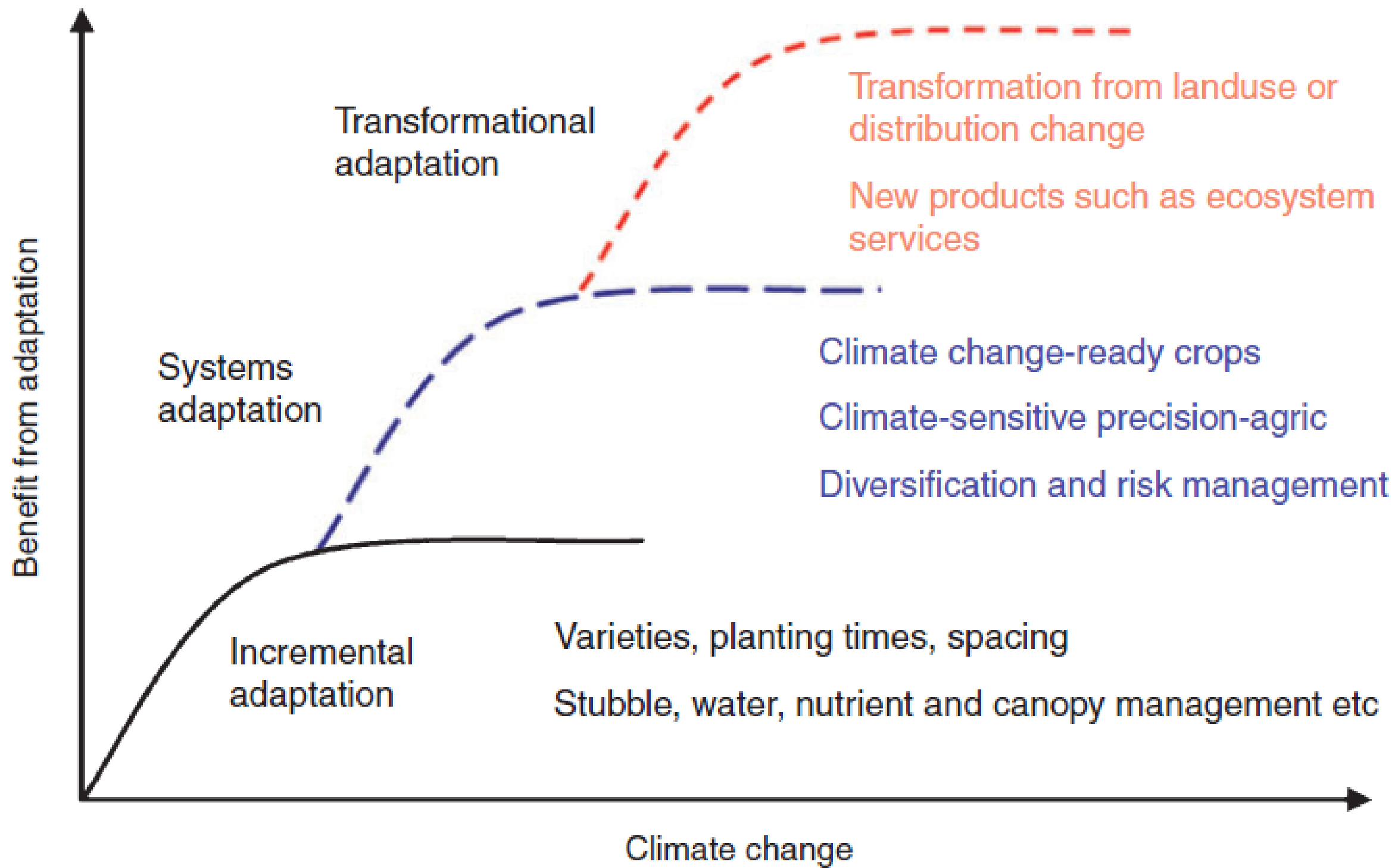
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Hypotheses

- Med silvopastoral systems regarded as **rural socio-ecological systems**: structurally coupled ecological and social processes (Lomba et al, 2020)
- **Pastoralism, forestry and agriculture** shaped Mediterranean rural landscapes and related ecosystem services (Elbakidze et al., 2021)
- Med silvopastoral systems face **sustainability threats** from socio-economic changes, climate pressures, limited adaptability, leading to the **loss of ecosystem services and identity landscapes** (Pinto Correia et al., 2018)
- Such dynamics threaten the **livelihoods** of rural communities and the **conservation of habitats** of Annex I of the Habitat Directive (Gigante et al., 2019).
- Business opportunities can be coupled with enhanced **soil fertility, biodiversity conservation and water conservation** (Ruiz et al., 2020)
- A new narrative that fosters people learning to **perceive and understand complexity** can support adaptive changes in practices (Roggero et al 2023)



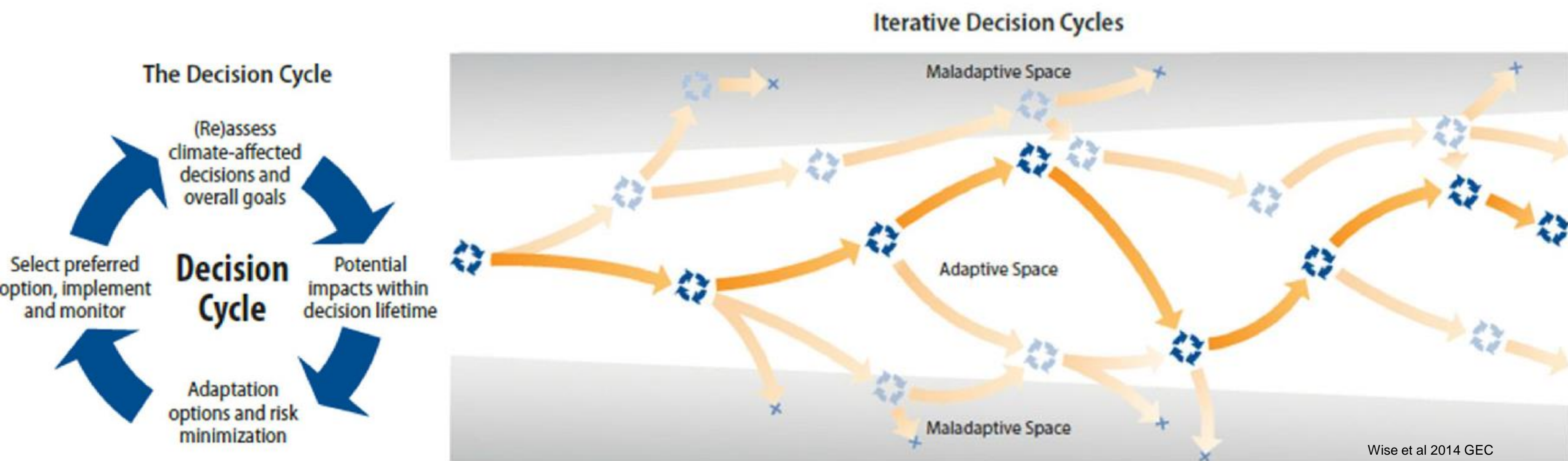
Conceptualizing adaptation



[Rickards & Howden 2012 Crops Past Sci](#)

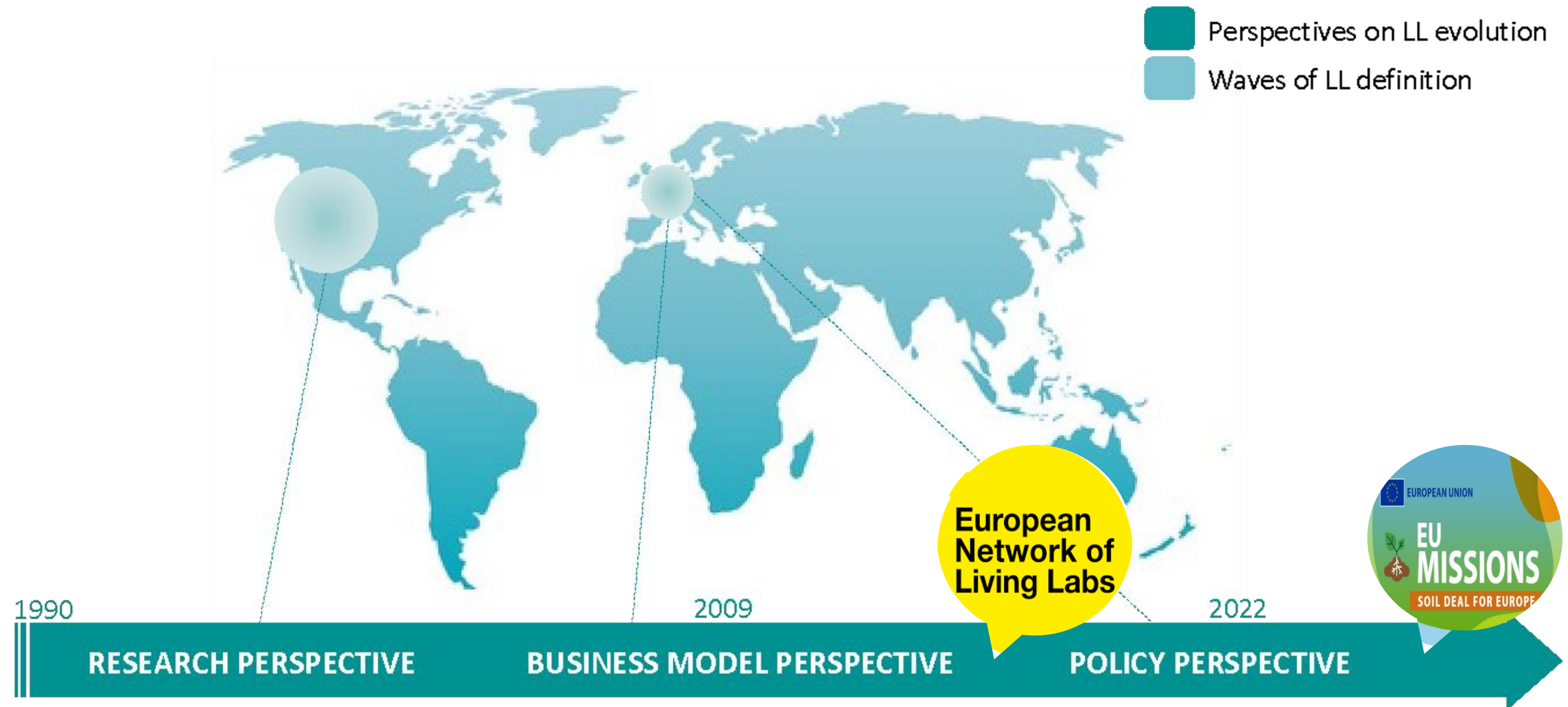
[Vermeulen et al 2013 PNAS](#)

Adaptive pathways



[Wise et al 2014 Glob Environ Change](#)

Conceptualizing Living Labs



- 1990s: the LL concept emerges in **US scientific literature**
- “**User-centric research methodology** for prototyping and validating solutions in real-life contexts”

- 2006: Creation of **ENoLL** and formalization of LLs
- LLs as a platform for **best practice exchanges** and facilitating user involvement in the development of **ICT-based innovations**”

- 2020s: Mainstream of the LL concept into **EU research programs**
- LLs as a form of **collective governance** to co-create innovation through participatory, **transdisciplinary research**

Living labs for rural SES

LLs are gaining ground as novel approach to tackle sustainability challenges in rural SES

- “**Transdisciplinary** approaches which involve farmers, scientists and other interested partners in the **co-design**, monitoring and evaluation of agricultural practices and technologies to improve their effectiveness and early adoption” (Agroecosystem LL Executive Report, 2019)
- “**User-centred**, **place-based** and **transdisciplinary** research and innovation ecosystems” (EU Mission “A soil deal for Europe”)
- Experimental, **co-creative** approach to test, demonstrate, and advance new **sociotechnical** arrangements and **governance** approaches under real-world conditions (Engels et al., 2019)



Existing LL literature is urban-centred, and linear transfer to rural SES raises challenges



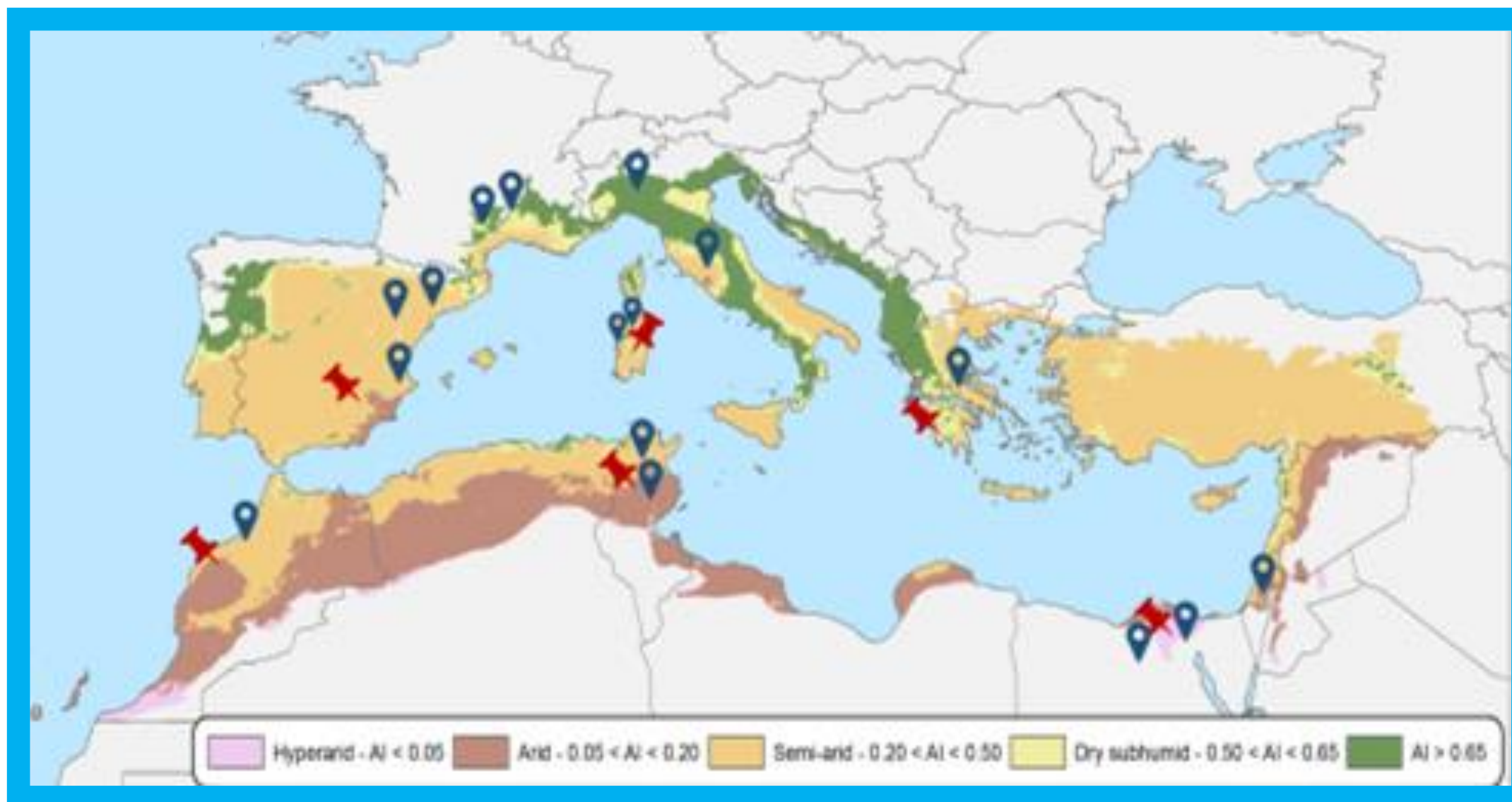
Can an adaptive LL approach support systemic innovation in rural SES?

Drawing on a systematic literature review and on empirical evidence from the PRIMA-funded SALAM-MED project, we offer new perspectives on how LL can contribute to innovative governance within rural SES by providing new learning spaces and business opportunities, especially for youth and women



SALAM-MED

sustainable approaches to land and water management in mediterranean drylands



15 Partners



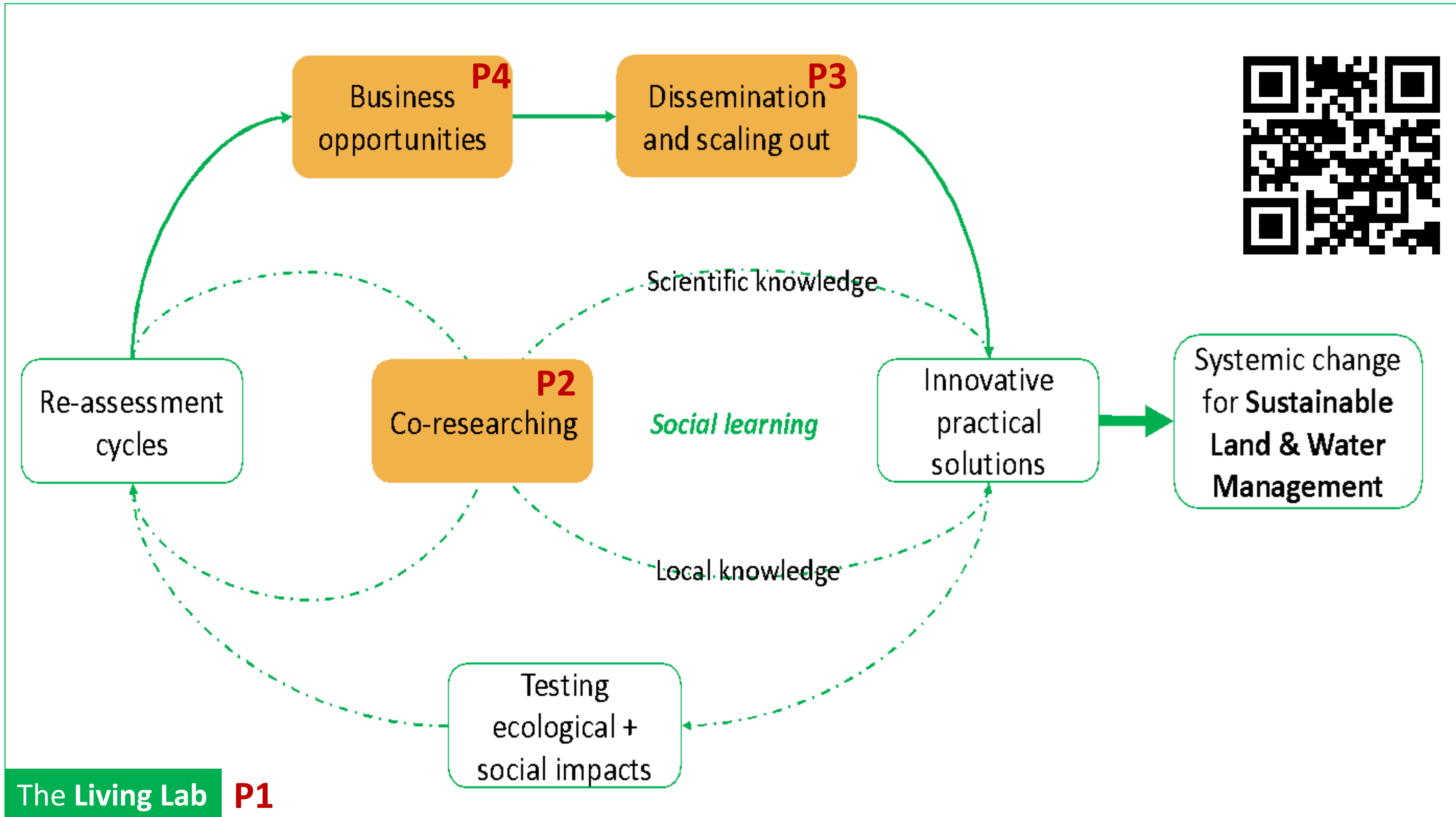
8 MED Countries



6 Living Labs in 'hotspots' for land degradation



Identifying practical solutions for promoting **resilience** and **restoration** in Mediterranean drylands



Long-term observatory of Berchidda-Monti

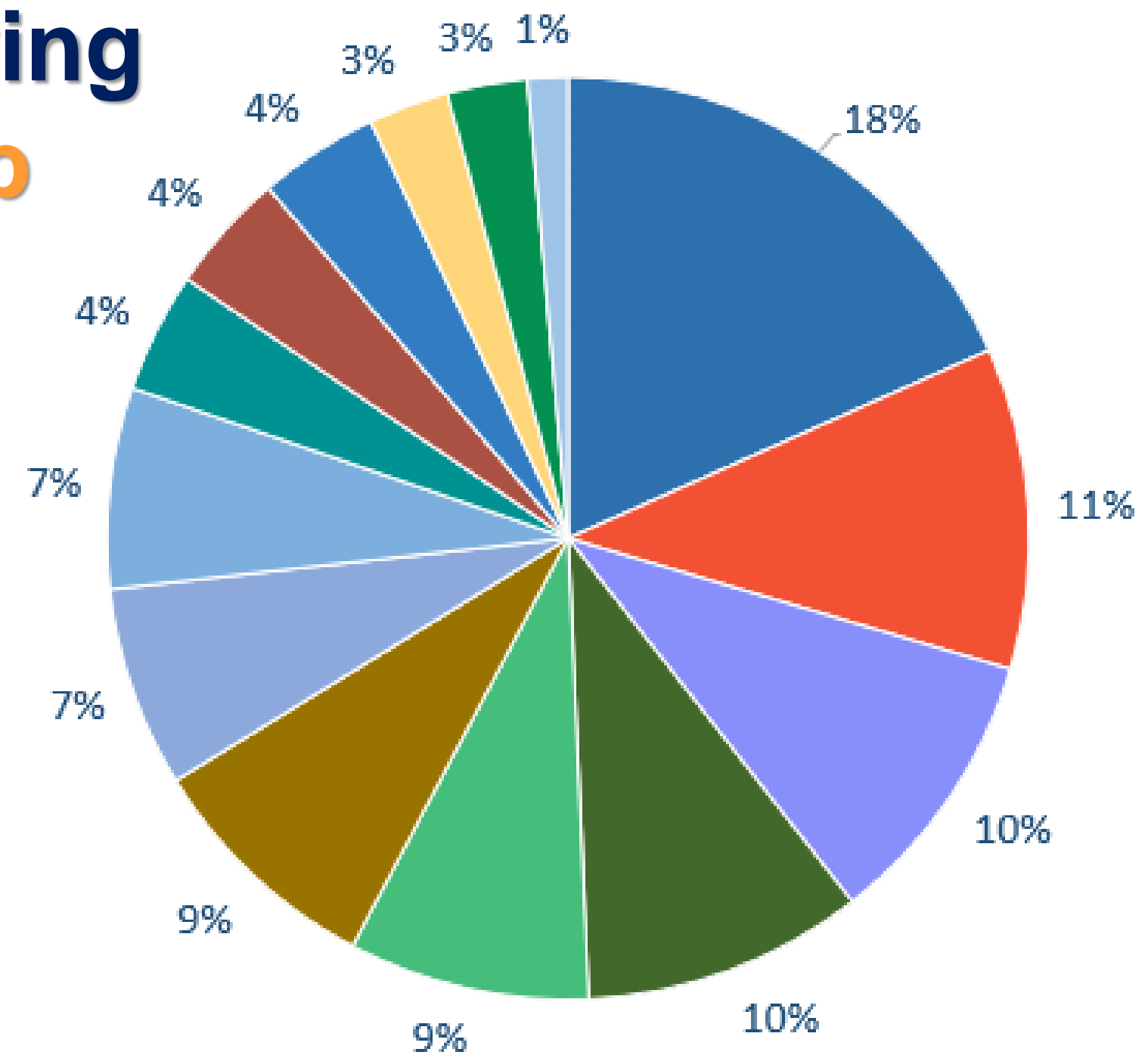
- Large-scale **grazing** systems and a mosaic of **croplands** (vineyards, cereals, forage crops), **permanent grasslands**, **woodlands** (cork oaks) and **wooded grasslands**
- **Challenges:**
 - Volatile economic **profitability** of silvopastoral activities
 - **Depopulation**
 - Constraints to **generational turnover**
 - **Abandonment**
 - **Climate change** impacts
 - Lack of **oak regeneration** and *Phytophthora cinnamomi*
- Co-exploring the **hydrological, meteorological, and ecological dynamics** of Med silvopastoral agroforestry systems
- Co-designed as a “**laboratory**” to test and validate techno-scientific solutions, but also as a “**living**” learning system rooted in dynamic and long-lasting stakeholder engagement processes



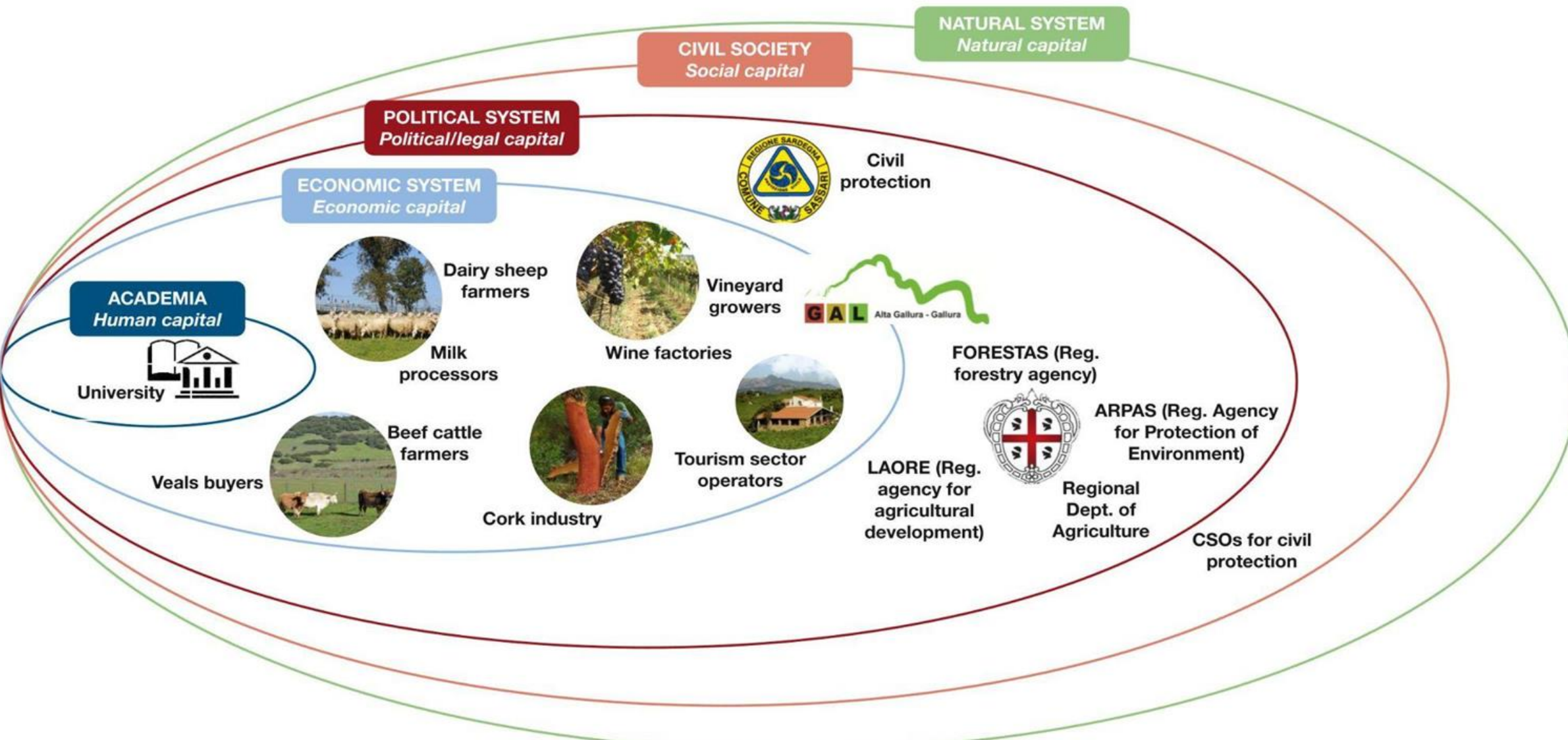


Perceived ecosystem services

- **Imbalanced stakeholders' capacity** to respond to economic, climate, and ecological pressures
- Key stakeholders **unaware of benefits** from silvopastoral ecosystem services
- Limited awareness of **interdependencities** among powerful and weak enterprises for ecosystem services
- **Fragmented perception** of ongoing changes

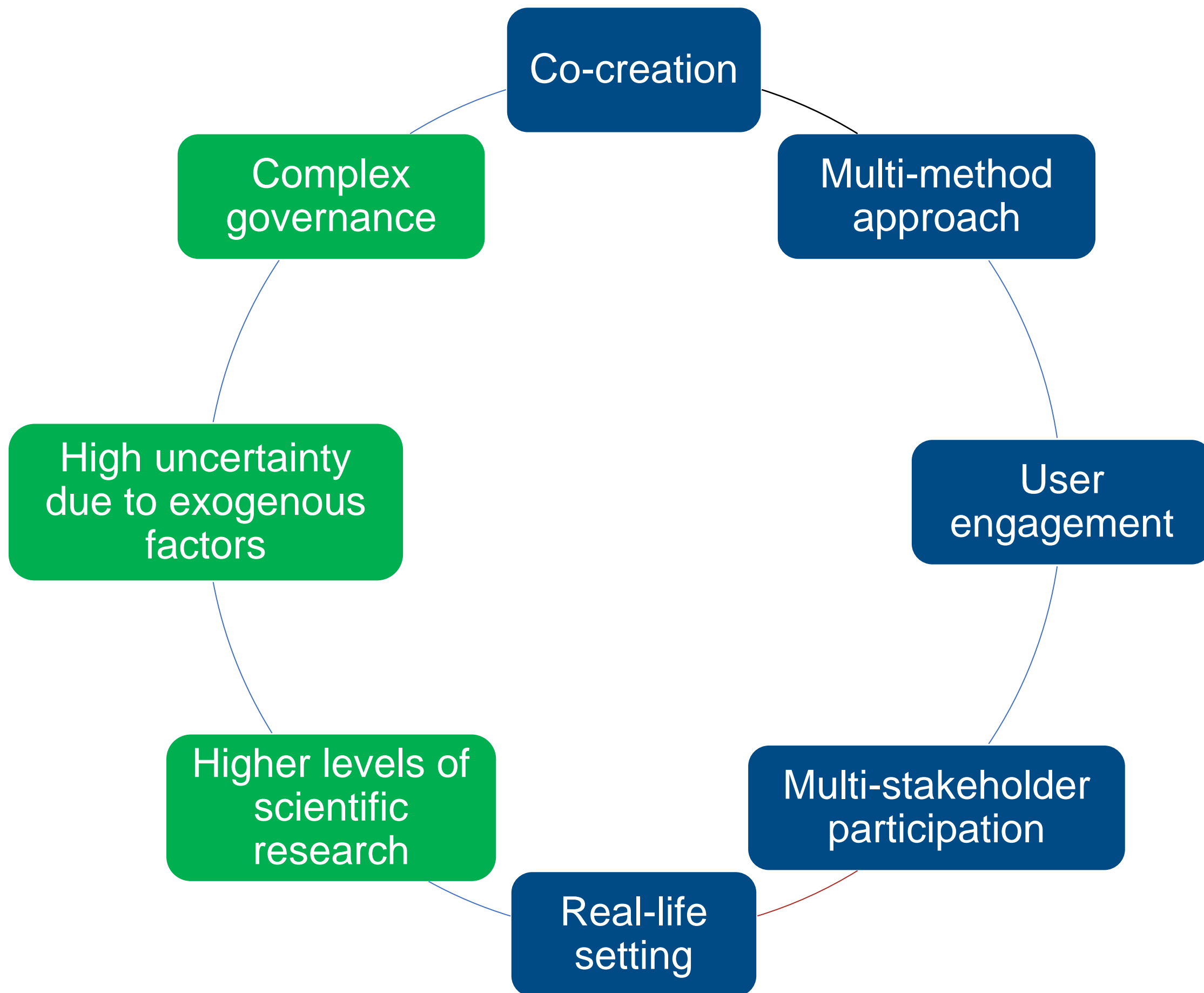


- Water availability
- Wildfire risk reduction
- Soil fertility (N, P...)
- Land accessibility
- Landscape aesthetic value
- Non-wood forest products incl pastoral production
- Biodiversity conservation
- Cork
- Soil organic matter
- Erosion
- Carbon sequestration
- Biomass, yield and productivity
- Legumes abundance (N fixation)
- Pollination





Distinguishing emerging features of rural LLs



ENoLL 5 LL characteristics



Peculiar characteristics or rural LLs

Learning to **perceive**

- The LL is generating new learning spaces about:
 - The perception of **interdependencies** among stakeholders and ecosystems (eg vineyards and wooded grasslands)
 - The structural coupling between socio-economic and bio-physical processes,
 - The **co-design of field and lab experiments among** farmers and scientists
 - Co-designing new **grazing management practices**: virtual Fencing and GPS collars
 - Learning to perceive **climate change** and support adaptation
 - Testing **microbial-based technologies** enhancing plant resilience to biotic (e.g. Phytophthora sp.pl.) and abiotic (e.g. drought/flooding cycles) stressors
 - Monitoring the impact of sparse trees or woodlands on the **hydrological balance**
 - Combine **technical effectiveness** informed by techno-scientific knowledge and **practical feasibility** informed by community tacit knowledge
 - Identify options that combine **economic development** with **soil fertility** and water conservation objectives

Learning with stakeholders

- LLs offer new spaces to explore models of learning -based, adaptive, multi-level **governance** of **silvopastoral systems**
- Engaging **stakeholders** on ongoing changes and the **future** through **mediating objects and dialogical tools** (Toderi et al., 2007)
- Explore how innovation is envisaged and perceived
- Identifying **adaptive pathways** and understanding the **technical, social, economic and institutional dimensions of change**
- Engaging **women and youth** on the sustainability of silvopastoral systems to bring diverse perspectives and explore different sets of skills
- Engaging conversations with the **elderly** to preserve and pass on knowledge and experience related to farming practices and silvopastoral systems



➤ **Role of the researchers in the LLs**

- **Beyond knowledge dissemination**
 - **Collaborative learners** vs. detached experts
 - Exploring **new narratives** that foster shifts in how people perceive and understand complexity to drive changes in practices
- **LLs governance** may be complex and entails challenges of institutionalization
- Capitalizing on existing initiatives (e.g. **LAGs**) vs top-down design
 - Avoid **co-option** from stakeholders with high resistance to change

Timing mismatch

- Short-term project-based timeframes
- Urgency of action



- Long-term and unpredictable **socio-ecological processes**
- Long **innovation cycles** and extensive scientific research
- Recruiting living lab participants and **establishing mutual trust**

Opportunities

- Broad conception ensures **versatility** of approach and applicability to various contexts
- LLs provide a **diversity of evidence, impacts and learning**
 - Socio-technical innovation
 - New forms of **hybrid knowledge** (Nguyen et al., 2016; Klerkx et al., 2012)
 - Collective sense-making and changes in understandings and practices
 - Community activation and **empowerment**
- Learning process in the LLs may help foster **legitimacy of and trust in innovative solutions**

Ceseracciu et al., J Rur Studies – under revision

Challenges

- Systematic review of semantics reveals **semantic stretch** (overuse/misuse of the term “living lab”), generating **methodological ambiguity**
- **Distinguish features of rural LLs**: complex governance, high uncertainty, longer timeframes, higher level of scientific research
- **Human/financial costs** for setting up and running LL can be high
- Current **research assessment criteria** do not acknowledge cultural and societal impacts
- Political priorities and cultural/organizational **barriers** could lead to implementation challenges
- The experimental results may have **limited scaling potential** being context-specific

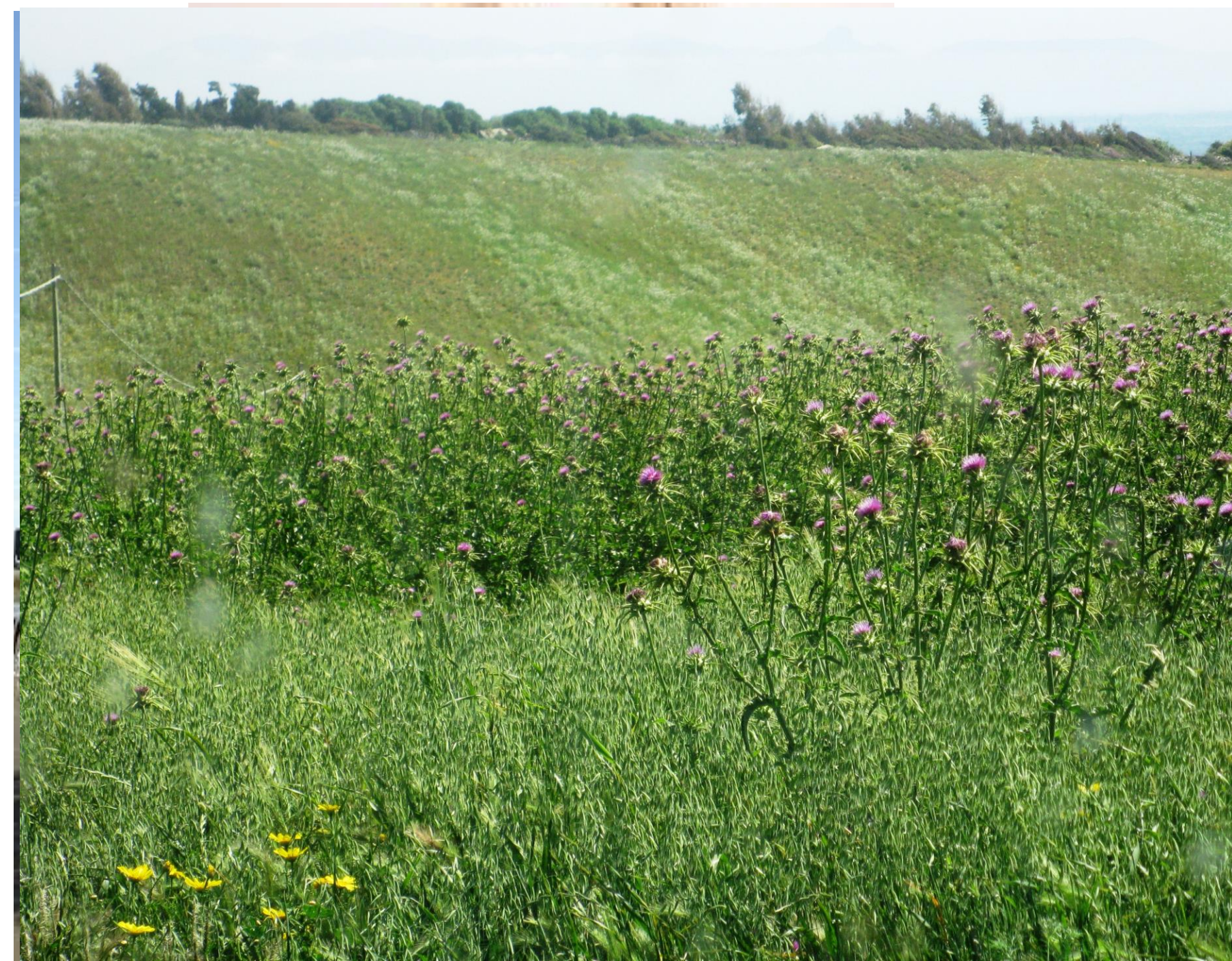
Stories of change: **Efisio**, 1980, 20 yrs old

- Son of a mountain shepherd in Sardinia
- **600** dairy sheep yield **120 kg/yr** milk
- Milk sold to a shepherd **coop** exporting Pecorino cheese to the USA
- Milk price is rewarding but depending on the international **market volatility**
- The **cork** extracted from his oaks helps, and some 10 ha of holm **oak coppice** provide integrative income
- A small reservoir is used to **irrigate** 2 ha of silage maize to destagionalize milk production and supply ricotta cheese for the farmers' market in the **coast**, but **energy costs** are substantial
- All the arable land is ploughed and sown with leys every year to contrast **thistle weeds**



Stories of change: **Efisio, 2023, 63 yrs old**

- The flock has been expanded to 700 ewes
- Efisio secured a 30 yrs **loan** for the construction of a new stable and irrigation equipment, with trust in EU funds, that instead are delayed 2-3 yrs
- A multinational company sets his ewes' **feeding** program
- Efisio serves as the head of the cheese-making **cooperative** facing budget constrains due to the low milk price (0,70 € kg⁻¹). The price of Cork also dropped
- In 2017, which marked the **driest year in six decades**, he had to purchase hay at triple the usual cost
- Due to bureaucratic obstacles, he has discontinued the practice of coppice
- **Thistles** have become a severe issue, and the available forage seeds in the market are unsuitable for the changing climatic conditions
- **Efisio's daughter, Gavina**, is employed as waiter in a coastal restaurant in the coast
- The future is **uncertain**, causing significant concerns for Efisio



Stories of change: **Efisio, 2035, 75 yrs old**

- Efisio abandoned his activity ten years ago and **relocated to an urban area**
- Raising **costs** of feed and irrigation made livestock farming financially unsustainable
- **Recurring droughts** further escalated production expenses for animal feed
- **Complex EU bureaucracy** and delayed payments rendered loans unfeasible
- The **cooperative** shut down after several years of economic struggle
- **Gavina resides and work as a waiter in Milan**
- **Abandoned pasture** have transitioned to woodlands and shrublands
- A severe storm in November 2025 caused a significant damage to the 10 ha abandoned woodland, resulting in numerous fallen trees
- A devastating **wildfire** occurred in 2028, marking the driest year in the past two centuries
- Efisio relies on a **social pension as a source of income**



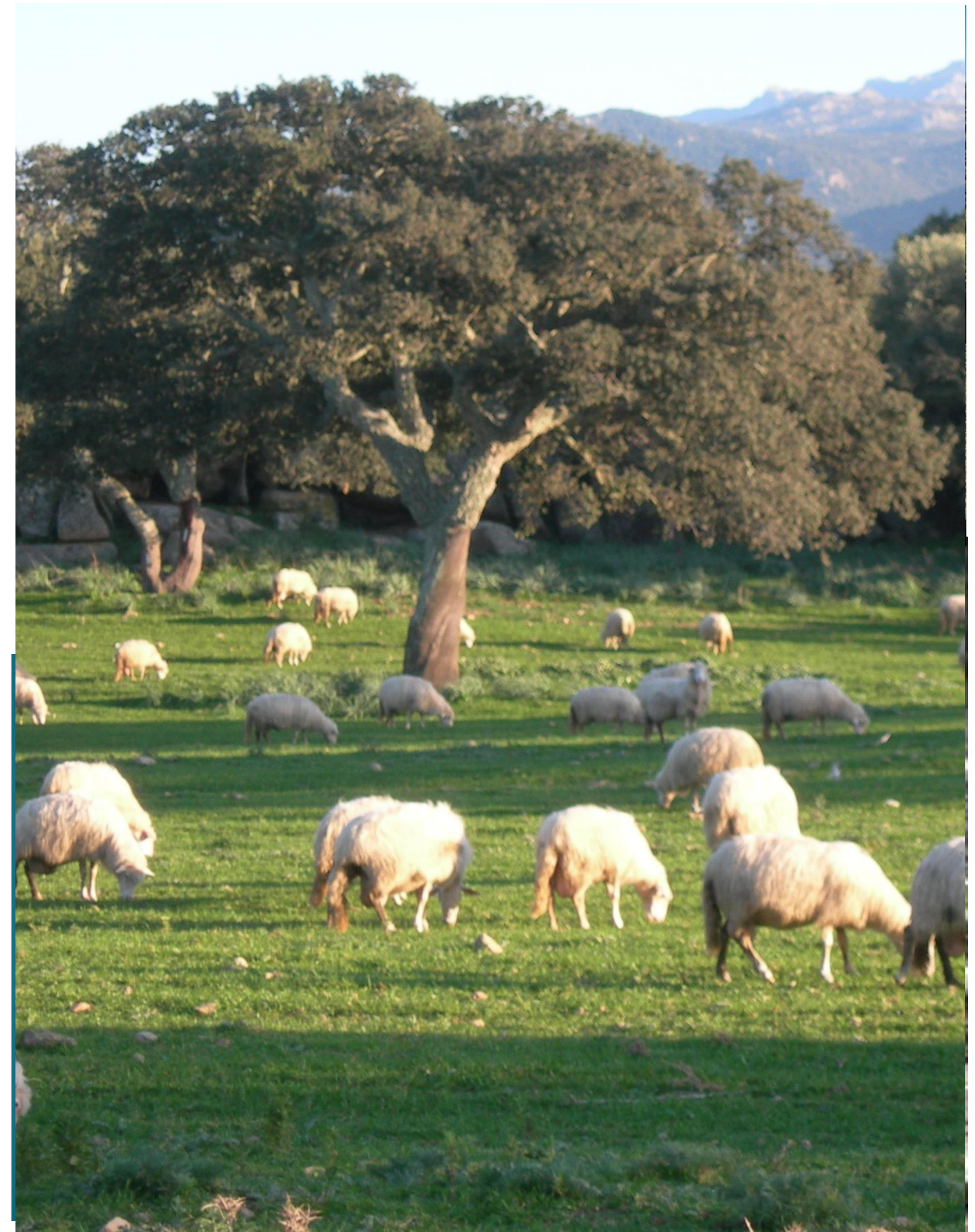
Stories of change: **Efisio2, 2023, 63 yrs old**

- Efisio2 **kept 400 of the 600 ewes** but each yielding **250 kg/yr of milk**, by introducing improved rams from the breeding centre for dairy sheep of the Sarda breed
- Haycrops were converted into permanent grazed meadows improved with self-reseeding legumes and summer dormant perennial grasses
- Hay production and quality increased enough to feed also destagionalised summer lactating ewes and keep producing ricotta cheese for tourists
- The sheep milk is processed **in the farm** since 20 years: the milk price at the coop was too low and the marketing policy a failure
- **The high quality cheese and ricotta** result in a gross income of more than 2,5 EUR/kg milk
- In 2017, the driest year since 60 years, the hay was supplied by a consortium of irrigated farms with whom Efisio made an agreement to guarantee a maximum price
- The coppice is managed as uneven-aged coppicing and contributes to the production of a small biomethane production system
- **Gavina** is graduating in Agricultural sciences and is currently spending an Erasmus traineeship in the Roquefort area in France



Stories of change: **Efisio, 2035, 75 yrs old**

- **Gavina**, 43 yrs old, is now an agronomist and **speaks three languages**
- 15 years ago was successful in submitting an **EIP-Agri call** and engaged a **LAG living lab** involving some 30 livestock and cereal farms through a public-private partnership with University and research centres
- Through **milking robots and digital farming**, they manage some 50.000 ewes over 9.000 ha mainly reclaimed from farms that had been abandoned
- A **digital platform** facilitates the network deliberative processes and info sharing
- The **network** supplies services and inputs (fertilizers, feeds) through a partnership with other private enterprises
- The EU bureaucracy is completely dematerialized based on hi-resolution satellite data
- The high quality pecorino cheese is all commercialized through an **international consortium**
- For the 10 ha coppice the neighbour vine and fruit growers co-fund the ecosystem services recognized by the EU such as pollination and wildfire prevention.
- **The ecosystem services of wooded grasslands** a mosaic of hi-biodiversity priority habitats are rewarded by public subsidies.



Take-home messages

- **Concerted actions for Med silvopastoral systems:** shared visions and ecosystem service perceptions
- Facing climate change and economic pressures: urgent needs for **transformational adaptation**
- Empowering next generations: **tailored solutions** for sustainable livelihoods
- Harnessing **living labs** for learning: enhancing perceptions across social, economic, technological and institutional dimensions of change
- **Rural Living labs** have the potential to transcend the command-control paradigm of rural development policies
- Semantic stretch, misuse, methodological ambiguity and timing mismatches are **challenges** to be addressed to design effective LLs
- **Storytelling and scenario exercises:** catalysts for shifting perceptions and driving practice changes
- Investing in social capital: engaging with **youth and women needs and visions**



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