# PRESENTING NEXTRES PROJECT

09/11/2023

Rossella Guerrieri & Giorgio Matteucci

# Meeting agenda

- Overview of NEXTRES project
- Discussion with participants
- Final remarks

# OVERVIEW OF NEXTRES PROJECT

# NEXTRES

Effects of nitrogen deposition and climate extremes on European forests: combining stable isotopes in tree rings and ecosystem fluxes (September 2023-September 2025)

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Effects of nitrogen deposition and climate extremes on European forests: combining stable isotopes in tree rings and ecosystem fluxes (September 2023-September 2025)

Ministero dell'Università e della Ricerca

MUR

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# Proposers

Research Unit 1

Rossella Guerrieri,
Alma Mater Studiorum,
Università di Bologna
Principal Investigator

Postdoc

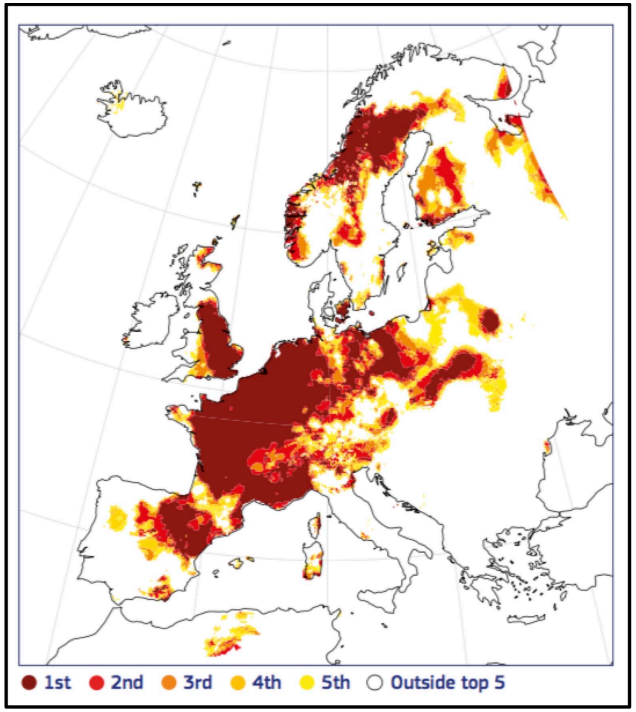
Will be hired

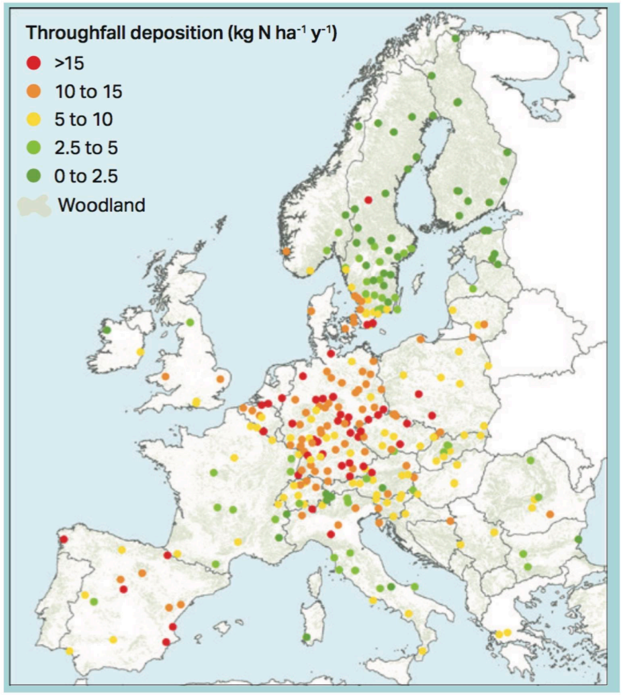
Research Unit 2

Giorgio Matteucci,
Istituto per la
BioEconomia, CNR
co-Investigator

Postdoc

# NEXTRES project – backgroud




Hotspots for the heatwaves recorded during June and July 2019 (left, source: Copernicus|European State of the Climate 2019), and Wet nitrogen deposition (Schmitz et al. 2018 ICP Forests Brief #2)

Climate extreme events (drougths and heatwaves) more frequent and affecting not only Mediterranean region

Nitrogen deposition has been significantly reduced over the last decades, but trends and legacy are different across the EU continent

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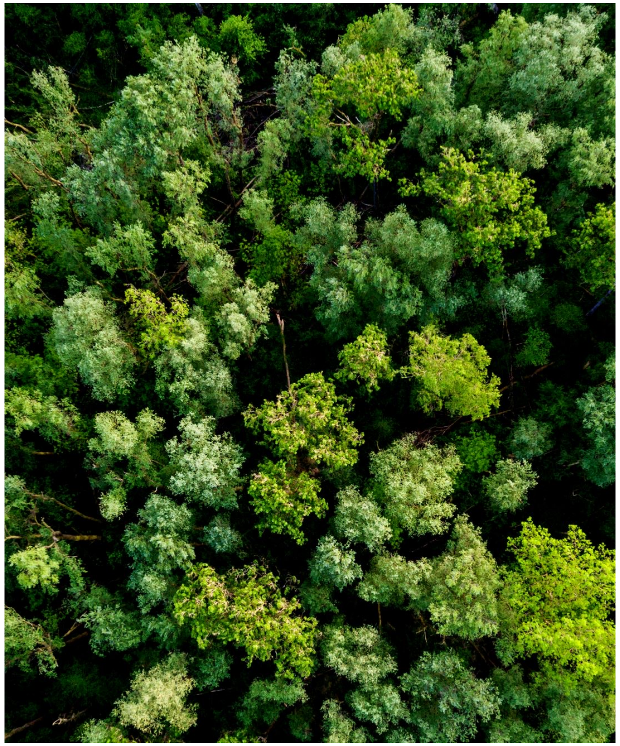

Scientific consensus on the $CO_2$ (Ca) fertilization effects on the forest carbon sink. However, its magnitude and the underpinning physiological mechanisms are still debated.

➔ Uncertainties on whether and to what extent the Ca fertilization will persist, when accounting for nutrient limitations and the interaction with other global change drivers, such as climate extremes and Ndep.

PLANT WATER USE

**Global water use efficiency saturation due to increased vapor pressure deficit**

Fei Li[1,2]*, Jingfeng Xiao[3]*, Jiquan Chen[2], Ashley Ballantyne[4,5], Ke Jin[1], Bing Li[1], Michael Abraha[2], Ranjeet John[6]

The ratio of carbon assimilation to water evapotranspiration (ET) of an ecosystem, referred to as ecosystem water use efficiency ($WUE_{eco}$), is widely expected to increase because of the rising atmospheric carbon dioxide concentration ($C_a$). However, little is known about the interactive effects of rising $C_a$ and climate change on $WUE_{eco}$. On the basis of upscaled estimates from machine learning methods and global FLUXNET observations, we show that global $WUE_{eco}$ has not risen since 2001 because of the asymmetric effects of an increased vapor pressure deficit (VPD), which depressed photosynthesis and enhanced ET. An undiminished ET trend indicates that rising temperature and VPD may play a more important role in regulating ET than declining stomatal conductance. Projected increases in VPD are predicted to affect the future coupling of the terrestrial carbon and water cycles.

Li et al., Science 381, 672–677 (2023)

LETTER

doi:10.1038/nature12291

**Increase in forest water-use efficiency as atmospheric carbon dioxide concentrations rise**

Trevor F. Keenan[1], David Y. Hollinger[2], Gil Bohrer[3], Danilo Dragoni[4], J. William Munger[5], Hans Peter Schmid[6] & Andrew D. Richardson[1]

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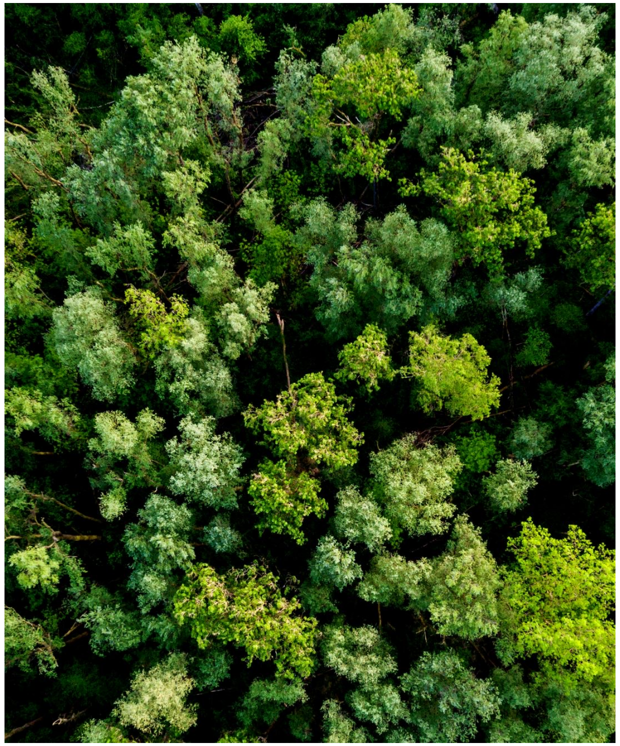
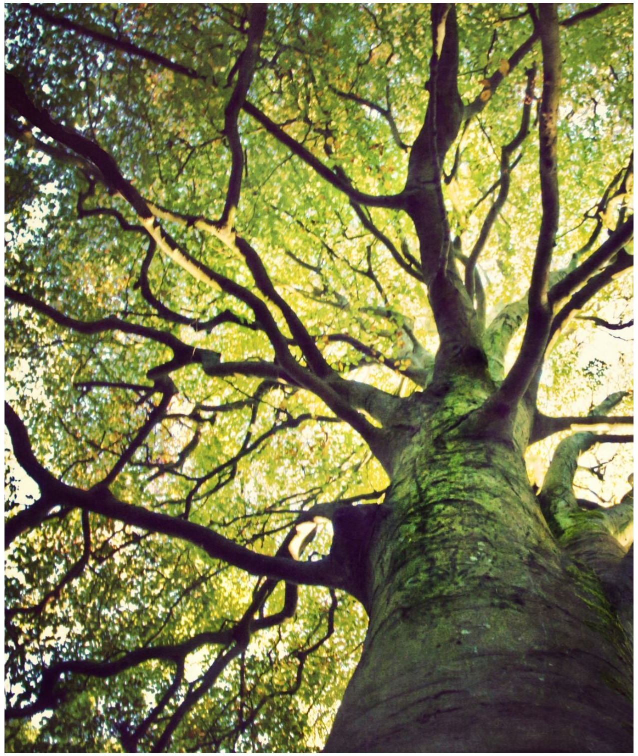


Ecosystem and tree responses at regional scales are more often assessed separately (at least at the EU scale)

- Physiological mechanisms that determine local to regional variability of ecosystem fluxes and species vulnerability to global change factors.
- Mechanisms underpinning forest resilience to climate extremes for the key species shaping European forests and ecosystem services associated to them



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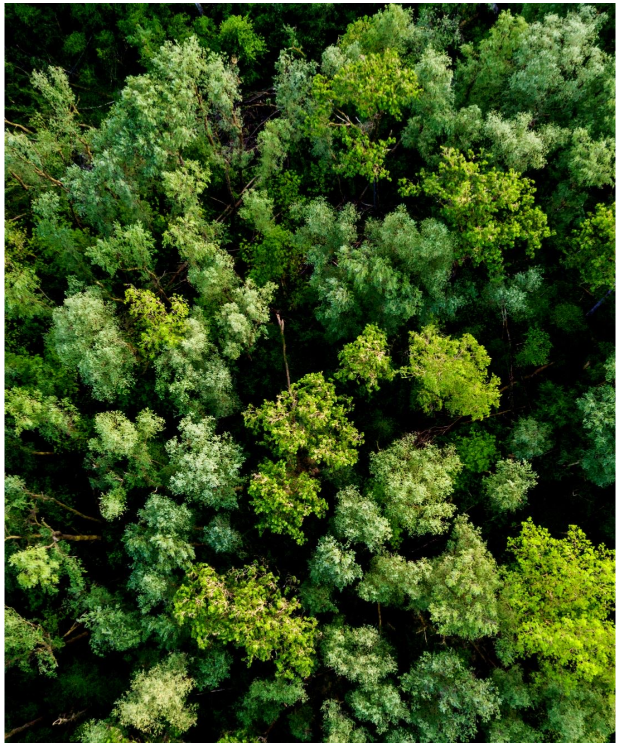

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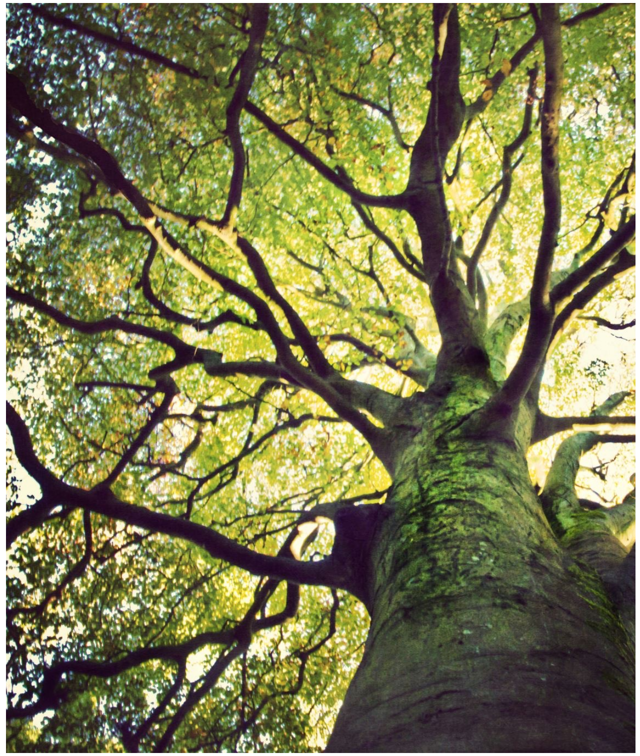
RESEARCH

FOREST ECOLOGY

**Cross-biome synthesis of source versus sink limits to tree growth**

Antoine Cabon[1]*, Steven A. Kannenberg[1], Altaf Arain[2,3], Flurin Babst[4,5], Dennis Baldocchi[6], Soumaya Belmecheri[5], Nicolas Delpierre[7,8], Rossella Guerrieri[9], Justin T. Maxwell[10], Shawn McKenzie[2,3], Frederick C. Meinzer[11], David J. P. Moore[4], Christoforos Pappas[12,13], Adrian V. Rocha[14], Paul Szejner[15], Masahito Ueyama[16], Danielle Ulrich[17], Caroline Vincke[18], Steven L. Voelker[19], Jingshu Wei[20], David Woodruff[11], William R. L. Anderegg[1]

25 sites with both flux and tree ring data (12 in Europe)



# NEXTRES project – general goal

Elucidating how major species in European forests cope and adapt to more frequent climate extremes and concomitant changes in atmospheric $CO_2$ (Ca) and nitrogen deposition (Ndep) by integrating approaches at the ecosystem and tree scales, and from the intra-annual to multi-decadal time-scale resolutions

# NEXTRES project – specific goals

Obj1. To examine the coupling between tree and ecosystem metrics over the recent decades across European forests.

Key questions

(Q1.1) Is the increase in WUE (both at tree and ecosystem scale) consistent across the large environmental gradient? Which are the physiological mechanisms underpinning changes in WUE?
(Q1.2) Are tree and ecosystem metrics significantly correlated along a large environmental gradient? Is the strength of the relationship (slope) affected by global change factors?
(Q1.3) Can we detect changes in N dynamics (retention vs. saturation) at the two levels of Ndep?
(Q1.4) How do climate extremes and atmospheric Ndep interact and affect the sensitivity of tree and ecosystem to increasing Ca?

# NEXTRES project – specific goals

Obj2. To elucidate physiological strategies adopted by different species in response to climate extremes along the latitudinal gradient and how they determine the ecosystem response.

Key questions

(Q2.1) Can we observe a divergence (among species) and convergence across sites (for a given species), in the physiological mechanisms underpinning tree responses to climate extremes?
(Q2.2) Are tree and ecosystem response decoupled during an extreme events?
(Q2.3) How quickly tree species recover from the disturbance and how this is reflected in carbon and water fluxes at the ecosystem scale?
(Q2.3) Within each species, is there a difference in the recovery capacity along the gradient?

# NEXTRES project – specific goals

Obj3. To evaluate the role of nitrogen deposition in driving tree and ecosystem responses to climate extremes.

Key questions

Q3.1) Can we detect differences in N dynamics at the contrasting levels of N deposition (i.e., sites above and below the CL) during an extreme event?
(Q3.2) To what extent is atmospheric deposition mediating sensitivity to drought events and which are the underpinning mechanisms?

# NEXTRES project – proposed sites

Forest ecosystems along a large environmental gradient in terms of climate and Ndep

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Forest ecosystems along a large environmental gradient in terms of climate and Ndep

- ➔ Ecosystem flux data (ICOS/FLUXNET or national network 🟣) and Ndep data (active ICP FORESTS 🟠 sites)
- ➔ Climate and Ndep gradient (below and above the critical loads for Ndep)
- ➔ Most representative species of EU forests (contrasting ecophysiological features)

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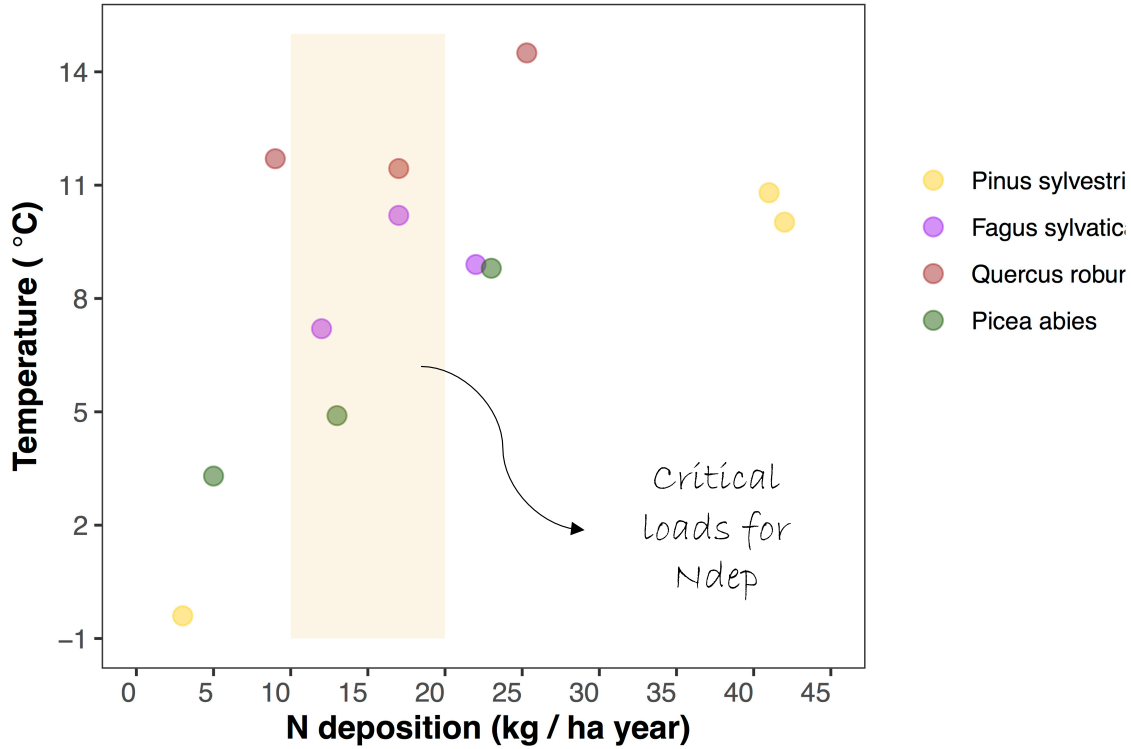
| **Country** | **Site** | **Species** | **PI and key collaborators** |
|---|---|---|---|
| Italy | Collelongo | Fagus sylvatica | Giorgio Matteucci |
| Italy | Bosco Fontana | Quercus robur | **Giacomo Gerosa**, Riccardo Marzuoli |
| Italy | Renon | Picea abies | **Leonardo Montagnani** |
| France | Fontainebleau-Barbeau | Quercus petrea | Eric Dufrene;**Nicolas Delpierre**, Claire Damesin |
| France | Hesse | Fagus sylvatica | **Matthias Cuntz**; Emilie Joetzjer |
| UK | Alice Holt | Quercus robur | James Morrison; **Elena Vanguelova**;Matt Wilkinson |
| Switzerland | Davos | Picea abies | **Mana Gharun; Nina Buchmann; Peter Waldner;Burri Susanne;Roman Zweifel** |
| Begium | Braschaat | Pinus sylvestris | **Arne Verstraeten; Ivan Jansen**,Matteo Campioli, Fran Lauriks |
| Danmark | Soroe | Fagus sylvatica | **Andreas Ibrom**;Kim Pilegaard |
| Netherlands | Lobos | Pinus sylvestris | **Michiel van der Molen** |
| Germany | Tharandt | Picea abies | **Matthias Mauder; Christian Bernhofer** |
| Finland | Sodankylä | Pinus sylvestris | **Mika Aurela** |

# NEXTRES project – proposed sites

Forest ecosystems along a large environmental gradient in terms of climate and Ndep

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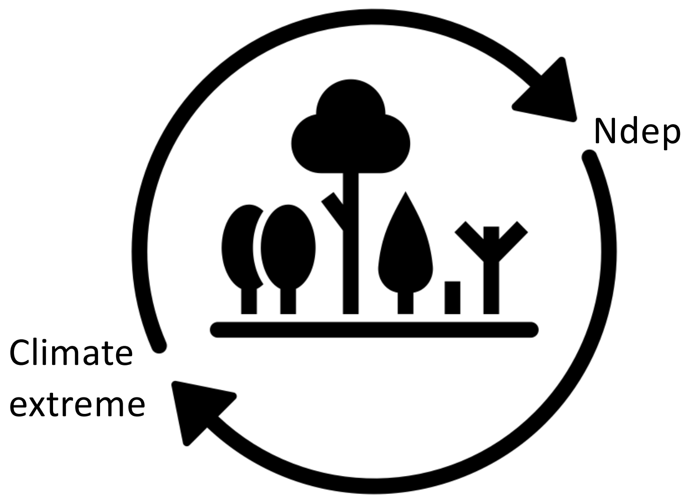
👉Deposition data from Flechard et al. (2020). Biogeosciences. 17 (6), 1621–1654.

# NEXTRES project – WPs

WP1.Assessing spatial and temporal variation in global change drivers (All Objs)

Last 50 years (for global change drivers)



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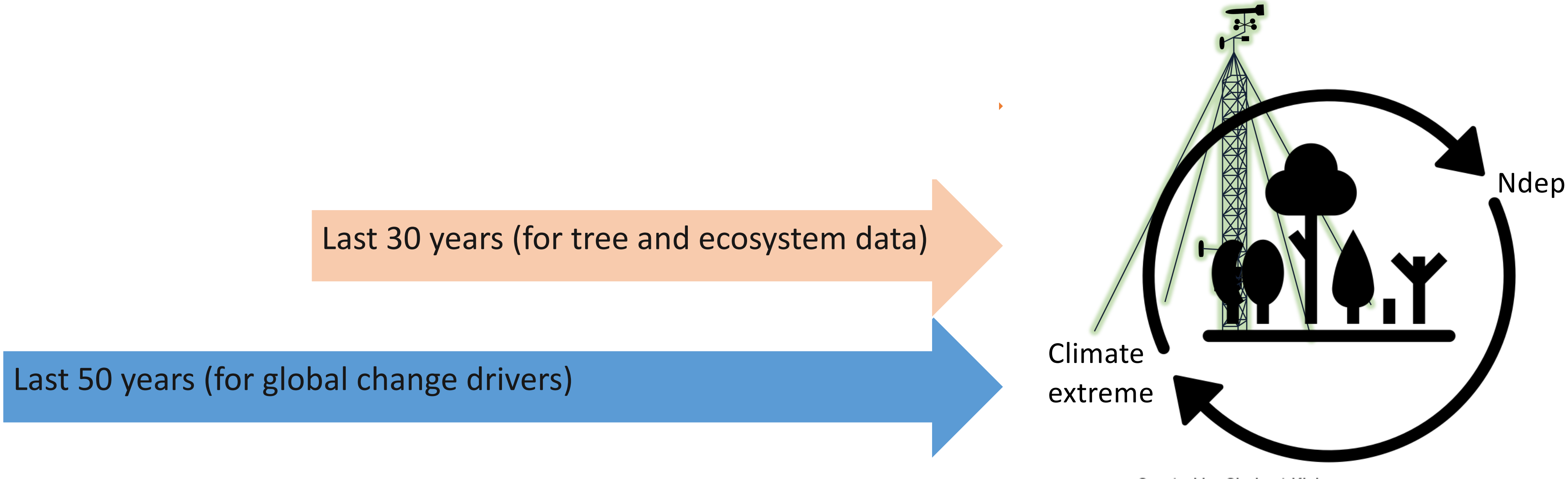
WP2.Analyses of ecosystem fluxes (Obj 1)



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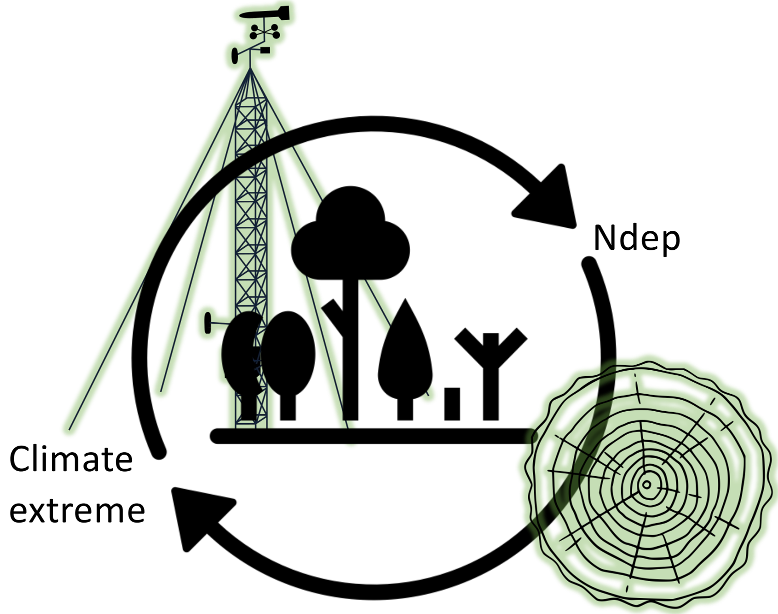
WP1.Assessing spatial and temporal variation in global change drivers (All Objs)

WP2.Analyses of ecosystem fluxes (Obj 1)

WP3.Dendroecological analyses (Obj 1) – ring widths (n=15 trees) and stable C, O and N isotopes in tree rings (n=5 trees)

Last 30 years (for tree and ecosystem data)

Last 50 years (for global change drivers)



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WP1.Assessing spatial and temporal variation in global change drivers (All Objs)

WP2.Analyses of ecosystem fluxes (Obj 1)

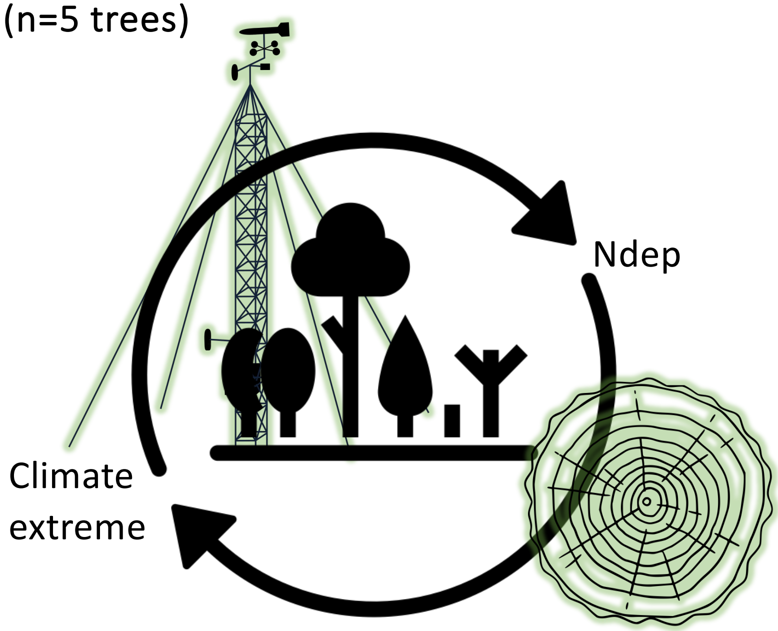
WP3.Dendroecological analyses (Obj 1)

WP4.Intra-annual investigation (Objs 2-3) – carbon isotopes (n=5 trees)

2 ‘pointer’ years

Last 30 years (for tree and ecosystem data)

Last 50 years (for global change drivers)



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WP2.Analyses of ecosystem fluxes (Obj 1)

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WP4.Intra-annual investigation (Objs 2-3)

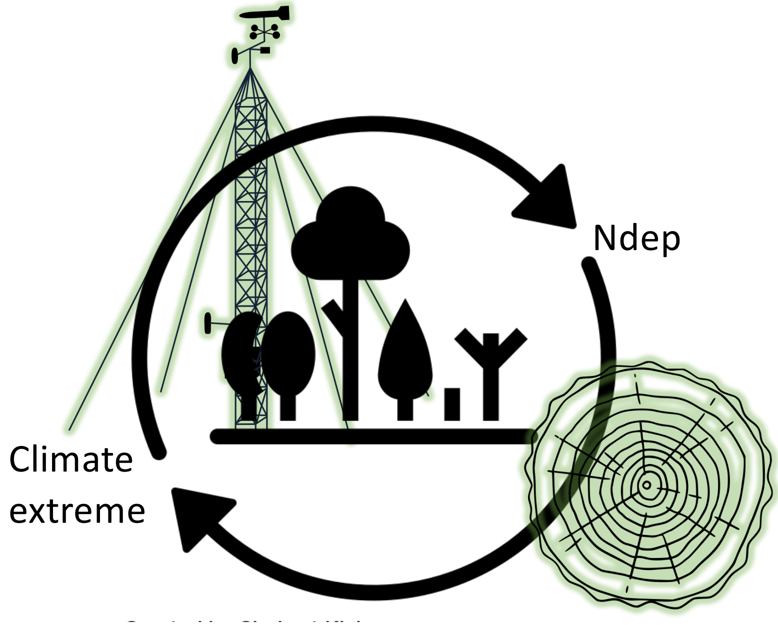
Difference in the physiological mechanisms, role of Ndep and coupling between scales

2 'pointer' years

Trends magnitude of changes and drivers

Last 30 years (for tree and ecosystem data)

Last 50 years (for global change drivers)



# NEXTRES project – fostering collaborations

How can you contribute?

# NEXTRES project – fostering collaborations

WP1.Assessing spatial and temporal variation in global change drivers (All Objs)

Providing all site information (including what is currently monitoring at the tree level)

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A form will be arranged to gather the information

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**WP3.Dendroecological analyses (Obj1) and WP4.Intra-annual investigation (Objs 2-3)**

Supporting during fieldwork (showing the site)
Providing wood cores (if sampling is not possible)

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**WP5.Dissemination**

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**WP5.Dissemination**

Co-autorship in scientific publications and presentations in national/international conferences

# Questions?