



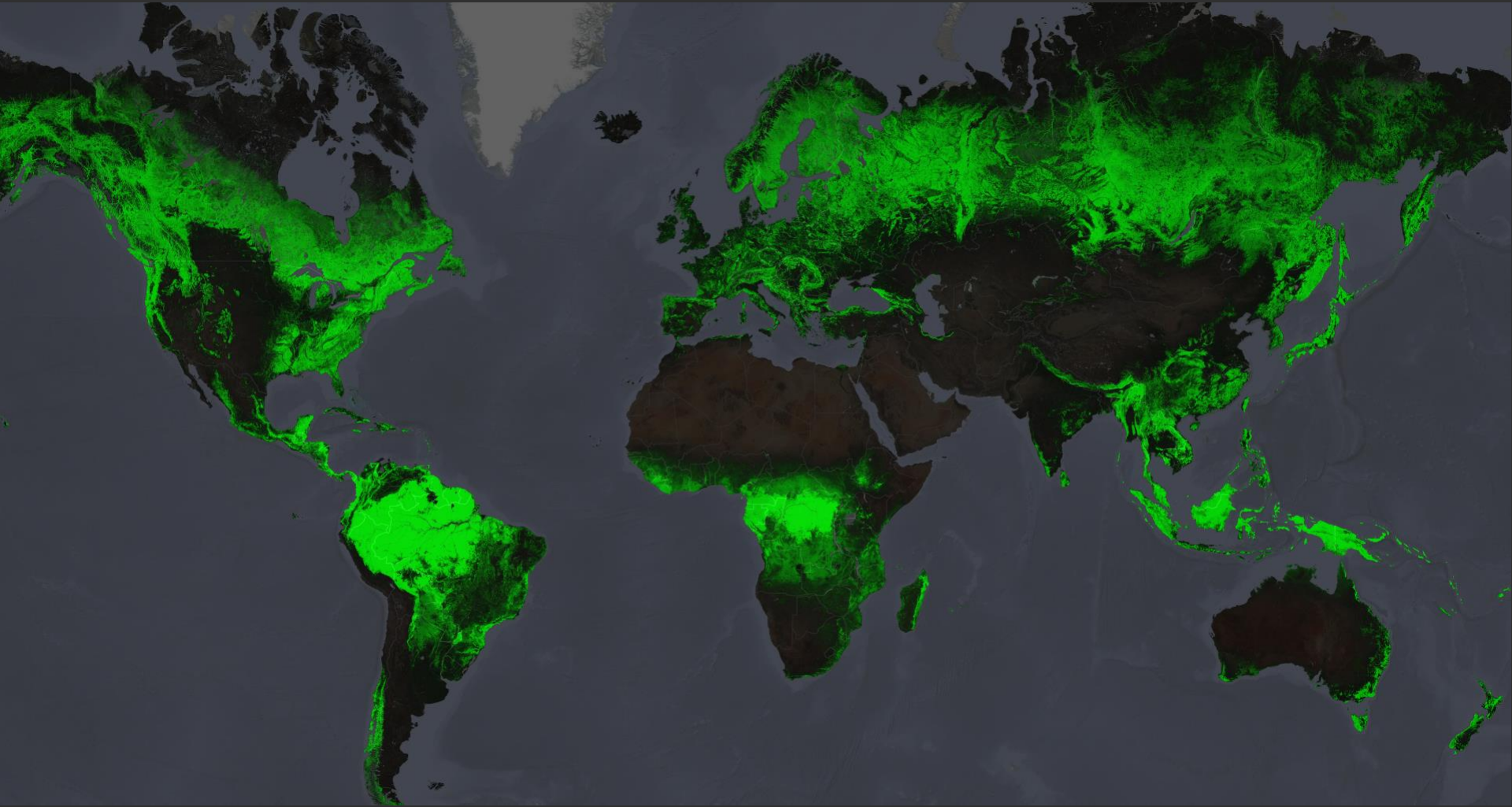
Universität für Bodenkultur Wien  
University of Natural Resources  
and Life Sciences, Vienna

# Climate impacts on forests: The good, the bad and the ugly

Rupert Seidl



~ 30% of the land area  
~ 3 trillion trees





~75% of all known terrestrial species



CPF (2008)



**1** NO POVERTY



**2** NO HUNGER



**3** GOOD HEALTH



**4** QUALITY EDUCATION




**5** GENDER EQUALITY




**6** CLEAN WATER AND SANITATION



**7** RENEWABLE ENERGY



**8** GOOD JOBS AND ECONOMIC GROWTH



**9** INNOVATION AND INFRASTRUCTURE



**10** REDUCED INEQUALITIES



**11** SUSTAINABLE CITIES AND COMMUNITIES



**12** RESPONSIBLE CONSUMPTION



**13** CLIMATE ACTION



**14** LIFE BELOW WATER



**15** LIFE ON LAND



**16** PEACE AND JUSTICE



**17** PARTNERSHIPS FOR THE GOALS

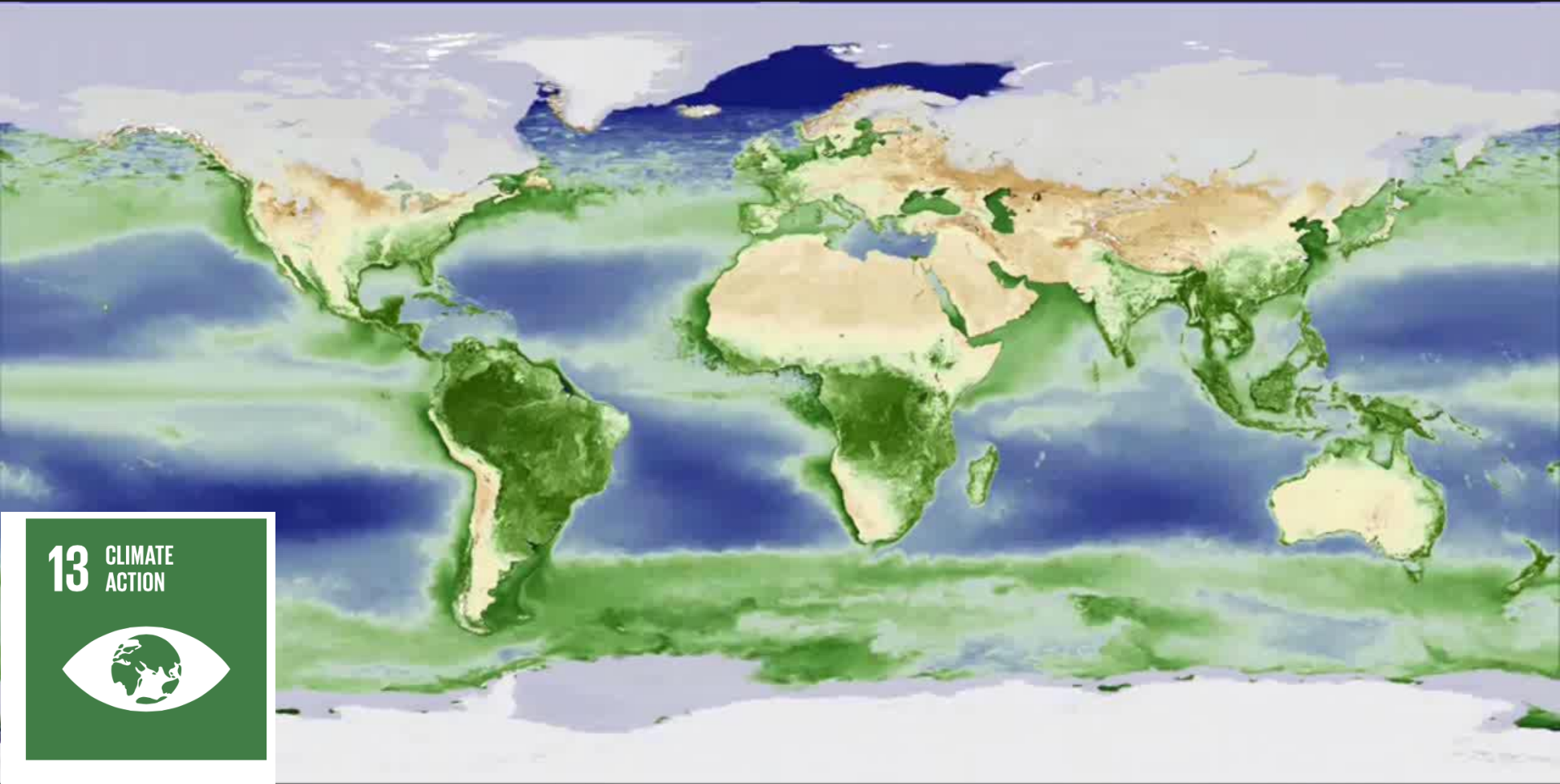


**THE GLOBAL GOALS**  
For Sustainable Development



# Forests have been taking up 60% of the cumulative fossil fuel emissions in recent years.

Pan et al. (2011, Science)



13 CLIMATE ACTION



Jan Dec

Land Vegetation (NDVI)

0.1 0.9

Ocean Chlorophyll Concentration (mg/m<sup>3</sup>)

0.01 0.1 1 10 20

# Forested watersheds supply 75% of the world's accessible fresh water.

FAO (2017)

6 CLEAN WATER AND SANITATION





# Forests are impacted by climate change



Longevity  
Immobility

# Forests are impacted by climate change



**THE GOOD THE BAD AND THE UGLY**







**THE  
GOOD**



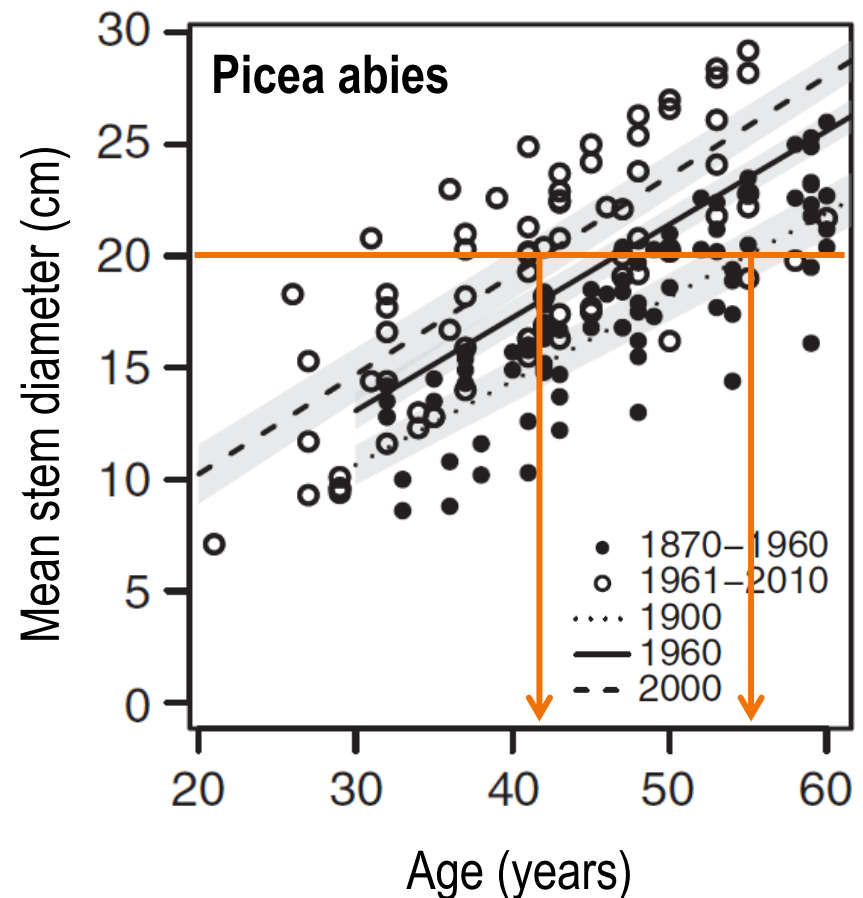
# Tree growth is benefiting from climate change

Accelerated tree growth in many parts of the world, due to

- CO<sub>2</sub> fertilization
- Longer growing seasons
- Other (not climate-related factors)



20 cm

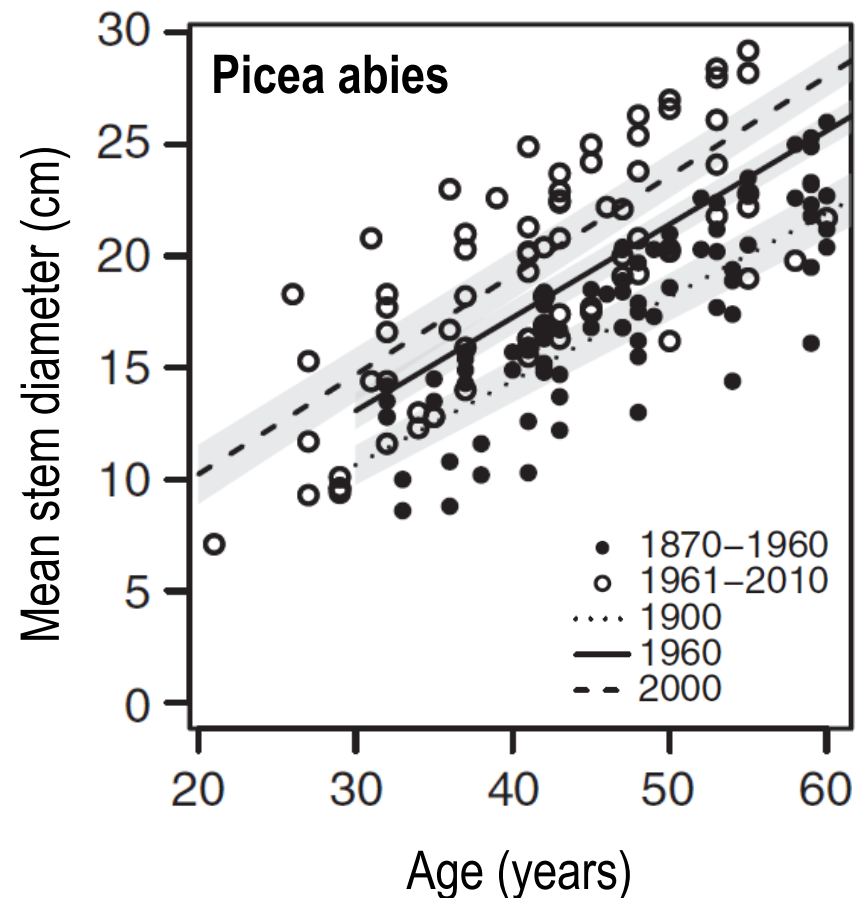




# Tree growth is benefiting from climate change

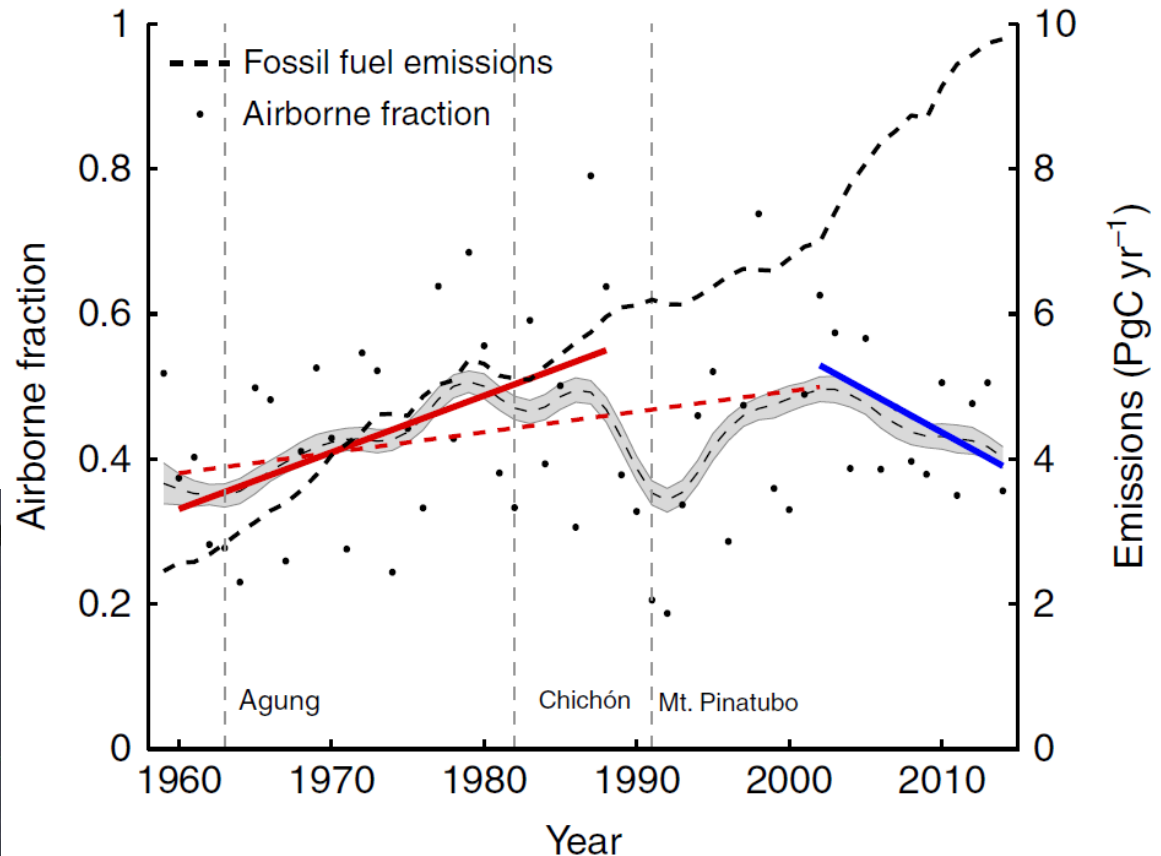
Accelerated tree growth in many parts of the world, due to

- CO<sub>2</sub> fertilization
- Longer growing seasons
- Other (not climate-related factors)



# Increased tree growth mitigates climate change

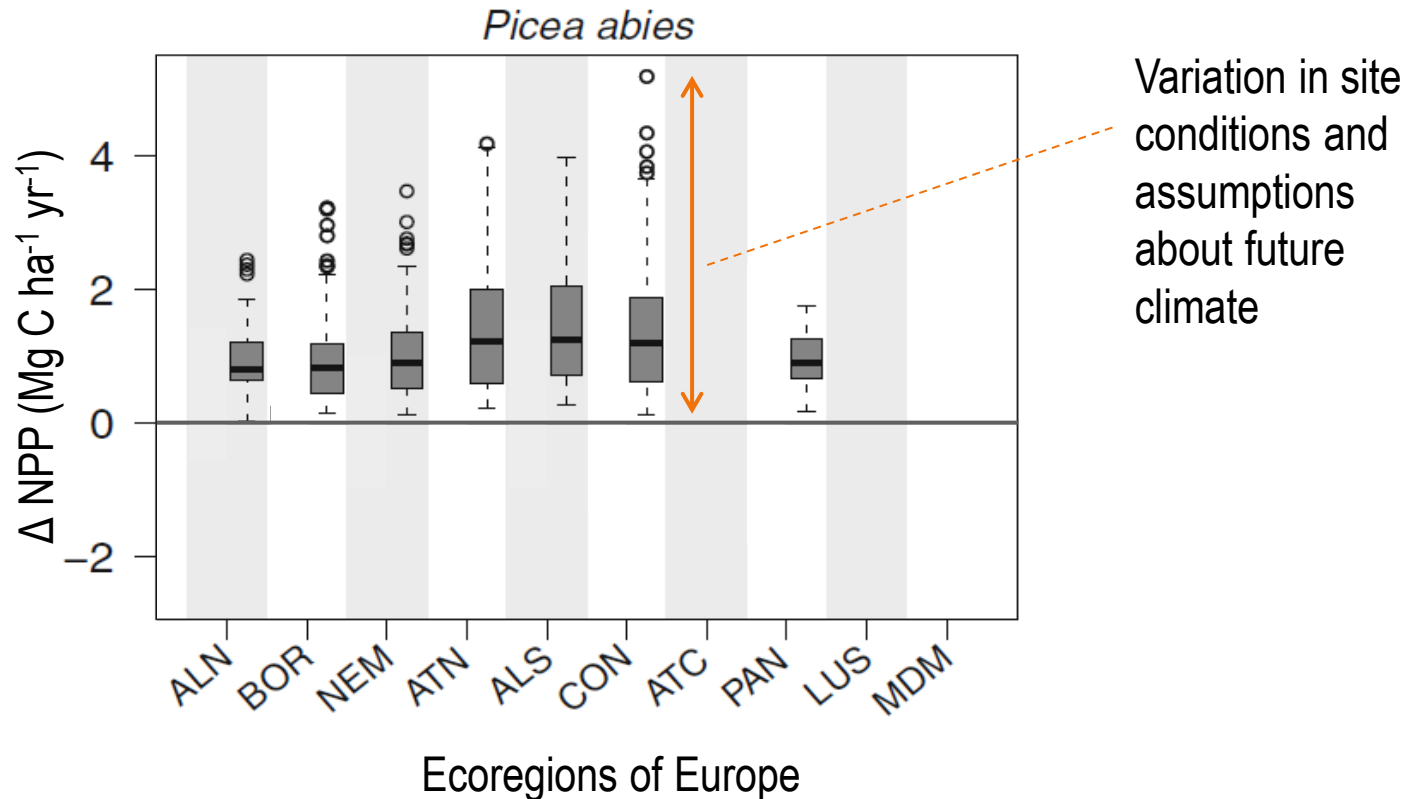
The increased terrestrial C sink strength reduces the fraction of anthropogenic C emissions that remain in the atmosphere



Keenan et al. (2016, Nature Communications)

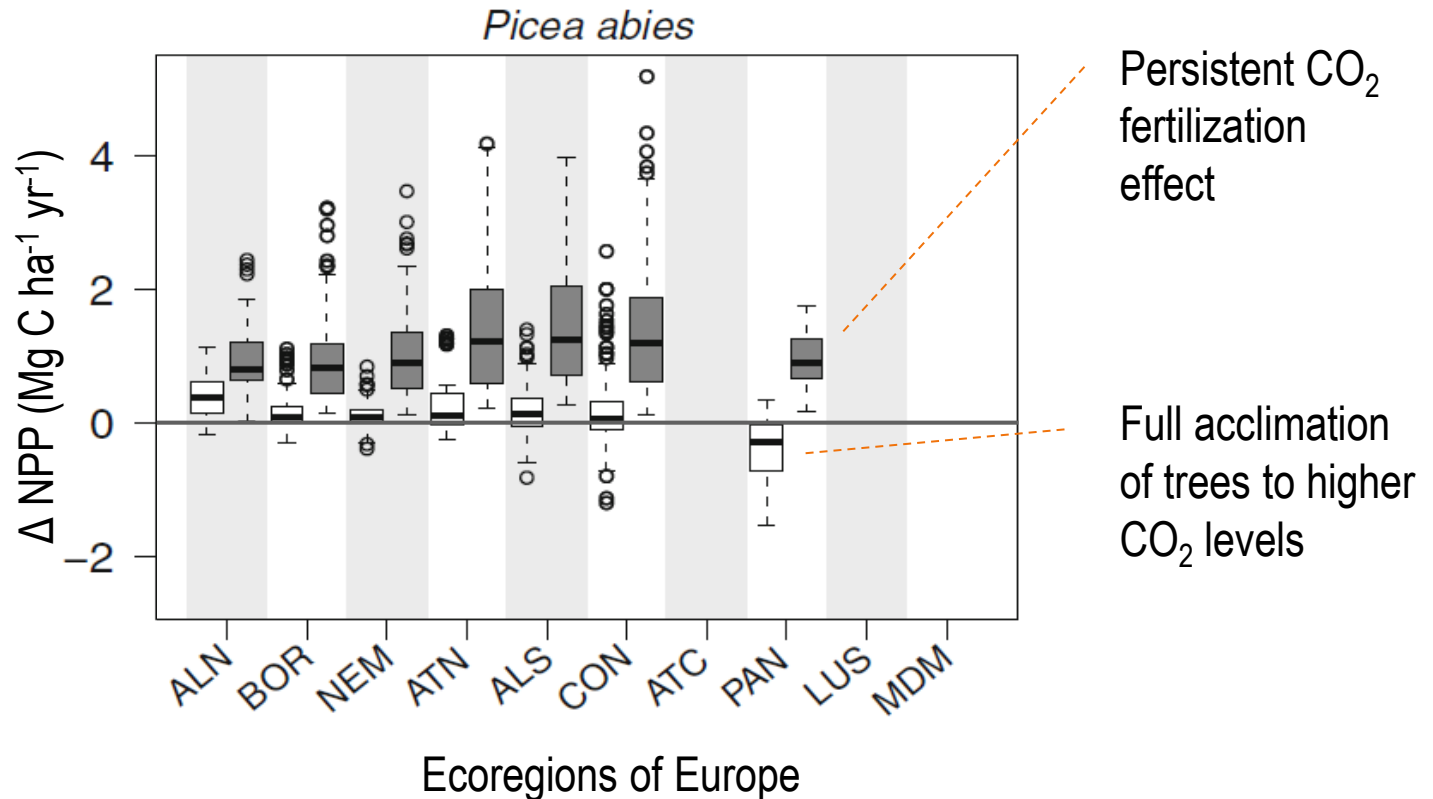


# Expected future changes in tree growth



Simulated change in NPP at continental scale in 18 different scenarios of climate change for the 21<sup>st</sup> century, relative to 1971-2000

# Expected future changes in tree growth



Simulated change in NPP at continental scale in 18 different scenarios of climate change for the 21<sup>st</sup> century, relative to 1971-2000





**THE GOOD THE BAD AND THE UGLY**



**THE  
BAD**



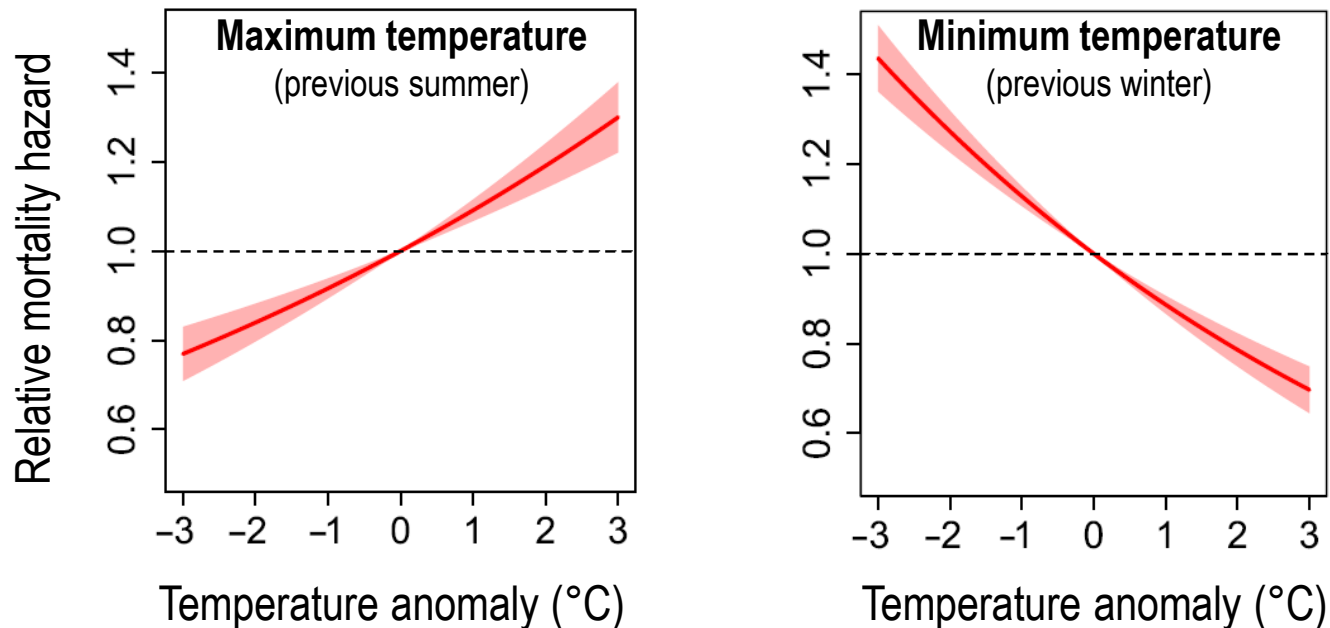




# Climate affects tree mortality

Influence of climate on the mortality of individual trees is complex

Higher warm-induced mortality could be (partly) compensated by lower cold-induced mortality



Based on the analysis of ~ 1 Mill. observations of >230,000 trees across the entire European continent.

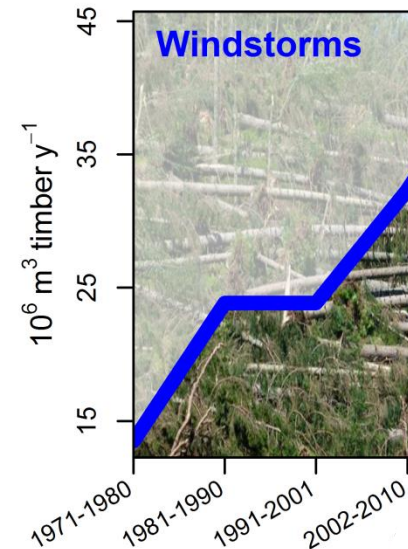
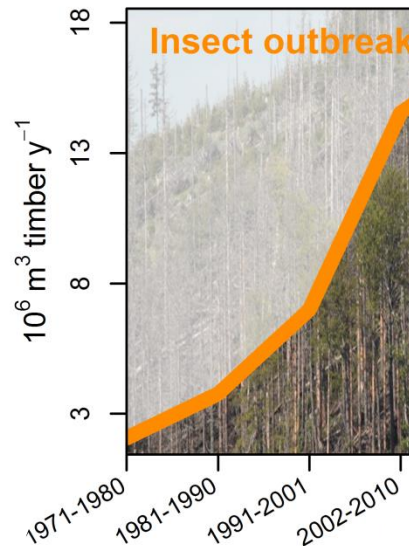
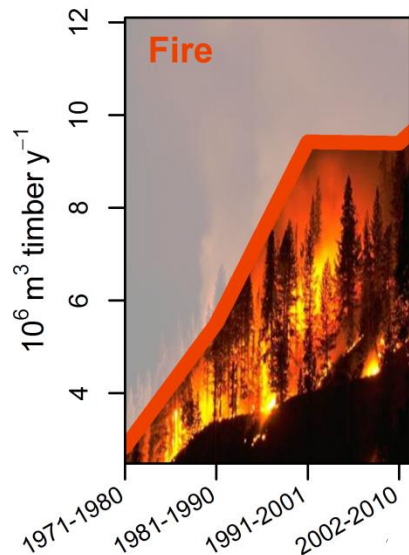
Neumann et al. (2017, Glob. Change Biol.)

# Climate change increases disturbances

Mortality from disturbances is increasing in forest ecosystems

Disturbance impacts have nearly tripled over the last 40 years in Europe

Climate change is a major driver of this increase (but not the sole driver)



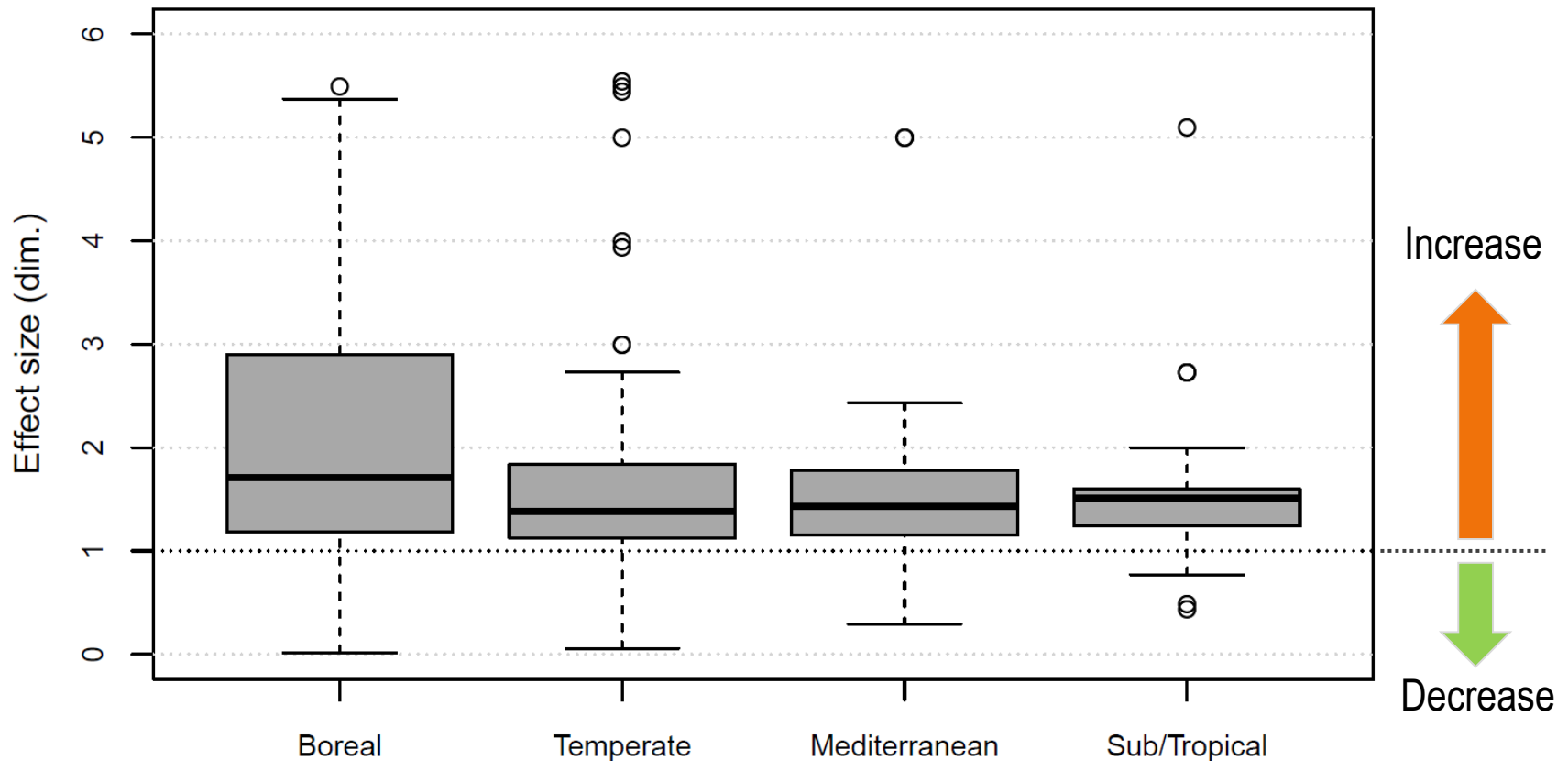
Seidl et al. (2014, Nature Climate Change)





# The future of forest disturbance regimes

Climate change effect relative to reference climate conditions, summarized across all climate change scenarios studied in the reviewed literature.

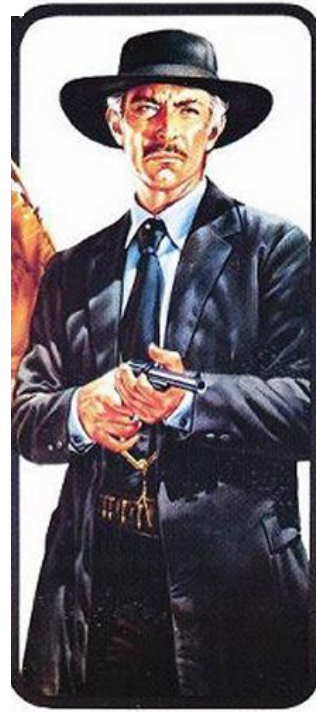


Based on a global meta-analysis of >650 paper reporting on climate-disturbance relationships

Seidl et al. (2017, Nature Climate Change)



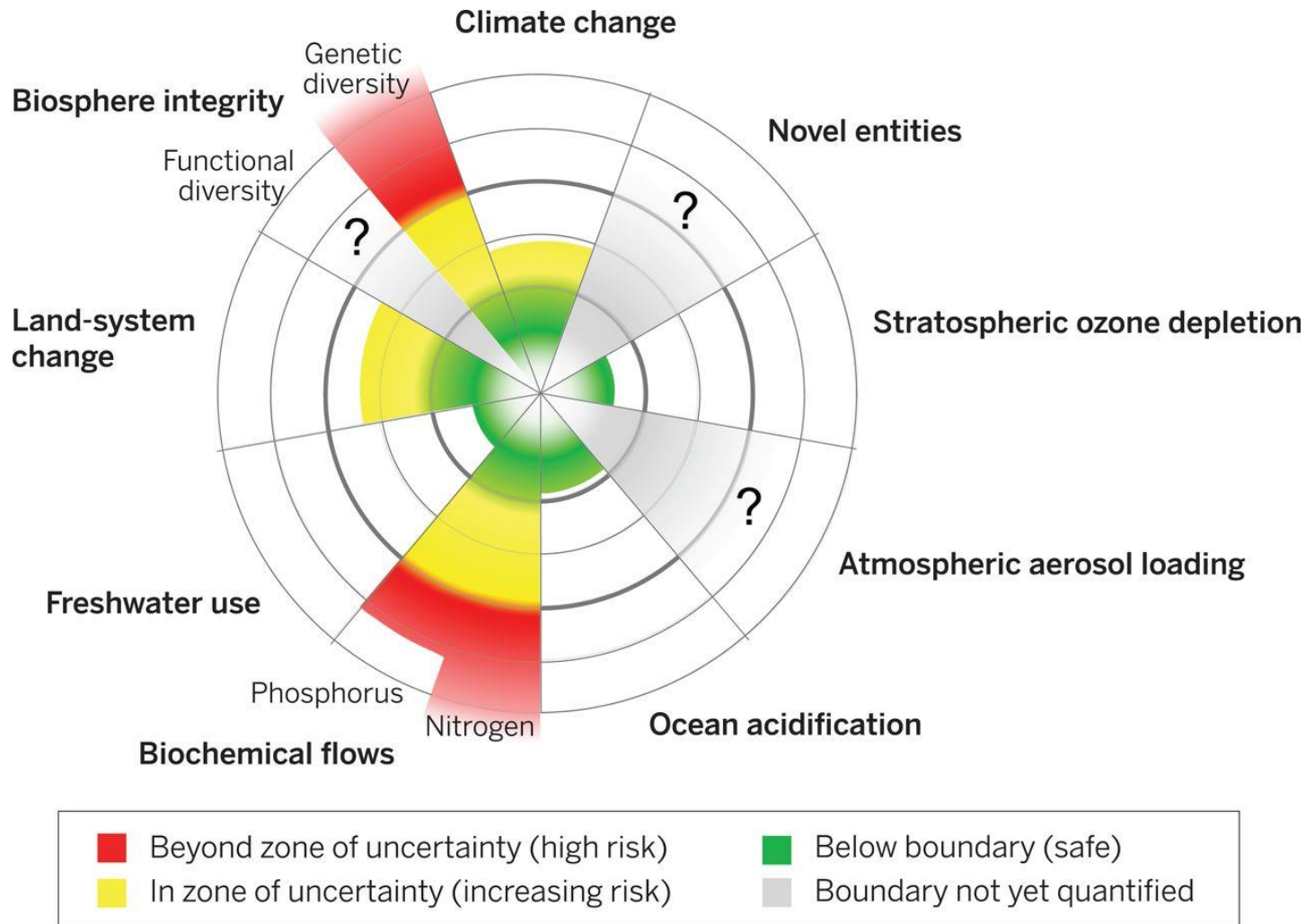
**THE GOOD THE BAD AND THE UGLY**



**AND THE  
UGLY**

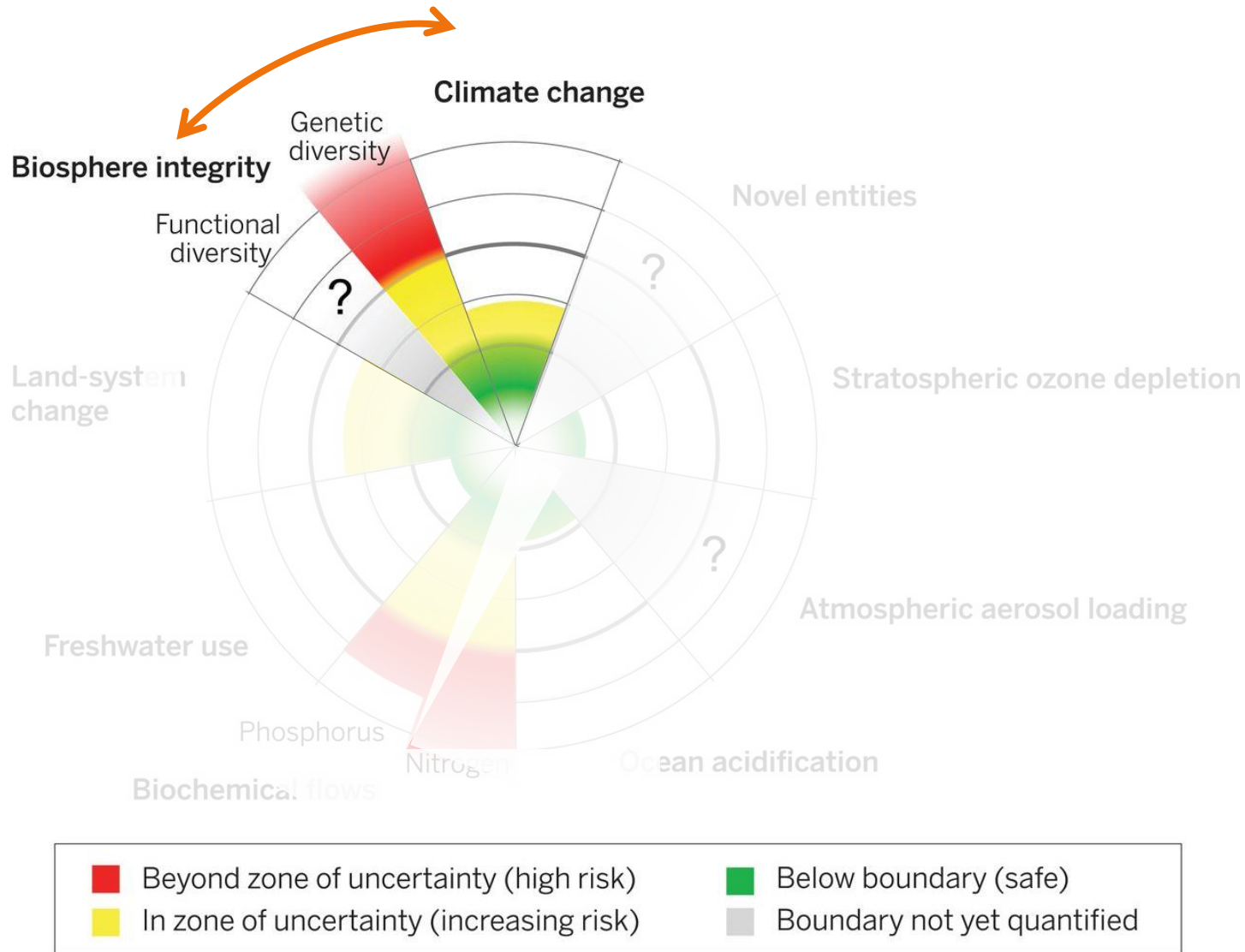


# Interactions between global change drivers



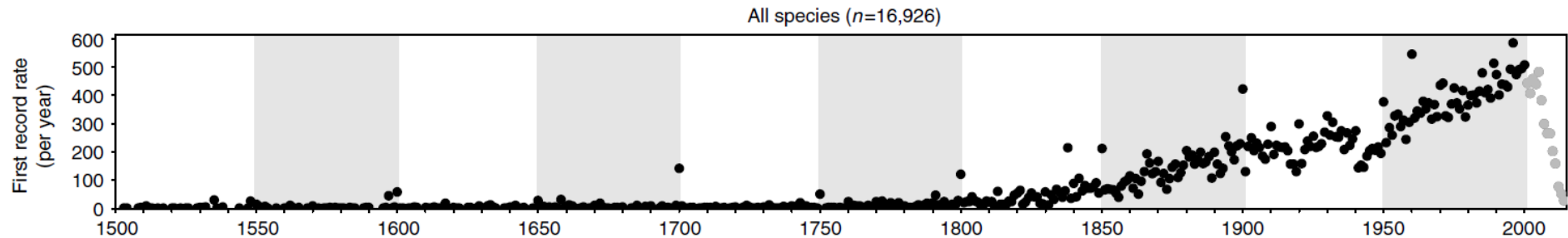
Steffen et al. (2015, Science)

# Interactions between global change drivers



Steffen et al. (2015, Science)

# Continued accumulation of alien species



Introduced species include highly aggressive tree pests

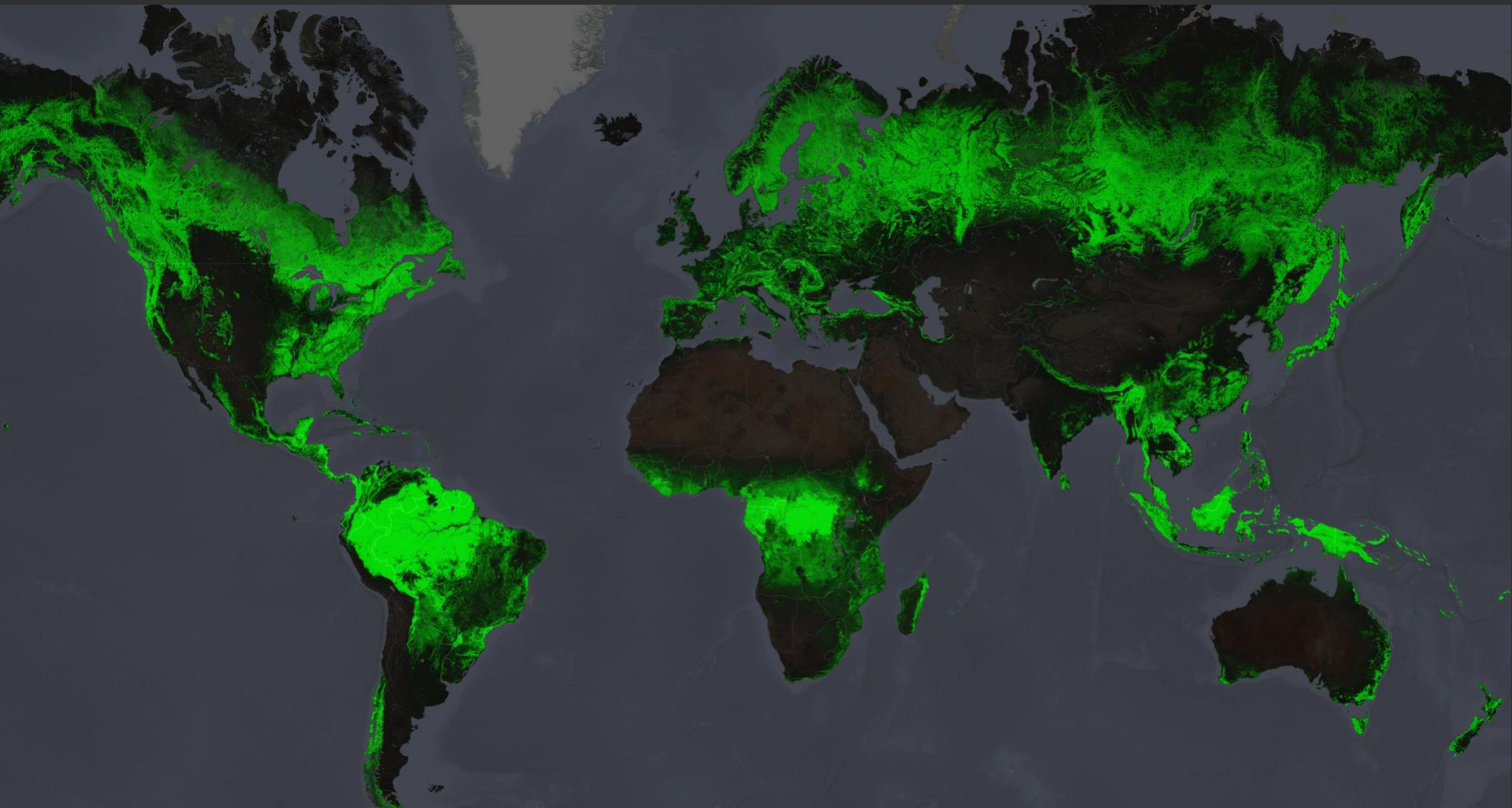


Pine Wood Nematode  
(*Bursaphelenchus xylophilus*)



Pitch Pine Canker  
(*Fusarium circinatum*)





Hansen et al. (2013, Science), Crowther et al. (2015, Nature), Beech et al. (2017, J. Sus. For.)

**1** NO POVERTY



**2** NO HUNGER



**3** GOOD HEALTH



**4** QUALITY EDUCATION




**5** GENDER EQUALITY




**6** CLEAN WATER AND SANITATION



**7** RENEWABLE ENERGY



**8** GOOD JOBS AND ECONOMIC GROWTH



**9** INNOVATION AND INFRASTRUCTURE



**10** REDUCED INEQUALITIES



**11** SUSTAINABLE CITIES AND COMMUNITIES



**12** RESPONSIBLE CONSUMPTION



**13** CLIMATE ACTION



**14** LIFE BELOW WATER



**15** LIFE ON LAND



**16** PEACE AND JUSTICE



**17** PARTNERSHIPS FOR THE GOALS



**THE GLOBAL GOALS**  
For Sustainable Development

# Climate impacts on forests

## The good

Climate change currently enhances tree growth, an effect that is likely to continue in the future. This benefits the climate regulation function of forests, among others.

## The bad

Climate change alters tree mortality, and amplifies pulses of tree loss through disturbances such as wildfire, drought, wind, and insects.

## The ugly

Climate change interacts with other drivers of global change, e.g., facilitating the spread of alien species, with potentially dire consequences for forests.





Thank you!

rupert.seidl@boku.ac.at  
[www.wabo.boku.ac.at/seidl.htm](http://www.wabo.boku.ac.at/seidl.htm)