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UNIVERZITA J. E. PURKYNĚ V ÚSTÍ NAD LABEM

Forests and climate change

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EUROPEAN UNION
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Operational Programme Research,
Development and Education

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What does it mean “forest”?

The most common forest definition was elaborated by FAO in 1998:

Forest is a land spanning more than 0.5 ha with trees higher than 5 m and a canopy cover of more than 10%, or trees able to reach *in situ* these thresholds.

What does it mean “forest”?

The FAO forest definition includes:

- Areas that are **temporarily** deforested due to clear-cutting as part of a forest management practice or natural disasters, and which are expected to be regenerated within 5 years
- Forest roads, firebreaks and other small open areas

What does it mean “forest”?

The FAO forest definition includes:

Areas with young trees that have not yet reached but which are expected to reach a canopy cover of 10% and tree height of 5 m.

What does it mean “forest”?

- The FAO forest definition does not include the land that is predominantly under agricultural or urban land use

Forests from a global perspective

- Forests cover <u>31% of total land area on the Earth</u> (4.06 billion ha, *i.e.* area equal to Europe + Africa)
  (FAO, 2020)

- The second largest global land cover/land-use type, after farmland

Forests from a global perspective

- The GlobalTreeSearch database reports the existence of 60,082 tree species.

- Nearly 58% of all tree species are single-country endemics.

(FAO, 2020)

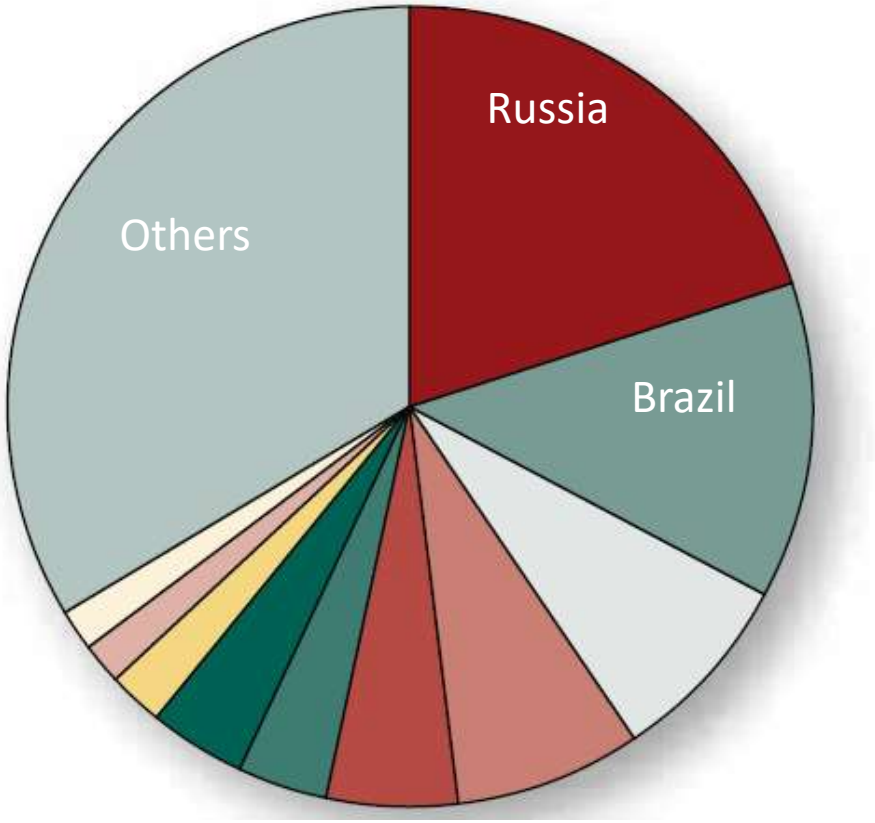
Forests from a global perspective

- The five most forest-rich countries (the Russian Federation, Brazil, Canada, the United States of America and China) account for more than half of the total forest area

(FAO, 2020)

Distribution of forest area by country in 2010

Ten countries with the largest forest area



	(million ha)
Russian Federation	809
Brazil	520
Canada	310
United States of America	304
China	207
Democratic Republic of the Congo	154
Australia	149
Indonesia	94
Sudan	70
India	68
Others	1 347

Source: Data from FAO (2010)


World Map
Kilometers
0 1000 2000 3000
0 1000 2000
Miles
Arctic Ocean
Atlantic Ocean
Pacific Ocean
Indian Ocean
Southern Ocean
Russia
Canada
United States
China
India
Brazil
Australia
Indonesia
Kazakhstan
Mongolia
Japan
Iran
Saudi Arabia
Algeria
Libya
Egypt
Sudan
Nigeria
Mali
Niger
Chad
Ethiopia
South Sudan
Kenya
Tanzania
Angola
Zambia
Mozambique
Madagascar
Namibia
South Africa
Peru
Bolivia
Paraguay
Chile
Argentina
Uruguay
Colombia
Venezuela
Ecuador
Mexico
France
Spain
Portugal
Turkey
Iraq
Pakistan
Malaysia
Philippines
Micronesia
Marshall Islands
New Zealand
Papua New Guinea
Seychelles
Mauritius
Sri Lanka
Maldives
1. Burundi
2. Malawi
3. Rwanda
4. Armenia
5. Azerbaijan
6. Bahrain
7. Qatar
8. Albania
9. Andorra
10. Belgium
11. Bosnia and Herzegovina
12. Croatia
13. Czech Republic
14. Vatican City
15. Kosovo
16. Liechtenstein
17. Luxembourg
18. Moldova
19. Montenegro
20. North Macedonia
21. Netherlands
22. San Marino
23. Serbia
24. Slovenia
25. Switzerland
26. Saint Vincent and the Grenadines
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NeA1904190010

Forests from a global perspective

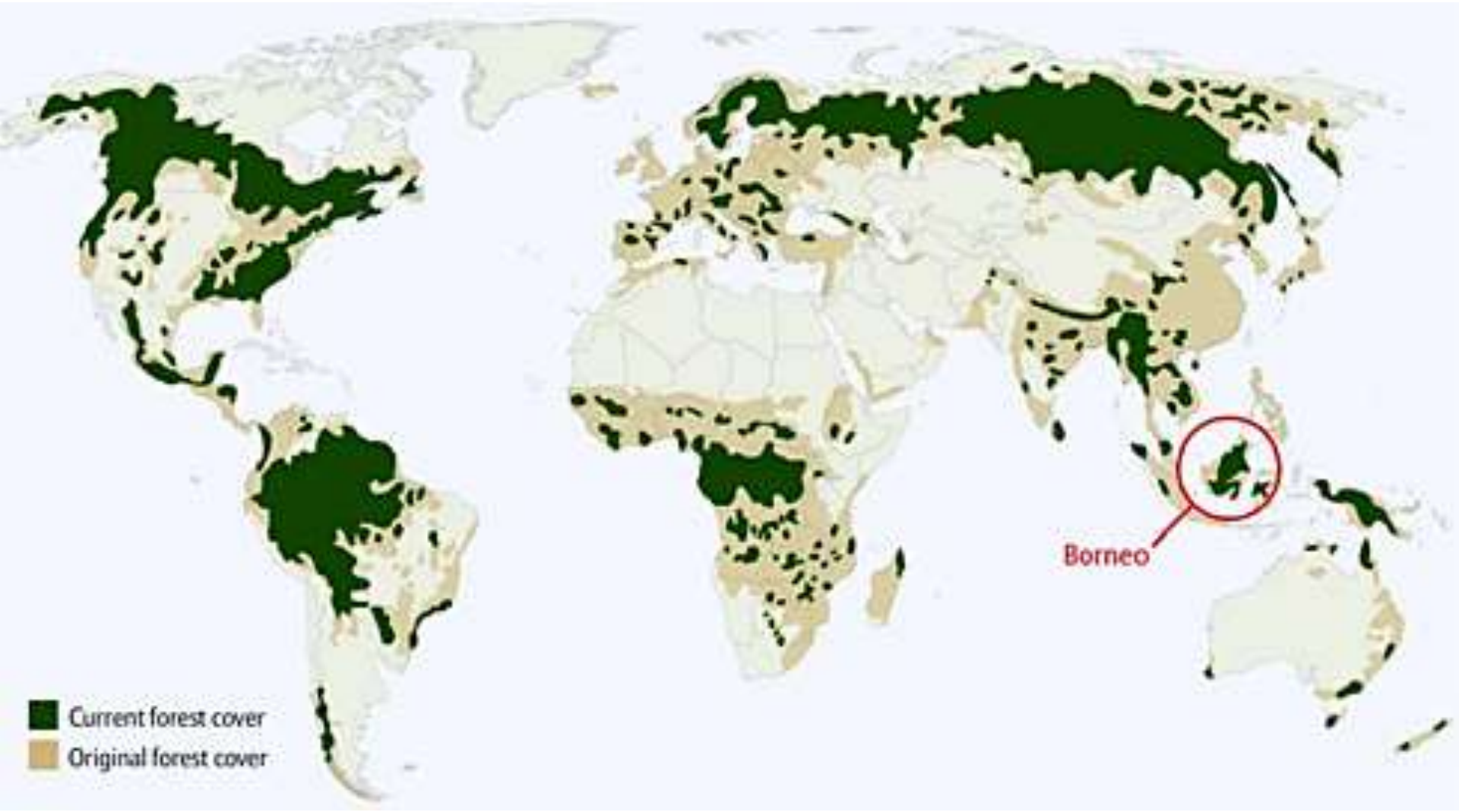
- An average of 0.52 ha per capita (ca square 72x72 m)
  (FAO, 2020)
- 10 countries or areas have no forest at all
- An additional 54 countries have forest on less than 10% of their total land area.

Forests from a global perspective

At the Neolith Era/New Stone Age (8,000 years ago, before the Neolithic Revolution had introduced farming), forests covered approx. half of the total land area on Earth.

(Nowadays the forests cover 31% of total land area on the Earth)

Deforestation



Map source: http://uclast203-2010.wikispaces.com/Deforestation+of+the+Amazon produced by Allianz

Forests from a global perspective

	world	Europe	European Union
Forest cover (%)	30.6	44.5	37.9
Change in forest cover since 1990 (%)	-1.0	+2.7	+3.2
Proportion of forests in protected areas (%)	16.2	4.5	13
Proportion of undisturbed forests (%)	31.9	27.2	1.9
Proportion of planted area from the total forest cover (%)	7.2	8.1	34.4

Forests from a global perspective

- From 1990 to 2015, there was a natural loss of some 129 million hectares of forests (the size of Peru)
- An annual rate -0.13%

Forests from a global perspective

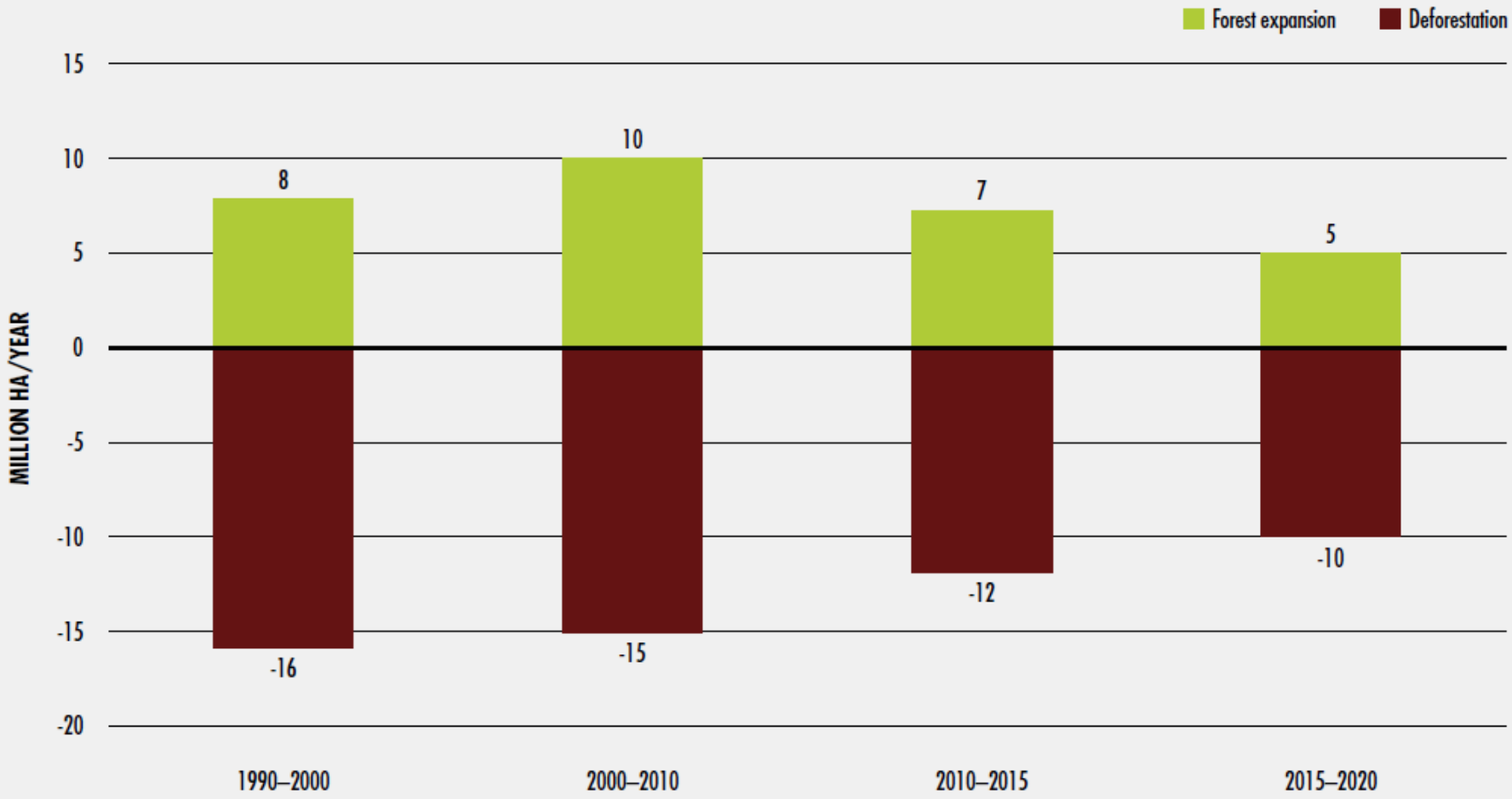
- Large-scale planting of trees is significantly reducing the net loss of forest area globally

Forests from a global perspective

- Afforestation and natural expansion of forests in some countries and regions have reduced the net loss of forest area significantly at the global level

Forests from a global perspective

GLOBAL FOREST EXPANSION AND DEFORESTATION, 1990–2020 (MILLION HECTARES PER YEAR)

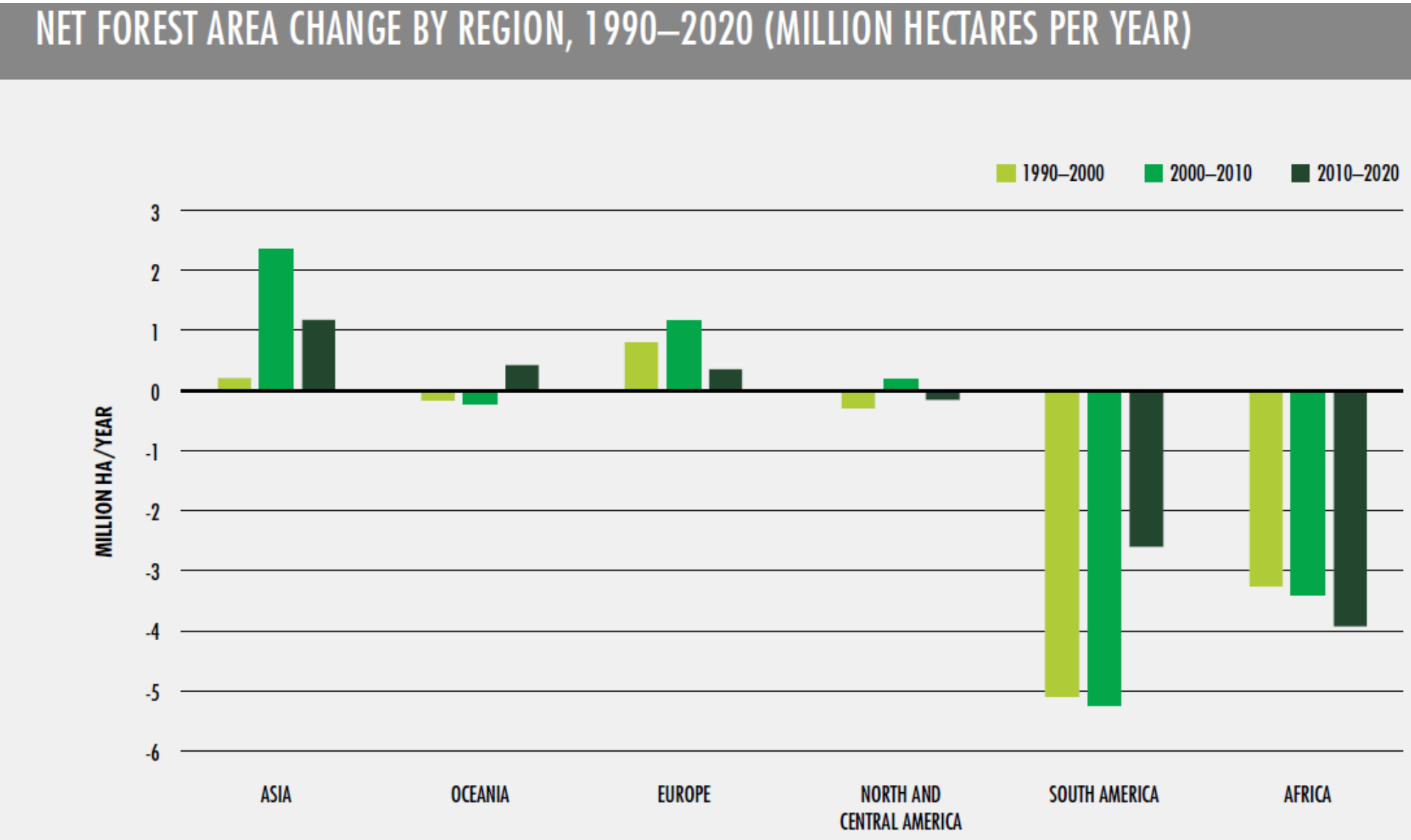


SOURCE: FAO, 2020.

Forests from a global perspective

- South America and Africa continue to have the largest net loss of forest
- In North and Central America and Oceania forest cover has been stable
- In Europe and Asia, forest cover increased in 2000-2015

Forests from a global perspective



SOURCE: FAO, 2020.

Forests from a global perspective

ANNUAL RATE OF FOREST AREA CHANGE

Period	Net change (million ha/year)	Net change rate (%/year)
1990–2000	–7.84	–0.19
2000–2010	–5.17	–0.13
2010–2020	–4.74	–0.12

SOURCE: FAO, 2020.

- The net change in forest area in the period 2010–2020 is estimated at -4,74 million ha/year (an area about the size of Slovakia (4.9 millions ha))

Forests from a global perspective

- A good news: The rate of global deforestation has been decreasing ☺
- A bad news: but it is still alarmingly high ☹
- Deforestation occurs mainly in primary forests, particularly in tropical developing countries

- But in 2019 large fires (Amazonia, Russia),
  bark beetle (Europe)
  ☹☹☹

Forests from a global perspective

DEFORESTATION!

Amazon deforestation – 2000 (NASA)

Amazon deforestation – 2001 (NASA)

Amazon deforestation – 2002 (NASA)

Amazon deforestation – 2003 (NASA)

Amazon deforestation – 2004 (NASA)

Amazon deforestation – 2005 (NASA)

Amazon deforestation – 2006 (NASA)

Amazon deforestation – 2007 (NASA)

Amazon deforestation – 2008 (NASA)

Amazon deforestation – 2009 (NASA)

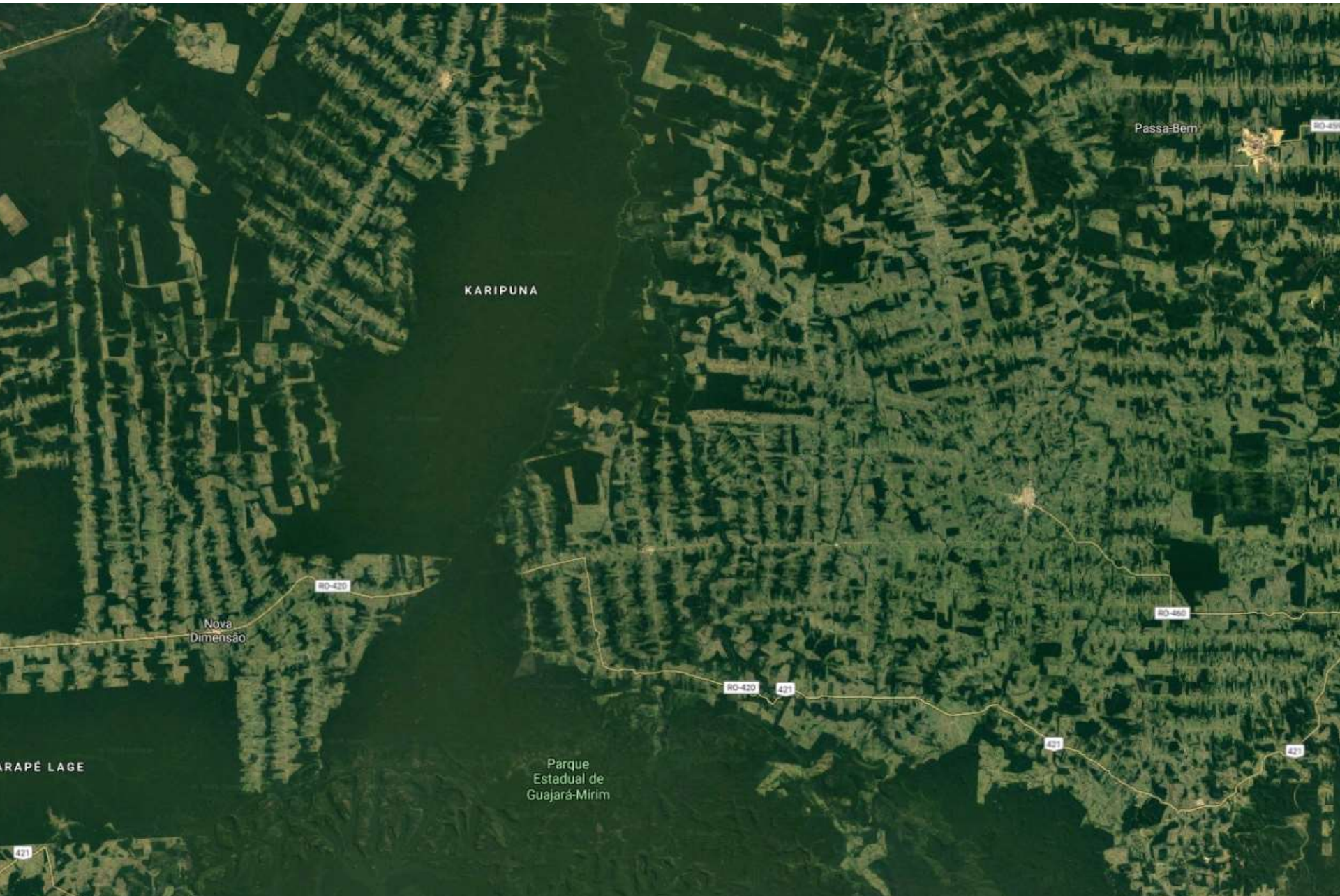
Amazon deforestation – 2010 (NASA)

Amazon deforestation – 2011 (NASA)

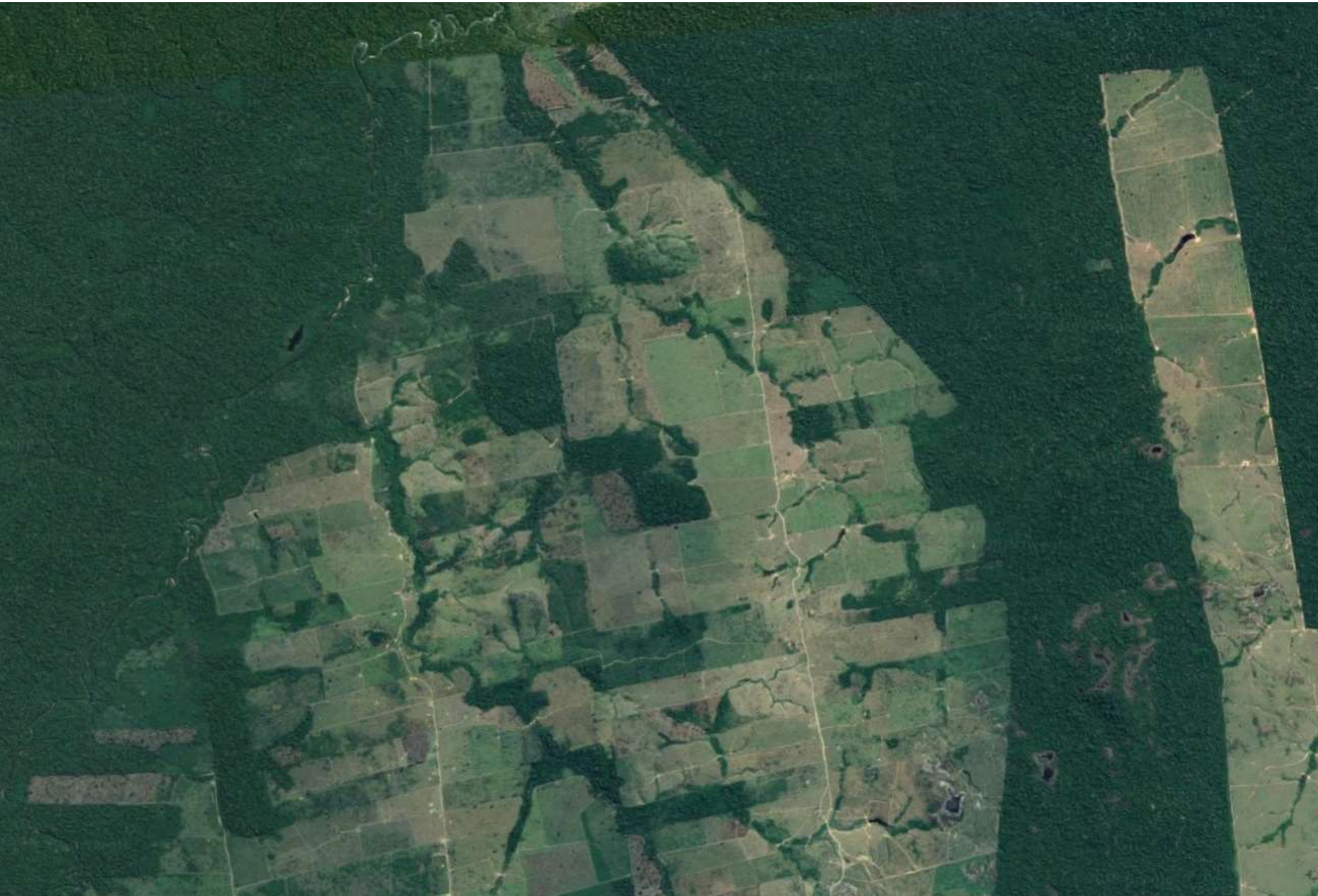
Amazon deforestation – 2012 (NASA)

Amazon deforestation – 2000 (NASA)

Amazon deforestation – Google (2019)



Amazon deforestation – Google (2019)



Forests from a global perspective

- Primary or undisturbed forest is a forest of native species where there are no clearly visible indications of human activities and the ecological processes have not been significantly disturbed

- Nowadays all the forests are affected by humans (by climate change, air polution)

Forests from a global perspective

- Primary forests account for 32% of forest area
- Key for
  - Biological diversity
  - !!!Climate change mitigation and adaptation

Deforestation

- Main driver of deforestation is not logging for timber, but seeking for <u>new agricultural or urban land</u> (slash & burn approach)
- Selective logging can be profitable if dealing with the highly demanded timber

Deforestation

- Main driver of deforestation is not logging for timber, but seeking for <u>new agricultural or urban land</u> (slash & burn approach)
  - **<u>Rapid degradation of soils in tropical areas after deforestation</u>**
  - Necessity to seek for new agriculture land

Forests in a Changing World

- The global area of planted forest is increasing – it accounts for 7.2% of total forest area (290 million ha)
- During 2010–2015, the area of planted forest increased by about 3.1 million ha/year

Forests in a Changing World

- Most of the planted forests was established through **afforestation**, *i.e.* planting of areas not forested in recent times, particularly in China.
- Three-quarters of all planted forests consist of native species, while one-quarter comprises introduced species.

Is it a good idea to plant introduced species?

Forest biodiversity

- Global forests are a safe-box of the global biological diversity, namely at the species level.

Forest biodiversity

- Although tropical rain forests cover 6% of the Earth´s terrestrial land, they harbour more than half of the wild plant and animal species

Forest biodiversity

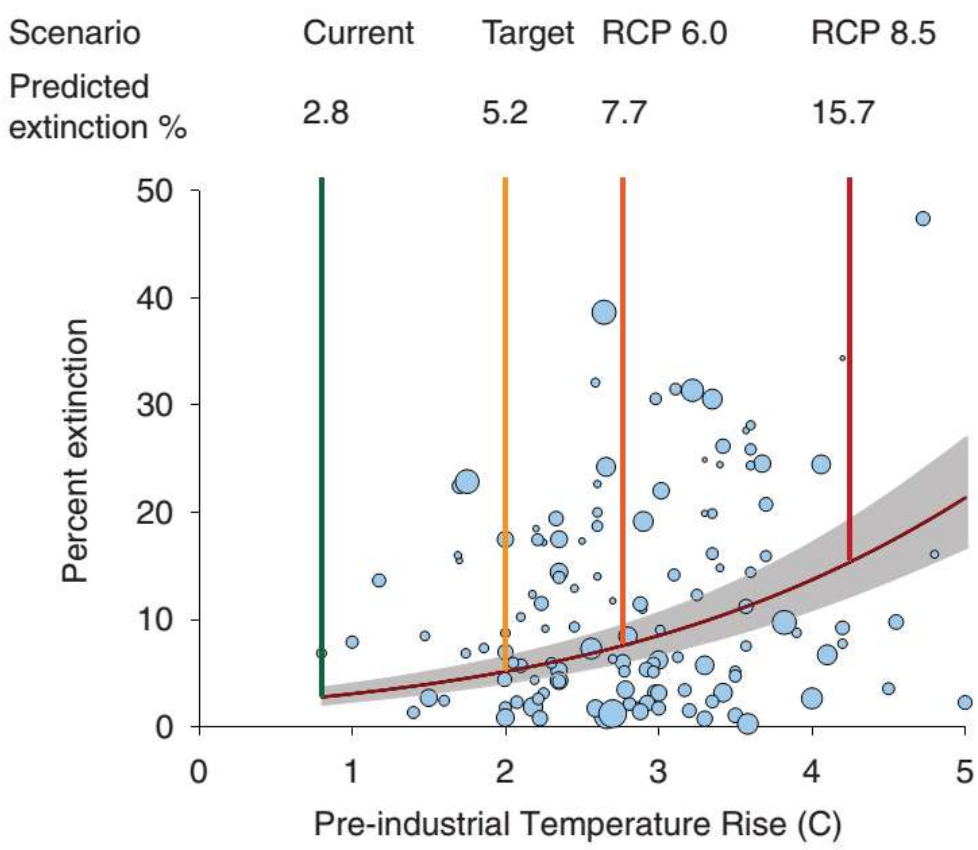
- Forest biodiversity is being lost at an alarming rate: up to 100 animal and plant species are lost every day in tropical forests !!!

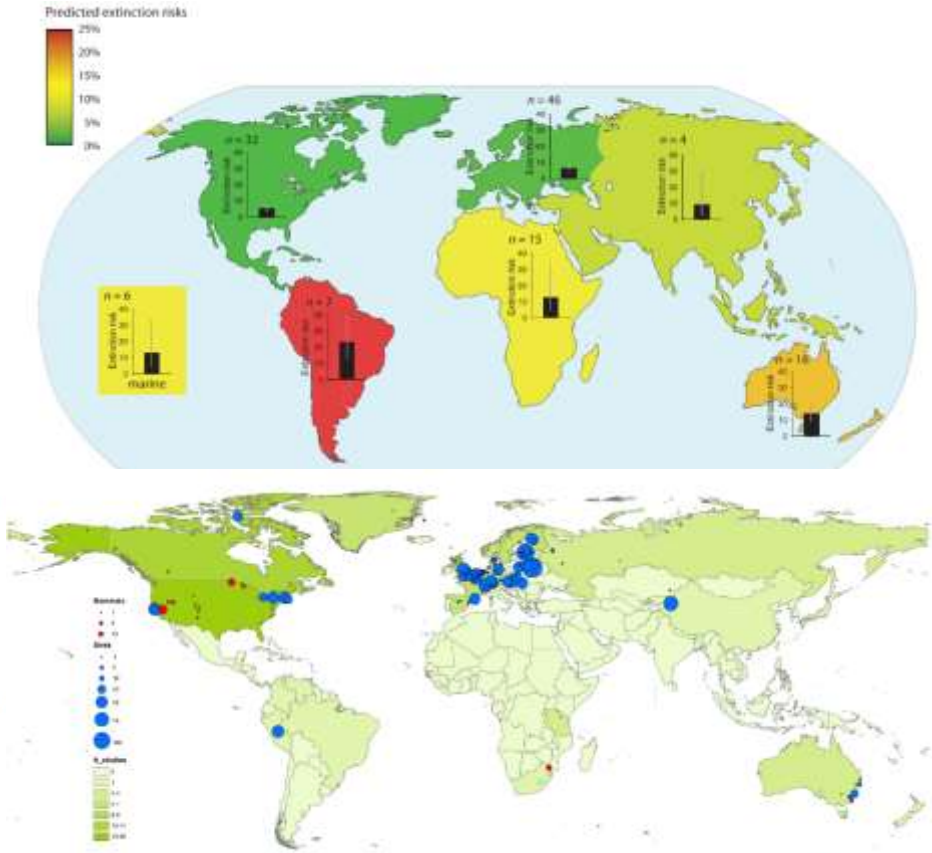
CLIMATE CHANGE

Accelerating extinction risk from climate change

Mark C. Urban*

Largest extinction risk is in the least studied areas of the world





Forest biodiversity

Australian scientists warn of 'extinction crisis' in open letter

Forest as a protected area

A protected area is a clearly defined geographical space, recognised, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values (IUCN 2008).

Forest as a protected area

- Legally established protected areas cover an estimated 16% of the world's forests
- The primary function of these forests may be the biological diversity conservation, the soil and water protection, or the conservation of cultural heritage.

Forest is not a factory for wood production!

Forest as an economic tool

- 30% of the world's forests (close to 1.2 billion ha) are primarily used for production of wood and non-wood products

Forest as an economic tool

- An additional 1,049 million ha (26%) are designated for multiple uses – in most cases including the production of wood and non-wood forest products

Forest as an economic tool

- After a decrease in the 1990s and in 2007-2010, wood removals began to increase
- Globally, reported wood removals amounted to 3.4 billion cubic meters per year in 2015, equivalent to 0.7 % of the total growing stock.

Status, changes and trends in global forests: Good and bad news

- Considering that informally and illegally removed wood, especially wood-fuel, is not usually recorded, the actual amount of wood removals is undoubtedly higher.

Forests – woodfuel source

- At the global level, woodfuel accounted for about half of the removed wood.
- Woodfuel provides 27% of total primary energy supply in Africa

Forest ecosystem services

- 8% of the world's forests have soil and water conservation as their primary objective
- Around 330 million ha of forest are designated for soil and water conservation, avalanche control, sand dune stabilization, desertification control or coastal protection.

Forests from a global perspective

Designated functions of the world's forests (%)	
Production	30
Protection	8
Conservation	12
Social services	4
Multiple use	24
Other	7
Unknown	16

Forests from a global perspective

- More than 1.6 billion people depend on forests for their livelihoods
- Forests are home to an estimated 1.2 billion people around the world.

Forests from a global perspective

- 80 % of people in developing countries rely on traditional medicines, up to half of which originate from plants found mainly in tropical forests.

Forests from a global perspective

- Forest biodiversity is the basis for more than 5,000 commercial products, from aromatic oil distilled from leaves to herbal medicines, food and clothing

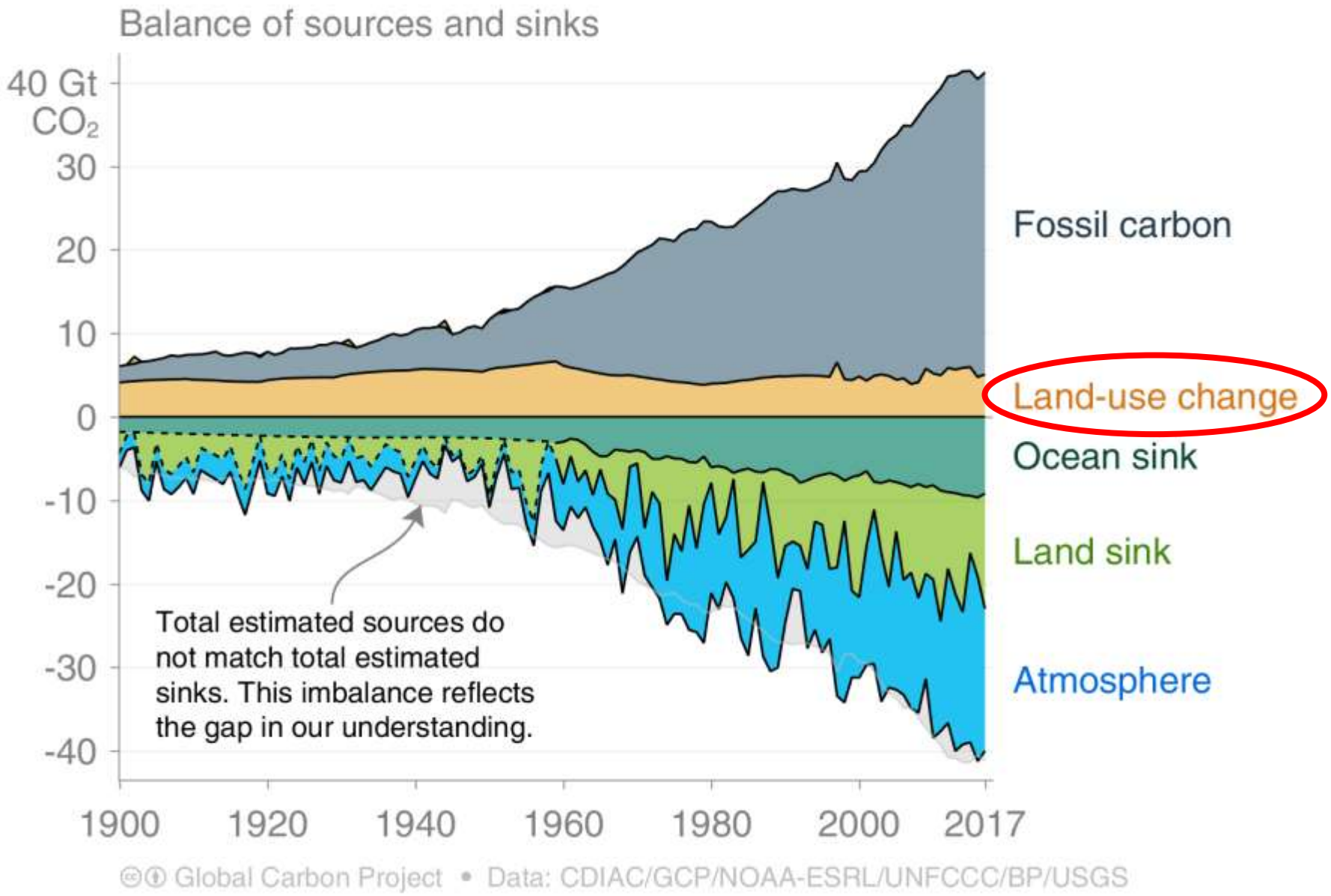
„Forests = water source and filter“

- Three quarters of the world’s accessible fresh water comes from forested watersheds

- Forests purify drinking water for two-thirds of the major cities in developing countries.

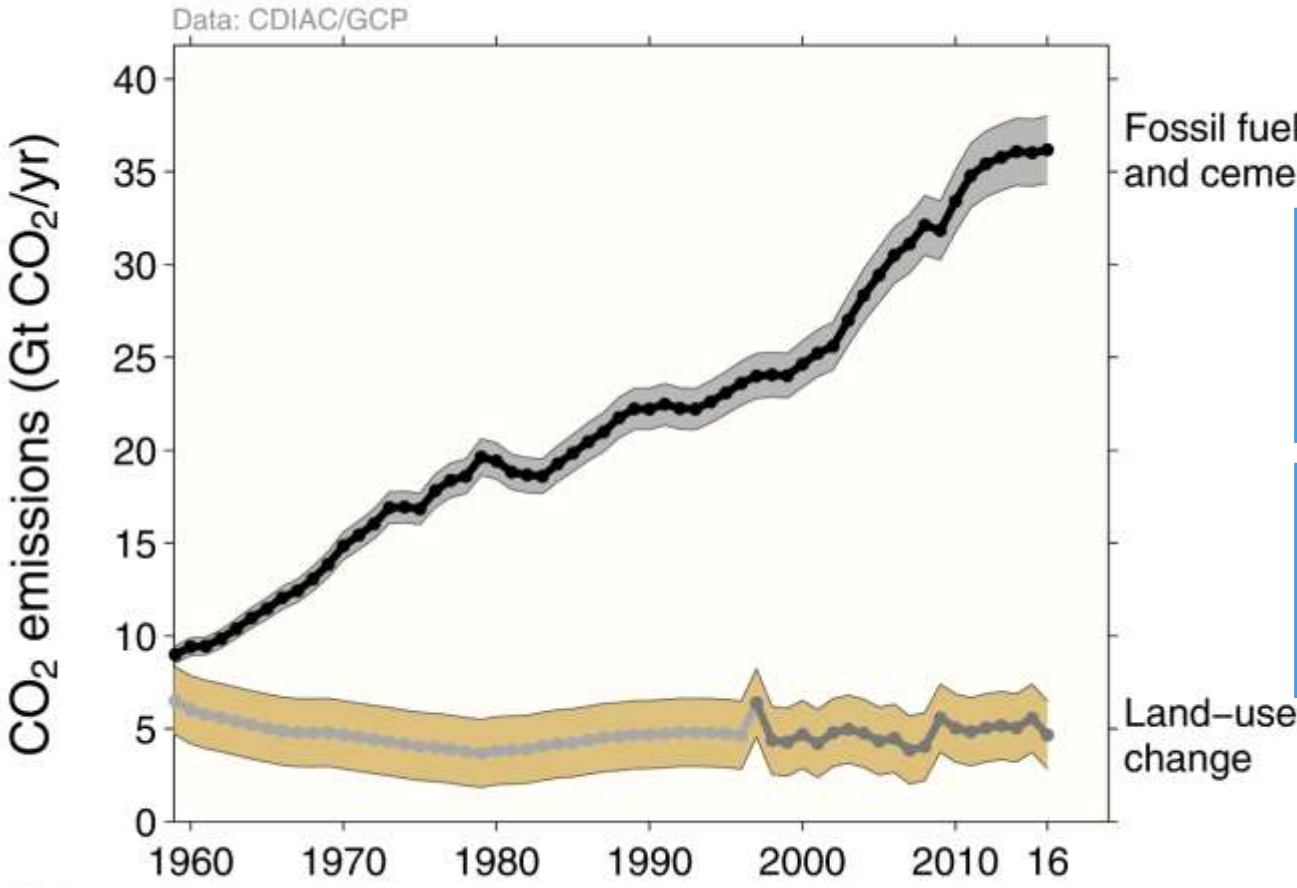
- Burning particularly tropical forests is responsible for 10–25% of all the greenhouse gas emissions !!!

Global carbon sources and sinks



Global Carbon Project 2018

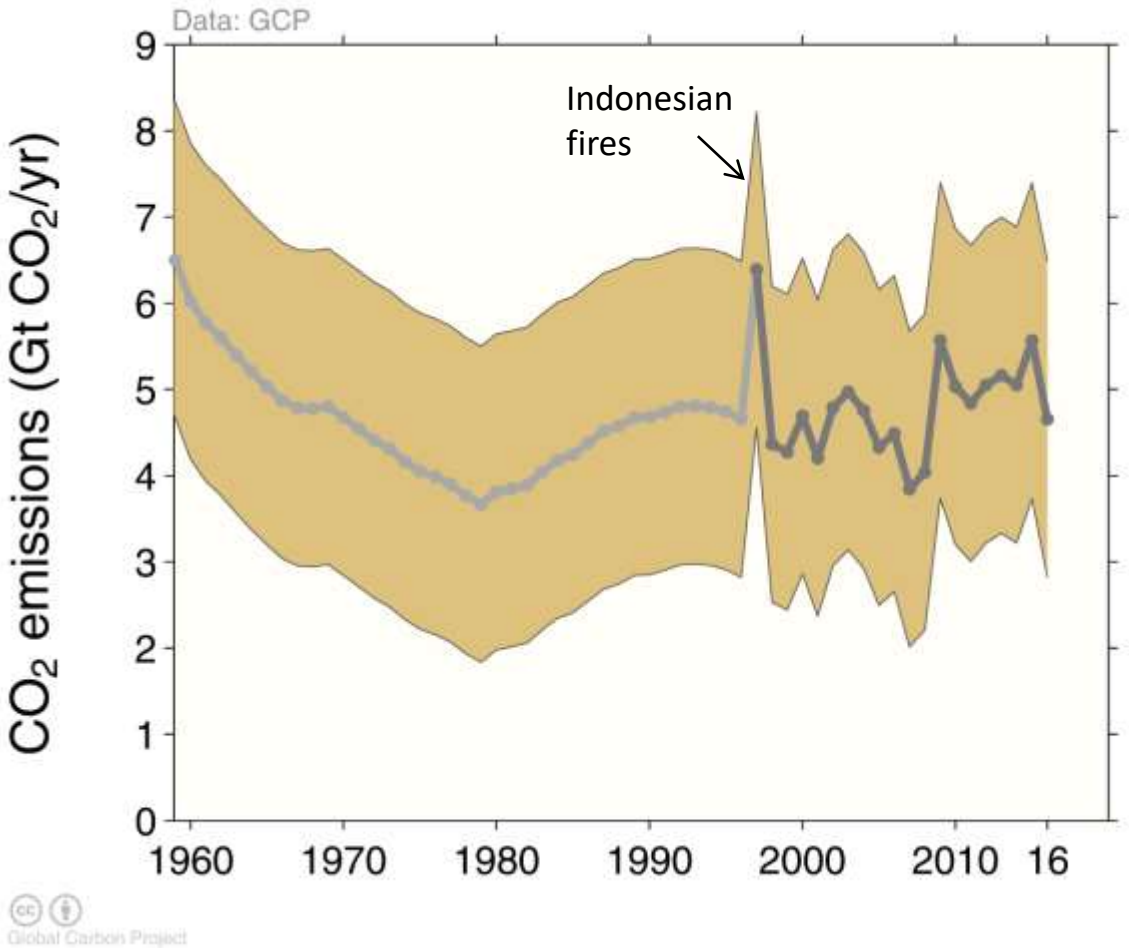
Global CO_2 emissions



Land-use change estimates from two bookkeeping models, using fire-based variability from 1997 Source: CDIAC; Houghton and Nassikas 2017; Hansis et al 2015; van der Werf et al. 2017; Le Quéré et al 2017; Global Carbon Budget 2017

Global CO_2 emissions

Higher emissions due to land use change in 1997 are related to a higher number of forest fires during the El Niño phenomenon in tropical Asia.



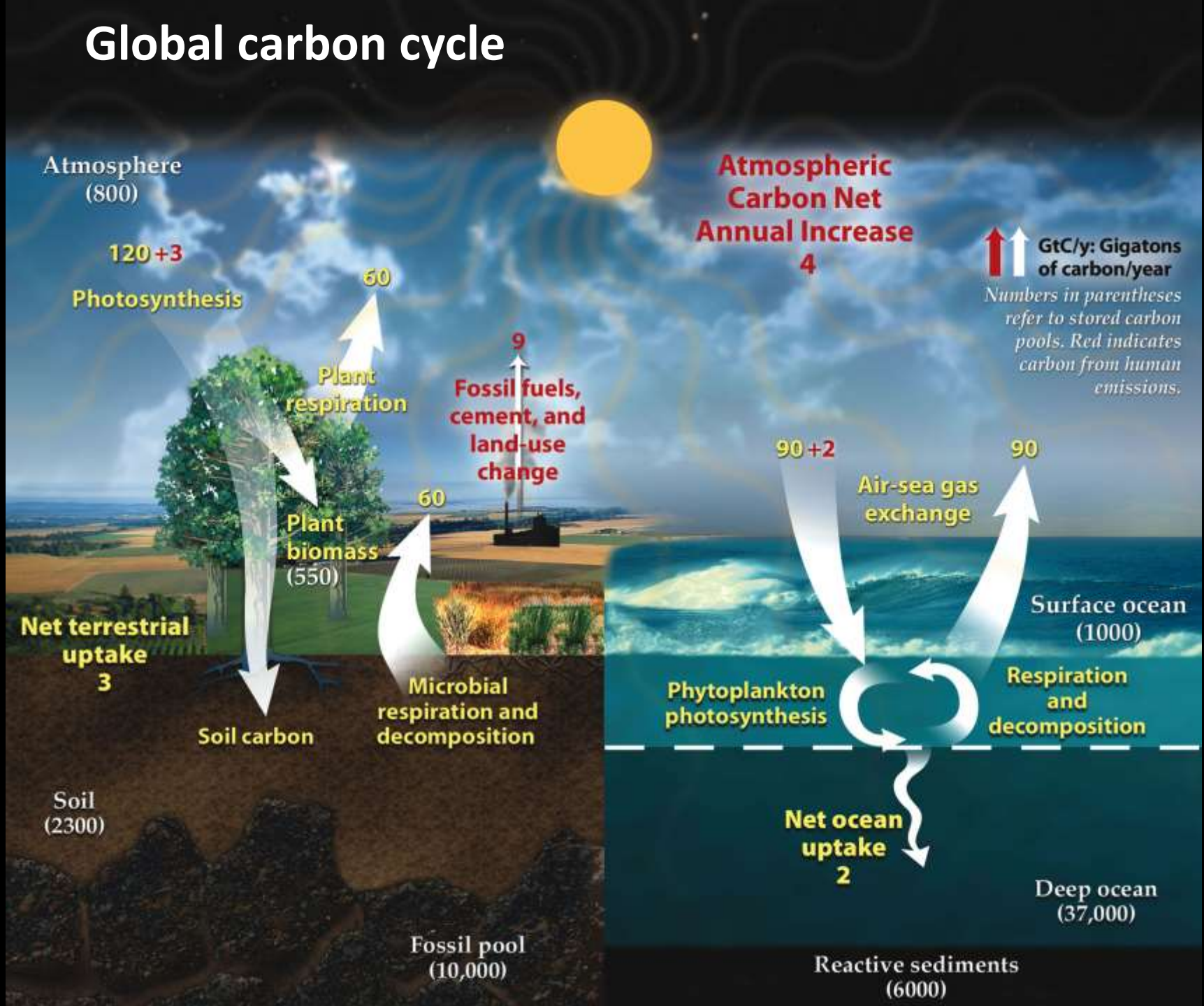
Estimates from two bookkeeping models, using fire-based variability from 1997

Source: Houghton and Nassikas 2017; Hansis et al 2015; van der Werf et al. 2017; Le Quéré et al 2017; Global Carbon Budget 2017

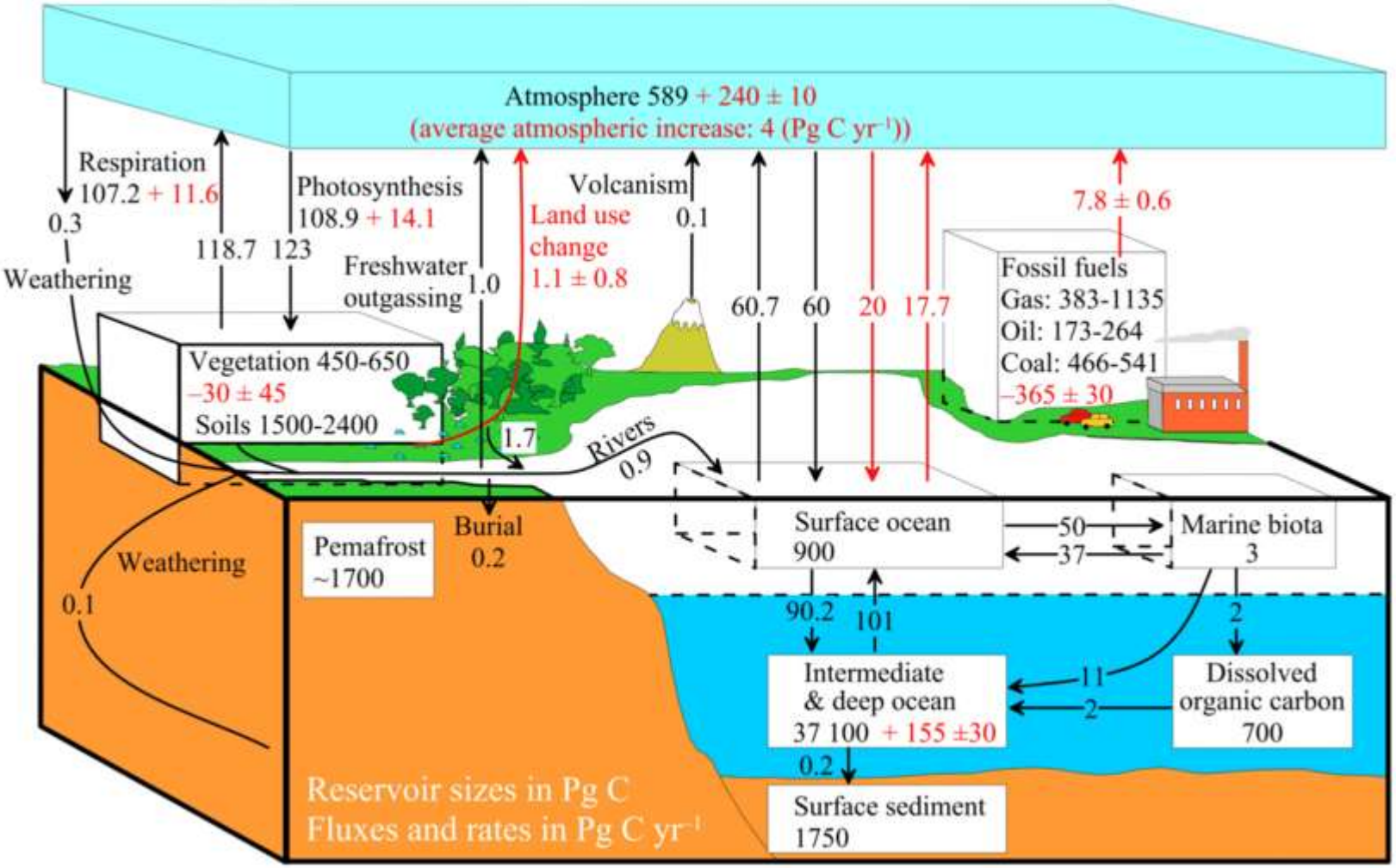
Forests in a Changing World

- Unique role of forests in carbon sequestration: they store half of the total terrestrial above-ground carbon

Global carbon cycle



Global carbon cycle

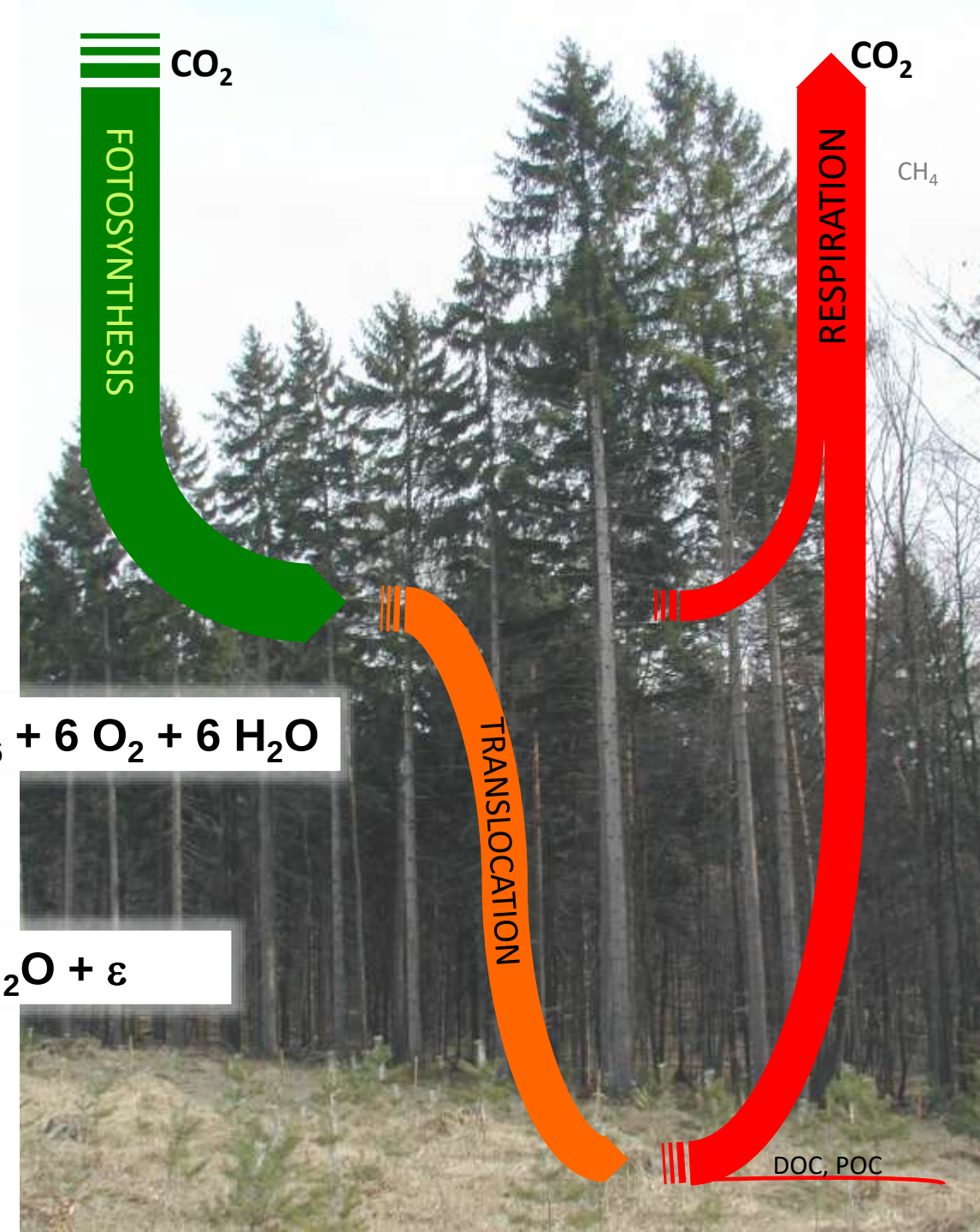


Simplified diagram of the global carbon cycle. Numbers denote reservoir mass (carbon stocks) in Pg C (1 Pg C = 10^{15} g C) and annual carbon exchange fluxes (Pg C yr^{-1}) between the atmosphere and its two major sinks, the land and ocean. Black numbers and arrows indicate reservoir mass and exchange fluxes estimated for the time prior to the Industrial Era, about 1750. Red arrows and numbers indicate annual " anthropogenic " fluxes averaged over the 2000–2009 time period. These fluxes are a perturbation of the carbon cycle during Industrial Era post 1750. Red numbers in the reservoirs represent cumulative changes of anthropogenic carbon over the Industrial Period 1750–2011. The diagram model is taken from Sarmiento and Gruber (2002) and all numbers of stocks and fluxes are reproduced from Ciais et al. (2013).

FOTOSYNTTHESIS – biologic pump of air carbon

Live plants, especially trees, function as a **permanent carbon pump** from the atmosphere to biomass and soil.

Carbon input and release

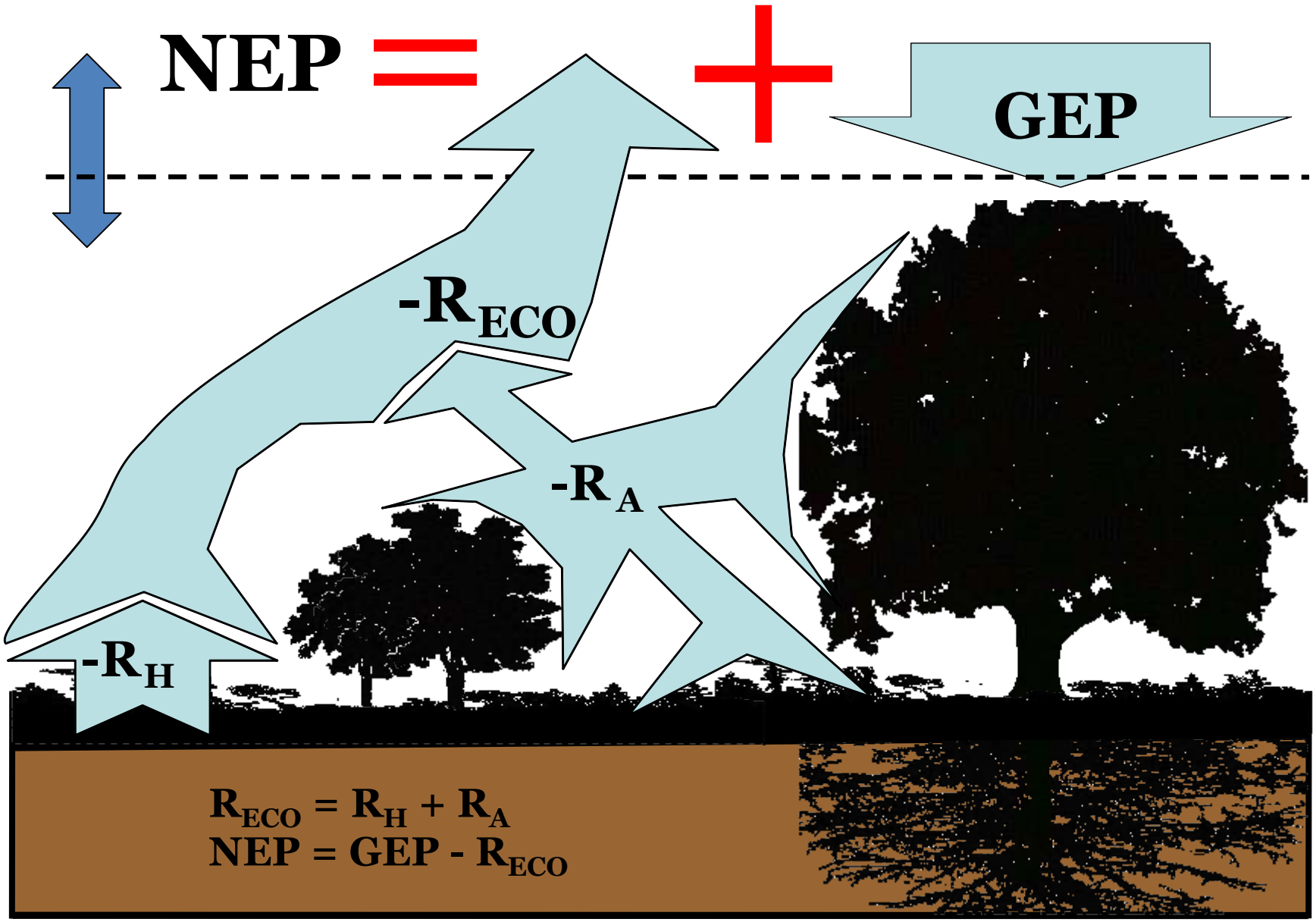


PHOTOSYNTHESIS

$$6\ CO_2 + 12\ H_2O + \varepsilon \rightarrow C_6H_{12}O_6 + 6\ O_2 + 6\ H_2O$$

RESPIRATION

$$C_6H_{12}O_6 + 6\ O_2 \rightarrow 6\ CO_2 + 6H_2O + \varepsilon$$


NEP
=
+
GEP
-R_ECO
-R_A
-R_H
R_ECO = R_H + R_A
NEP = GEP - R_ECO

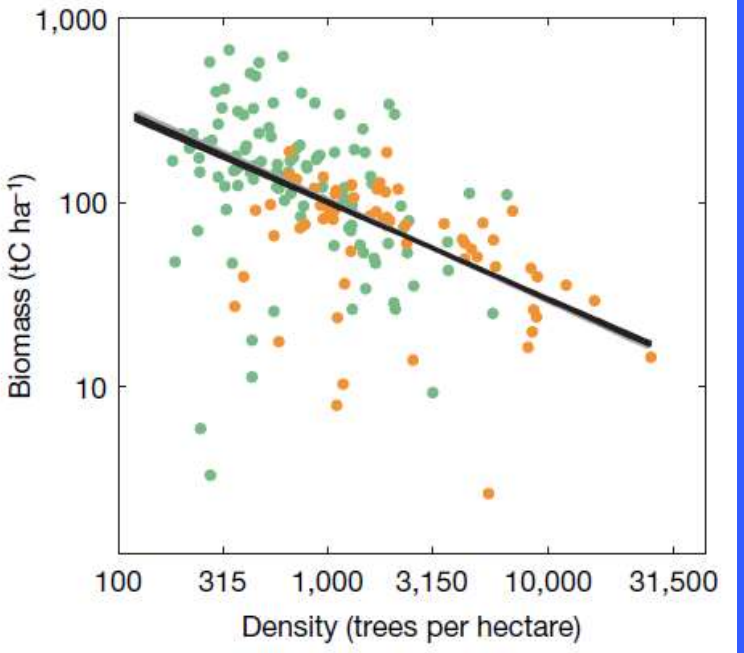
DISTURBANCES:
storms,
fires,
Insect attacks,
…

CLIMATE:
temperature,
precipitation,
…

TREE SPECIES:
pinus,
spruse,
…

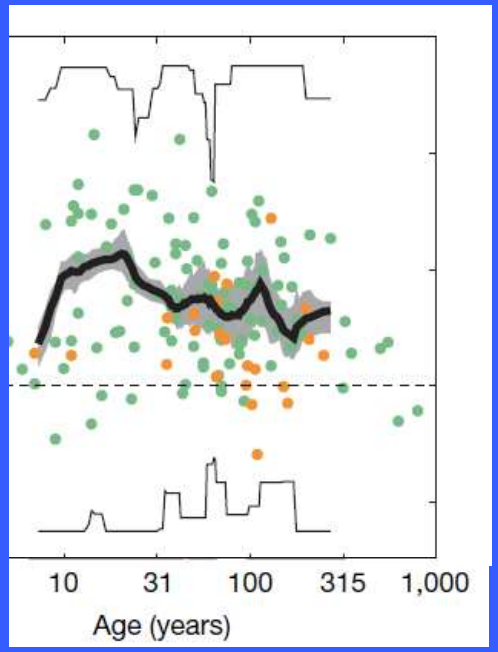
SOIL PROPIERTIES:
structure,
type of soil,
hydrology,
nutriens,
…

ES OF FORESTS:
ical rainforests ,
-tropical forests ,
diterranean forests,
iferous forests,



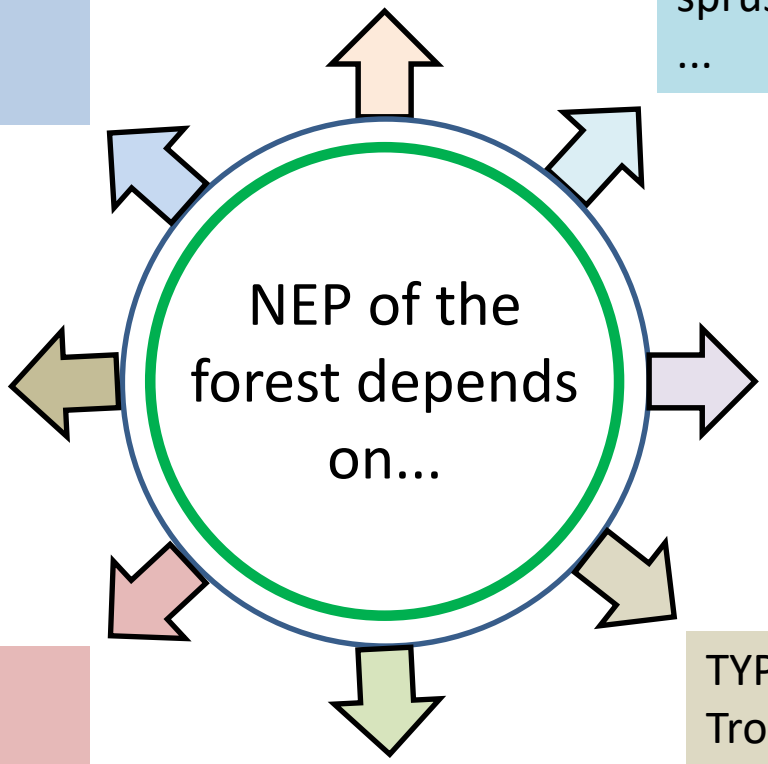
Biomass accumulation as a function of stand density.

Source: Luyssaert S., Nature 2008.



carbon fluxes as a function of age.

Source: Luyssaert S., Nature 2008.



CLIMATE:
temperature,
precipitation,
…

TREE SPECIES:
pinus,
spruse,
…

DISTURBANCES:
storms,
fires,
Insect attacks,
…

SOIL PROPIERTIES:
structure,
type of soil,
hydrology,
nutriens,
…

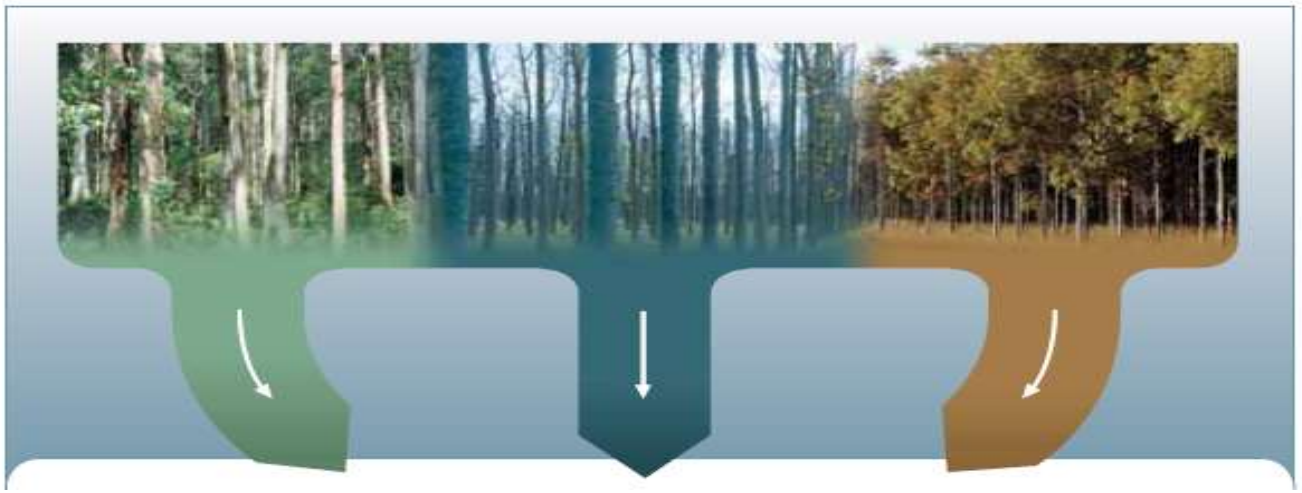
AIR POLLUTANTS:
ozone,
acid rains,
...

TYPES OF FORESTS:
Tropical rainforests ,
Sub-tropical forests ,
Mediterranean forests,
Coniferous forests,
…

MANAGEMENT:
timber extraction,
planting and replanting of various species,
recreation,
...

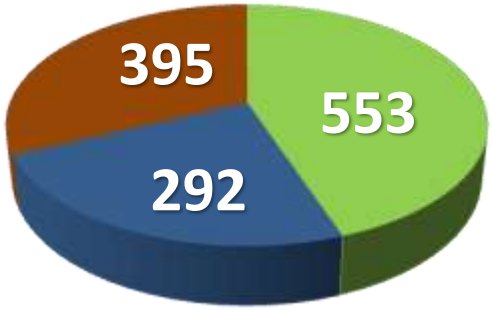
AGE OF THE FOREST:
at least several ranges of age of the forest
(**from 0 to 150 and more years**)

The global forest carbon pools



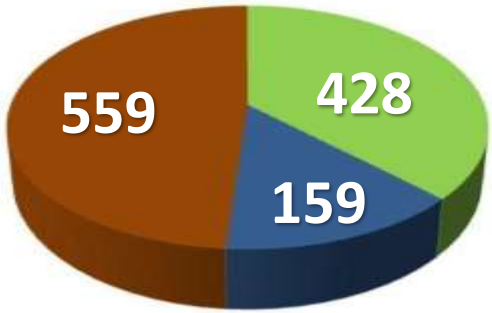
TROPICAL **TEMPERATE** **BOREAL**

The particular forest biomes carbon pools given in the Gt C.



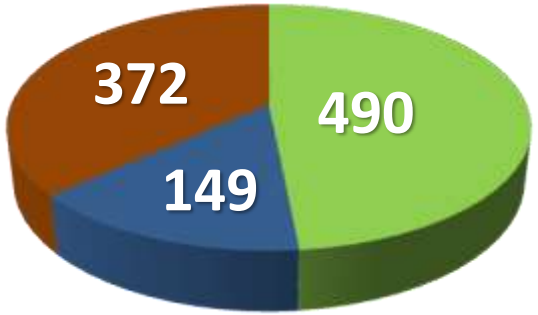
Total 1240 Gt C

Prentice et al. 2001



Total 1146 Gt C

Dixon et al. 1994
Grace 2001, Lal 2005

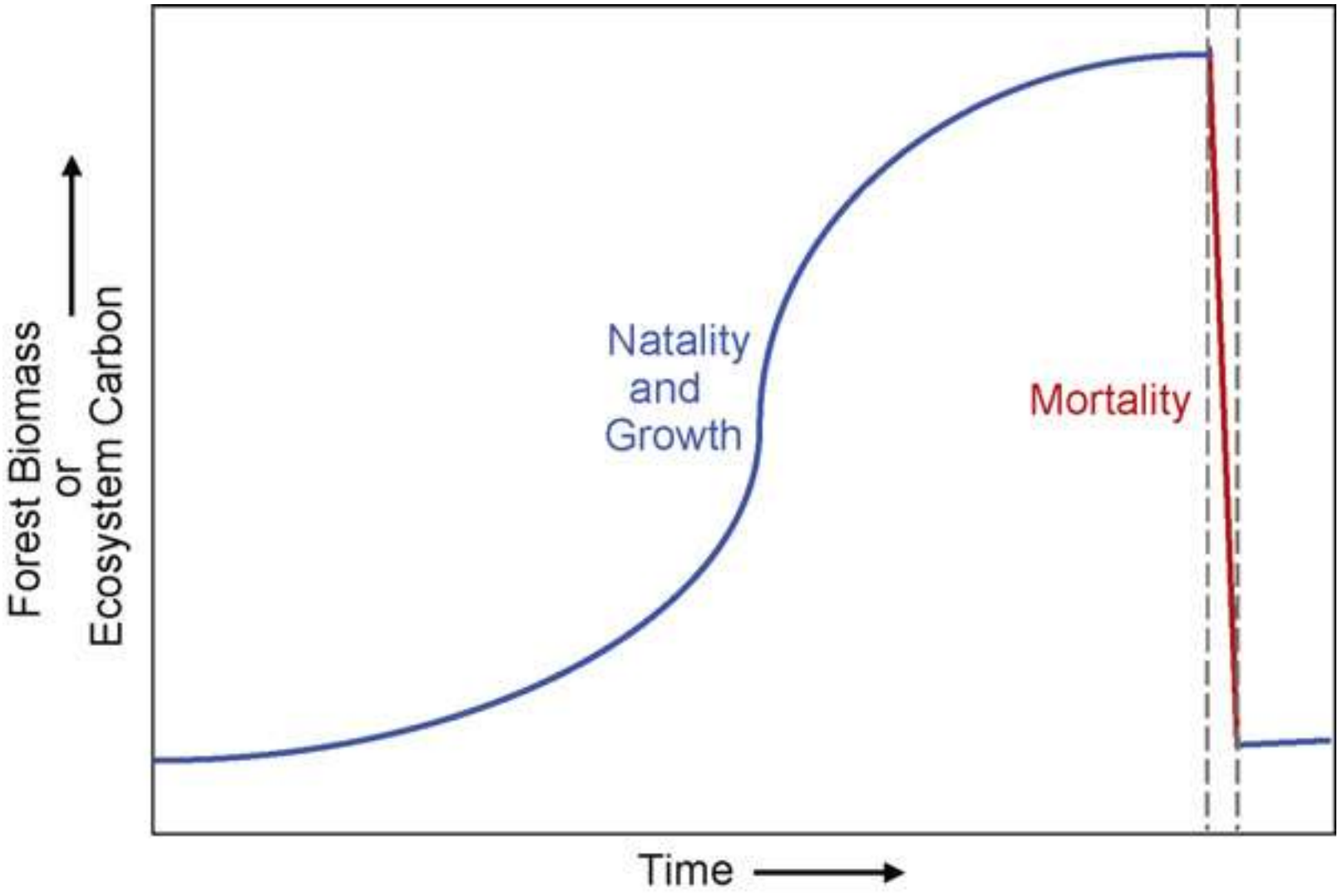


Total 1011 Gt C

Luyssaert et al. 2007

Prentice *(2001). The carbon cycle and atmospheric carbon dioxide. IPCC 2001. The scientific basis, Houghton et al.(eds). Cambridge University Press, Cambridge: 182-237*
Dixon et al. *(1994). Carbon Pools and Flux of Global Forest Ecosystem. Science 263: 185-190.*
Luyssaert et al. *(2007). CO_2 balance of boreal, temperate, and tropical forests derived from a global database. Global Change Biology 13: 2509-2537.*

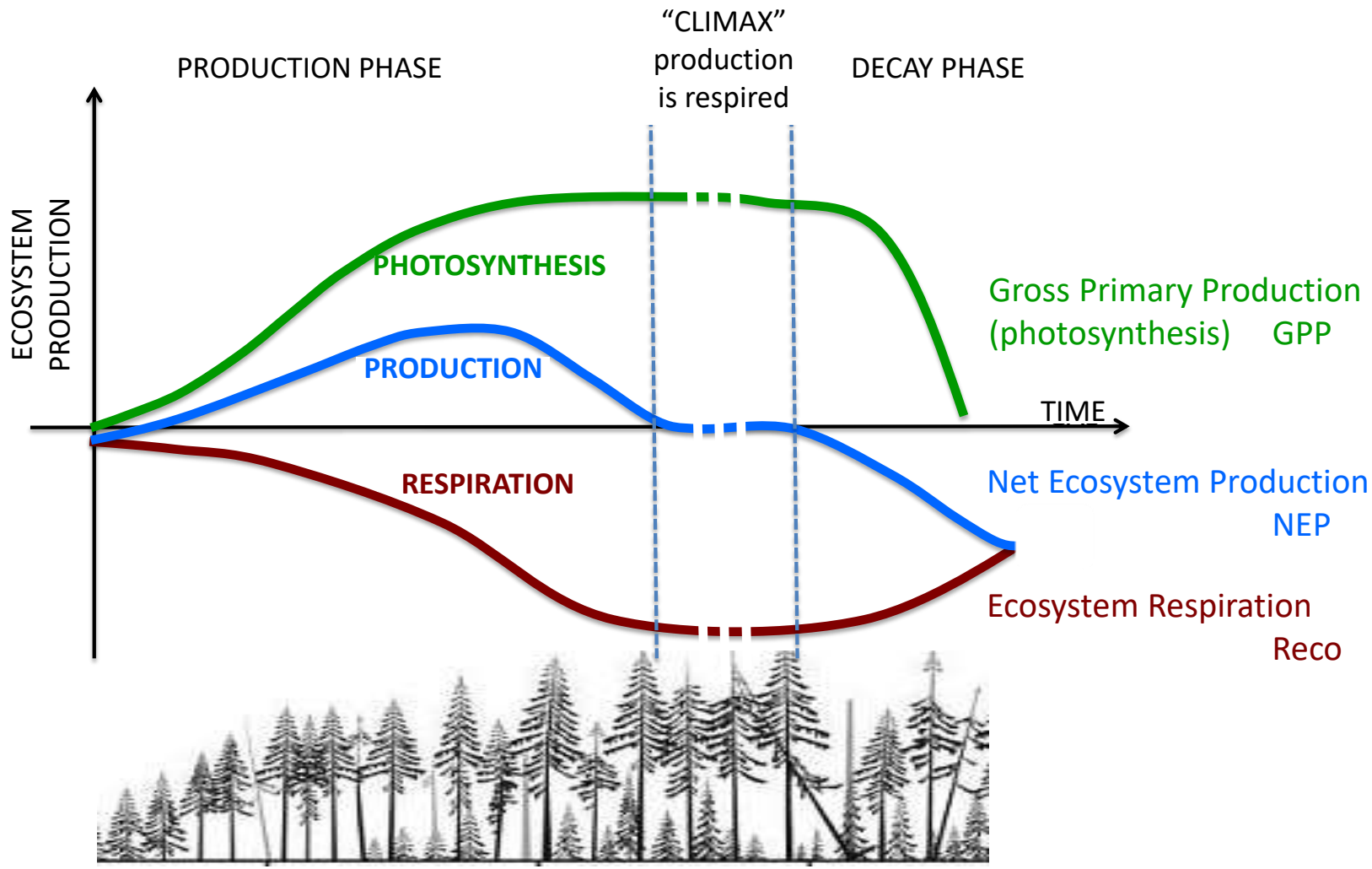
Dynamics of biomass (carbon) in time



Allen et. al., 2009, For. Ecol. Manag.

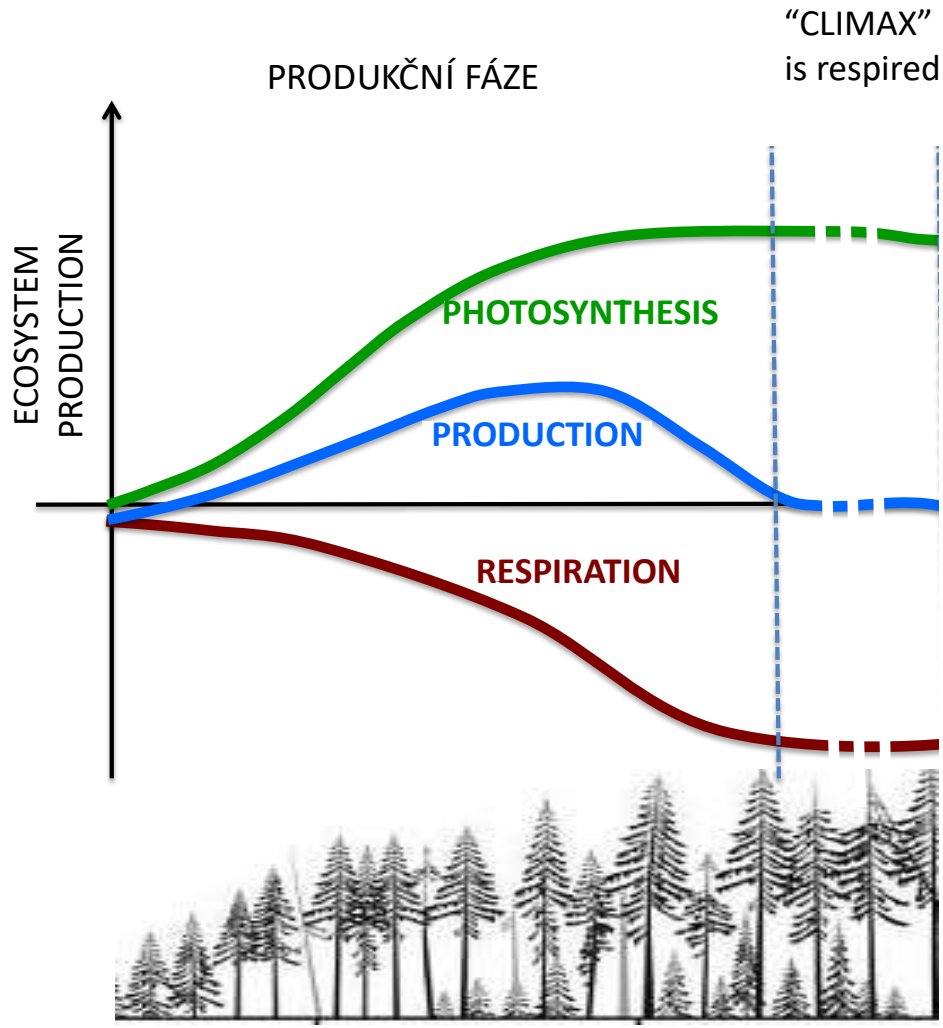
Forest production and respiration in long term perspective

Effect of stand age on production



Forest production and respiration in long term perspective

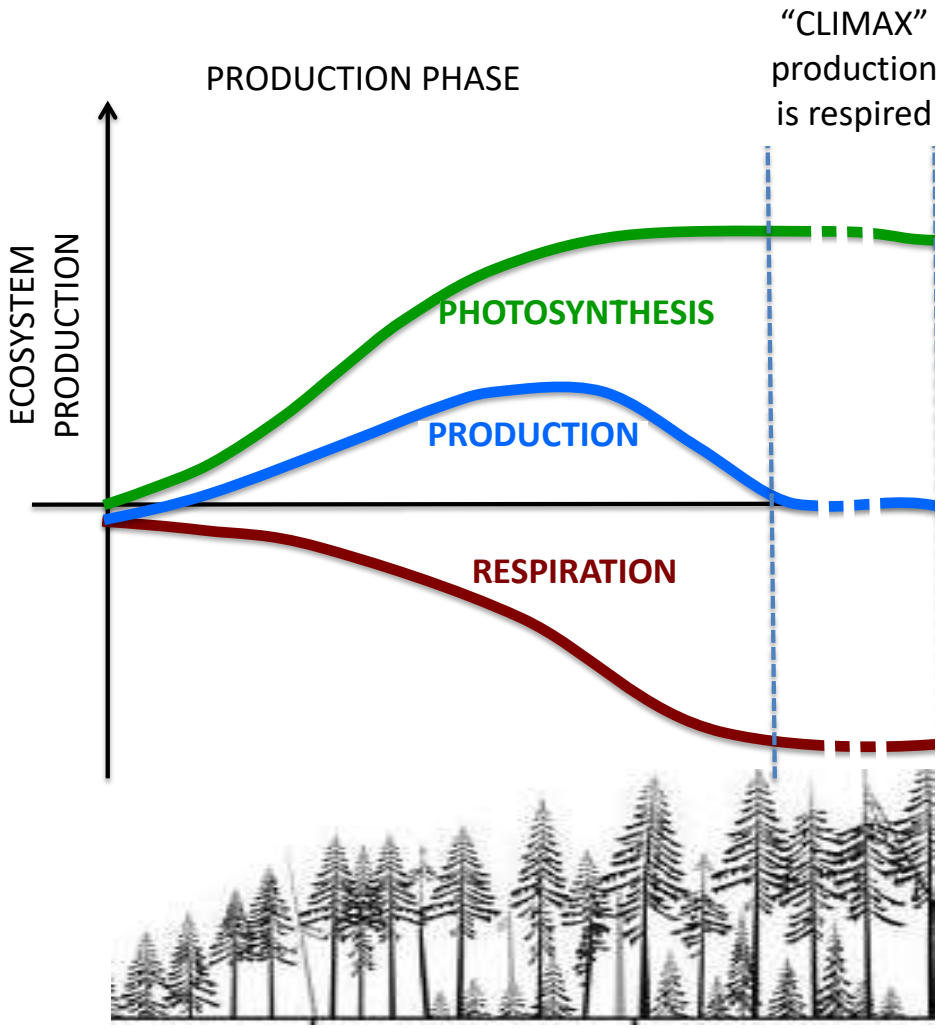
Effect of stand age on production



By increasing CO_2 in the atmosphere, man has disturbed the balance, and therefore climax does not exist. The "climax" forests again produce and accumulate organic matter, therefore produce oxygen too and sequester CO_2, but not more significantly than other forest biomes.

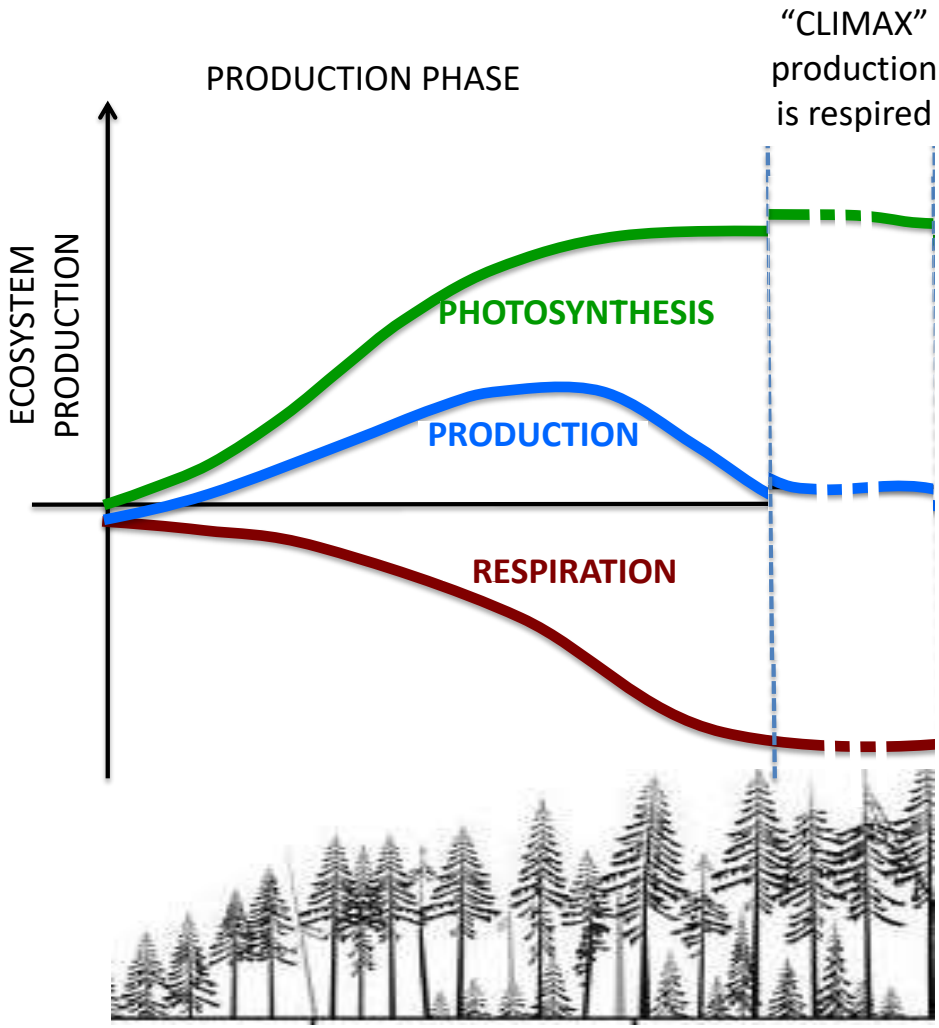
Forest production and respiration in long term perspective

Effect of stand age on production



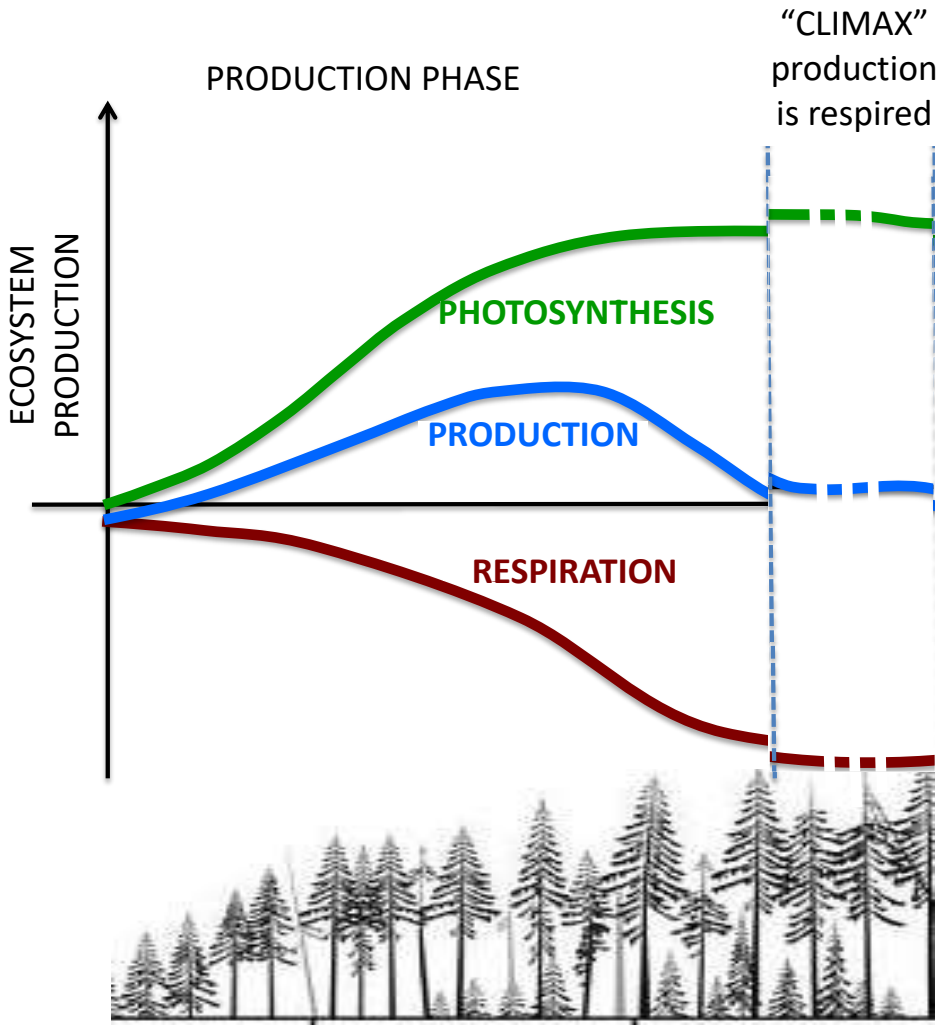
Forest production and respiration in long term perspective

Effect of stand age on production



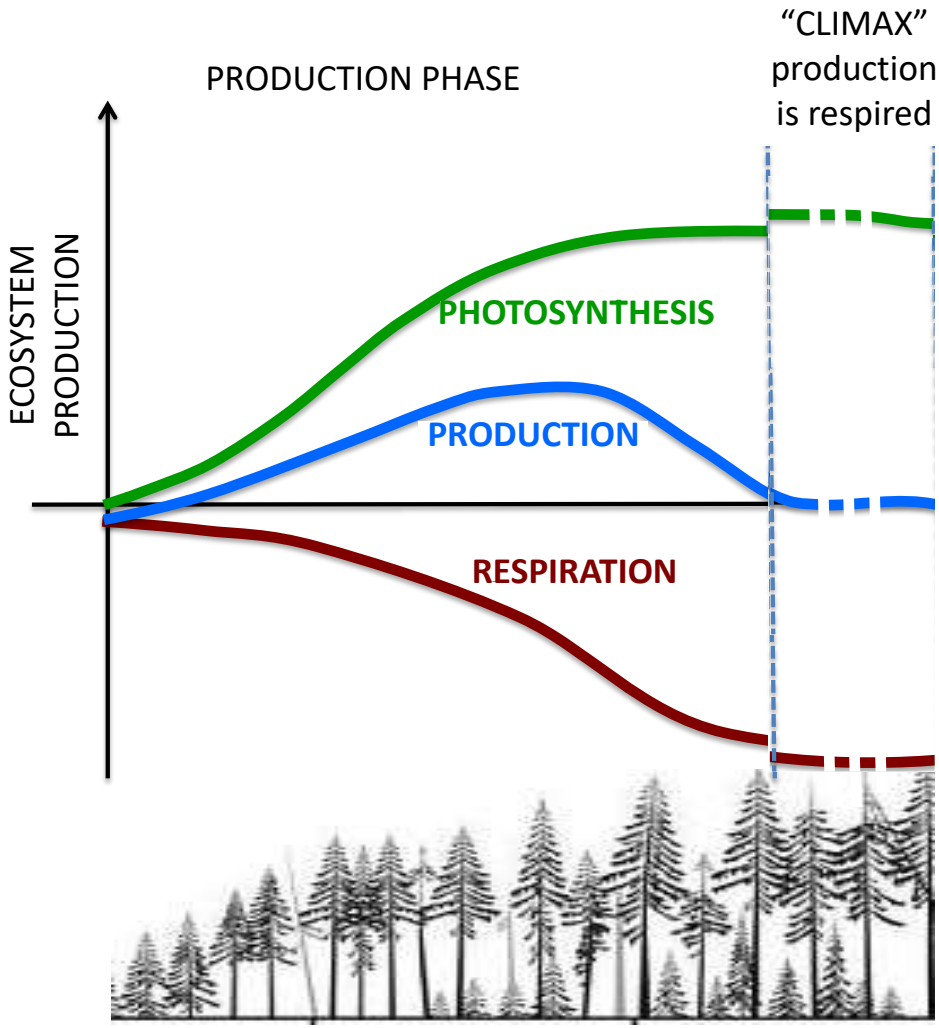
Forest production and respiration in long term perspective

Effect of stand age on production



Forest production and respiration in long term perspective

Effect of stand age on production



The Amazon Rainforest Fires: Details On Earth's Burning Lungs

Sakshi Awasthi

***Amazon rainforest**, an ecosystem on which the whole world depends is being ripped through the record-breaking fires. Thousands of fires are burning the southern areas of the Amazon, resulting in the formation of a blanket of smoke and soot affecting wildlife and the downwind settlements. According to the National Institute for Space Research of Brazil, there have been over 72,843 fires in Brazil since January 2019 which means that more than one-and-a-half soccer fields worth of rainforest are being annihilated every minute. Read more to know the latest updates on **Amazon fires**.*

About Amazon Rainforest

The Amazon Rainforest Fires: Details On Earth's Burning Lungs

NONSENSE

Sakshi Awasthi

***Amazon rainforest**, an ecosystem on which the whole world depends is being ripped through the record-breaking fires. Thousands of fires are burning the southern areas of the Amazon, resulting in the formation of a blanket of smoke and soot affecting wildlife and the downwind settlements. According to the National Institute for Space Research of Brazil, there have been over 72,843 fires in Brazil since January 2019 which means that more than one-and-a-half soccer fields worth of rainforest are being annihilated every minute. Read more to know the latest updates on **Amazon fires**.*

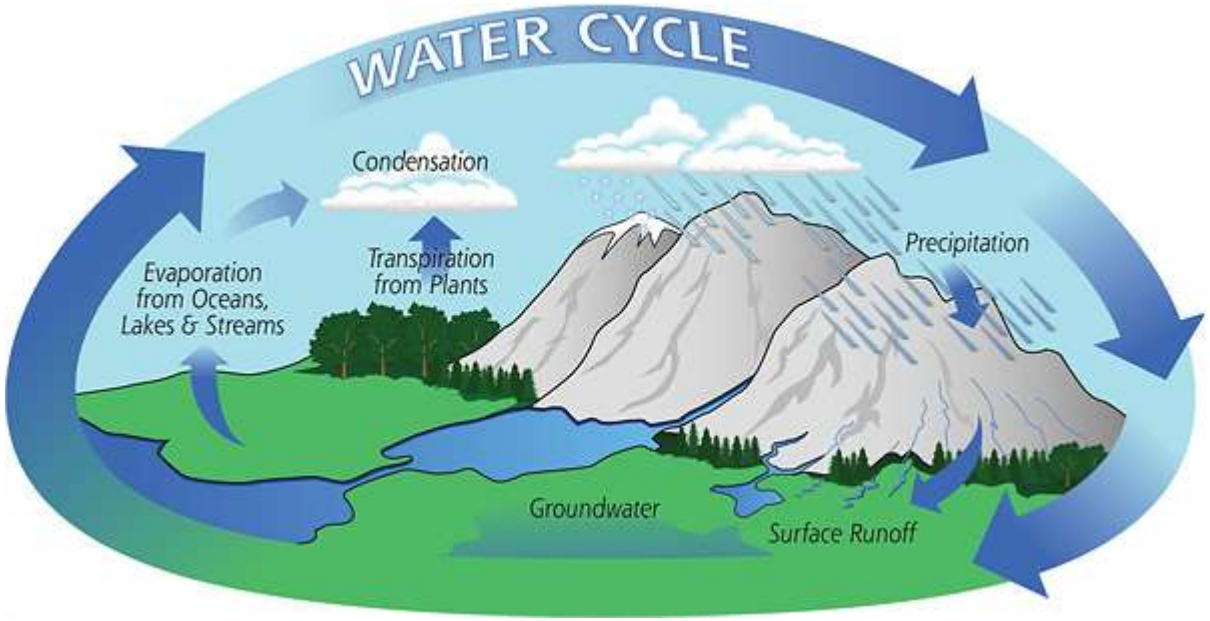
About Amazon Rainforest

Forests in a Changing World

- Global forests are not the world´s lungs, rather world´s air-condition or a humidifier.
- Particularly, they are a safe-box of the global biological diversity, namely at the species level.

Forest – air conditioning system

Strong effect on global water cycle



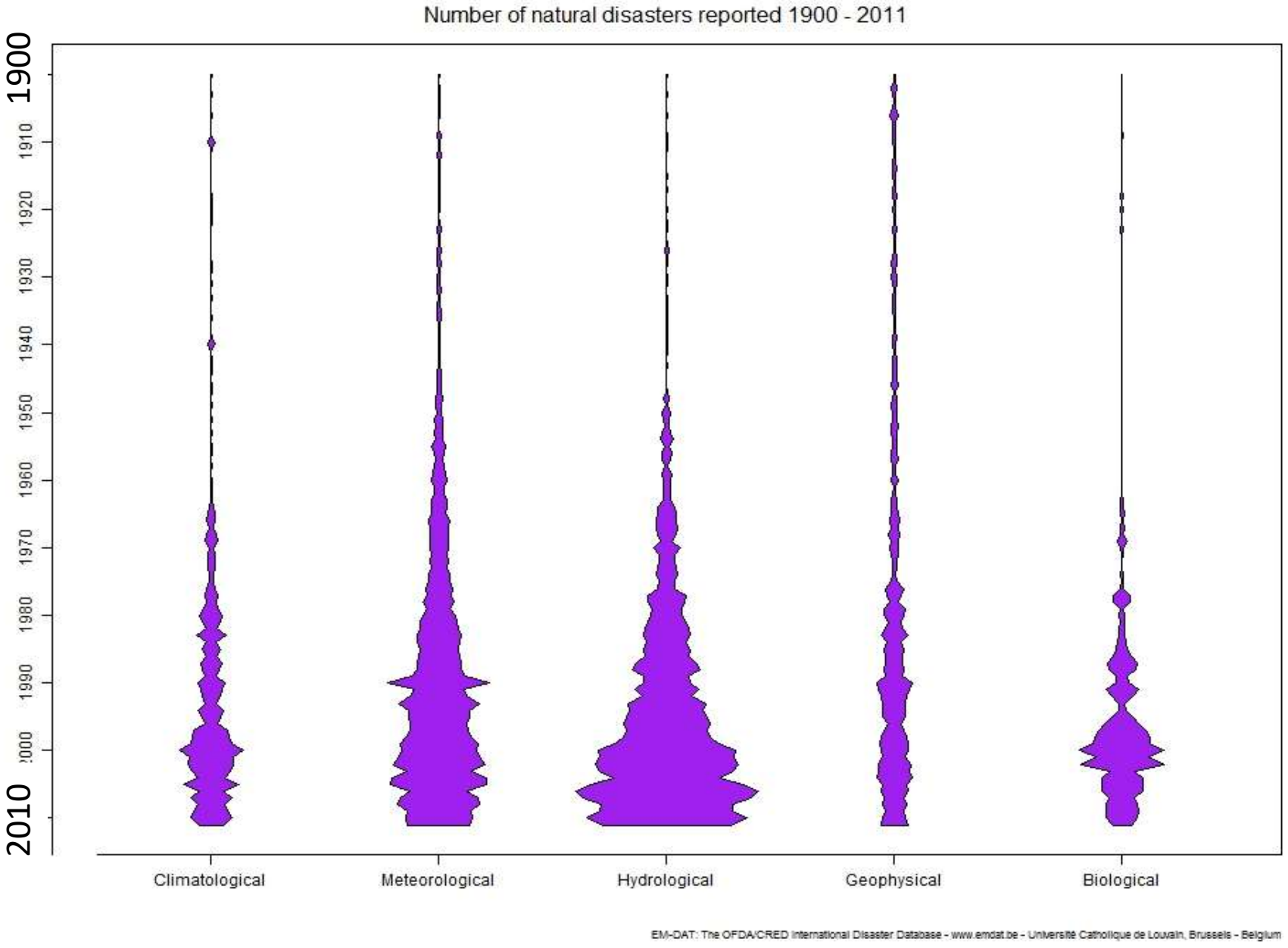
Forest – air conditioning system

Disturbances

Abiotic: fire, windstorm, floods, landslides…

Biotic: insects, fungi, viruses, big animals…

More natural disasters are being recorded

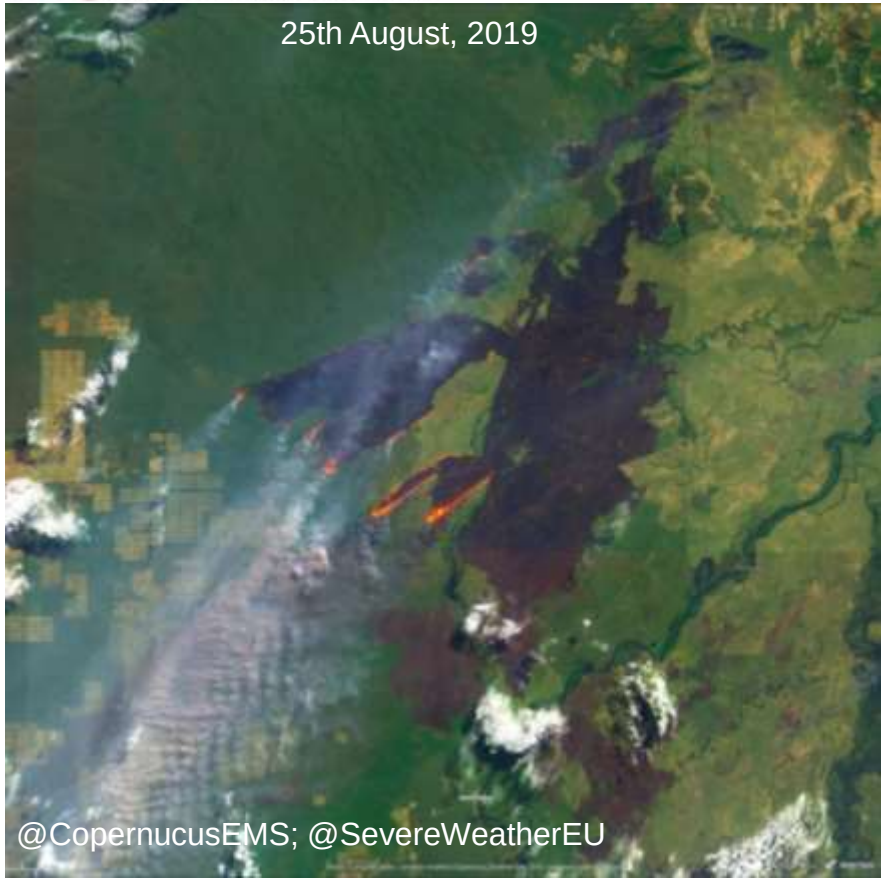


Fires

Flying above the Amazon fires, 'all you can see is death'

By Nick Paton Walsh and Natalie Gallón, CNN

Updated 1153 GMT (1953 HKT) August 26, 2019



2019 to be 'worst-ever year' for wildfires in Siberia and 'only rain can now extinguish flames'

By The Siberian Times reporter

14 August 2019

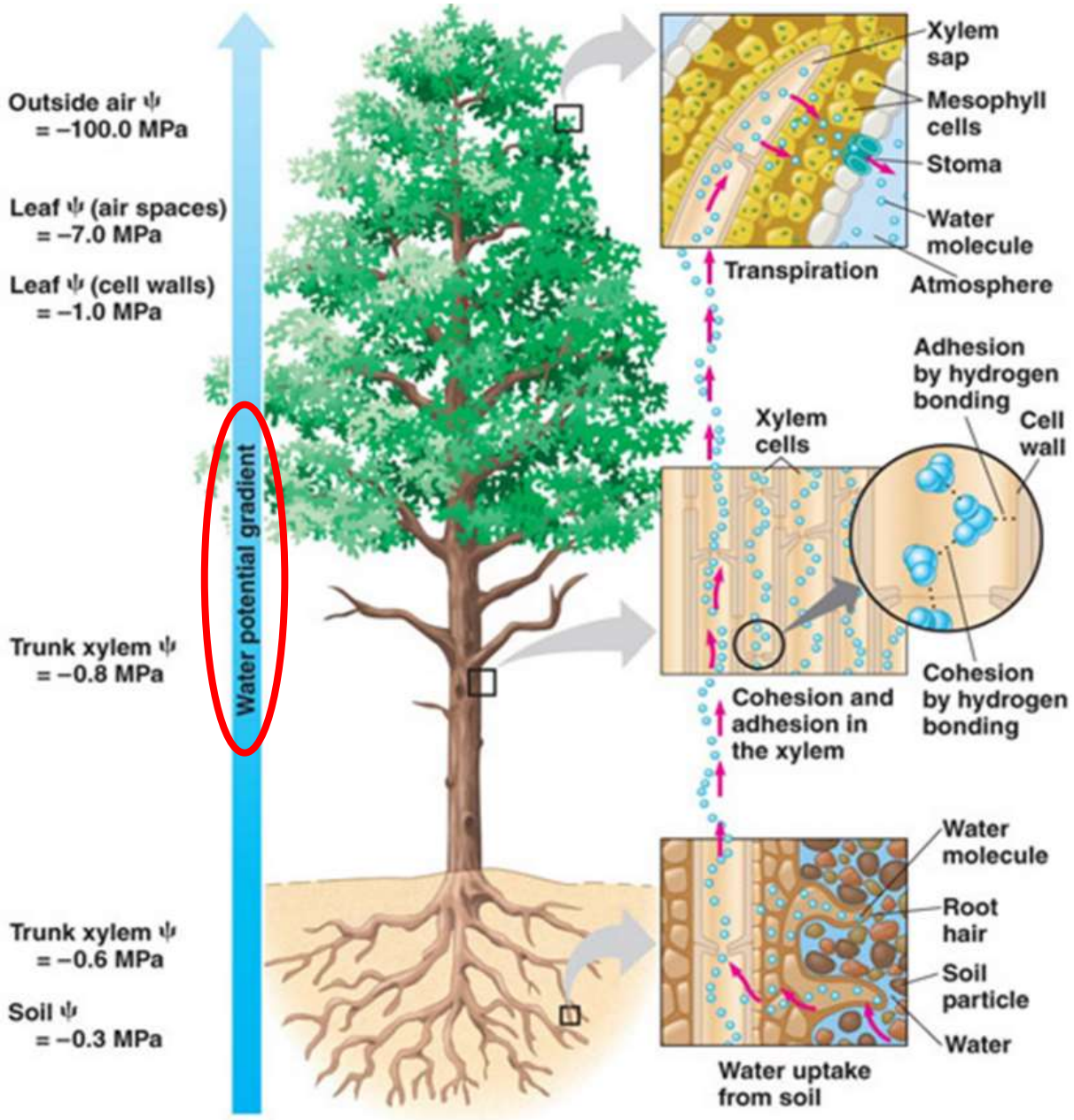
Military fully engaged in minimising carnage, but water sprayed by planes to extinguish infernos is 'as expensive as Champagne'.

Ice storm in Slovenia (february 2014)

Drought !!!

- Drought decreases trees fitness.
- Drought can kill the trees or prepare a way for tree pathogens (bark beetle)

Water regime of tree species



Water movement in continuum soil-plant-atmosphere

Water evaporation from leaves to the atmosphere

Movement of water in xylem

Water intake by roots

Insect

750 mil m^3 of wood damaged by pine beetle (Canada)

1 mil m^3 of wood (Sweden)

Global greening seen as one of the few benefits of global change…

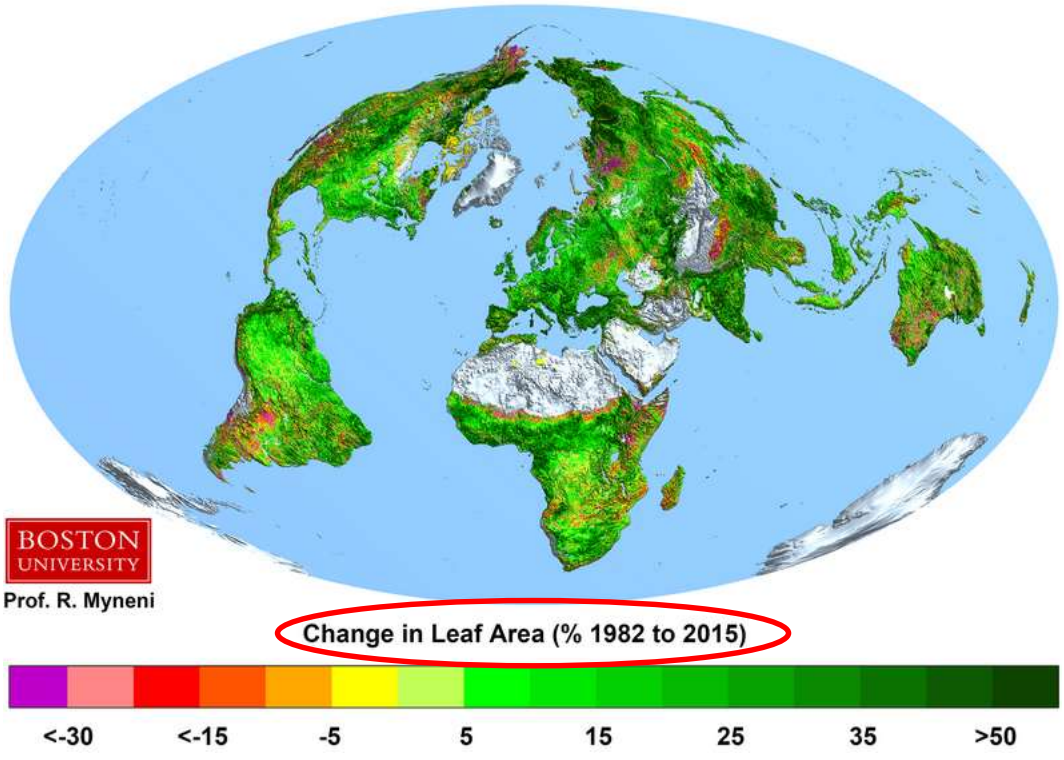
nature climate change

LETTERS

PUBLISHED ONLINE: 25 APRIL 2016 | DOI: 10.1038/NCLIMATE3004

Greening of the Earth and its drivers

Zaichun Zhu[1,2], Shilong Piao[1,2]*, Ranga B. Myneni[3], Mengtian Huang[2], Zhenzhong Zeng[2], Josep G. Canadell[4], Philippe Ciais[2,5], Stephen Sitch[6], Pierre Friedlingstein[7], Almut Arneth[8], Chunxiang Cao[9], Lei Cheng[10], Etsushi Kato[11], Charles Koven[12], Yue Li[2], Xu Lian[2], Yongwen Liu[2], Ronggao Liu[13], Jiafu Mao[14], Yaozhong Pan[15], Shushi Peng[2], Josep Peñuelas[16,17], Benjamin Poulter[18], Thomas A. M. Pugh[8,19], Benjamin D. Stocker[20,21], Nicolas Viovy[5], Xuhui Wang[2], Yingping Wang[22], Zhiqiang Xiao[23], Hui Yang[2], Sönke Zaehle[24] and Ning Zeng[25]



Just 4% of surface impacted by „browning“

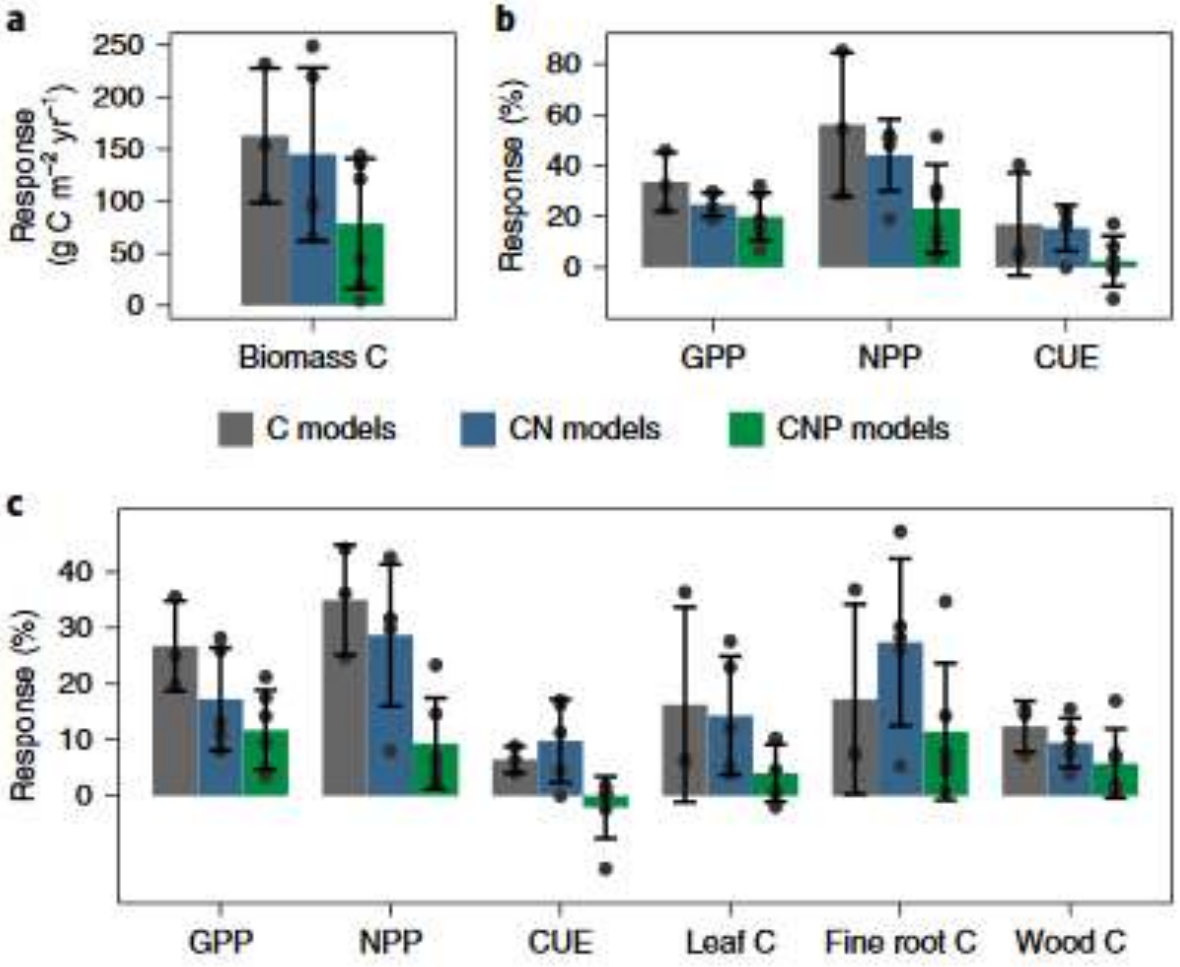
70% of greening explained by CO_2 fertilization effect

9% nitrogen deposition

8% climate warming (growing veg. season), mainly in colder areas

Zhu et al., 2016, NCC

… but global change related **counter-effects** will increasingly impact the (net) plant growth - **phosphorus**

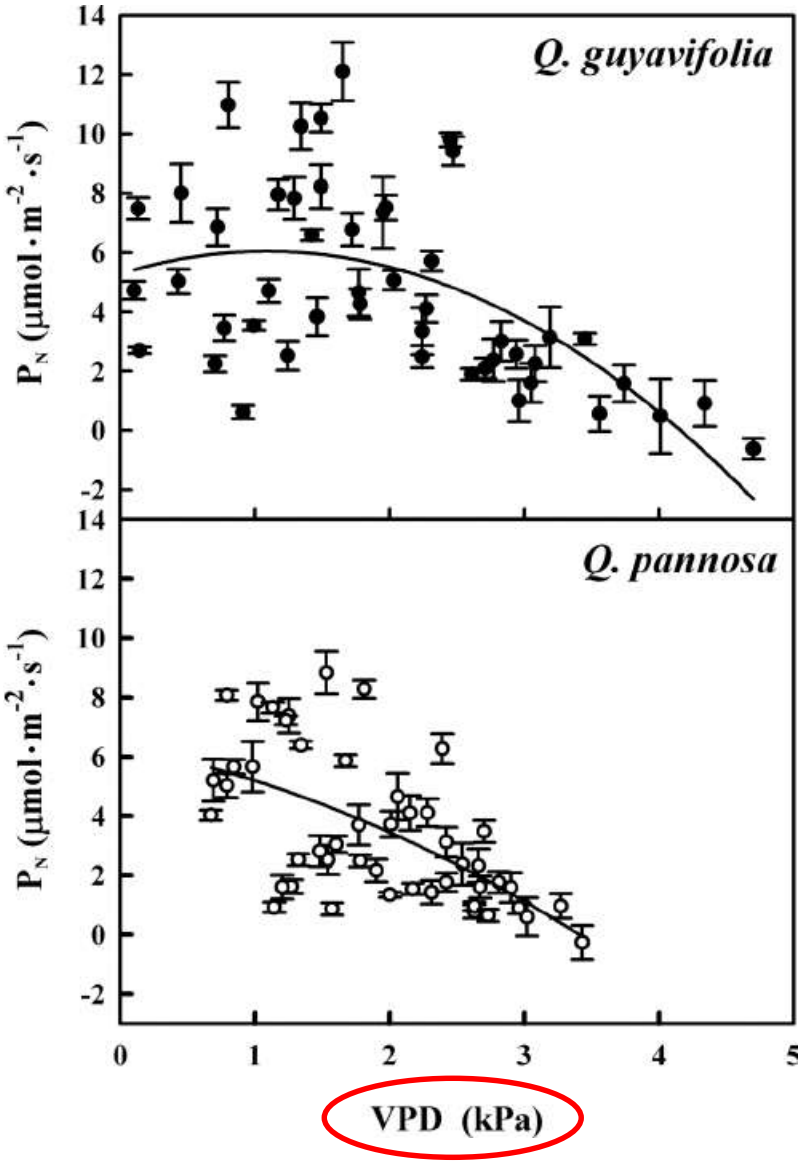


Adding nitrogen and phosphorus limitations to the terrestrial ecosystem models reduce the net benefit of CO_2 fertilization

Adding phosphorus limit reduced net tropical forest growth by about 50 % compared to nitrogen limit only.

Fleischer et al., Amazon forest response to CO2 fertilization dependent on plant phosphorus acquisition, 2019, Nat. Geo.

… but global change related **counter-effects** will increasingly impact the (net) plant growth - VPD



Zhang et al., 2007, Can. J. of For. Res.

Leaf-level VPD effect of two Quercus species on photosynthetic rate

Declining Pn rate with increasing VPD values

Vapour pressure deficit (VPD) is the difference (deficit) between the amount of moisture in the air and how much moisture the air can hold when it is saturated.

VPD affects stomata closure

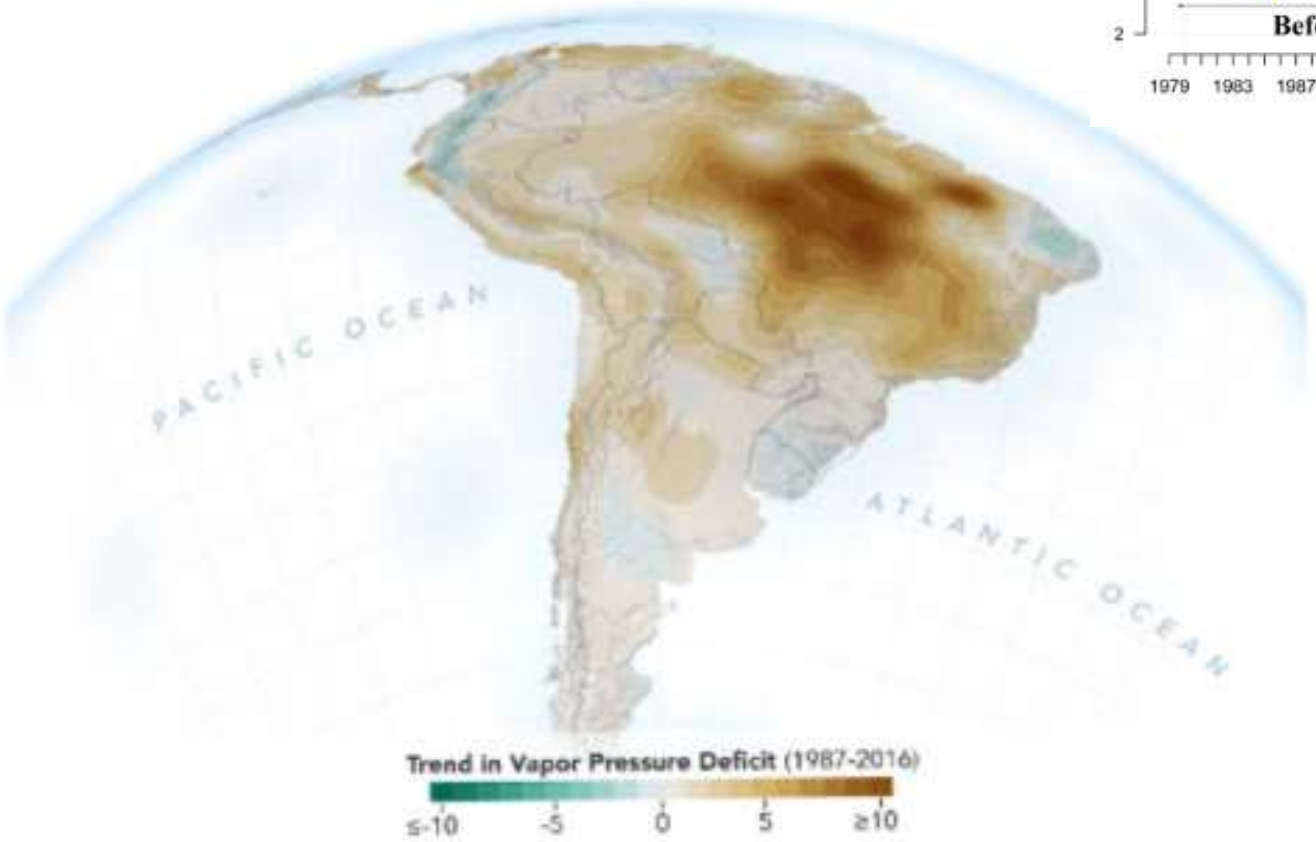
SCIENTIFIC REPORTS
nature research

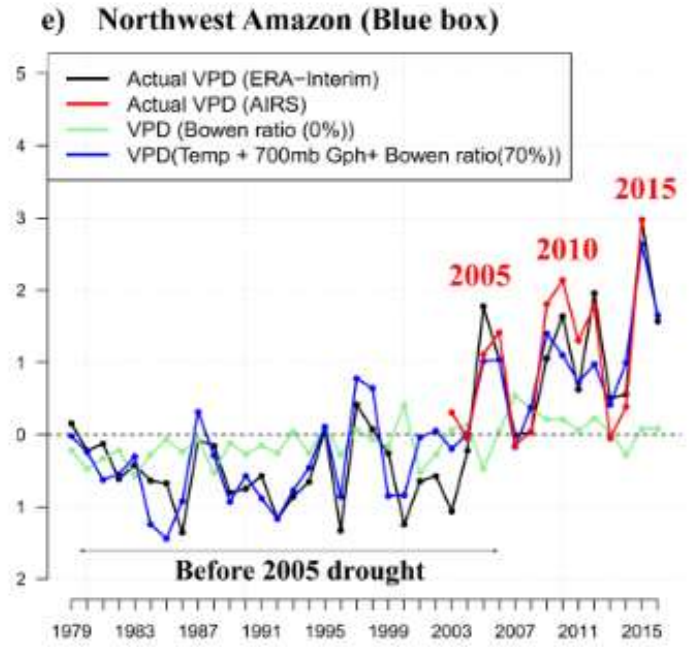
OPEN

A Recent Systematic Increase in Vapor Pressure Deficit over Tropical South America

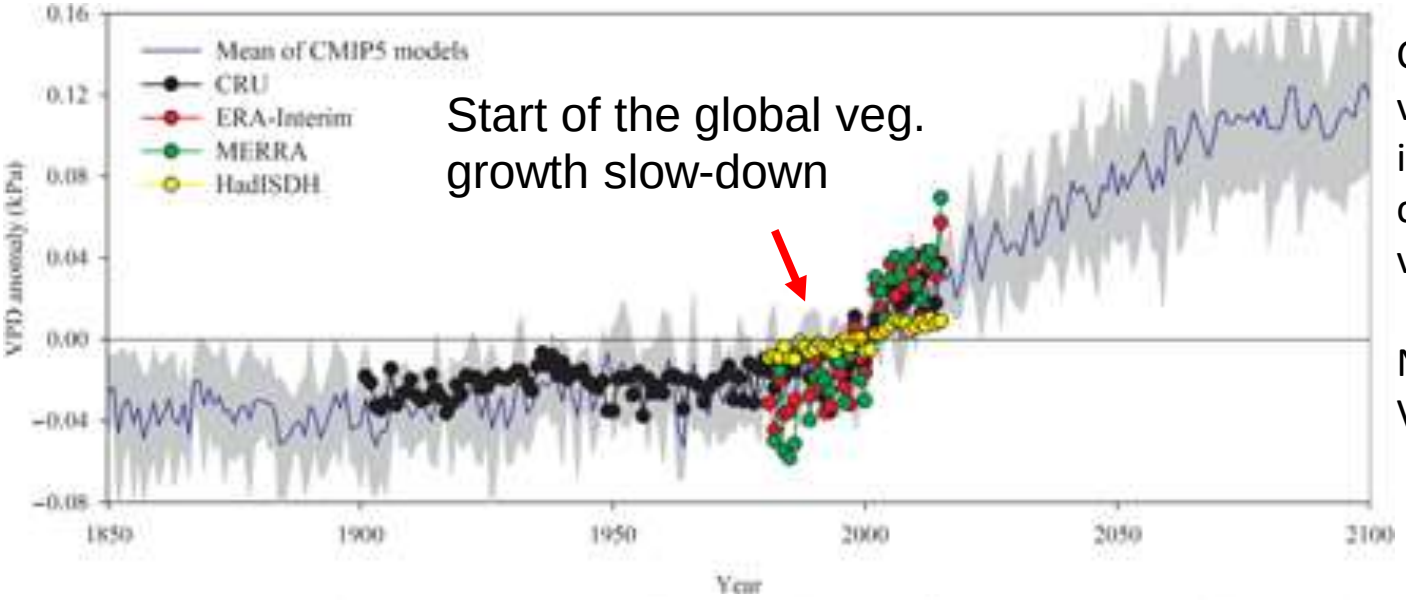
Armineh Barkhordarian[1,2*], Sassan S. Saatchi[2,3], Ali Behrangi[4], Paul C. Loikith[5] & Carlos R. Mechoso[1]

We show a recent increasing trend in Vapor Pressure Deficit (VPD) over tropical South America in dry months with values well beyond the range of trends due to natural variability of the climate system



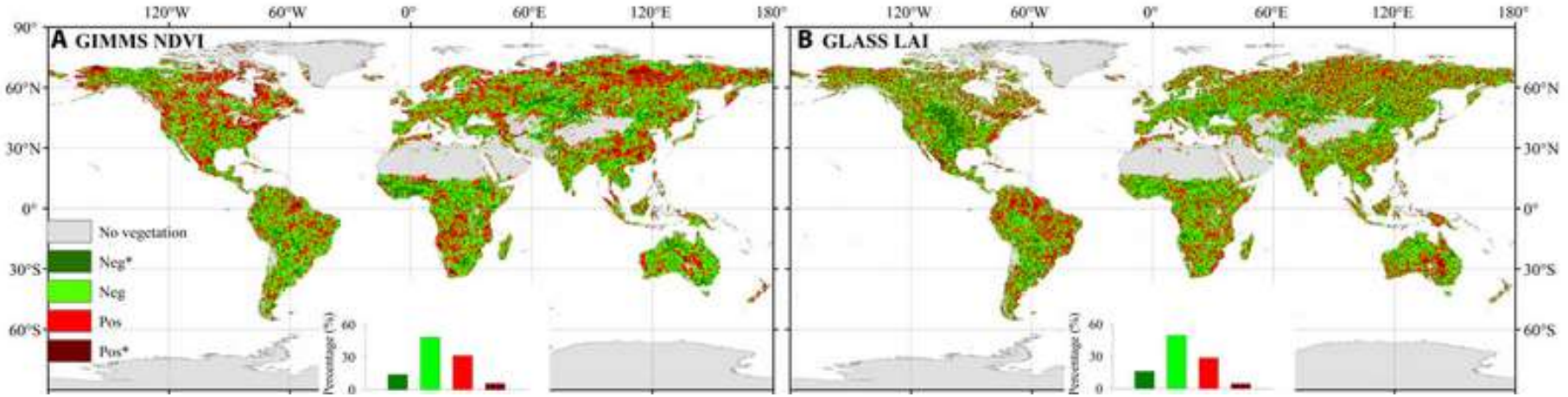


VPD will increasingly impact the (net) plant growth



Current response of vegetation to VPD increase is not well captured in the global vegetation models

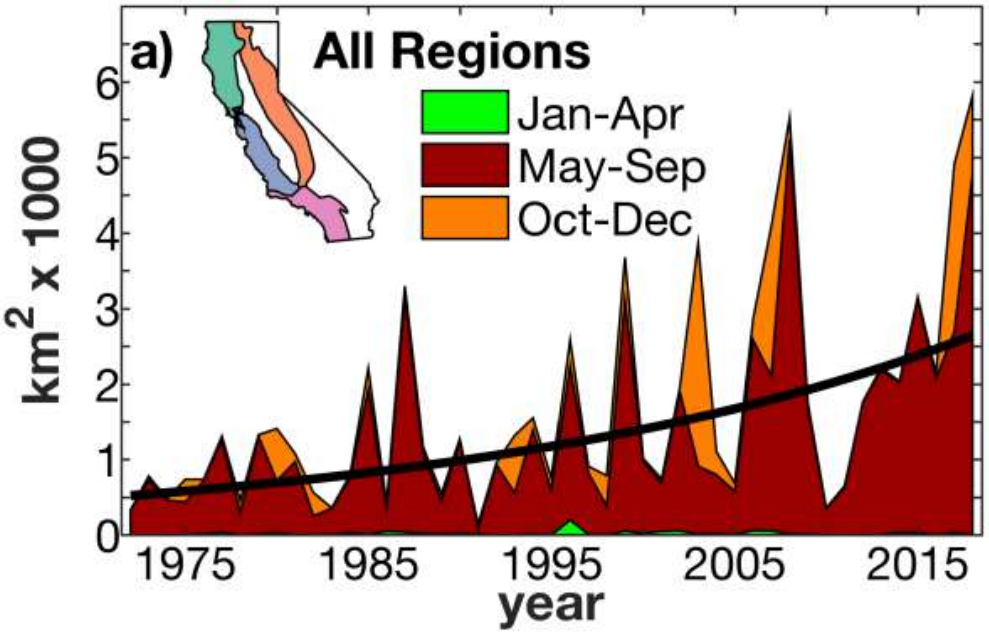
Neg. impact of increasing VPD over most land areas

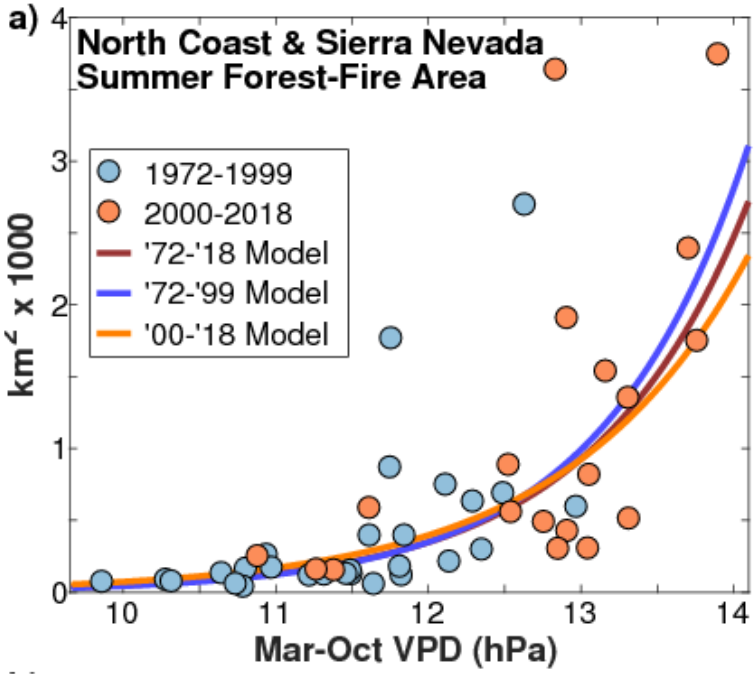


Yuan et al., 2019, Sci. Adv.

VPD will increasingly impact the (net) plant growth

!!! Fires !!!





California experienced 5-fold increase in forest burnt area since 1972.

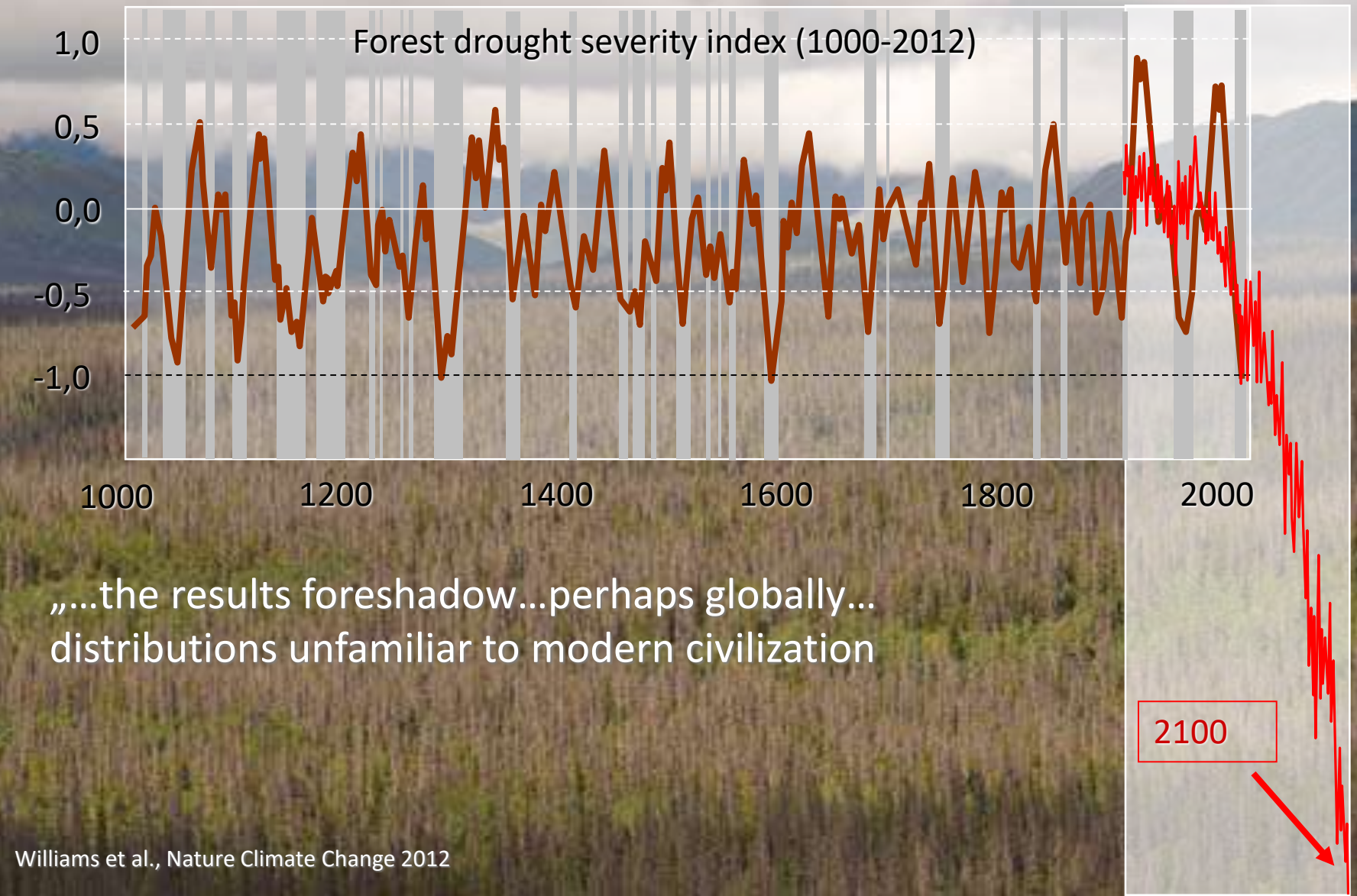
Changes in the **VPD were the best predictor of wildfire burnt area** in California during the summer.

Impact of increasing VPD is **non-linear.** It is exponential!

Increased VPD drives the “fuel drying” trend.

Williams et al., 2019, Earth’s Future

Drought will increasingly impact the (net) plant growth



„…the results foreshadow…perhaps globally… distributions unfamiliar to modern civilization

Williams et al., Nature Climate Change 2012

102 million dead California trees 'unprecedented in our modern history,' officials say

The number of dead trees in California's drought-stricken forests has risen dramatically to more than 102 million in what officials described as an unparalleled ecological...

LATIMES.COM | AUTOR: MATT STEVENS

Drought will increasingly impact the (net) plant growth

Since 2014 ≈ 130 million dead trees

10-fold increase in the death rate

All US forests are exposed to (negative) impacts of climate change

Global Change Biology

Special Feature

The impacts of increasing drought on forest dynamics, structure, and biodiversity in the United States

James S. Clark, Louis Iverson, Christopher W. Woodall, Craig D. Allen, David M. Bell, Don C. Bragg, Anthony W. D'Amato, Frank W. Davis, Michelle H. Hersh, Ines Ibanez, Stephen T. Jackson, Stephen Matthews, Neil Pederson, Matthew Peters, Mark W. Schwartz, Kristen M. Waring, Niklaus E. Zimmermann

New Forests
https://doi.org/10.1007/s11056-019-09745-6

INVITED REVIEW

How climate change might affect tree regeneration following fire at northern latitudes: a review

Dominique Boucher[1] · Sylvie Gauthier[1,2] · Nelson Thiffault[3,4] · William Marchand[1,2] · Martin Girardin[1,2] · Morgane Urli[4]

Received: 18 April 2019 / Accepted: 31 August 2019

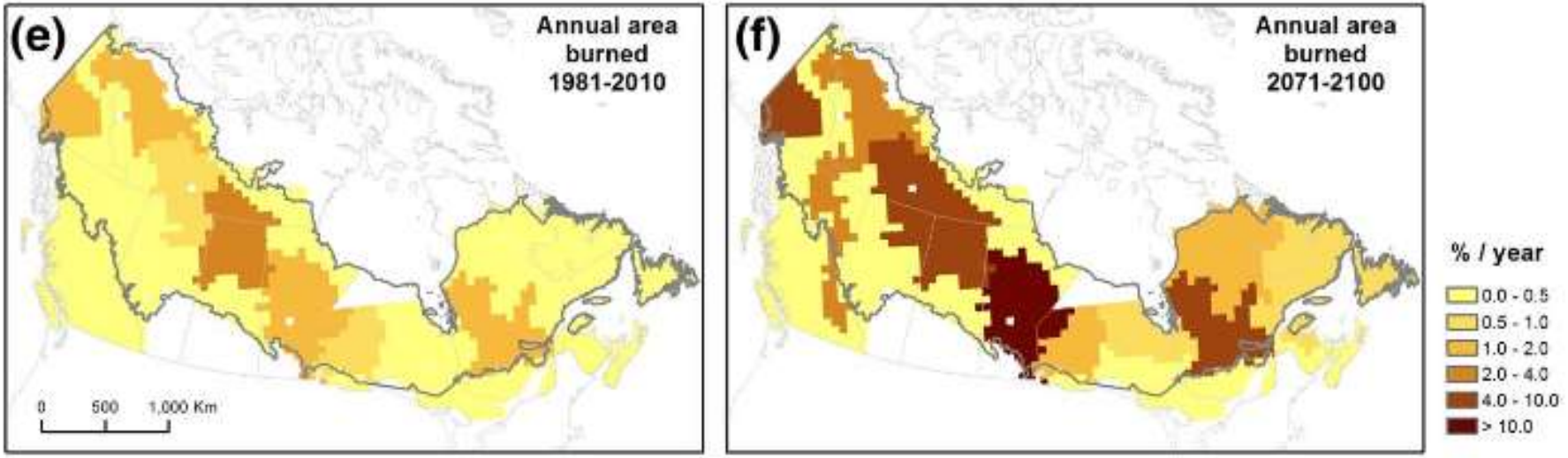
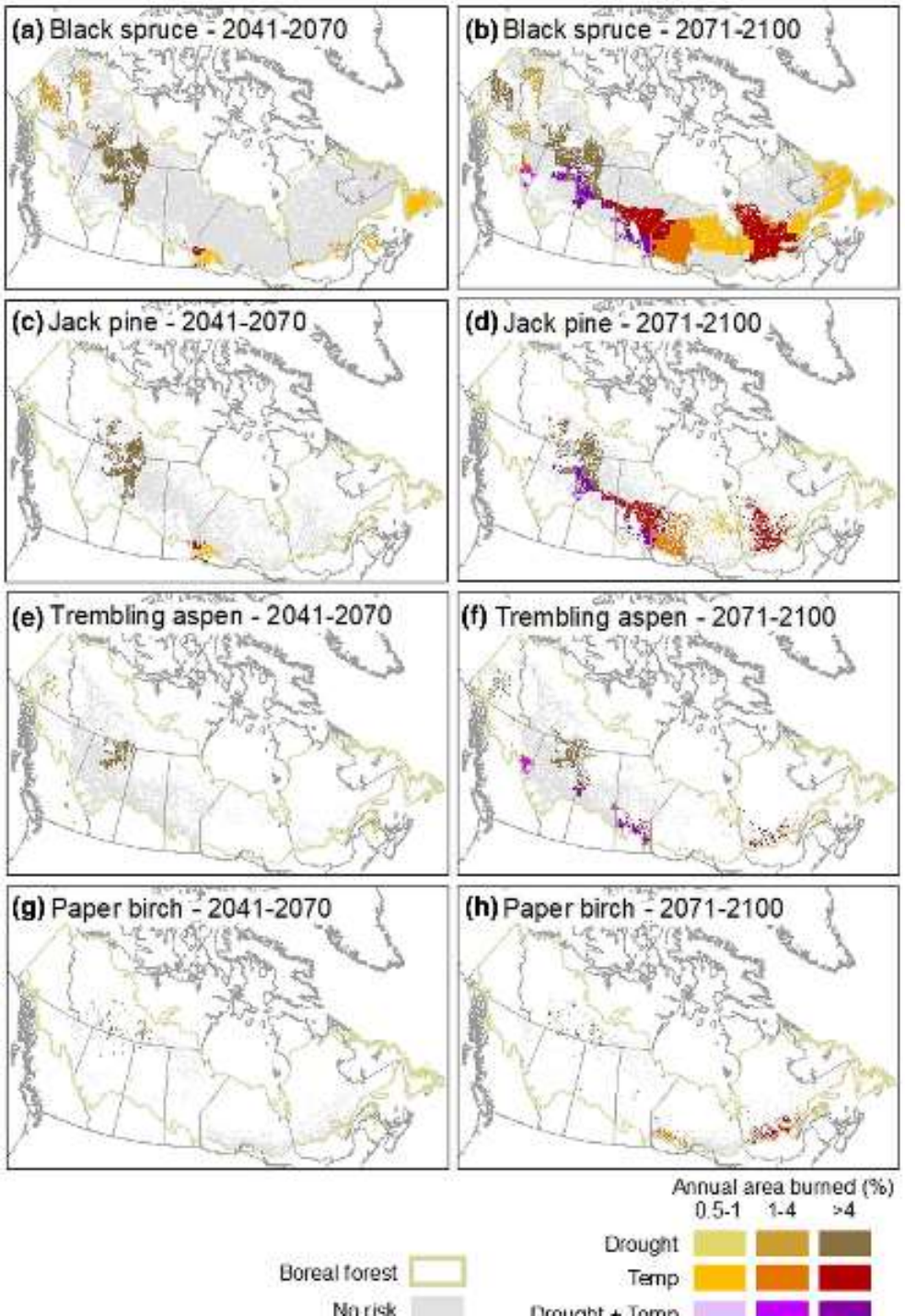
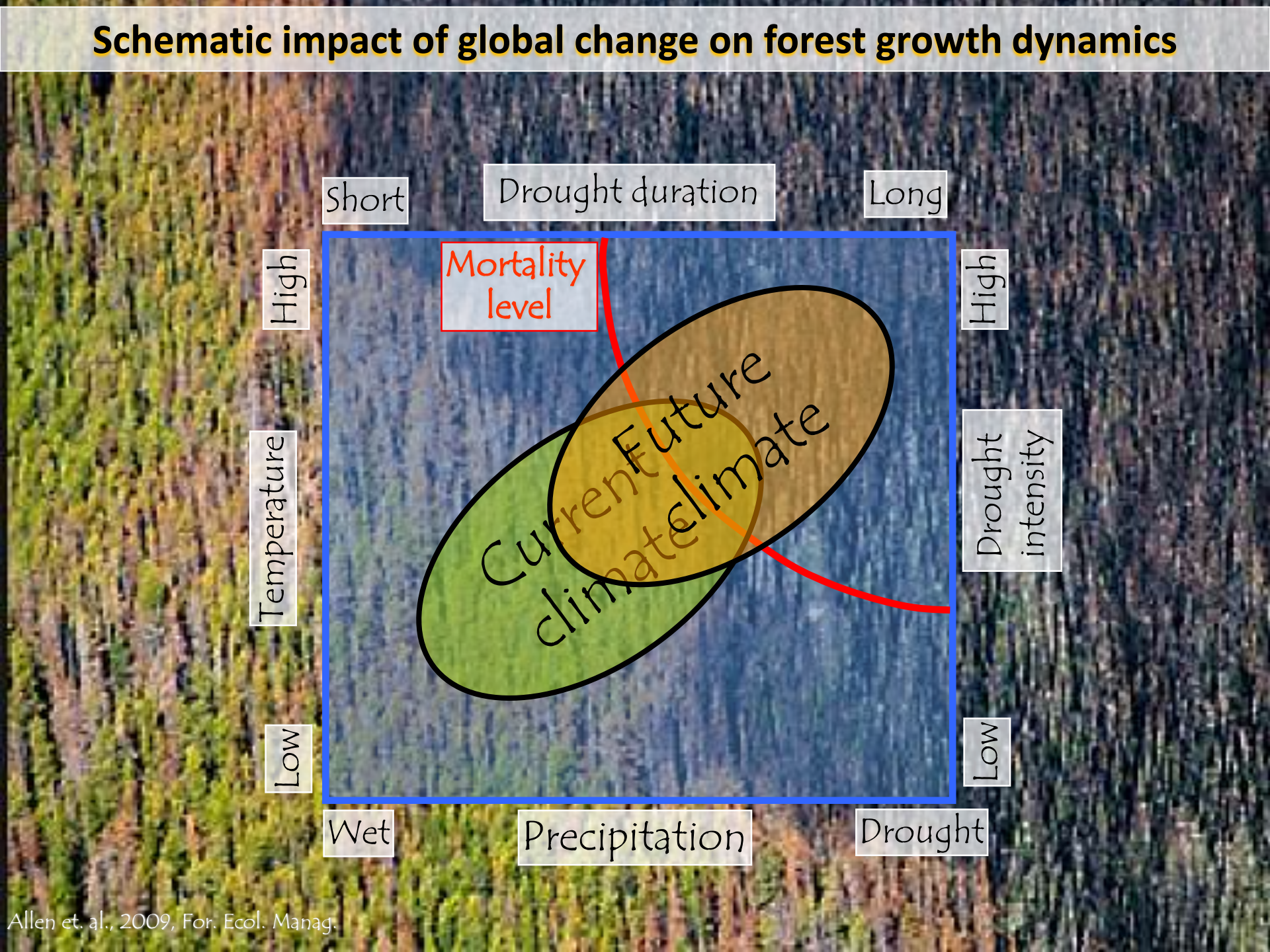


Fig. 1 Projections of annual mean temperature (°C), Climate Moisture Index (CMI) and annual burned area (%/yr) for the 1981–2010 and 2071–2100 periods based on the CanESM2 RCP 8.5 model



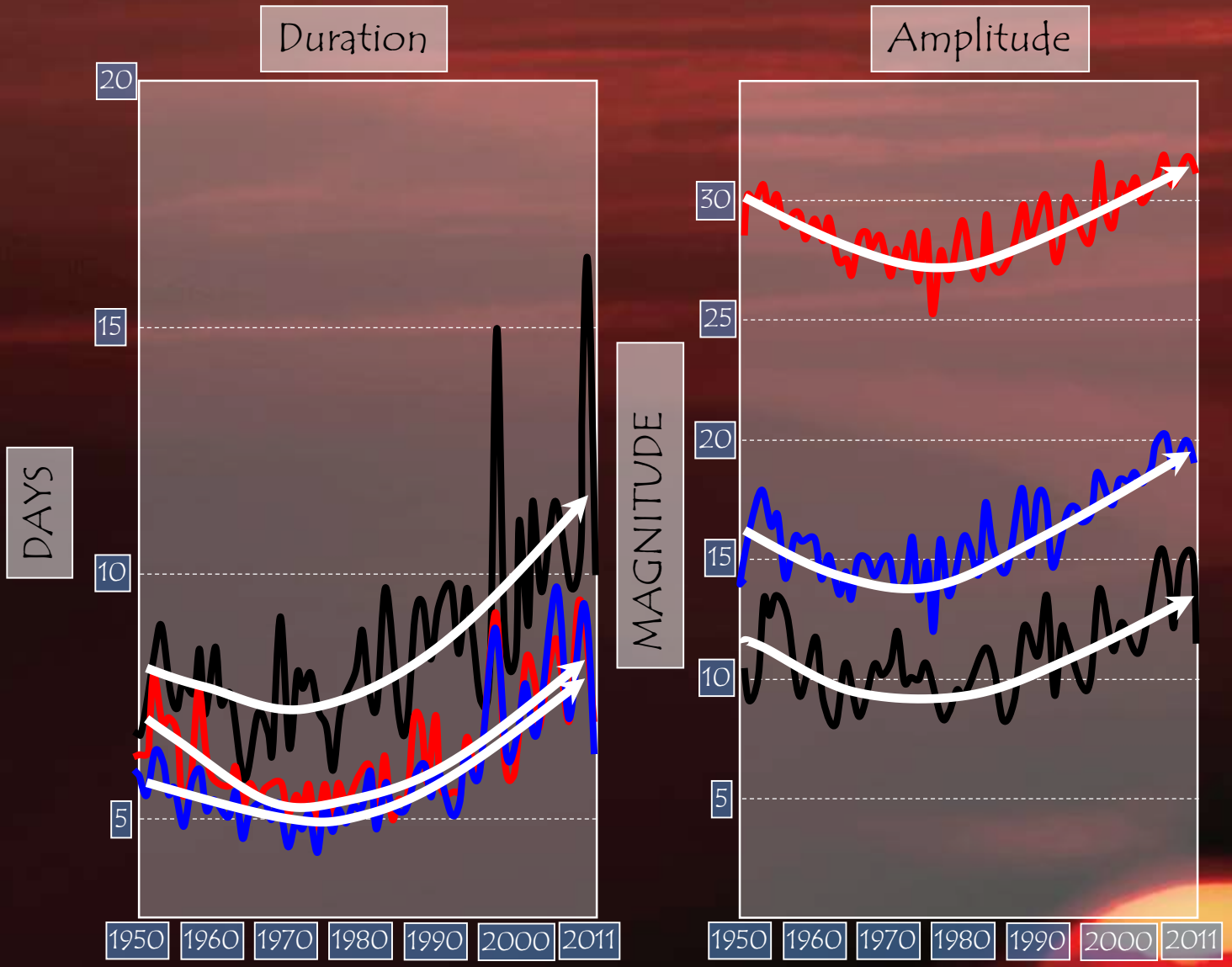
Increased risk for forest fires regeneration due to higher temperatures and drought

Schematic impact of global change on forest growth dynamics



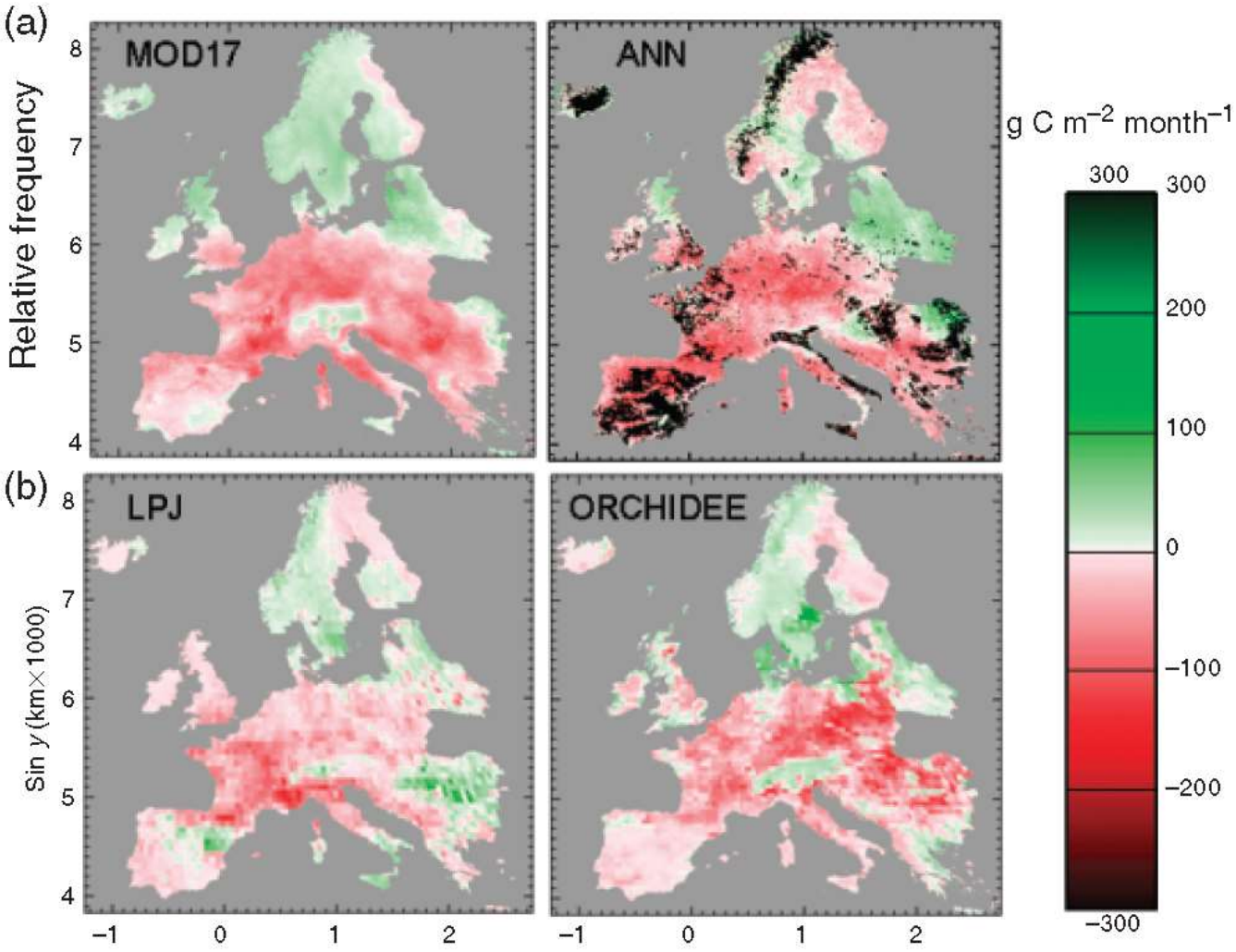
Allen et. al., 2009, For. Ecol. Manag.

Heatwaves are rising globally



Perkins et al. 2012, GLR

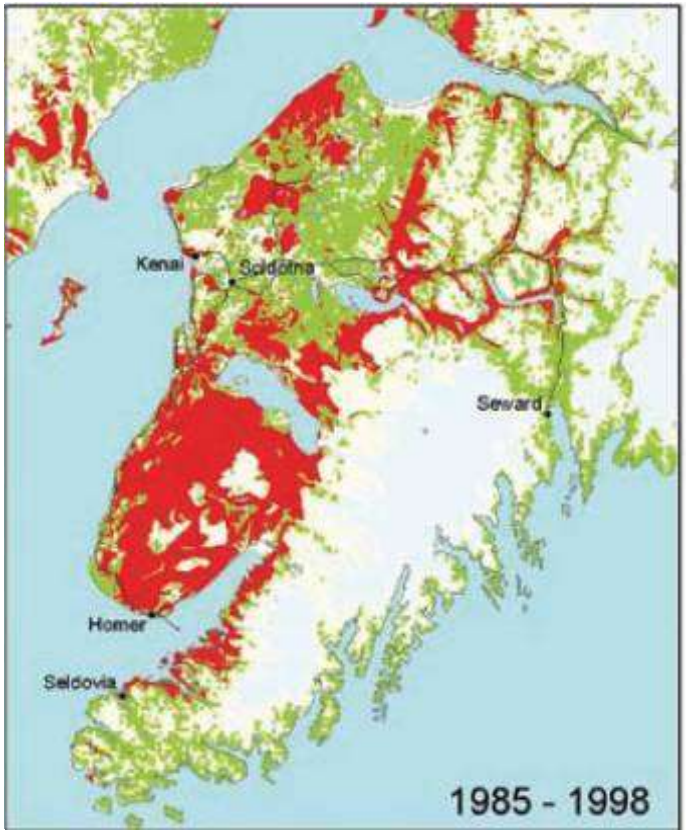
European heat wave of 2003 and carbon sink



Decrease in GPP and respiration!

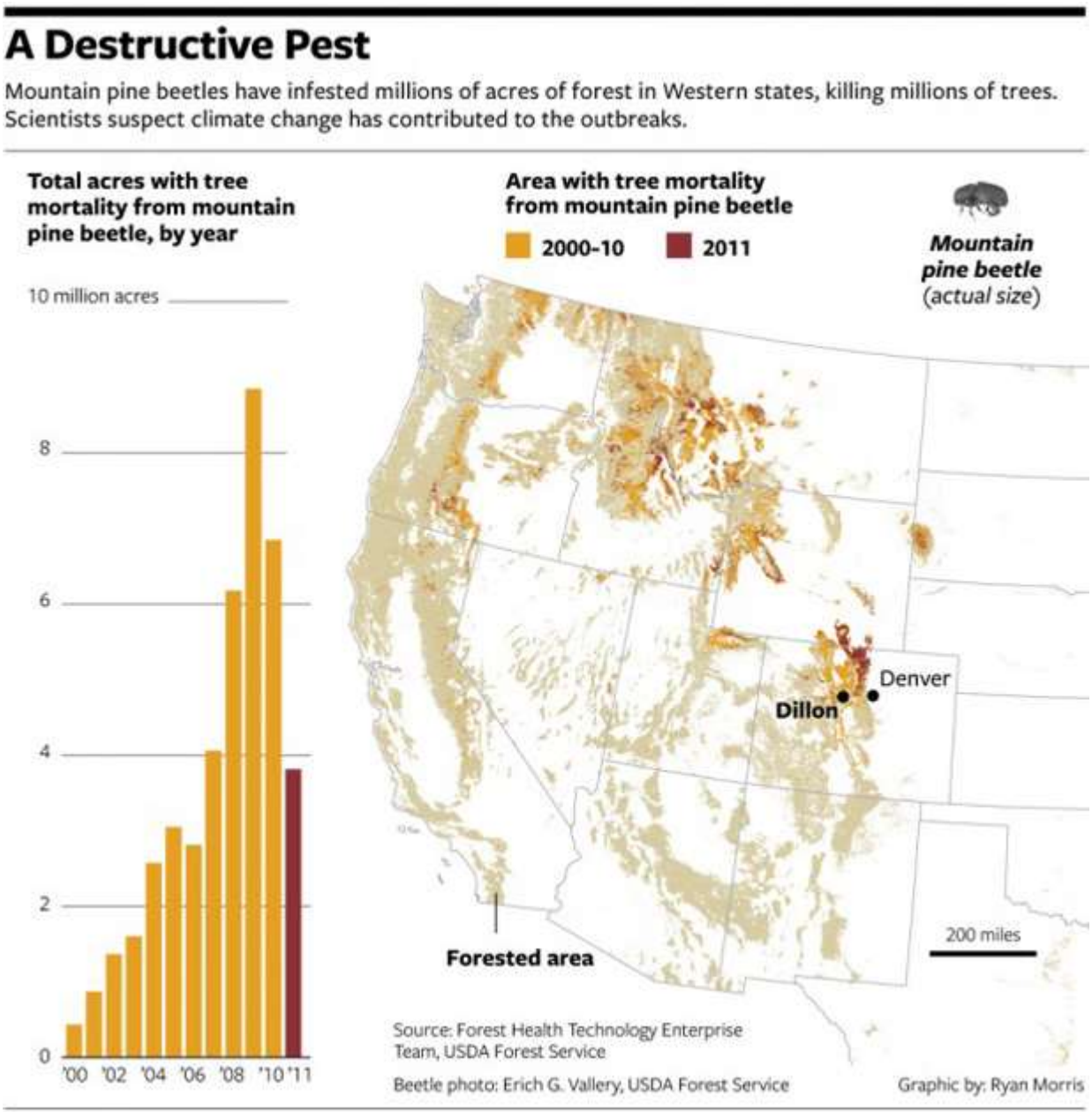
Reichstein et. al., 2006

Pests outbreaks and climate change - *Alaskan Spruce (pest Dendroctonus rufipennis)*



Global Climate Change Impacts In the United States, 2009

Western USA



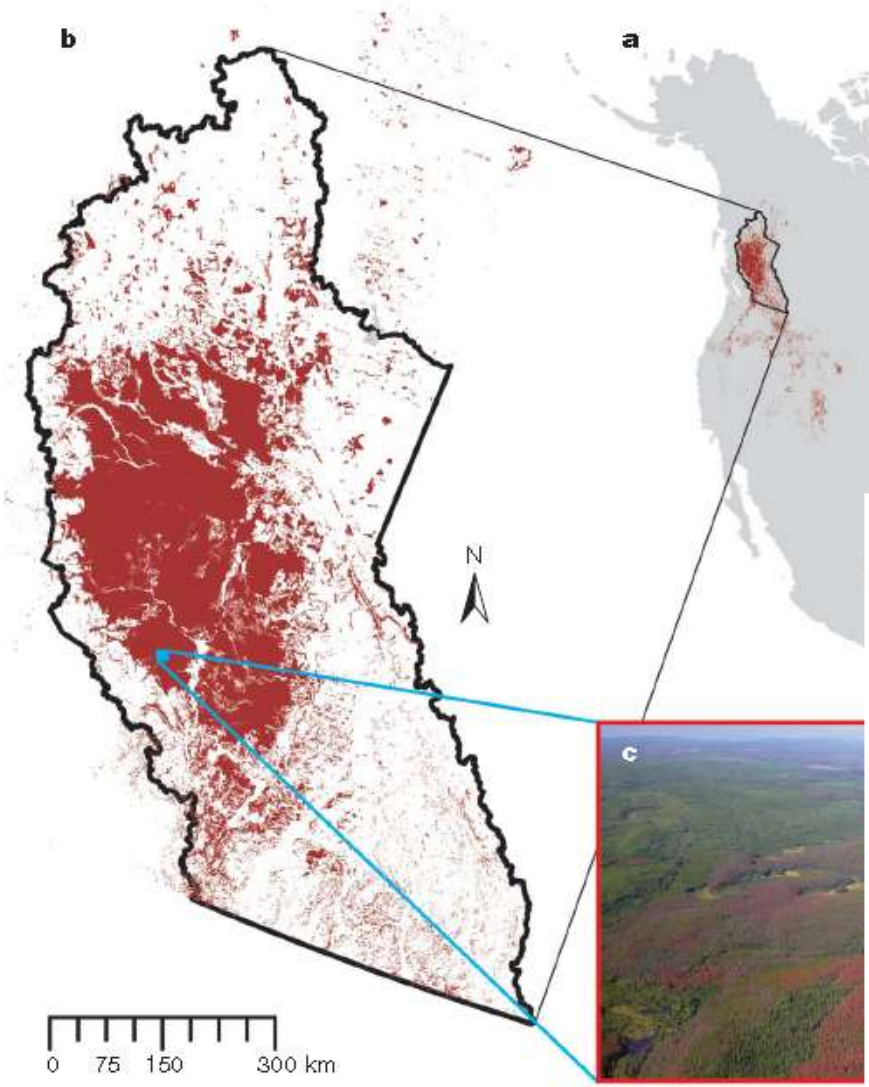
The Atlantic, 2012

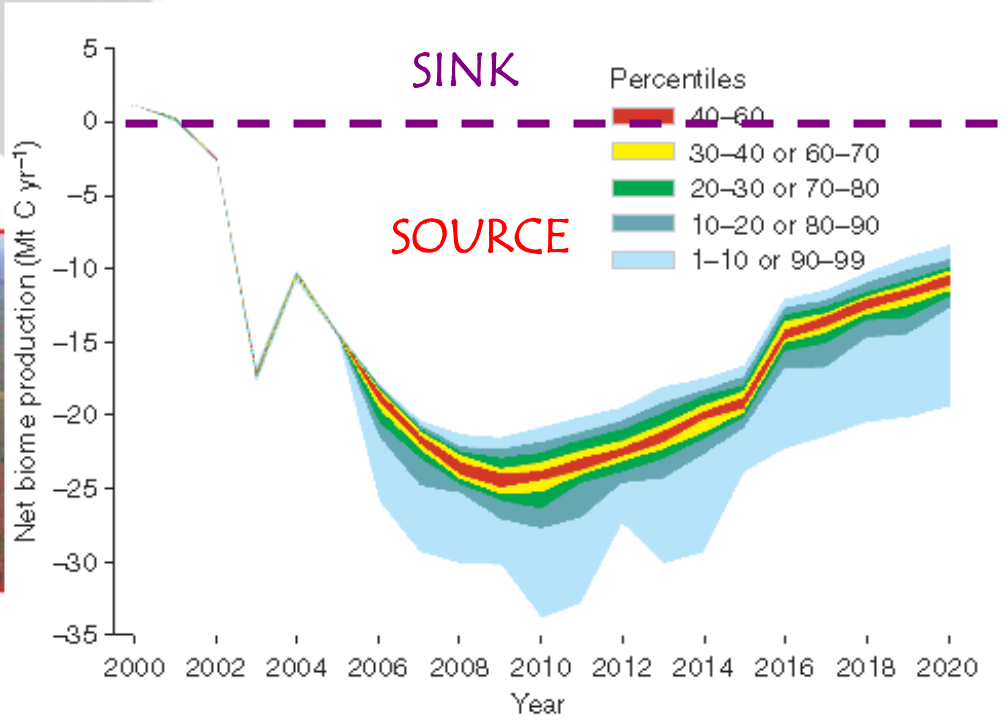
Forests in North America

Pinus ponderosa (pest *Dendroctonus ponderosae*)

Current outbreak is 10-fold bigger than any other in history

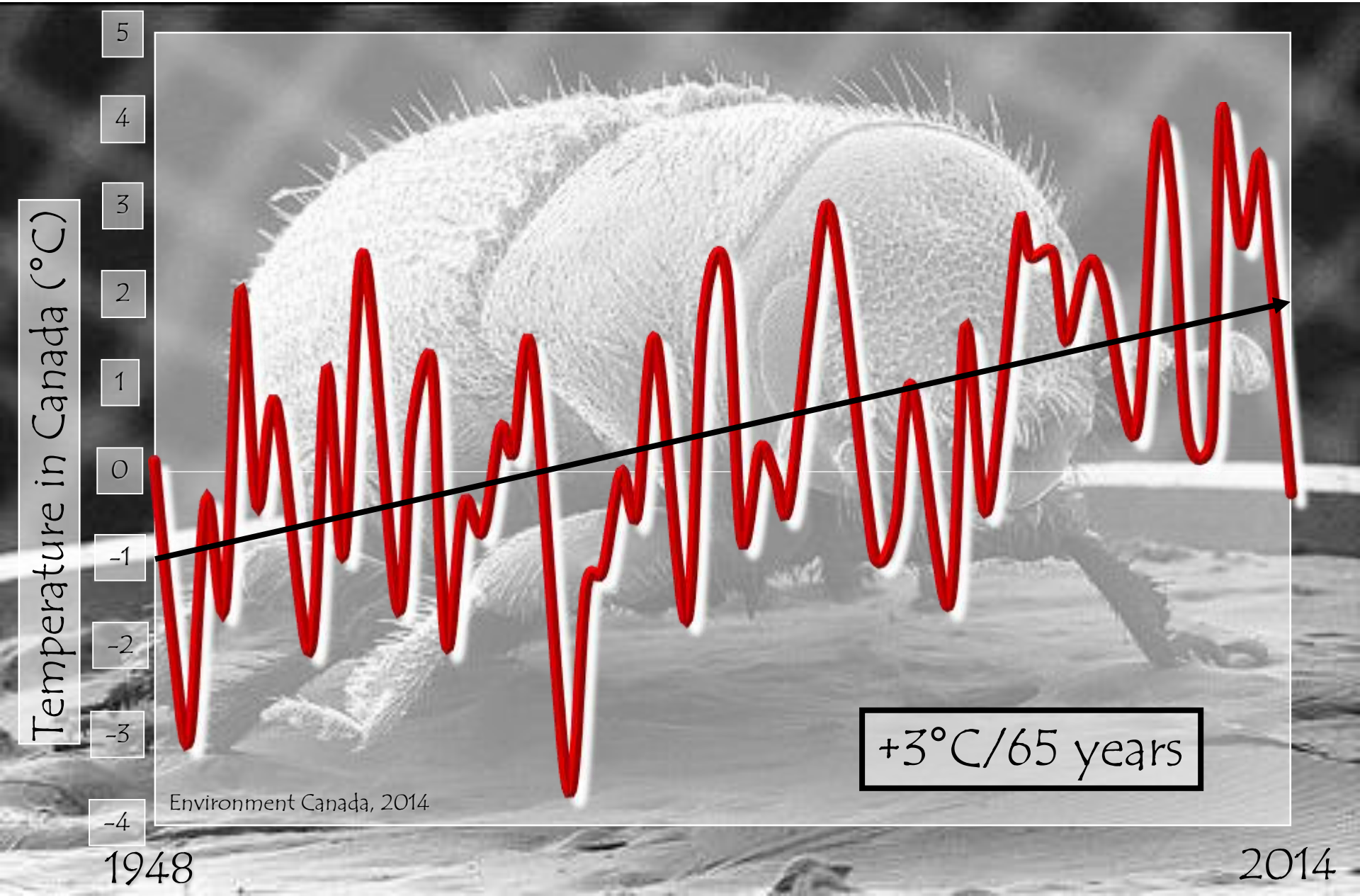
Decrease in productivity si similar to increase in 80 to 90-ties as a result of global change





Kurz et al., Nature 2008

Drought will increasingly impact the (net) plant growth



Canada (Yucon), boreal forest, *Picea glaucens* die-off at an area of 400 000 ha (= 4 000 km^2) as a consequence of mild winters

USA (Wyoming), july 2009

Pinus albicaulis (5 000 km^2 in 2007, 8 000 km^2 in 2009

Foto: Wally MacFarlane (in Betz et al., 2010)

„...rate of change is unprecedented" (Jesse Logan)

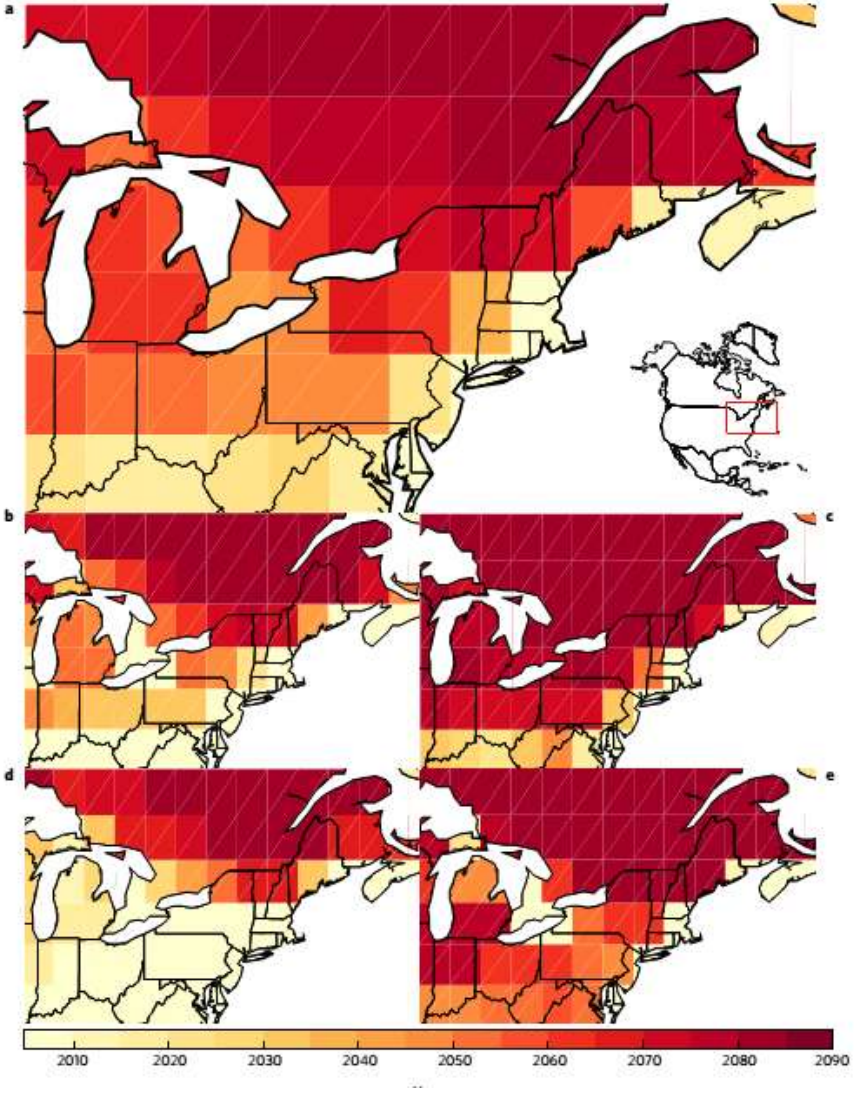
nature climate change
LETTERS
PUBLISHED ONLINE: 28 AUGUST 2017 | DOI: 10.1038/NCLIMATE3375

Threats to North American forests from southern pine beetle with warming winters

Corey Lesk[1]*, Ethan Coffel[2], Anthony W. D'Amato[3], Kevin Dodds[4] and Radley Horton[1,5]

Enlargement of potential habitat of *Dendroctonus frontalis* as **a result of increasing minimum winter temperature** and the resulting minimum floem temperature.

(Color scale show year of emergence)



Our study reveals a plausible new threat from southern pine beetle to vast areas of pine forest in eastern North America by 2050 and into subarctic Canada after 2080 under continued climate change.

Lesk et al., 2017, NCC

Climate change and forests in Europe – future

nature climate change

LETTERS

PUBLISHED ONLINE: 23 SEPTEMBER 2012 | DOI: 10.1038/NCLIMATE1687

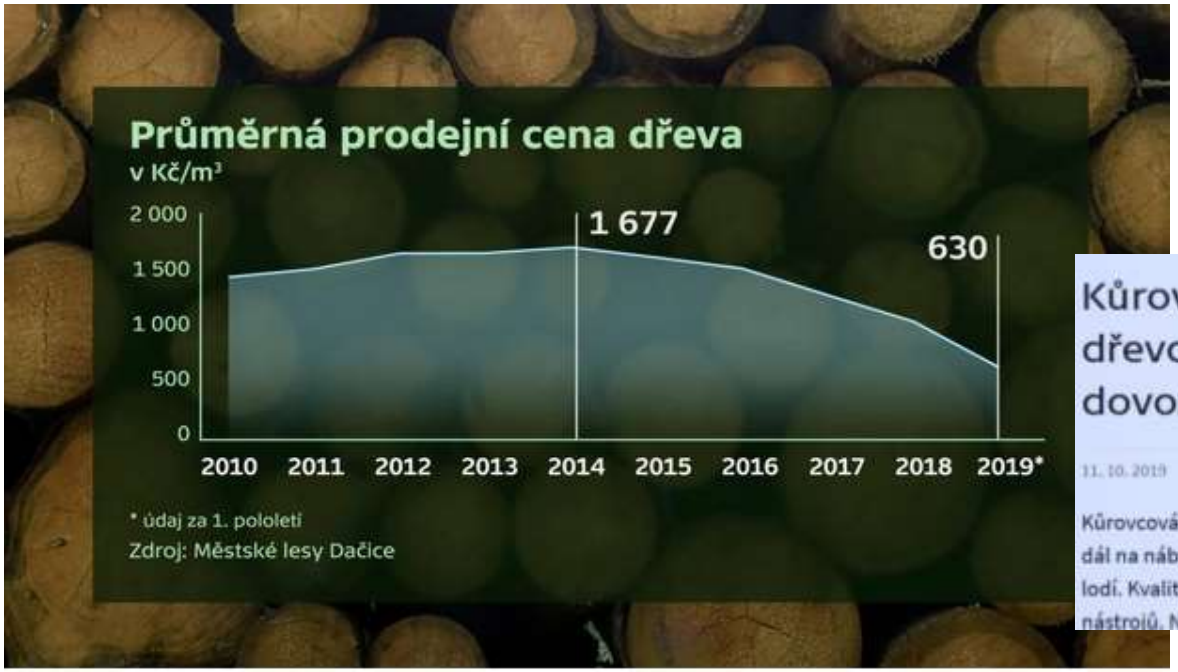
Climate change may cause severe loss in the economic value of European forest land

Marc Hanewinkel[1,2]*, Dominik A. Cullmann[3], Mart-Jan Schelhaas[4], Gert-Jan Nabuurs[5] and Niklaus E. Zimmermann[6]

Our model shows that—depending on different realizations of three climate scenarios—by 2100, **between 21 and 60%** (mean: 34%) of European forest lands will be **suitable only for a Mediterranean oak forest type with low economic returns for forest owners** and the timber industry and **reduced carbon sequestration**.

Economic damage

Expected damages = 600 billion CZK



The rapid decrease in wood price!

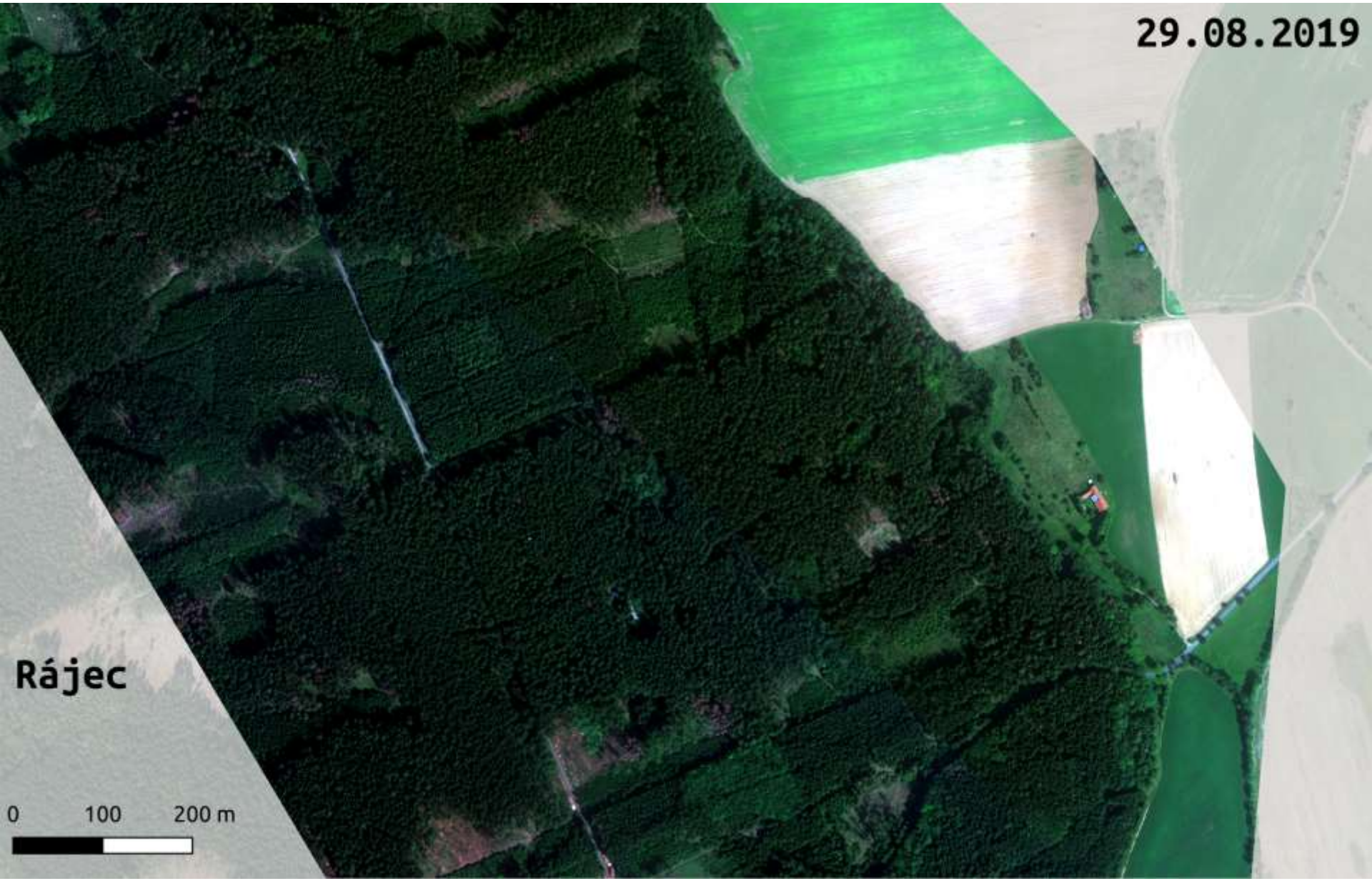
Kůrovcová kalamita zlevňuje české dřevo. Německo a Rakousko proti dovozu protestují

11. 10. 2019

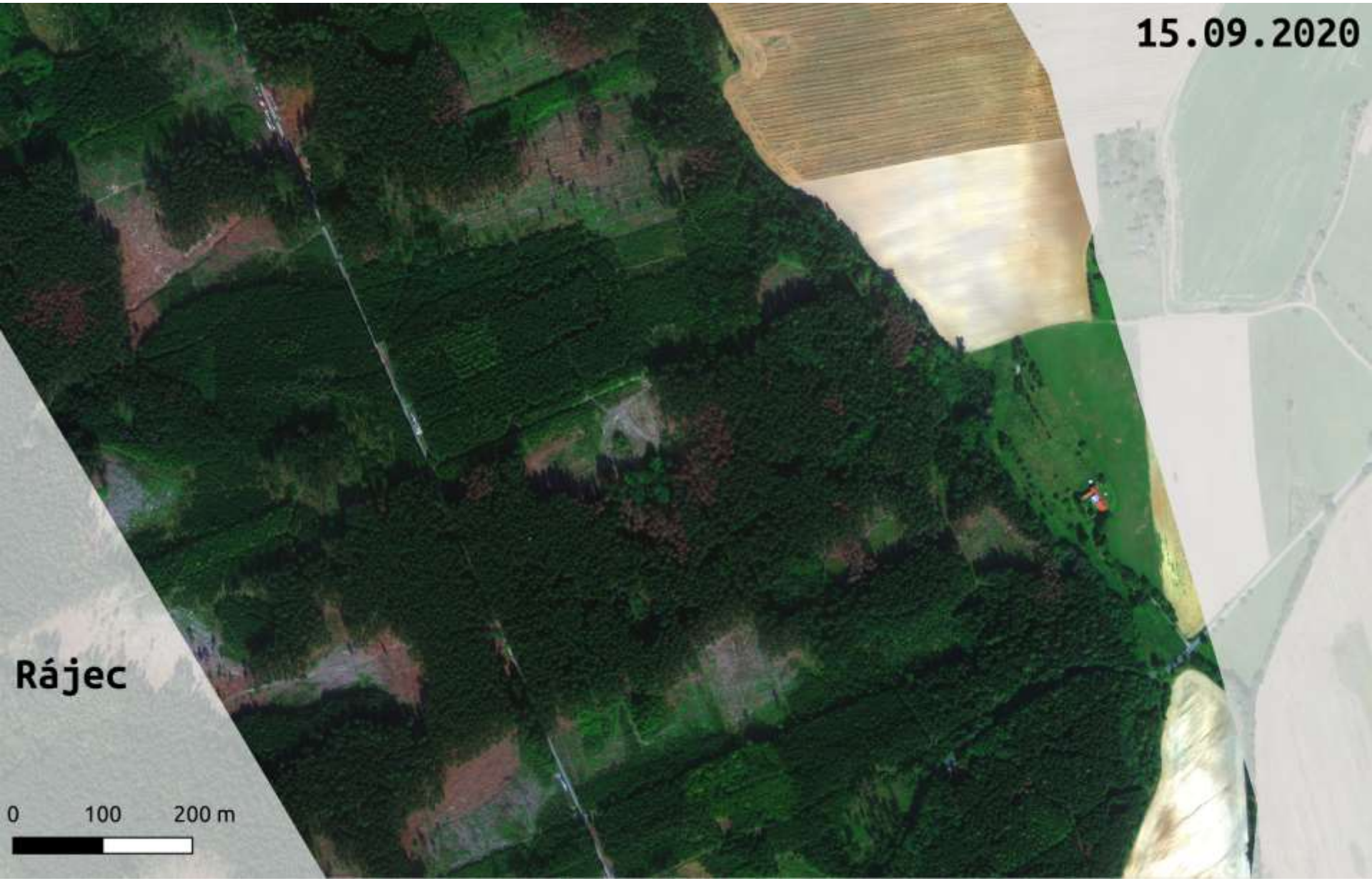
Kůrovcová kalamita dopadá na celý dřevozpracující a papírenský průmysl, dál na nábytkářství nebo stavebnictví, výrobu sportovních potřeb nebo lodí. Kvalitní smrkové dřevo vyžaduje například výroba hudebních nástrojů. Naopak ta neméně kvalitní surovina se ještě využije v

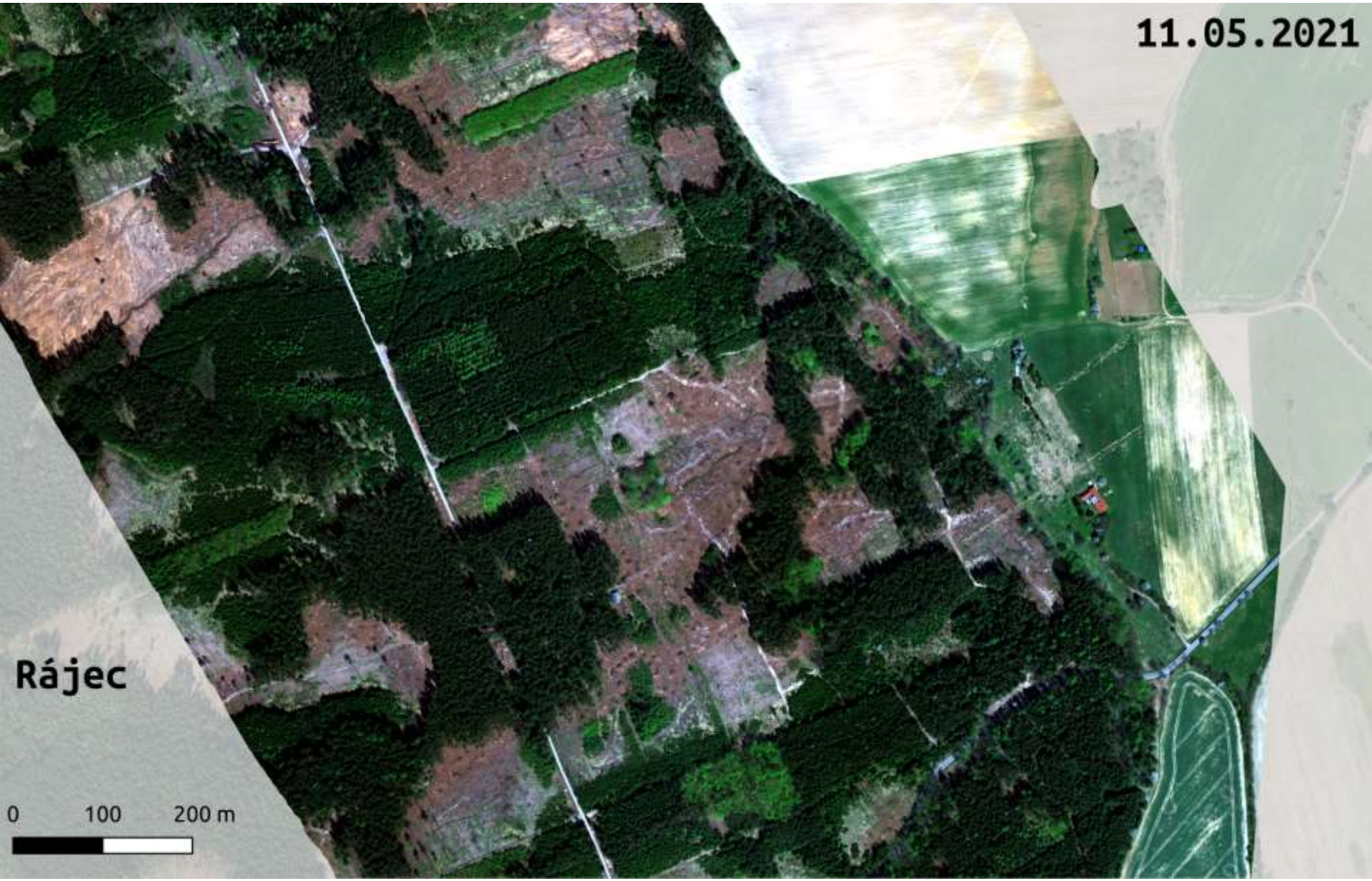
Rájec ecosystem station:
Bark beetle calamity from a bird's eye view


29.08.2017
Rájec
0
100
200 m


29.08.2019
Rájec
0
100
200 m


23.04.2020
Rájec
0
100
200 m


15.09.2020
Rájec
0
100
200 m


11.05.2021
Rájec
0
100
200 m


06.07.2021
Rájec
0
100
200 m

Potential range of major tree species for present time and near future

Normal period
1950-2000

Prediction
2070-2100

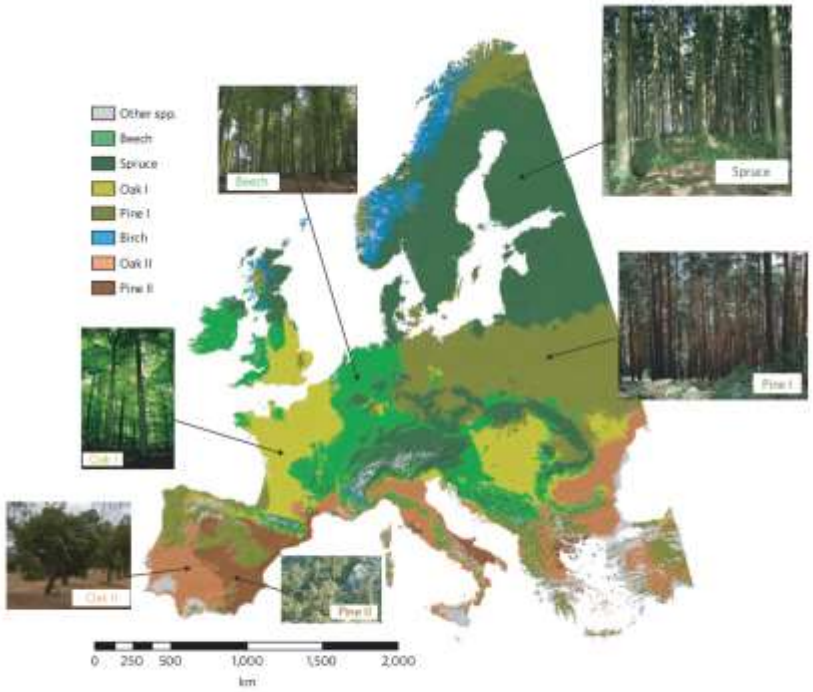


Figure 1 | Potential range of major tree species in Europe for the climate normal period (1950–2000). The size (area) of the pictures, showing typical aspects of forests dominated by the modelled species, approximately corresponds to the share of the total area in the climate normal period (birch <3% not depicted). For an explanation of the tree species groups, see Methods.

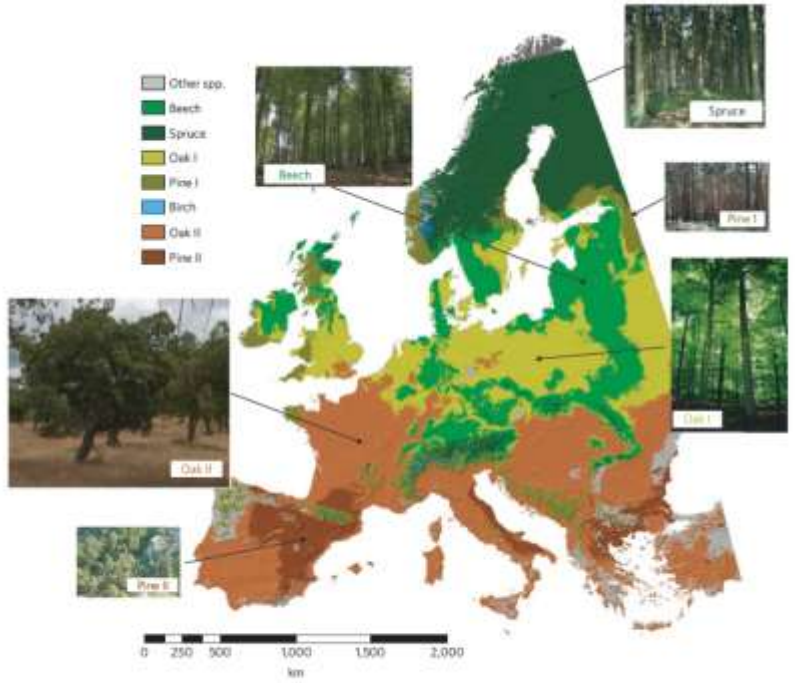
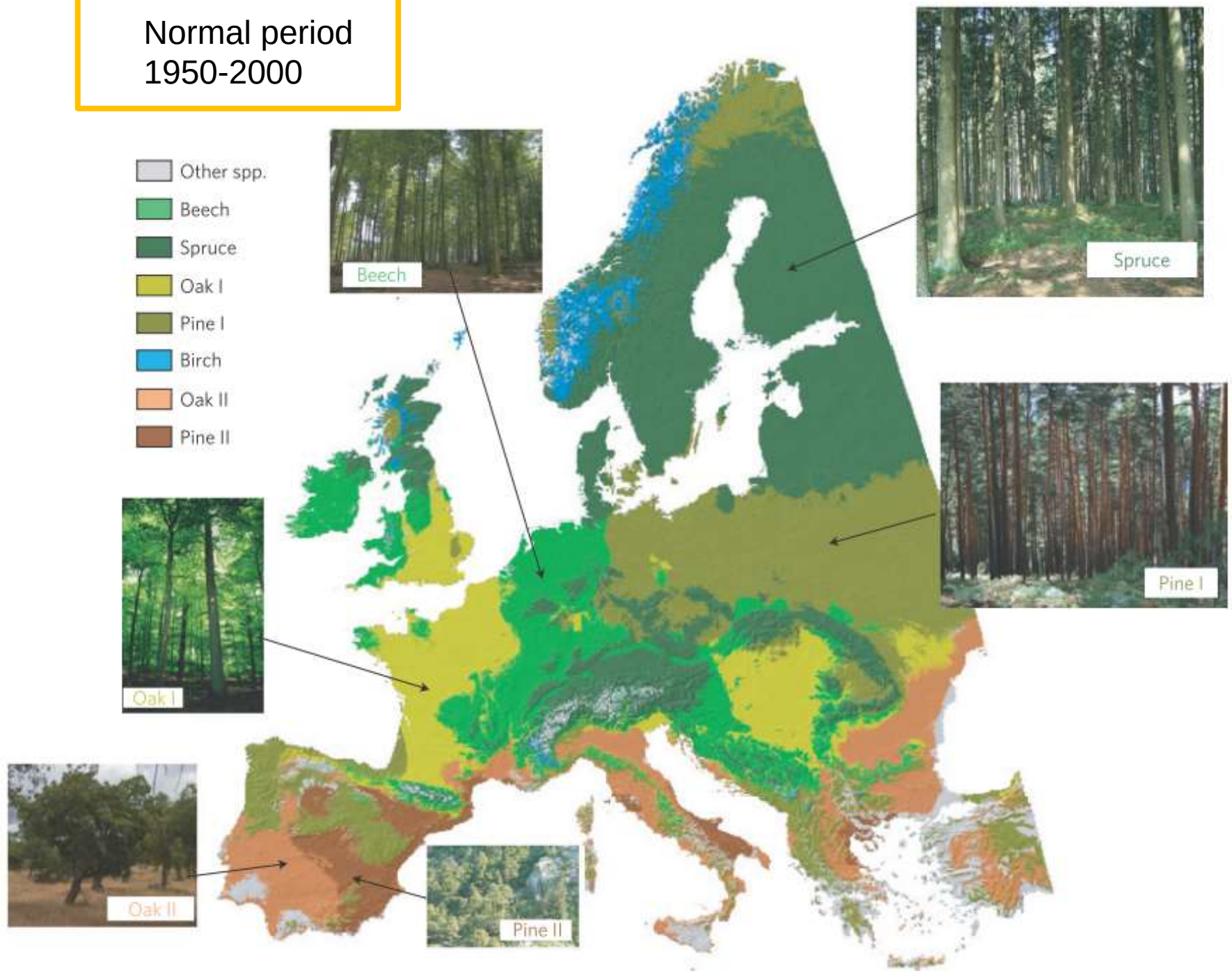
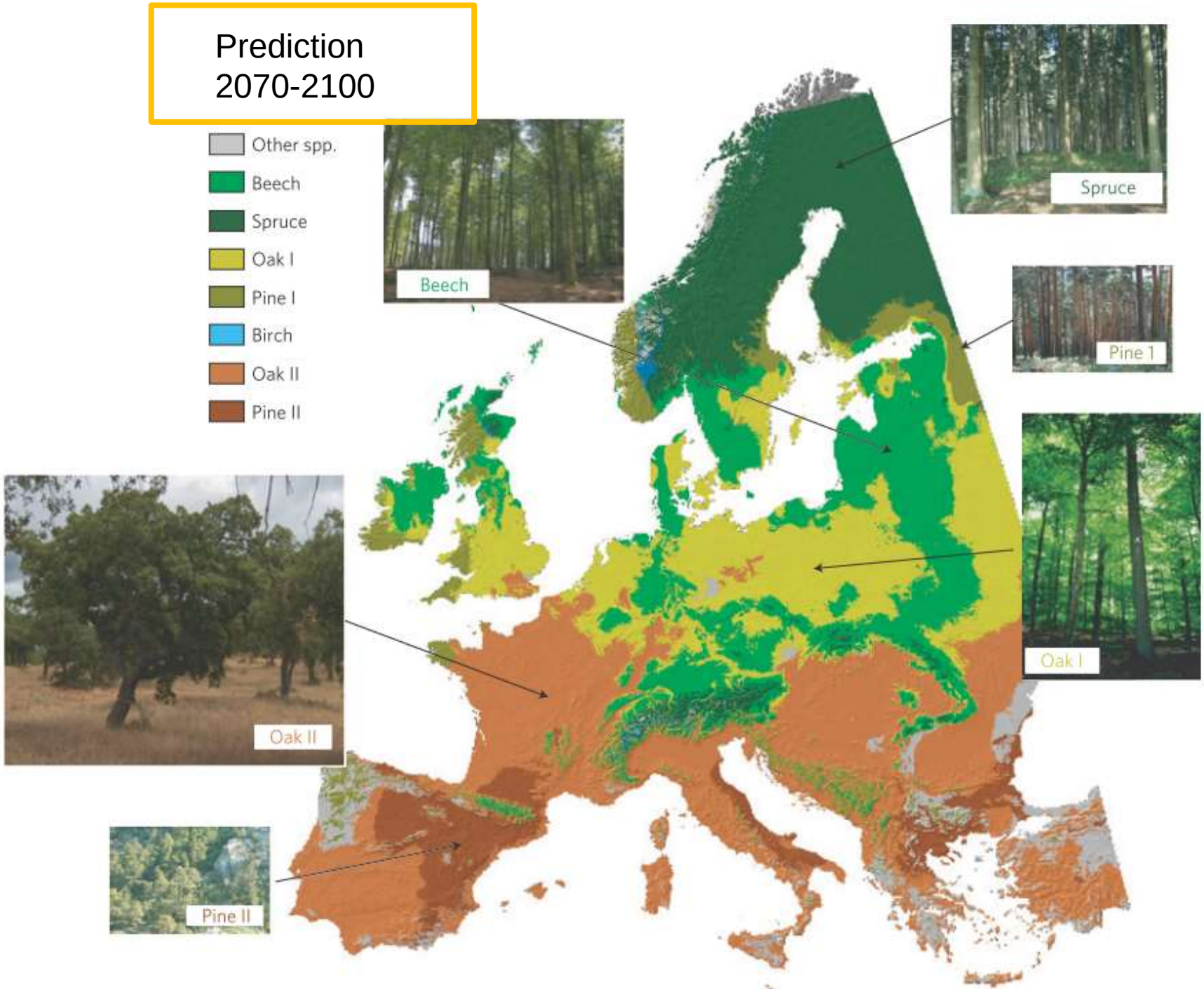


Figure 2 | Potential range of major tree species in Europe for scenario A1B, CLM/ECHAM5—moderate warming (2070–2100). The size (area) of the pictures, showing typical aspects of forests dominated by the modelled species, approximately corresponds to the share of the total area in A1B (2071–2100; birch ~0.3%, not depicted).

Hanewinkel et al. 2013

Normal period
1950-2000




Prediction
2070-2100
Other spp.
Beech
Spruce
Oak I
Pine I
Birch
Oak II
Pine II
Beech
Spruce
Pine 1
Oak I
Oak II
Pine II


Prediction
2070-2100

Conclusions

Deforestation – one of the biggest global problem

Biodiversity – extinction caused by massive deforestation, predicted big extinction due to climate change

Forest as an economic tool – forests must be not only “factory” for wood

Forest and carbon – forests are one of the biggest terrestrial carbon pool

Disturbances – more frequent, stronger due to climate change

Forest and water – problem with changes in precipitation dynamic and higher VPD

Pathogens – calamities caused by impacts of climate change (e.g. bark beetles)

The altitudinal and longitudinal shift of species due to climate change

Adaptation of forestry on climate change - species composition changes

Thank you for your attention

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