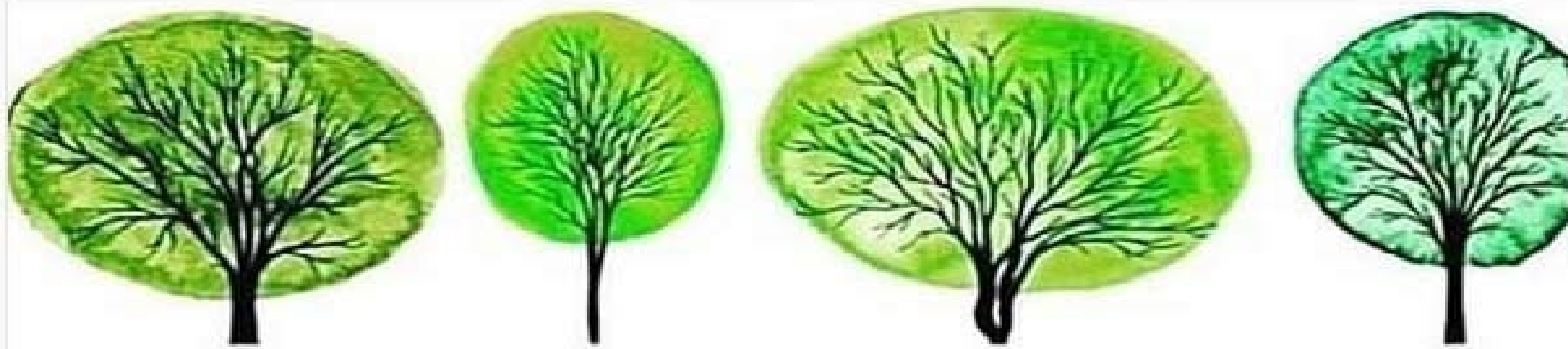


# K38e: Deforestation and Climate



# Forests Being Cut Faster Than They Can Grow

- Tropical deforestation, as countries scramble to clear-cut and sell off their timber so they can grow cattle (and soybeans, sugar), accounted for nearly 20% of carbon emissions early this century ([Canadell et al. 2007](#)).
- On Indonesia's main island of Sumatra, home of the last Sumatran Rhinos, deforestation destroys 5 football fields worth of rainforest **per minute**.
- Forests remove ~2.4 billion tons of carbon from atmosphere per year ([Canadell et al. 2011](#))
- Stopping tropical forest cutting leads to rapid carbon uptake into new trees, and also into root systems underground
- **An area the size of the UK is lost to deforestation every two years.** Stopping this would cut 4.5 - 8.8 billion tonnes of CO<sub>2</sub> emissions each year, the UN says (10-20 per cent of [global emissions](#)).



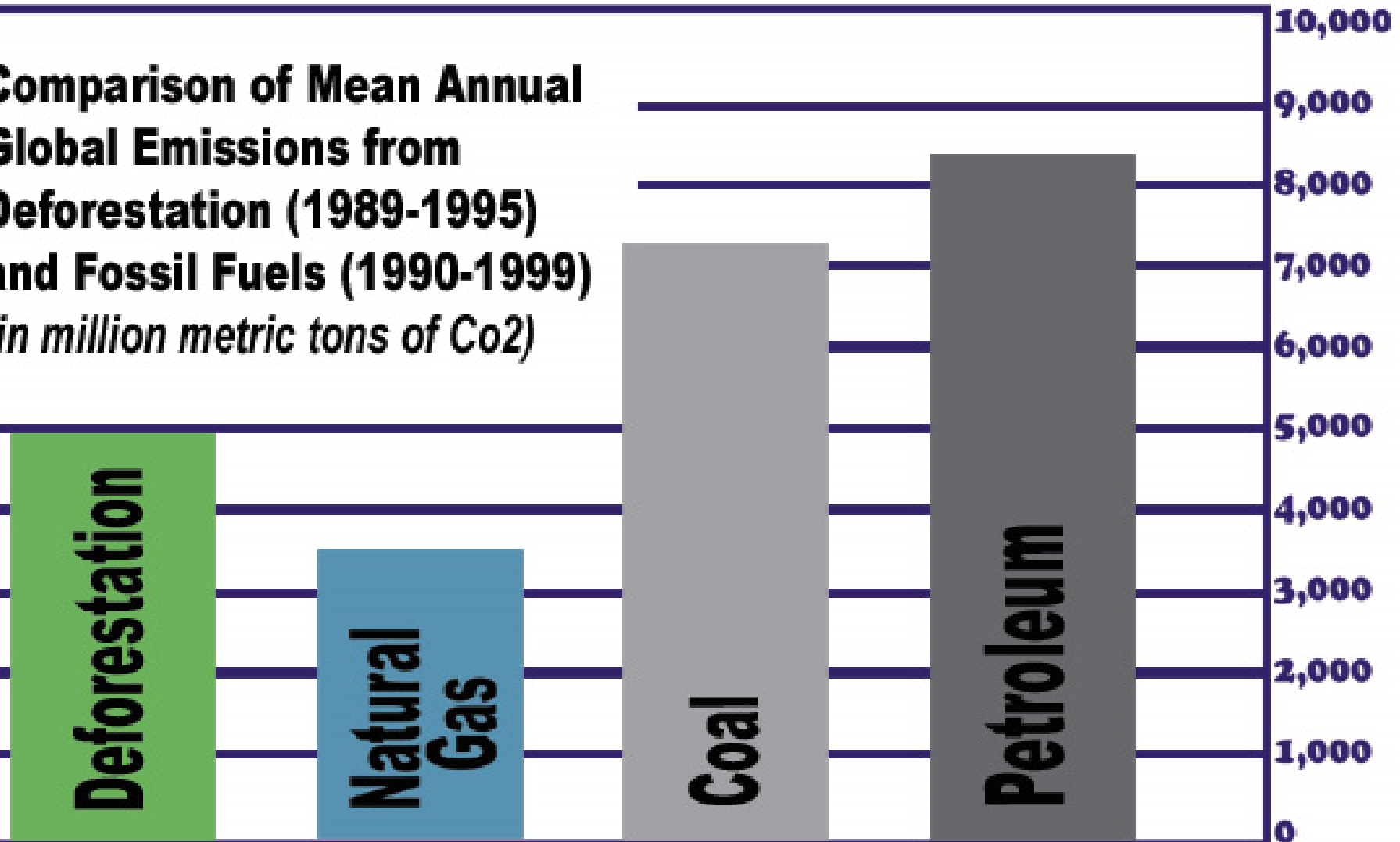
## **Something to think about.**

The Earth is 4.6 billion years old. Let's scale that to 46 years. We have been here for 4 hours. Our industrial revolution began 1 minute ago. In that time, we have destroyed more than 50% of the world's forests.

**This isn't sustainable.**

# Deforestation: Produces about 1/4 or 25% as much CO2 per year as fossil fuel burning

**Comparison of Mean Annual Global Emissions from Deforestation (1989-1995) and Fossil Fuels (1990-1999)**  
*(in million metric tons of Co2)*



# As of 2017 – These figures are now wrong.

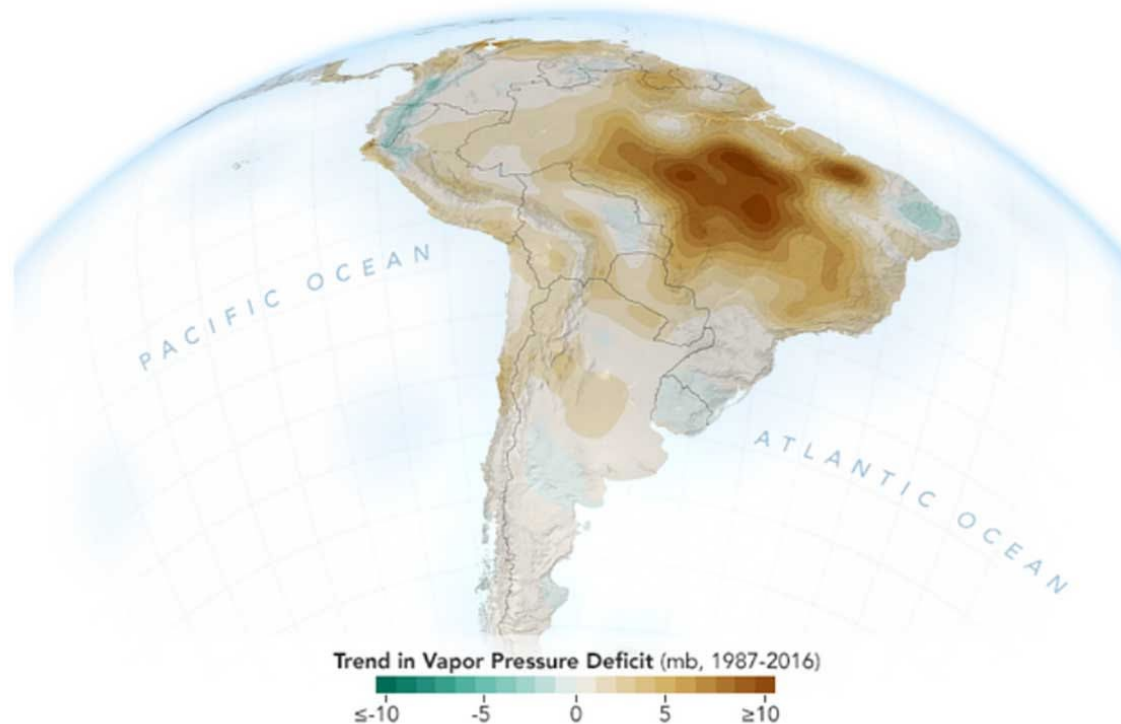
- First, deforestation is re-accelerating. But worse...
- New measurements which supplement satellite images with on-site evaluation of degradation under the existing canopy, find that **tropical forests are no longer sequestering carbon**, but instead are net emitters of CO<sub>2</sub> and methane ([Baccini et al. 2017](#)) and discussed [here](#).
- Clear cutting of the tropical forest is monitored by satellite, but sub-canopy human-induced degradation of uncut forest now turns out to be contributing even more carbon than the deforestation (!), enough so that...
- Rather than net sequestering carbon, tropical forests are degrading so rapidly they are now **emitting** CO<sub>2</sub> at ~5% the rate of all human CO<sub>2</sub> emissions. They had been thought to contribute a small net sequester of carbon.

# A New Study in 2020 Confirms

- "One big concern for the future of humanity is when carbon-cycle feedbacks really kick in, with nature switching from slowing climate change to accelerating it.
- "After years of work deep in the Congo and Amazon rainforests we've found that one of the most worrying impacts of climate change has already begun. **This is decades ahead of even the most pessimistic climate models.**" – [\(Lewis et al. 2020\)](#)

# Worse: The Amazon may have already hit the tipping point spelling the end of the rain forest

Since the 1980s, NASA has observed a significant increase in something called the vapor pressure deficit (VPD) over the Amazon rainforest. The VPD is the difference, or gap, between the amount of moisture in the air and the amount it can hold. That gap is widening, which represents a drop in relative humidity, due to an increase in greenhouse warming from human-caused climate change and aerosols from biomass burning.



NASA measures more vapor pressure deficit increasing in the Amazon Basin over recent decades which means the atmosphere trend is toward a lower relative humidity. Overall it is an indicator of drying.

# It's reached the 20% Deforestation Tipping Point

- “When Lovejoy started studying the Amazon in the 1960s, 10 million people lived there and the forest was 97% intact. Now there are 30 million people living there and deforestation in the Brazilian Amazon is at 20% — the critical level at which scientists believe the Amazon starts to tip towards the point of no return, where it no longer survives as a lush wet rainforest and transitions into an arid savanna.”



# Regrowth can soak up Carbon

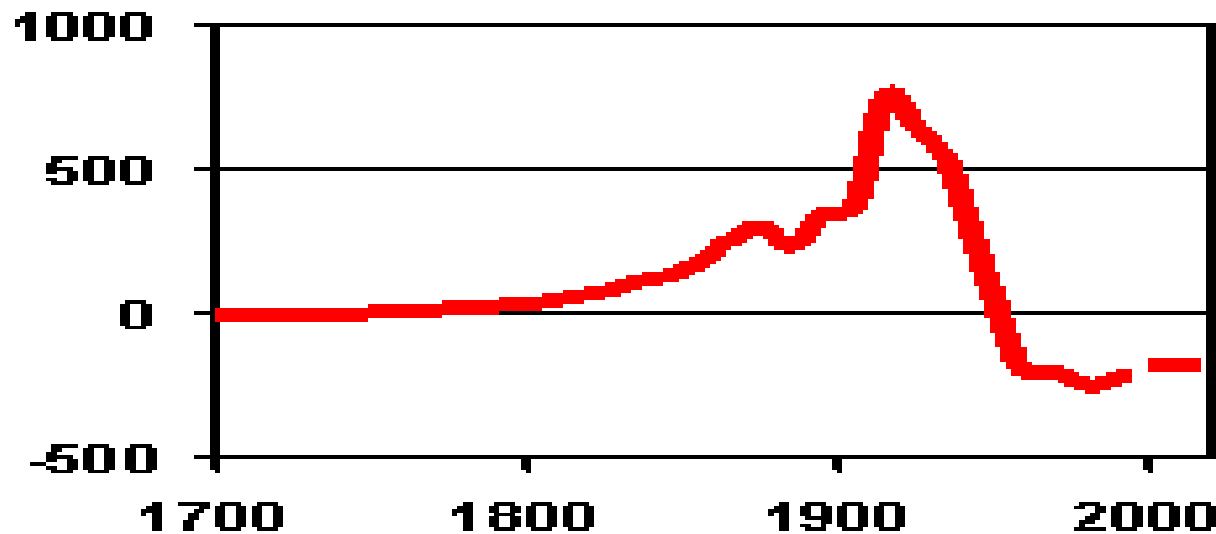
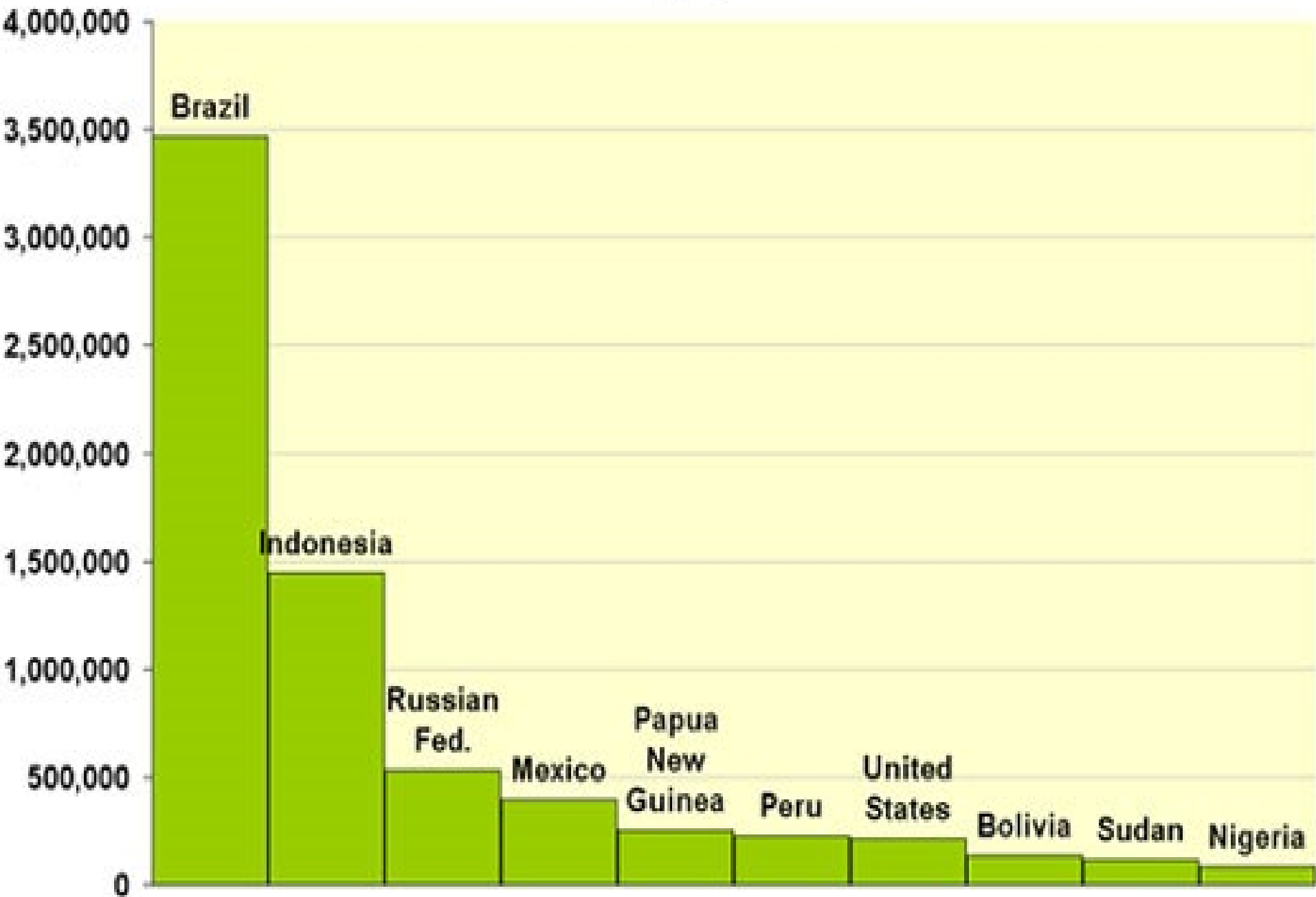


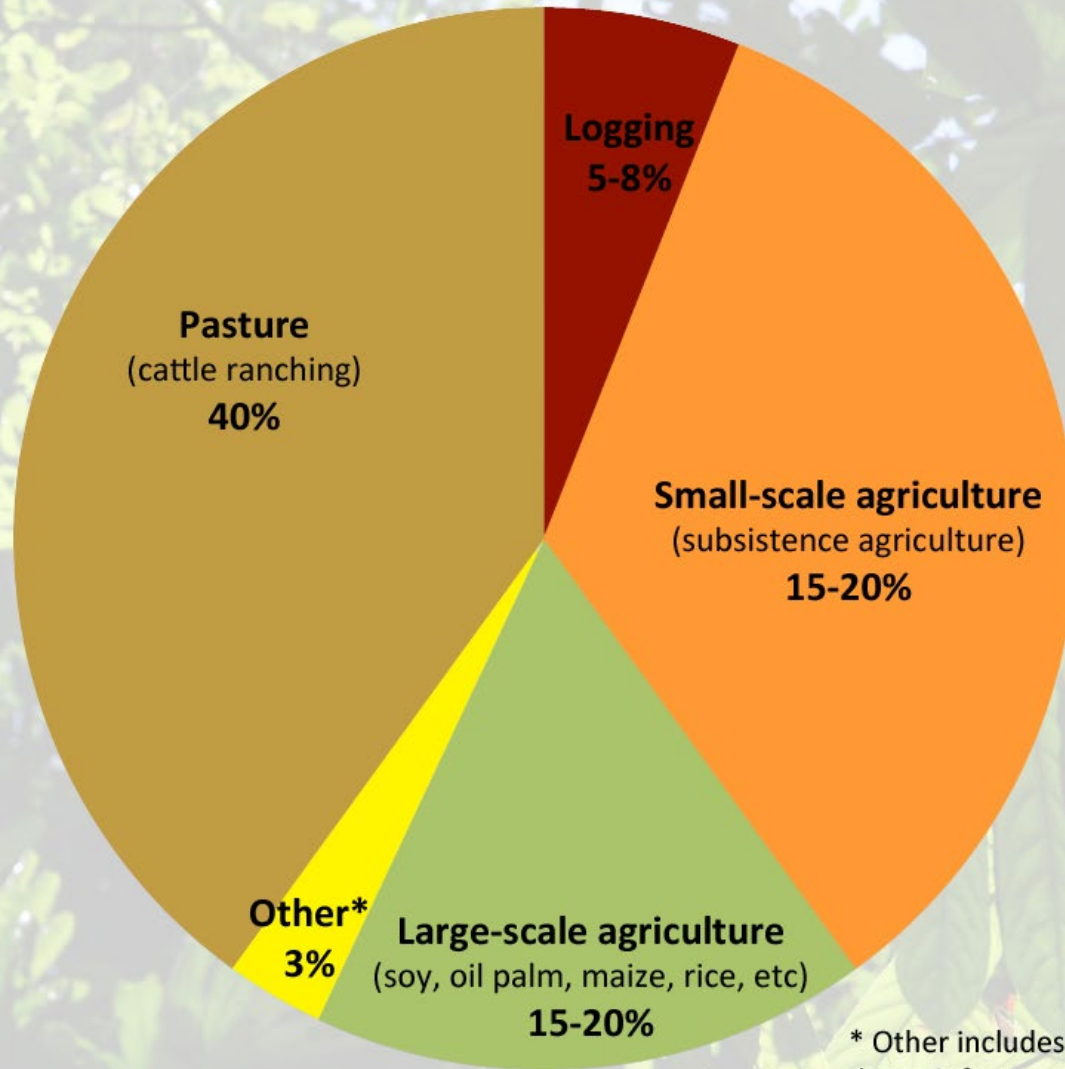
Figure 1—Carbon balance of the U.S. forest sector in millions of metric tons of carbon per year. The large flux of carbon from forests to the atmosphere (from logging and deforestation) peaked in 1915 at 760 million metric tons of carbon per year. Currently forests take up about 250 million metric tons of carbon per year. From Birdsey et al. (2006).

Highest deforestation of natural forests, 2000-2005. All countries.  
Hectares per year



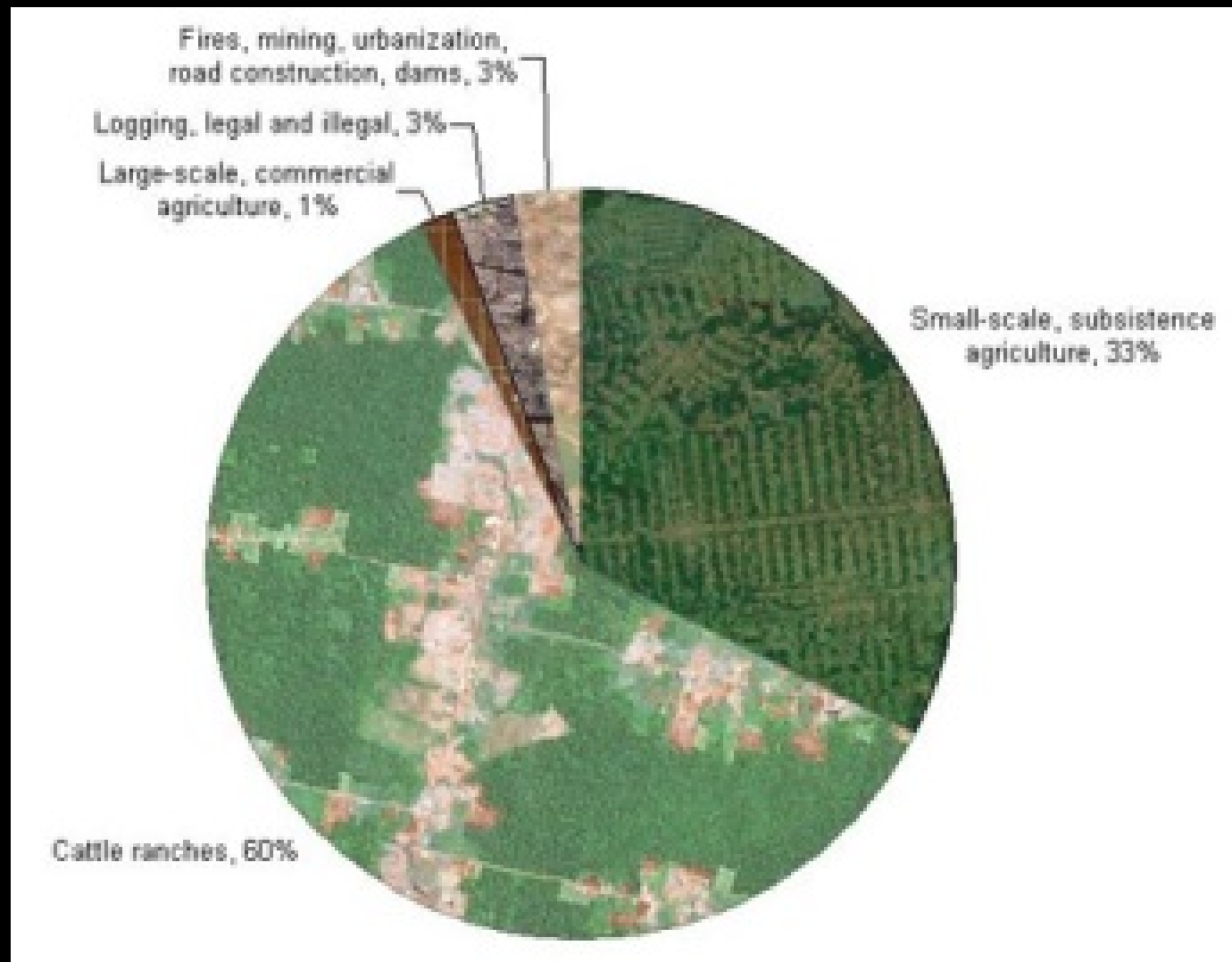
# For Tropical Forests Generally...

CAUSES OF TROPICAL DEFORESTATION, 2000-2005

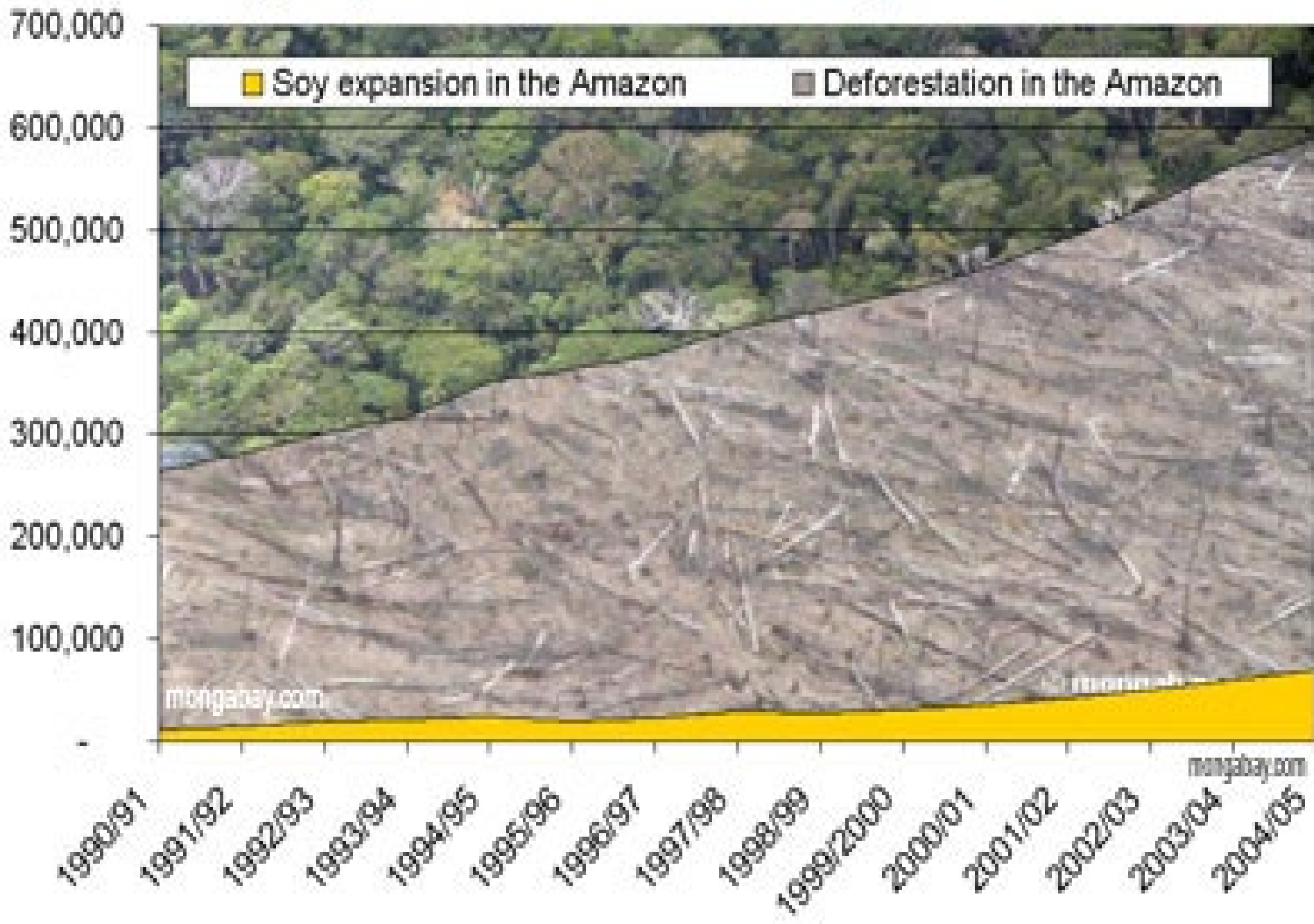


\* Other includes urbanization, dams, infrastructure, mining, non-agricultural fires

# Causes of Amazon deforestation: mostly cattle ranches due to demand from rapid proliferation of fast food outlets world wide



# Soy expansion in the Amazon, 1990-2005



# These vast areas planted for Palm Oil...

- Kill thousands of square miles of centuries old tropical hard wood forests and ecosystems.
- What's the payoff? A cheap oil – palm oil, found extensively in almost all fast foods
- These plantations have a commercial life of only 25 years. Is it really worth it?
- This is another example of the striking short-term'ism of our economic system

**60% of “Cerrado” land has been cut and converted to Agriculture, and 10% of the “Forest” Land, but that ignores the sub-canopy degradation documented in the [Baccini et al 2017](#) study. Now in ‘20, far worse.**



# Brazil Strongman Jair Bolsonaro

## – “The Trump of the Tropics”

- Has taken power in Brazil and forest fires in the Amazon have gone up 83% in 2019 vs. 2018, as land is cleared for development.
- *“In response to this latest data, Bolsonaro brushed it off and said ‘it was the season of the queimada’, when farmers use fire to clear land. ‘I used to be called Captain Chainsaw. Now I am Nero, setting the Amazon aflame’, [Reuters quoted](#)”*



- [Abatzoglou & Williams 2016](#) find that climate change has caused a **doubling** of the acreage that would normally have burned in the Western U.S. since 1984.
- [Williams et al. 2019](#) find that California's situation is worse. Since 1972 the annual burn area each year is up **500%**



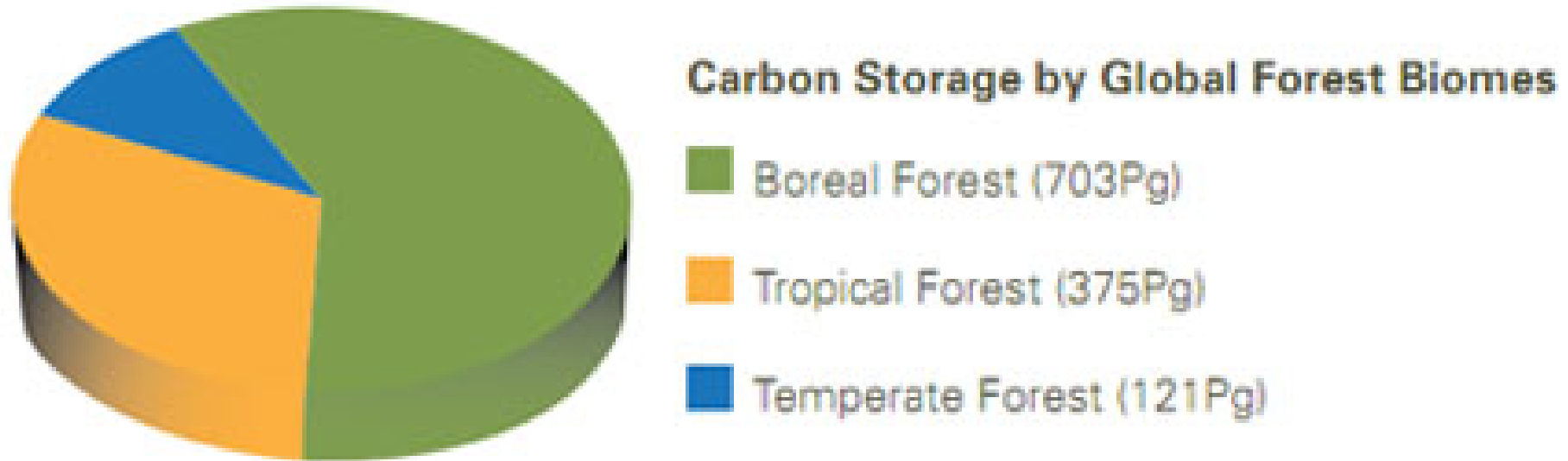
# Effects of Deforested Land on Climate

- **1.** Carbon burned or otherwise put back into the atmosphere as CO<sub>2</sub>
- **2.** Loss of photosynthesis = loss of ability to pull CO<sub>2</sub> out of the atmosphere
- **3.** Healthy forest returns  $\frac{3}{4}$  of rainfall back to the atmosphere where it can rain out elsewhere. Deforested land returns only  $\frac{1}{4}$  of rain water back to the atmosphere for further downwind rainmaking, instead causing severe runoff, erosion, loss of topsoil, and loss of all to the ocean
- **4. Leading to: Lost Forests convert to desert or shrub, since tropical soils generally poor.**

# Boreal Deforestation

- Boreal forests are 30% of the Earth's forests
- The far north of Canada, Alaska, and Eurasia has conifer forests under stress.
- This ecosystem is not evolved to handle +10C average temperature rise which they face, as Arctic temperatures rising 2-3 times faster than global land temperatures.
- Wildfires rising steeply due to hotter temperature-induced drying, spreading ash over Greenland, accelerating melt there.

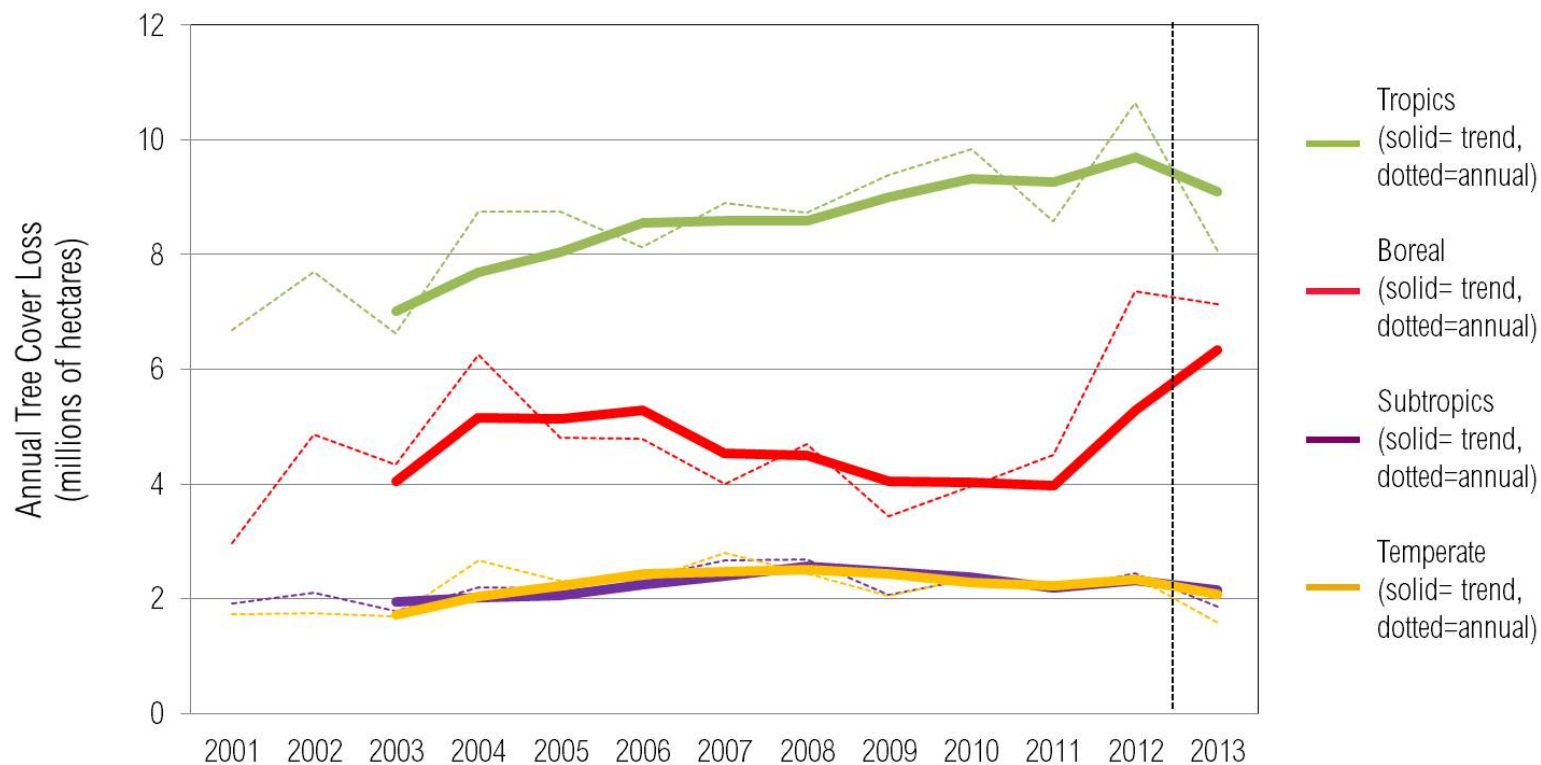
# Boreal: Only 30% of Forests, but 59% of the carbon storage, due to the vast carbon stored in the permafrost and other Boreal soils



**Figure 1:** A comparison of carbon storage by global boreal, tropical and temperate forests. One Pg (petagram) is equivalent to one billion tonnes.

# 21<sup>st</sup> Century rapidly accelerating Arctic Ocean loss is heating the Arctic faster than anywhere else on Earth, and so Boreal forests showing steepest loss.

## Steepest Increase in Annual Tree Cover Loss Occurs in Boreal Region, 2001-2013



Trend line represents a three-year moving average. The trend may represent a more accurate picture of the data due to uncertainty in year-to-year comparisons.

All figures calculated with a 30% minimum tree cover canopy density.

Data generated as update to "High-Resolution Global Maps of 21st-Century Forest Cover Change" by Hansen et al.

# Competing effect: Melting permafrost allowing tree line to migrate north

- This would sequester additional carbon, perhaps (except for the carbon release from the permafrost melting which permits this march northward).
- But, this is very slow, and is being dwarfed by the losses from insect-induced death, ecosystem loss, logging...
- And - very large fires in temperate latitudes are expected to rise 6-fold by mid-century
- Tree line migration is only 0.1 kilometers per decade (Source)

# Key Points: K38e - Deforestation

- Deforestation takes out an area half the size of the England, Scotland, and Ireland every year
- Deforestation CO<sub>2</sub> in 1990's was ¼ of that contributed by Fossil Fuel burning
- Cutting trees in tropics is the worst for climate: reduces rainfall, causes desertification.
- Brazil is the worst offender by far
- Prime reason for deforestation: cattle ranches for meat (mostly for fast-food outlets).
- Boreal forests showing steepest losses, due to fastest climate change. Hold 60% of Earth's forest carbon
- Tropical forest **degradation** accelerating rapidly, tropical forests now net carbon emitters – 5% as much as all human emissions. Previously thought to be carbon sequesters