Plants as solutions to global warming?

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A mature redwood tree can contain the equivalent of 800 tons of CO_2

That is 16 times the amount released into the atmosphere annually by an average US household.

Plants take up CO_2
(and produce it, too…)

Photosynthesis:

solar energy

$$CO_2 + H_2O \rightarrow CH_2O + O_2$$

- Some of the energy fixed by plants is used to maintain and repair plant tissues and their functions. That energy is used through respiration: $CH_2O + O_2 \rightarrow CO_2 + H_2O + \text{energy}$

Photosynthesis takes place in chloroplasts, mostly in leaves

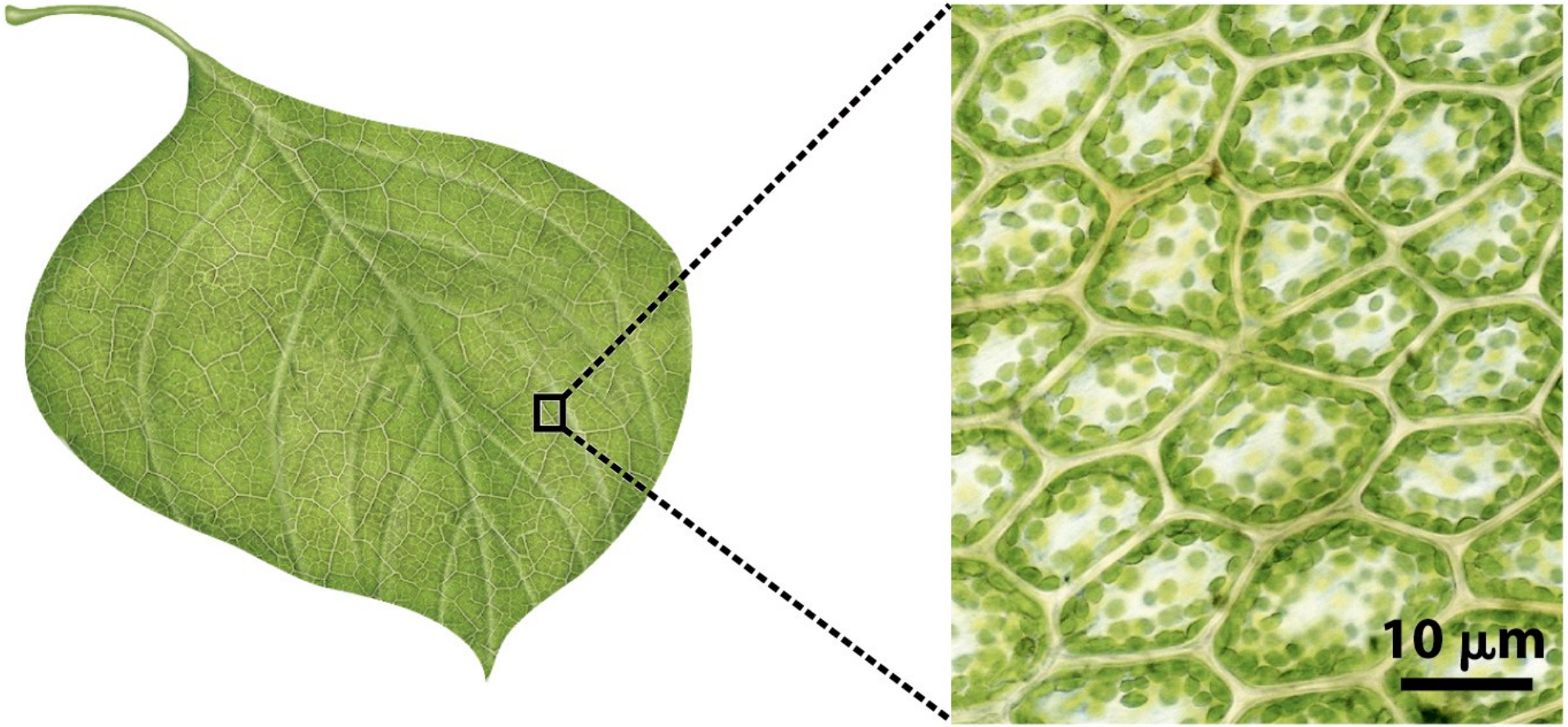


Figure 10-2a part 1 Biological Science, 2/e

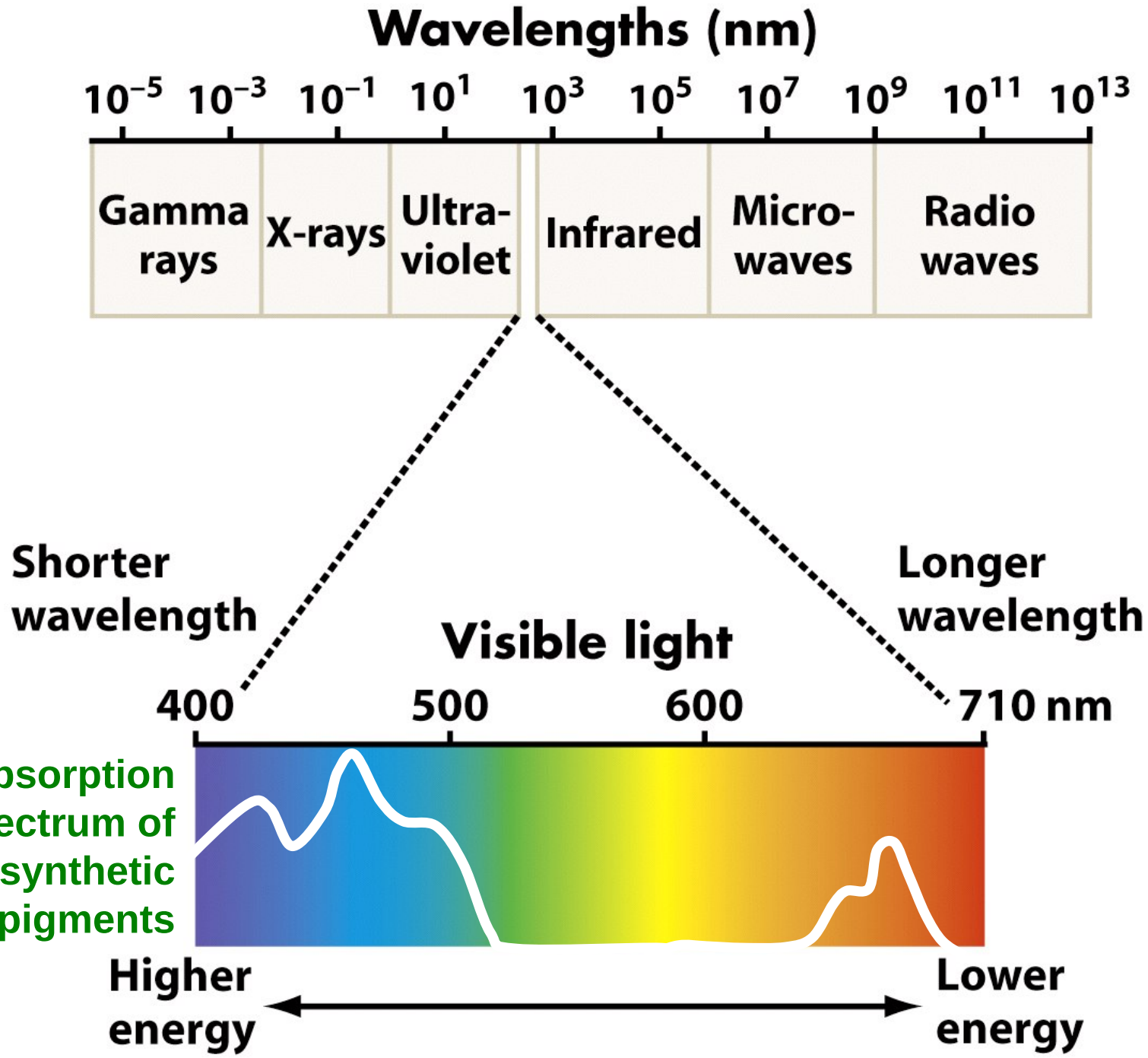
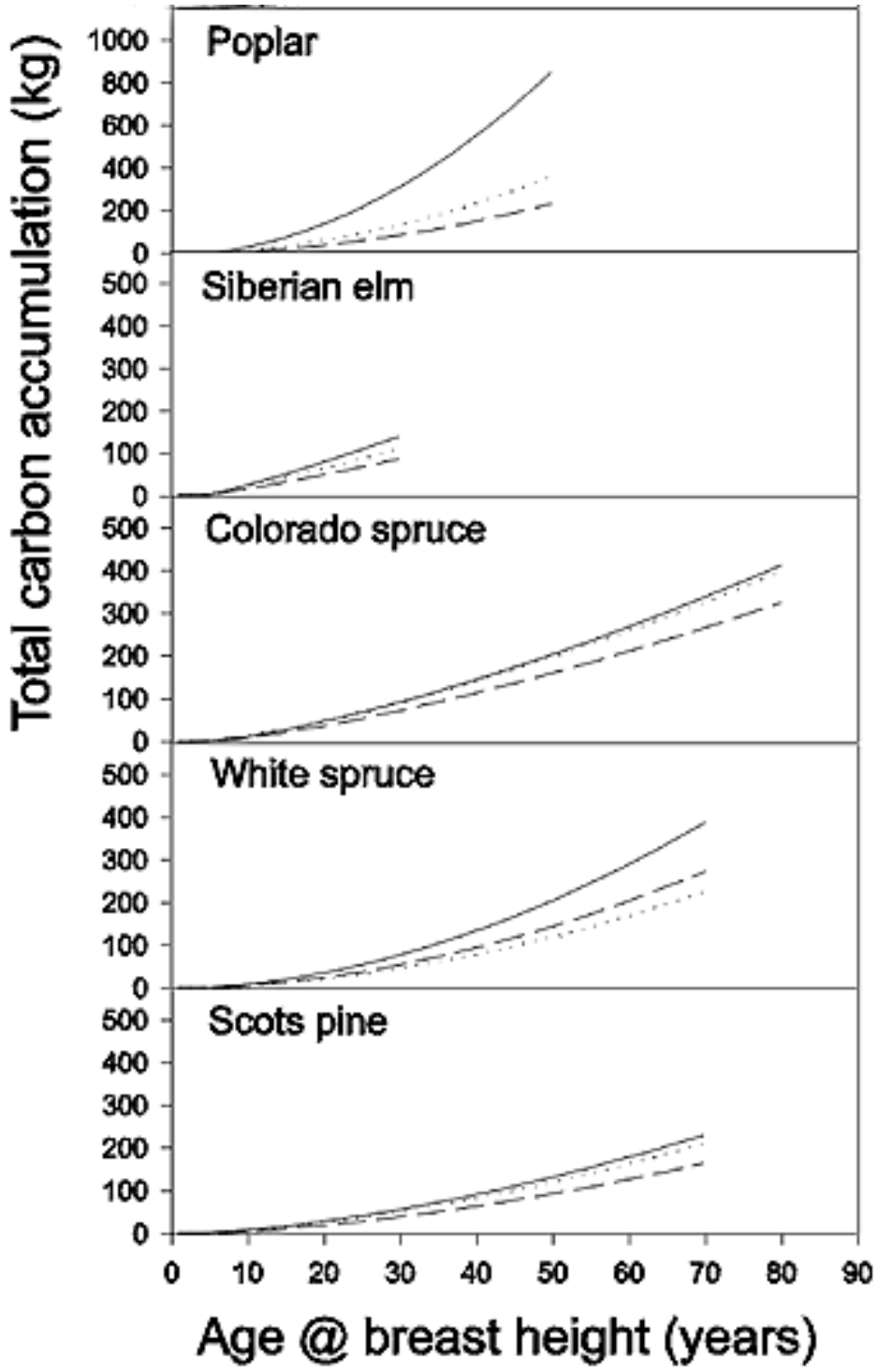


Figure 10-4 Biological Science, 2/e



Carbon accumulation takes time and trees

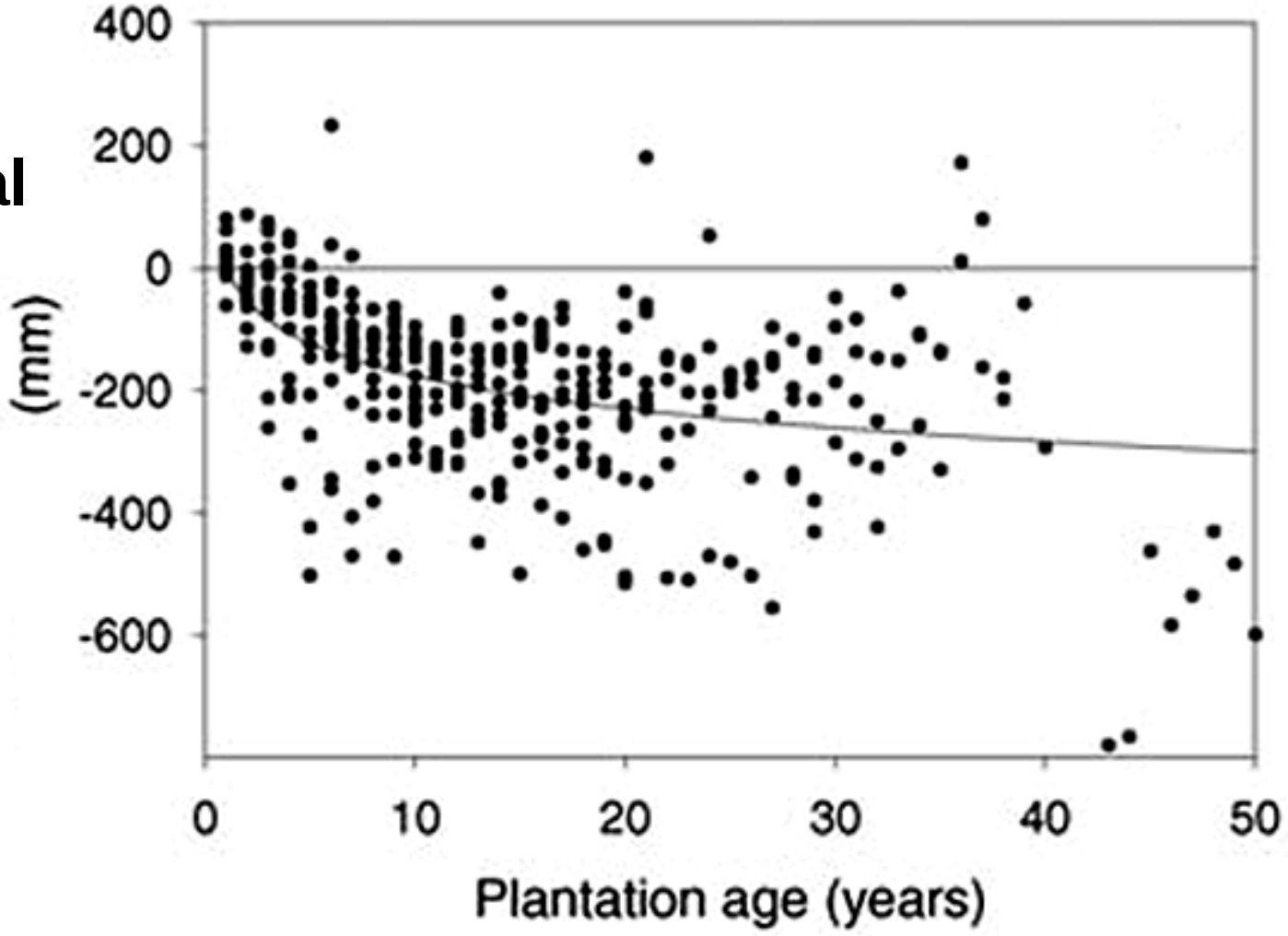
- It would take **300** 25-year-old pine trees to offset a typical US household's 50 t CO_2 carbon footprint.

http://www4.agr.gc.ca/resources/prod/img/pfra/shelterbelt/afifcarfig3.gif

1 house, 300 pine trees

… and trees use water …

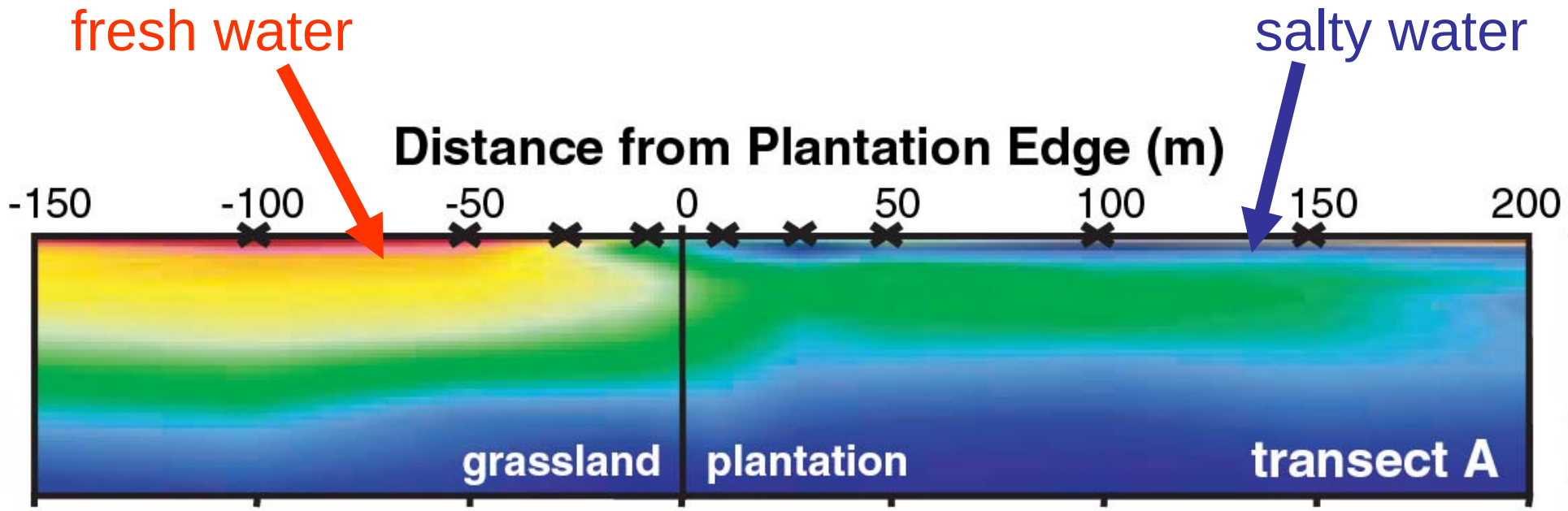
Change in annual runoff



- **Jackson et al. 2005.** Trading water for carbon with biological carbon sequestration. *Science* **310**: 1944-1947.

… and can have other effects on the environment, …

- …such as soil salinization by redistribution of saline groundwater to the surface soil. This was observed under *Eucalyptus* plantations in Argentina.



Jackson et al. 2005. Science 310: 1944-1947.

Carbon sequestration *vs.* plants as bioenergy

- Using trees for carbon sequestration (= carbon offsets)
  - requires a lot of trees,
  - requires water,
  - takes a long time,
  - may have adverse environmental impacts,
  - and requires certainty that carbon stays in the trees and their ecosystems for a long time (e.g., no fires!).
- Using plants as bioenergy to replace fossil fuels has a much more immediate impact on carbon emissions.

Bioenergy crops

Platforms	Feedstock	NEB[b] GJ/ha/yr	NER[b]	CO_2 balance
Ethanol from starch or sucrose	Maize	10–80	1.5–3.0	Positive
	Sugarcane	55–80	3.0–4.0	Positive
	Sugar beet	40–100	2.5–3.5	Positive
	Sweet sorghum	85–300	5–10	Positive
Ethanol from lignocellulosic feedstocks	Miscanthus	250–550	15–70	Possibly negative
	Switchgrass	150–500	10–50	Possibly negative
	Poplar	150–250	10–20	Possibly negative
Biodiesel	Soybean	−20–10	0.2–0.6	Positive
	Canola	−5–2	0.7–1.0	Positive
	Sunflower	−10–0	0.3–0.9	Positive

Possibly also sequester carbon

NEB = net energy balance, NER = ratio of energy output to energy input

Source: Yuan *et al.* 2008. Trends in Plant Science 13:421-429.

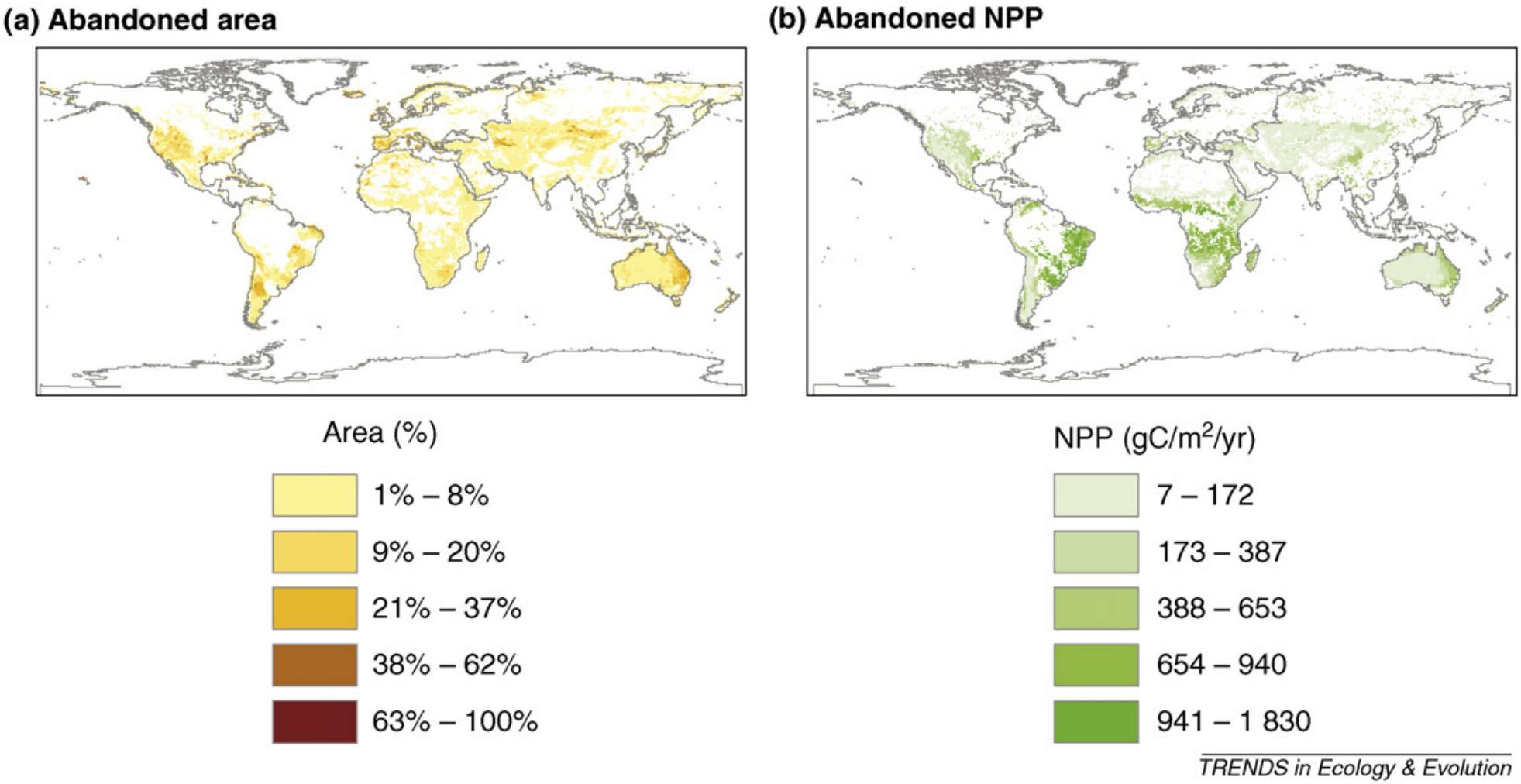
Miscanthus

Source: University of Arkansas: http://dailyheadlines.uark.edu/

Where to plant bioenergy crops?

- Lands now occupied by natural vegetation.
  - This would result in a net CO_2 release.
- Agricultural lands now used for food production:
  - A terrible idea that has already caused food shortages and resulted in rising food prices globally (Gallagher Review 2008, UK Renewable Fuels Agency).
- Abandoned agricultural lands.
  - The area of such lands worldwide is limited.

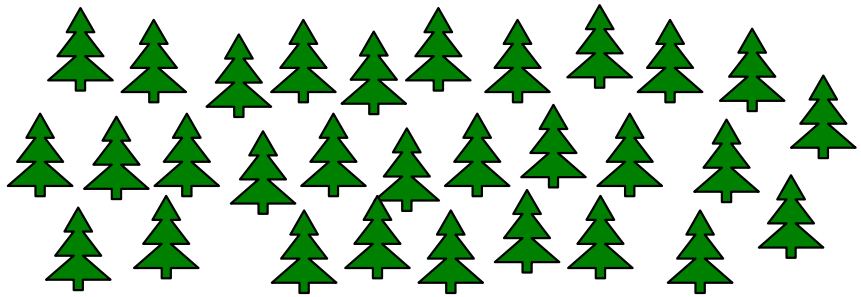
Abandoned agricultural lands



- Plant growth on these areas could offset ~5% of global energy consumption (Field *et al.* 2008. TREE 23:65-72).

So how can plants help us?

- Carbon sequestration in trees and bioenergy cannot be the only solutions to global warming,
- … but they can be solutions if we reduce our carbon footprints!
- Remember the 300 pine trees needed to offset a current US household's annual carbon footprint?
- How about reducing our households' carbon footprints to 5 t CO_2 and using 30 pine trees to offset that whole footprint?

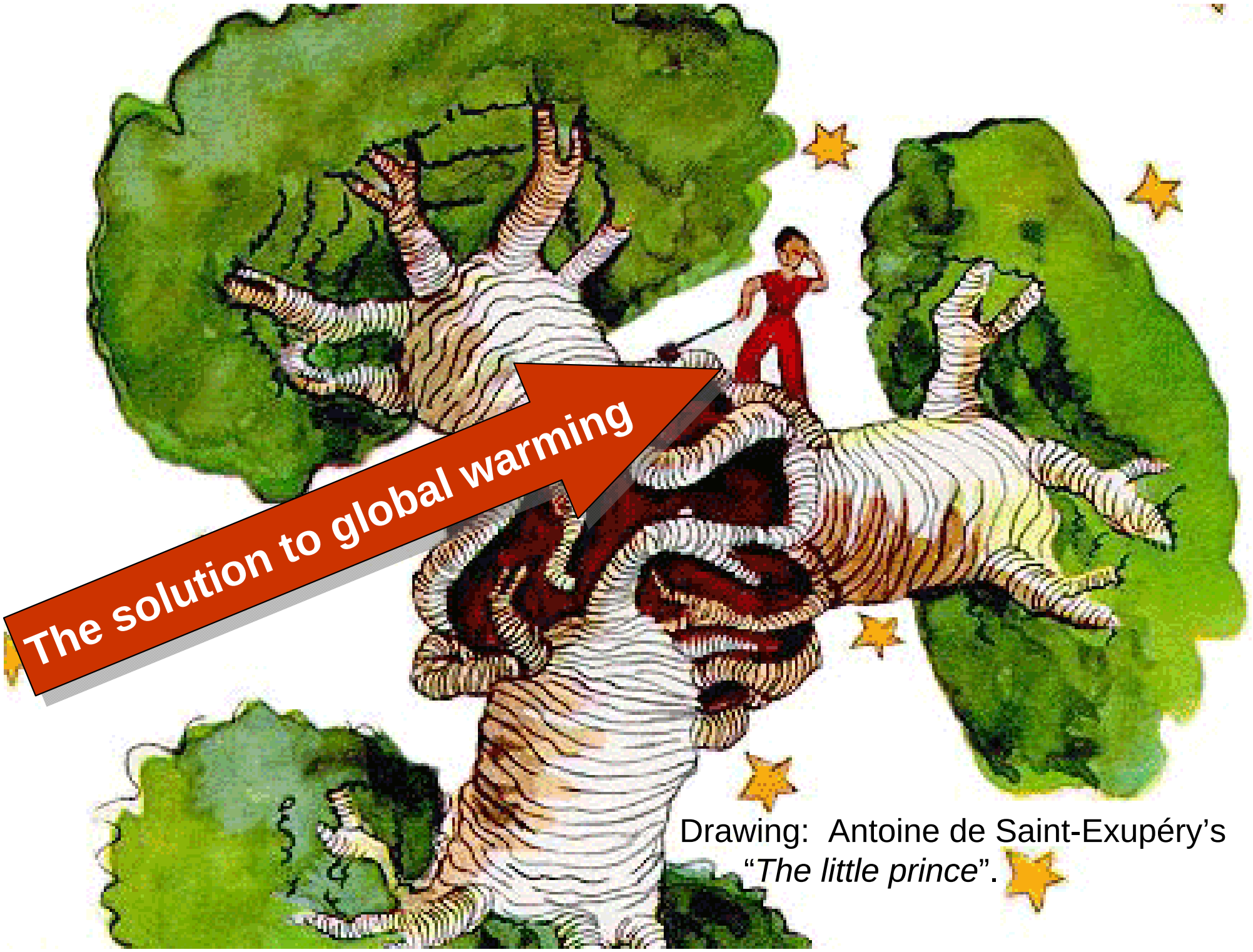


Calculate your carbon footprint

- One of the best carbon footprint calculators is at: http://www.coolcalifornia.org/calculator.html

What can you do?

- Help to **plant trees** now so that they can become part of a future solution as they grow.
  - Support the UNEP “Billion Tree Campaign”
- **Urban trees** sequester carbon and can reduce air-conditioning bills by shading buildings.
  - Calculate your carbon savings with the CUFR Tree Carbon Calculator at: http://www.fs.fed.us/ccrc/topics/urban-forests/
- **Biodiesel** is no global solution, but using biodiesel from used vegetable oil can be a solution for individuals like you.



Drawing: Antoine de Saint-Exupéry's "*The little prince*".