

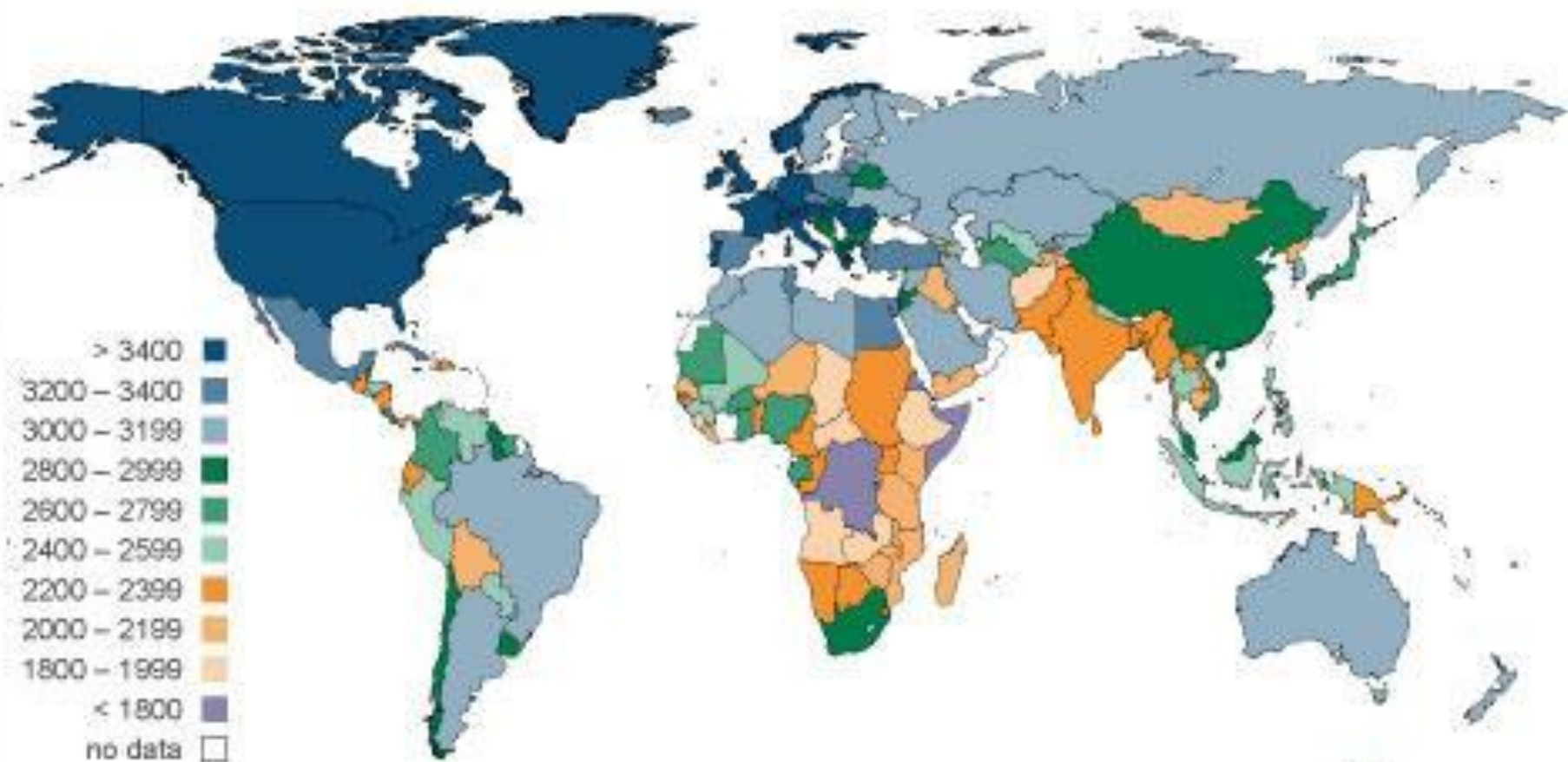
# 2014: High CO2 Makes Crops Less Nutritious

- Published in Nature, thanks Yumi!

<http://news.nationalgeographic.com/news/2014/05/140507-crops-nutrition-climate-change-carbon-dioxide-science/>

- Samuel Myers of Harvard University and colleagues report that the CO2 levels expected in the second half of this century will likely **reduce the levels of zinc, iron, and protein in wheat, rice, peas, and soybeans.** Some **two billion people** live in countries where citizens **receive more than 60 percent of their zinc or iron from these types of crops.** Deficiencies of these nutrients already cause an estimated loss of 63 million life-years annually.

# Daily calorie intake 2003-2005



Source: Food and Agriculture Organization/United Nations

Reuters graphic/Stephen Culp, Catherine Trevethan

 **REUTERS**

09/11/09

Last Time...

Timing of Seasons have changed: spring events occurring an average of 2.3 to 5.1 days earlier each decade

Autumn events delayed by 0.3 to 1.6 days per decade

# Effect on species ranges

- Heat and drought at mid-latitudes
- Expanded growing seasons at **higher latitudes**
- Expanded growing seasons at **higher altitudes**

Species have migrated 16.9 km closer to the poles and 11.0 meters higher in elevation each decade

# Amphibians and Temperature Change

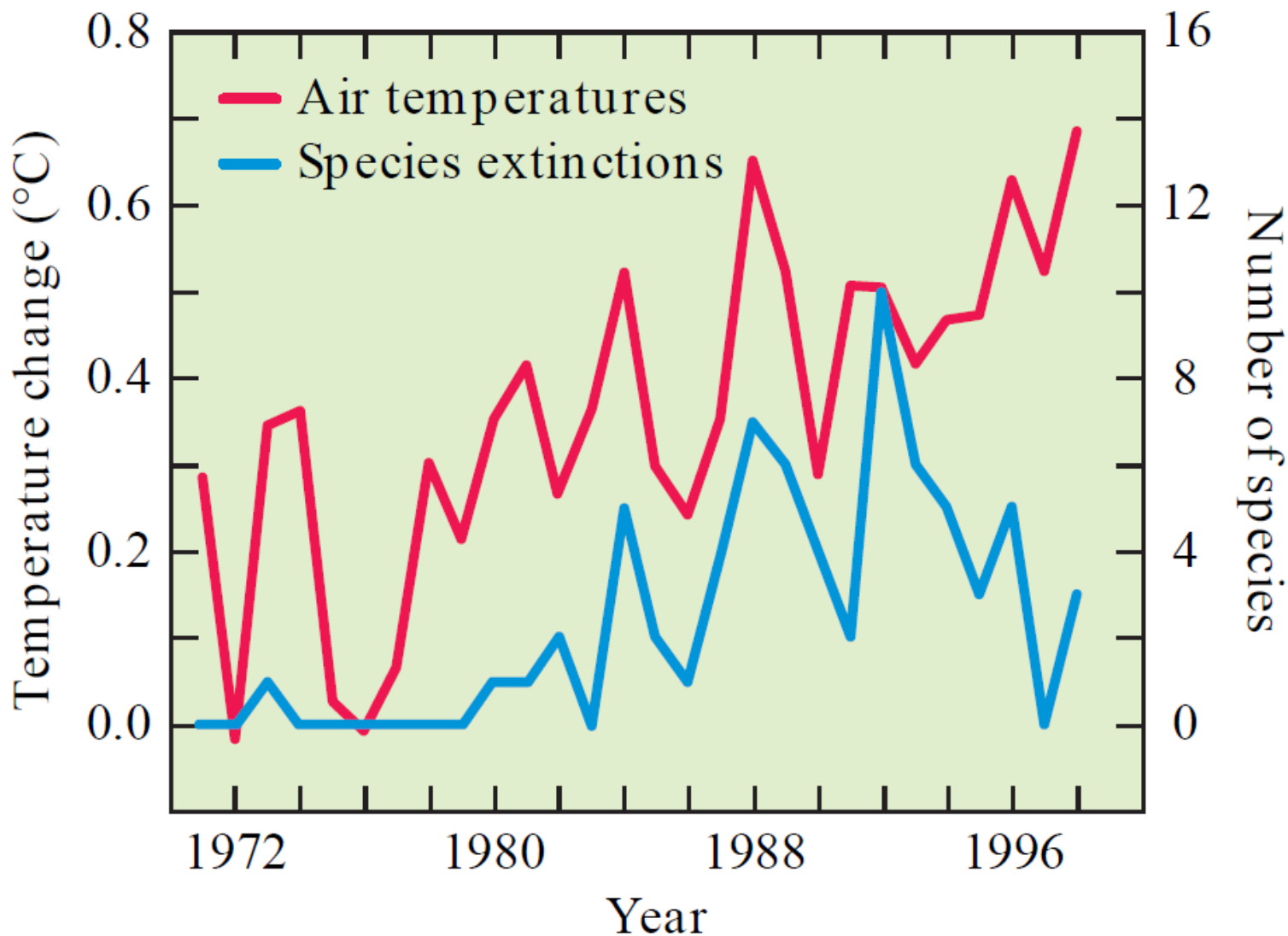
Rely on both aquatic and terrestrial systems  
Moist permeable skin functions as a respiratory organ

Pathogenic fungus infections

Warm temps = happy fungus



# Changes in Air Temp and number of frog species that became extinct





# Other Factors

- Habitat loss
- Disease
- Invasive species
- Overexploitation
- Chemical pollution



Golden Toad. in the cloud forest above Monteverde, Costa Rica. This species is presumed extinct because it has not been seen since 1989



- Since 1980, 32.3% of amphibious species have declined in population size
- 7.4% are on the brink of extinction
- Between 0.2% and 2.1% have disappeared



# California Tiger Salamander - Threatened









# Disease and Pathogens

**Table 6.4** Vector-borne diseases that may be sensitive to global warming. (Haines *et al.* 2006)

<b>Vector</b>	<b>Examples of major diseases</b>
Blackflies	Onchocerciasis (river blindness)
Mosquitoes	Malaria, filariasis (elephantiasis), dengue fever, yellow fever, West Nile fever
Sandflies	Leishmaniasis (Orient Boils, black fever, Dum-Dum fever)
Ticks	Lyme disease, tick-borne meningoencephalitis
Triatomines (kissing bugs)	Chagas disease (American trypanosomiasis)
Tsetse flies	African trypanosomiasis (sleeping sickness)

# Disease and Pathogens

Warmer temperatures speeds pathogen and vector development

Extended range of vectors (blood sucking insects)

- Cities that were too cold for vectors now warming
- Vectors and hosts gather at water sites in drought



Currently, 35% of the human population at risk of dengue fever

–Currently limited to tropics and subtropics by temperature

Models predict risk will rise to 50%-60% of the human population





# Climate change will affect the following factors

- Carbon Dioxide levels
- Temperature
- Precipitation
- Salinity
- pH (acid level)

# Precipitation and Food Production



tropical and polar regions have become wetter  
mid-latitudes have become drier

**geographical distributions shifting in response**

Most land on Earth that can be farmed already is

Crops not timed to take advantage of seasonal water. Instead, irrigated year round

Irrigated acreage and water withdrawals for agriculture have doubled over the last 25 years



# Central Valley, CA

- More than half of the fruits and vegetables consumed in the U.S. and Canada are grown here
- Dependent on irrigation during growing season
- Irrigation water comes from snowpack in the Sierra Nevada Mountains





- All emission scenarios predict a decrease in snowpack in the Sierra Nevada Mountains.
- Water flowing into reservoirs from snowmelt during spring will decrease by 50% by 2100



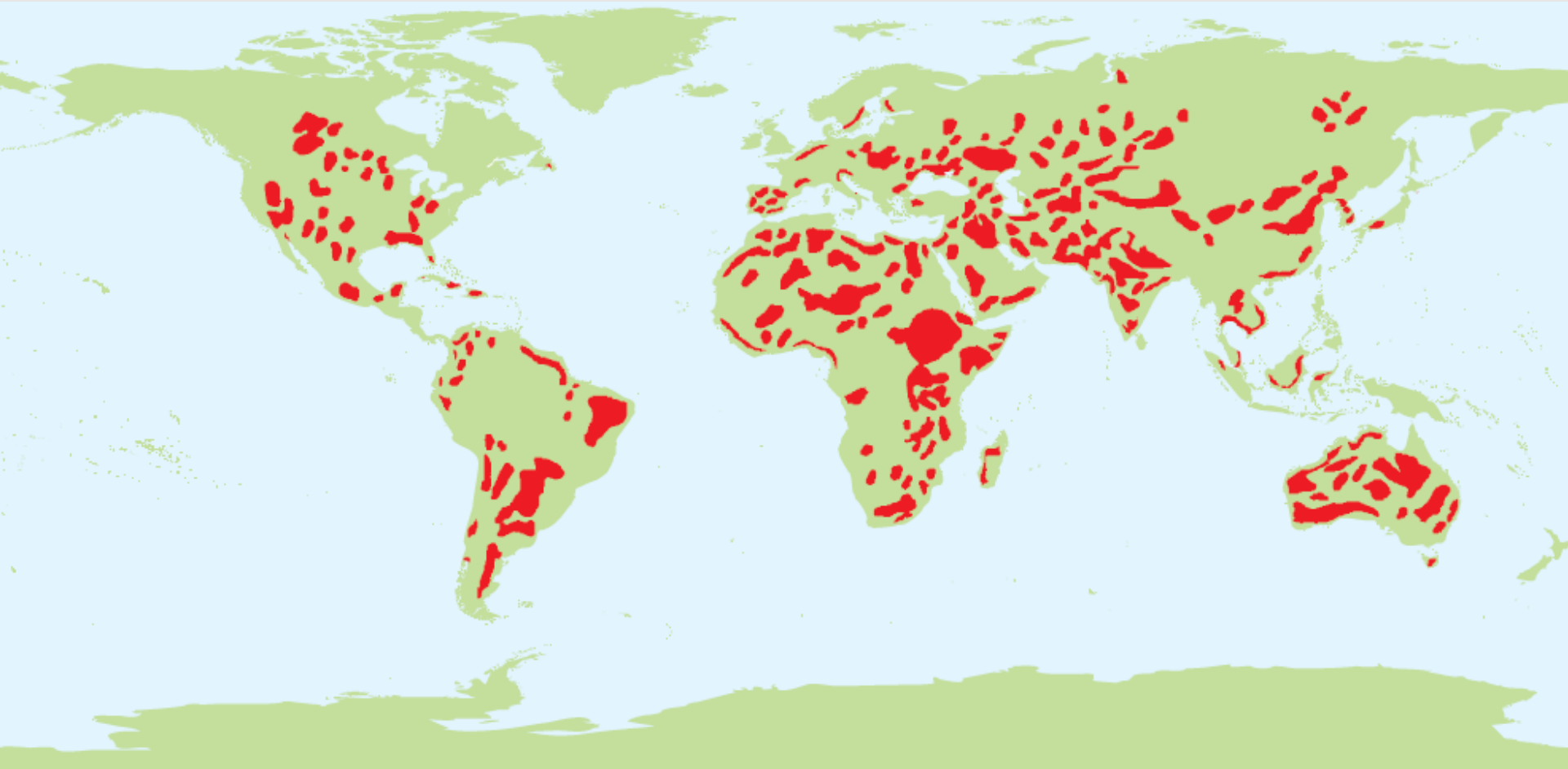
# Salinity

- During evaporation, pure water vaporizes
- Salts left behind becomes more concentrated
- Irrigated farmlands eventually become too salty
- Increased temperature will increase the rate of evaporation





# Global distribution of salt-inflicted areas





# pH: Acid-Base

- Increased atmospheric  $\text{CO}_2$  means increased water acidity
- Sea life with exoskeletons of calcium carbonate ( $\text{CaCO}_3$ ) will thin in more acidic sea water



# Adaptation

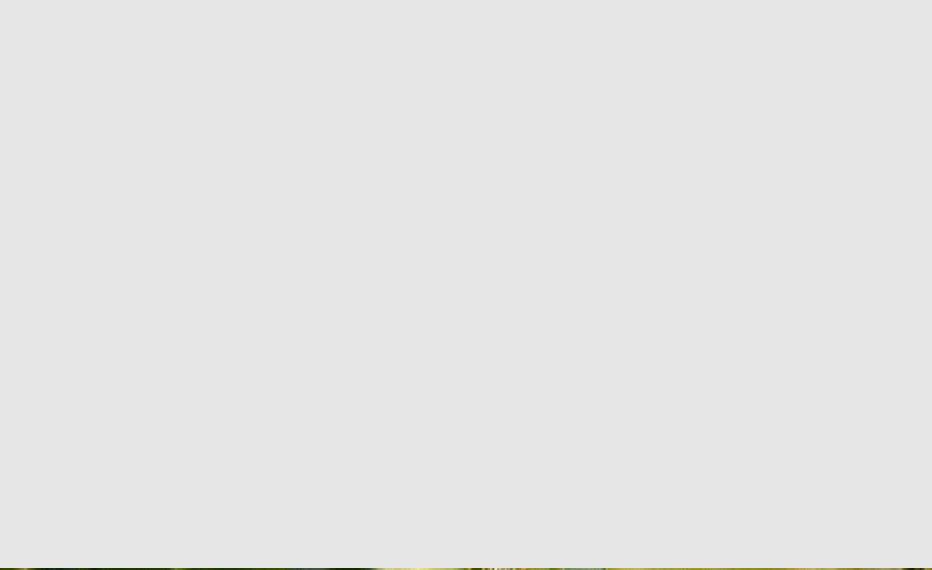
Many species have adapted to climate change in the past

- Current change is much faster
- Species with long generation periods
- Species with restricted habitats
- Species in habitats already impacted by humans



Green Sea Turtle – Sexual Maturity reached at 20-30 years.  
Long generation periods mean slower adaptation





- Small habitat range – no alternative area to move into.
- Conflict with humans

# Adaptation

Some species will adapt!



# Adaptation

- ***CLIMATE CHANGE: Evolutionary Response to Rapid Climate Change***
- *Science 9 June 2006: Vol. 312. no. 5779, pp. 1477 – 1478*

“over the recent decades, climate change has led to heritable, genetic changes in populations of animals as diverse as birds, squirrels, and mosquitoes”





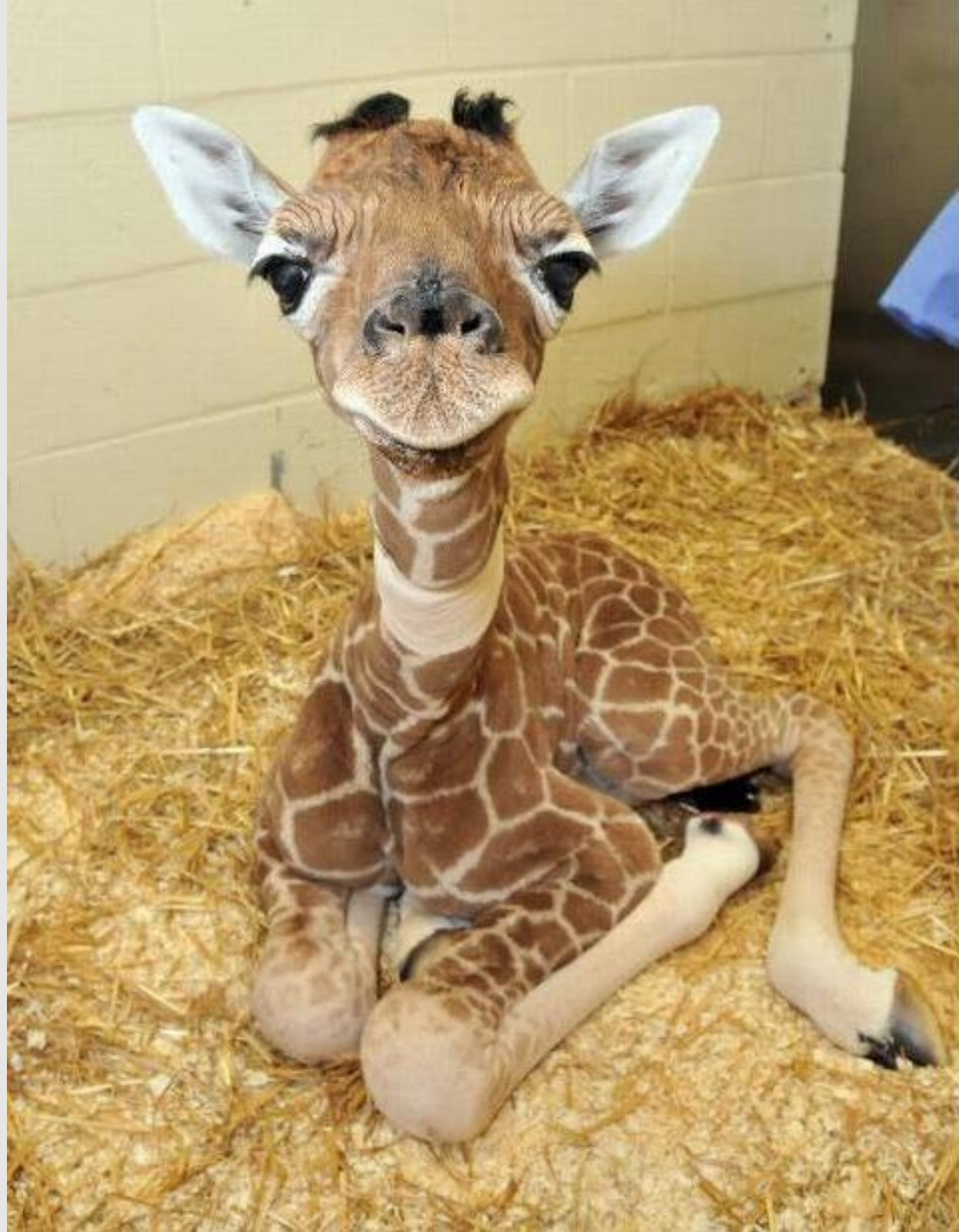
European Great Tit







- Depends on caterpillars to feed their young
- Earlier springs = caterpillars maturing earlier, before the chicks hatch
- Genetic variation in bird's ability to adjust egg laying date
- Birds most able to modify the timing of egg laying in response to the earlier springs are the ones that maintain the greatest lifetime reproductive success. They pass on those genes!



# Mitigation Strategies: Transportation

**Mitigation** = Diminishing the severity of the problem



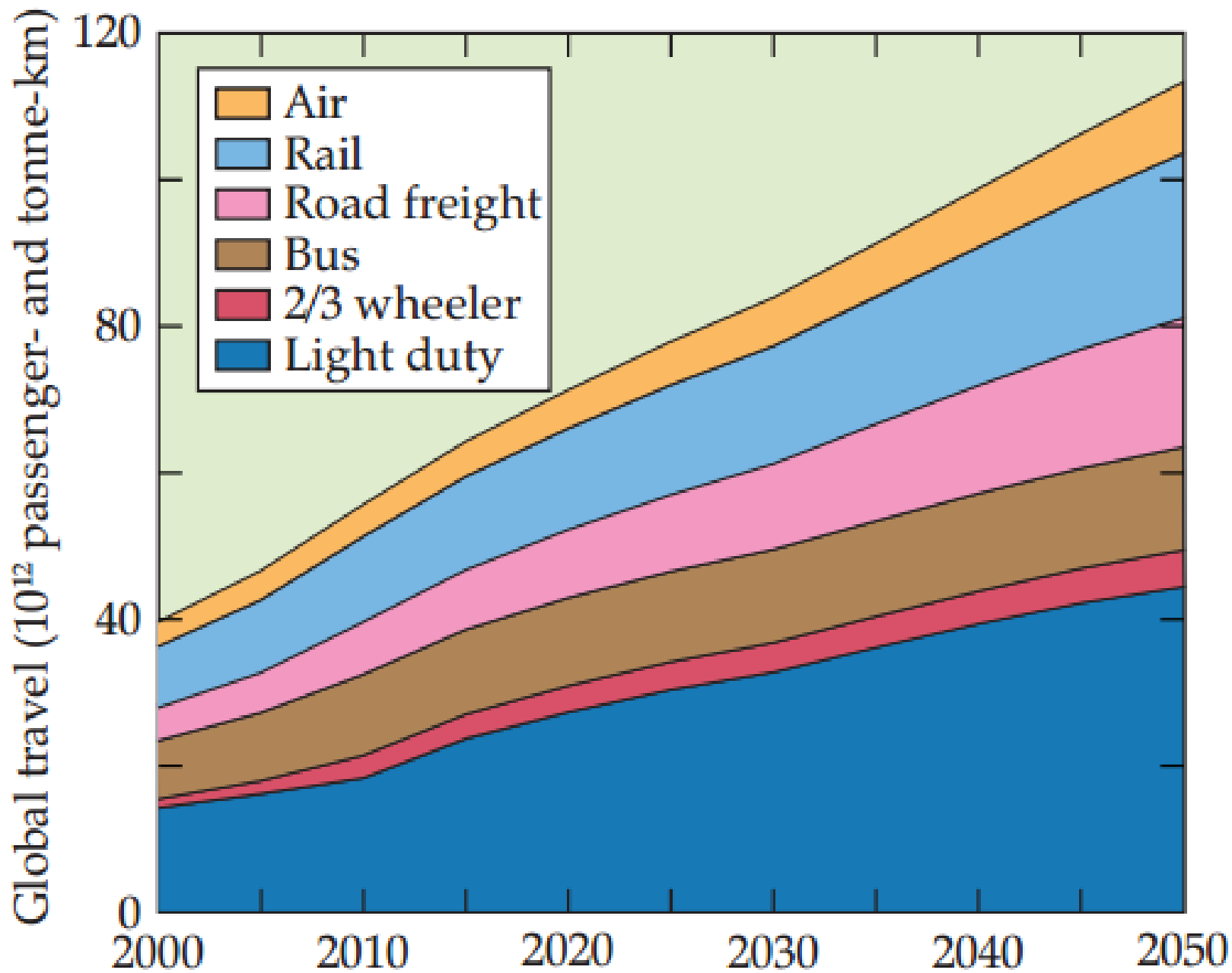
# Transportation

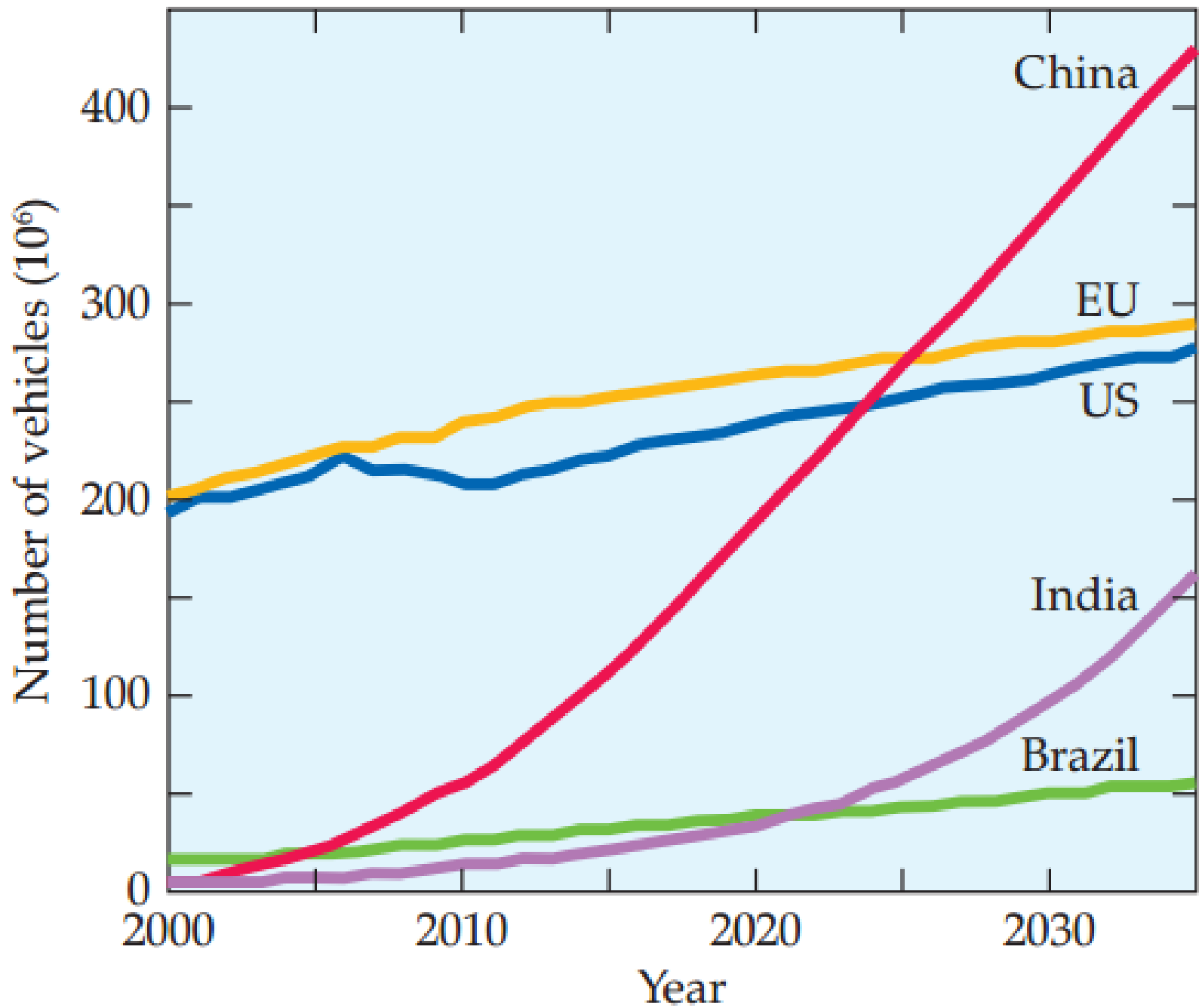
14.4% of global emissions currently come from transportation

- 28.2% in high income countries (USA)

- 7% in low-middle income countries (China)

Expected to increase by 25% from 2010-2030, mostly from passenger cars/trucks





# Fuel Efficiency of light-duty vehicles

Hard to get people to drive less

Easier to get people to drive more efficiently





# Fuel efficiency is influenced by:

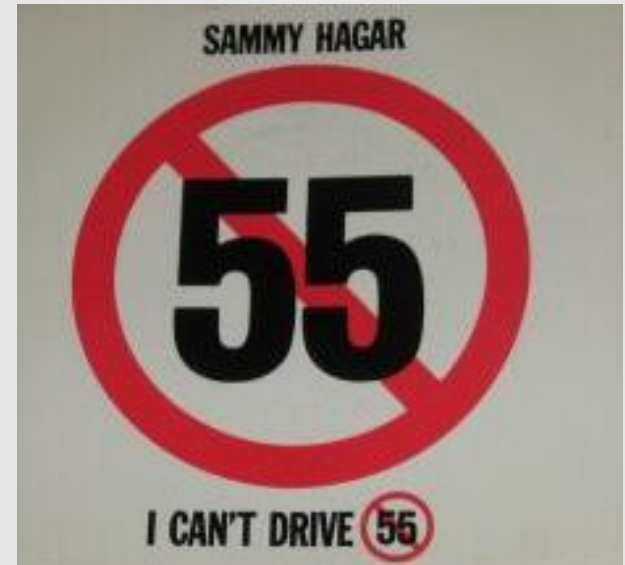
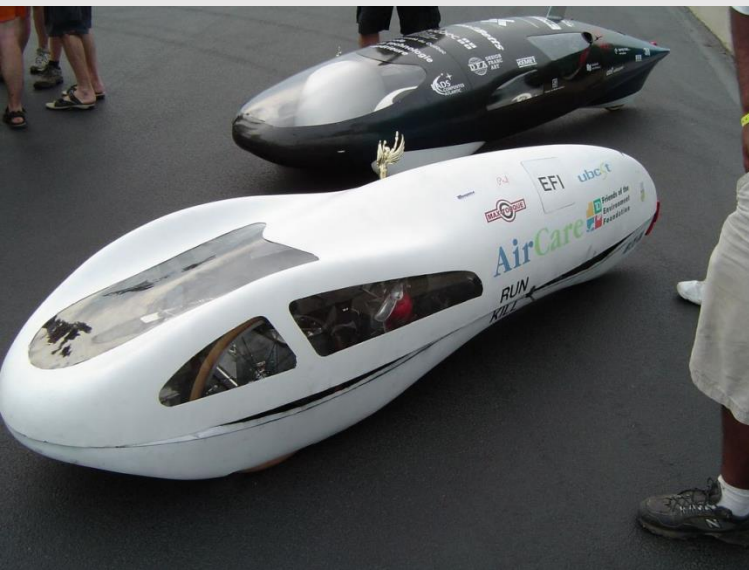
- Driving conditions
- Taxes on petroleum and vehicles
- Consumer preferences
- Use of diesel-powered vehicles
- Agreements with automobile manufacturers

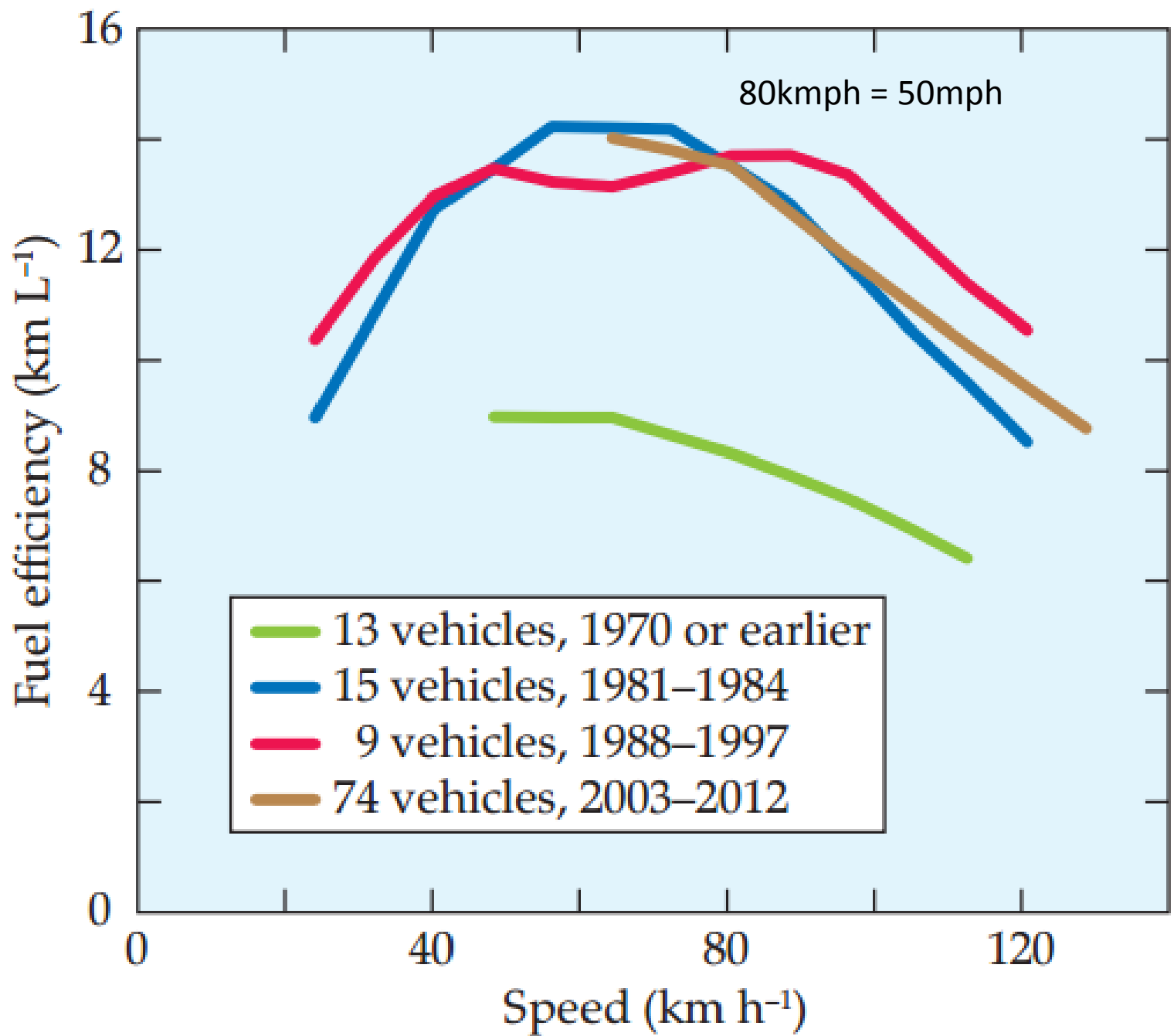
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# Driving Conditions

- Fuel efficiencies decline at speeds above 50mph
  - Wind resistance
- Newer vehicles have better aerodynamics
- But, vehicles moving at 75mph are 20% less efficient than those moving at 55mph





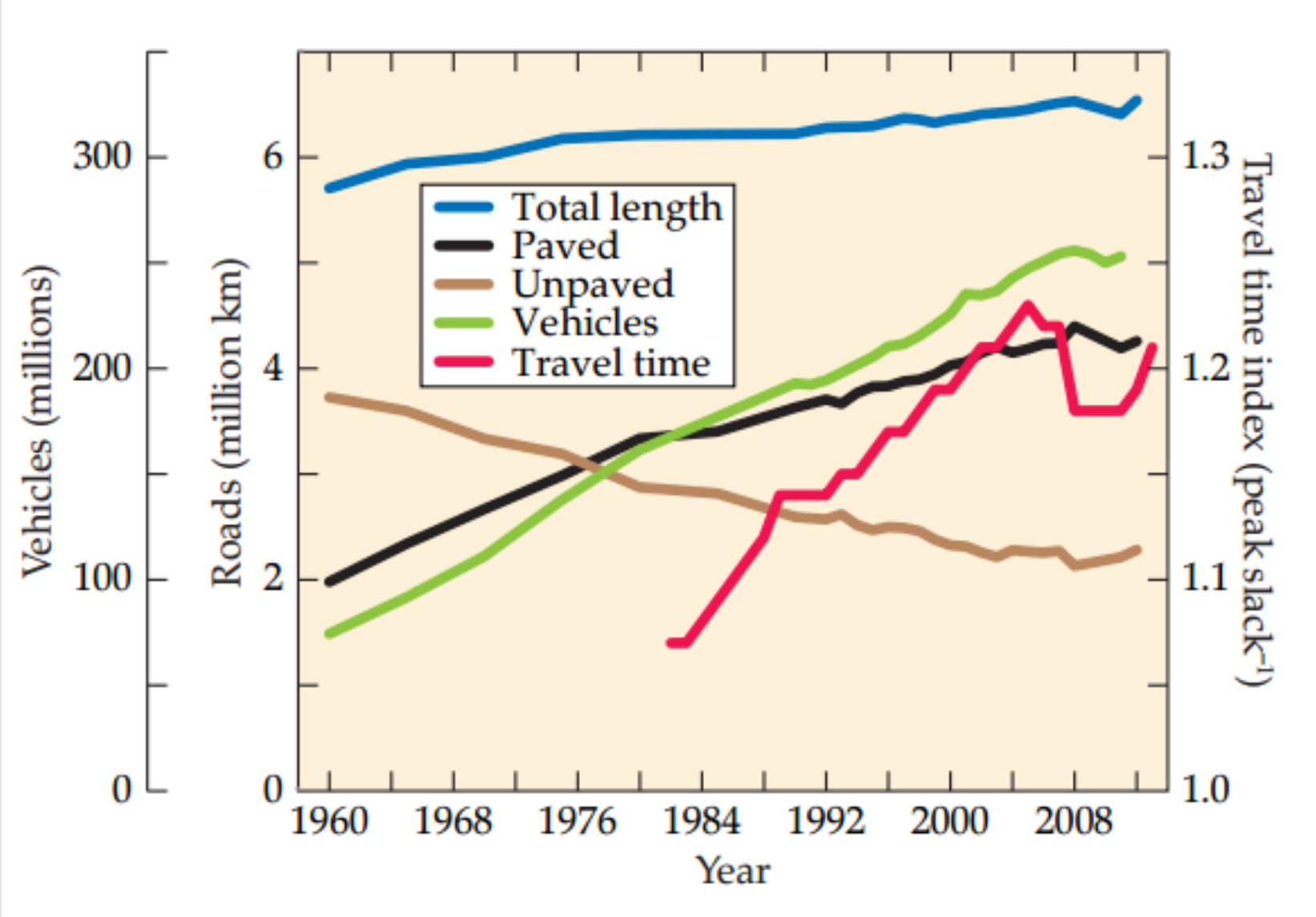


# Driving behavior determines fuel efficiency, more than speed!

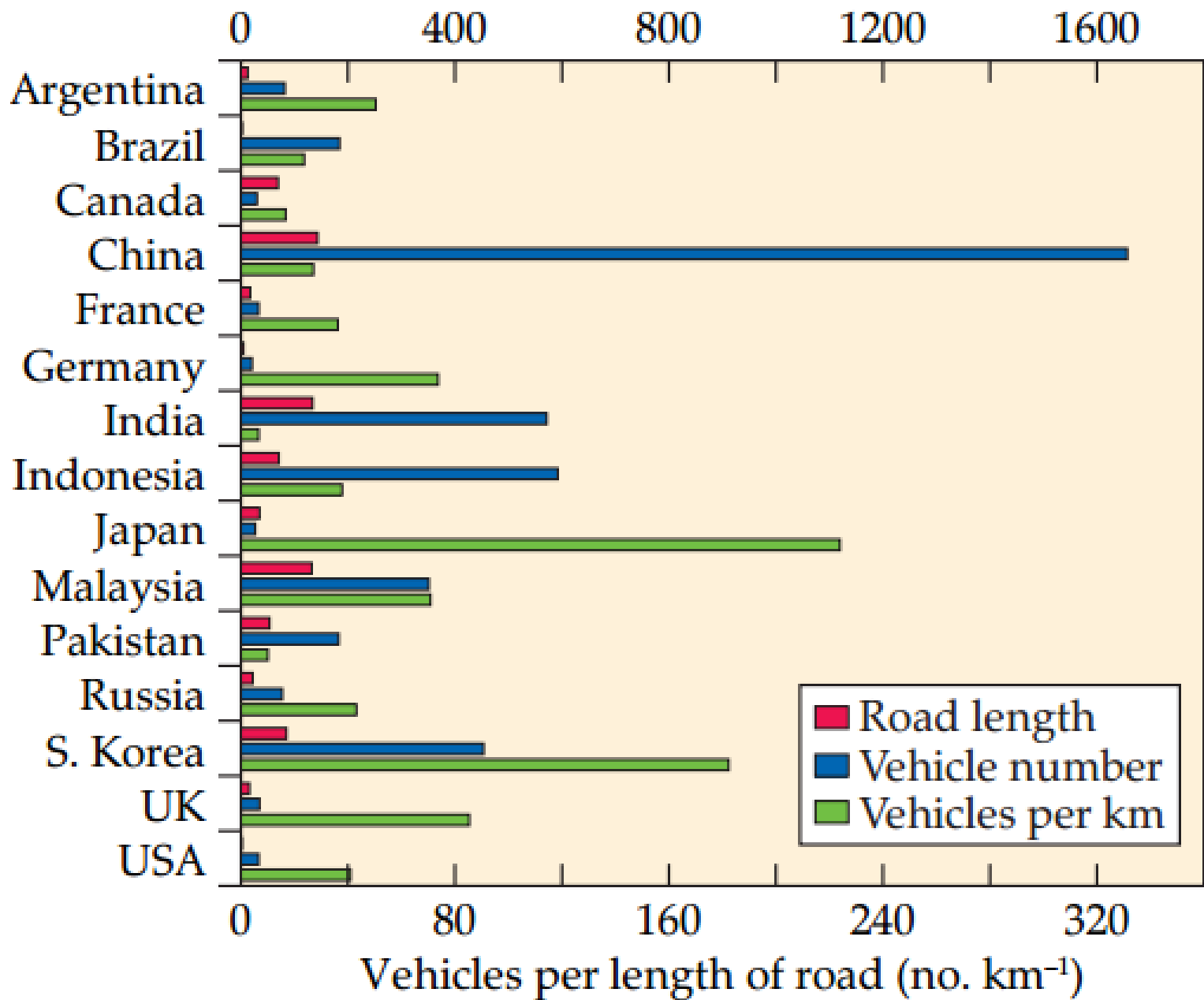
- Quick acceleration and heavy braking diminish fuel economy by more than 30%
- Stop and go traffic decrease fuel efficiency



# Amount of roads not growing at same rate as amount of vehicles



# Road or vehicle increase from 1990 to 2012 (%)



## Reducing Traffic:

- Flexible work hours
- Timed traffic lights
- No left turns at intersections during rush hour
- Metered entry onto highways
- Electronic tolls (fastrack)
- Charge fees to drive into city centers (London, Singapore, Stockholm)
- Restrict entry on alternate days of the week by odd/even license plate number (Athens, Mexico City, Sao Paulo)



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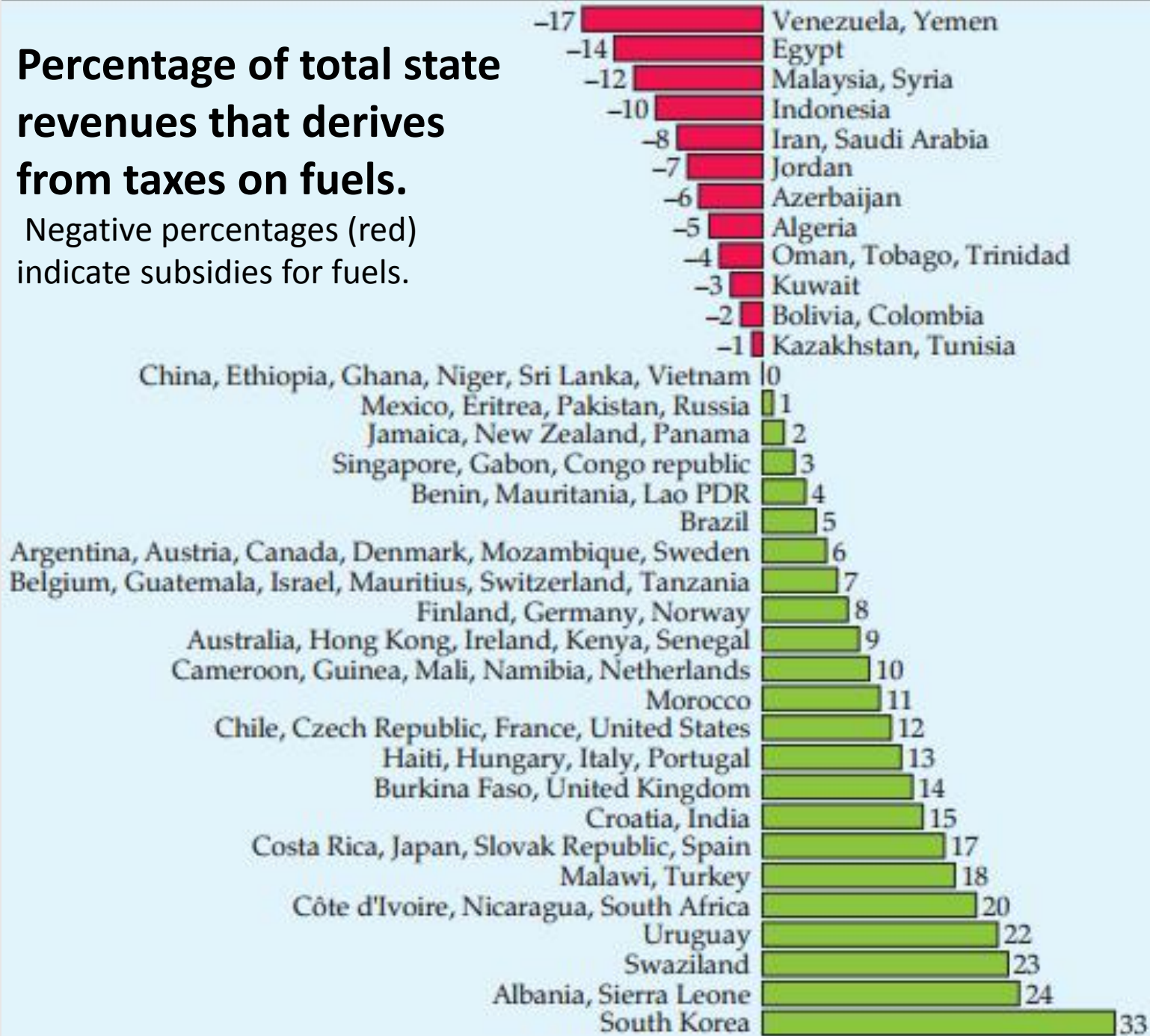
# Taxes on Fuel

- Tax amount varies locally
- Money goes to government, spent on infrastructure projects
- Fuel Tax discourages excess driving, encourages purchase of fuel efficient vehicles



# Percentage of total state revenues that derives from taxes on fuels.

Negative percentages (red) indicate subsidies for fuels.



# Taxes on Vehicles



## Vehicle taxes:

- Sales tax based on purchase price
- License or registration fee based on value of vehicle, sometimes also based on fuel consumption



