

1938

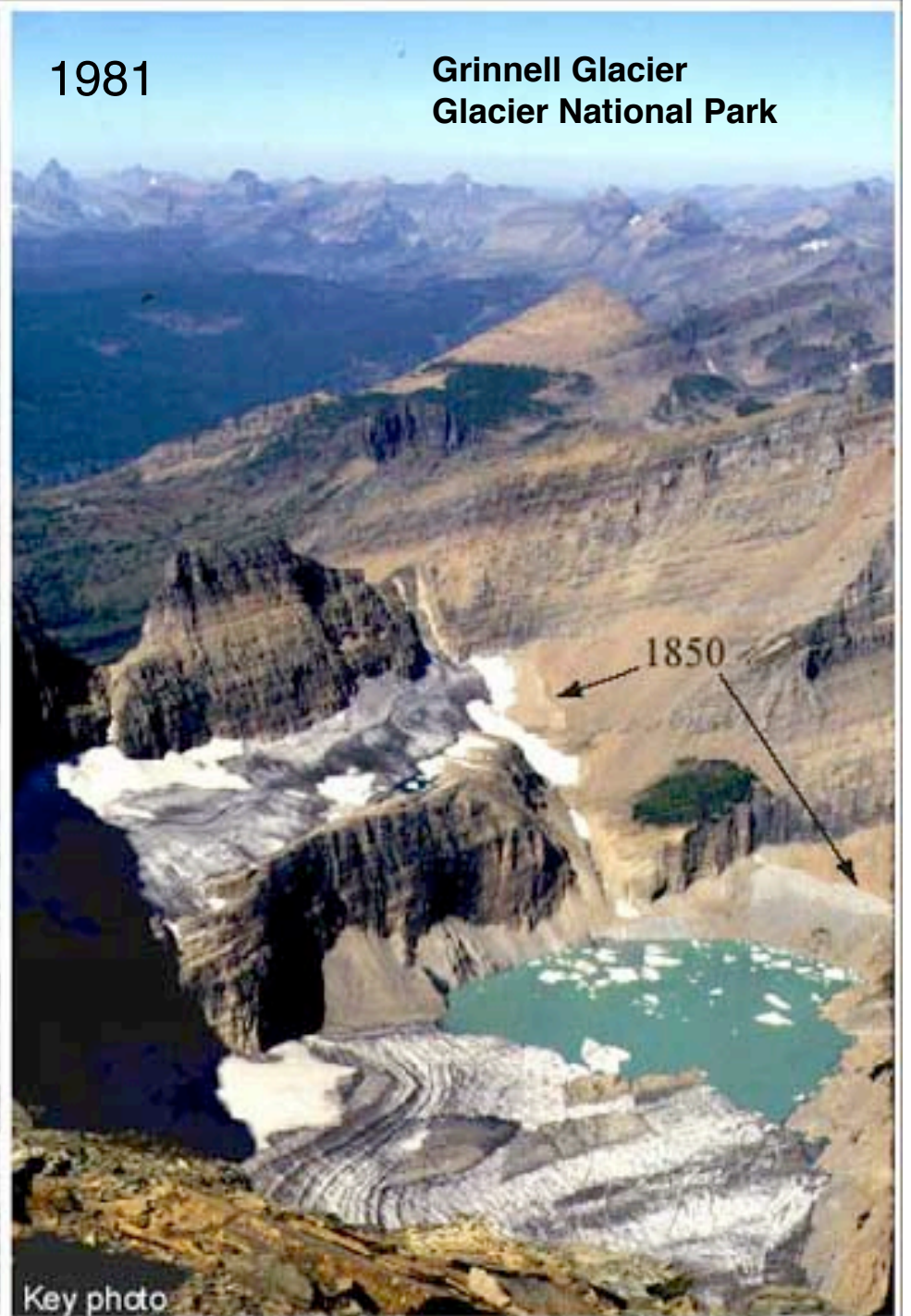
Climate Change Impacts



Hileman Photo

1981

**Grinnell Glacier
Glacier National Park**



Key photo



**Mountain glaciers
all over the world
are in retreat.
This is the Qori
Kalis glacier in
Peru in 1978.**



**Here is the same
glacier in the year
2000. The lake covers
10 acres.**

Global Glacier Mass Balance (Volume Change)

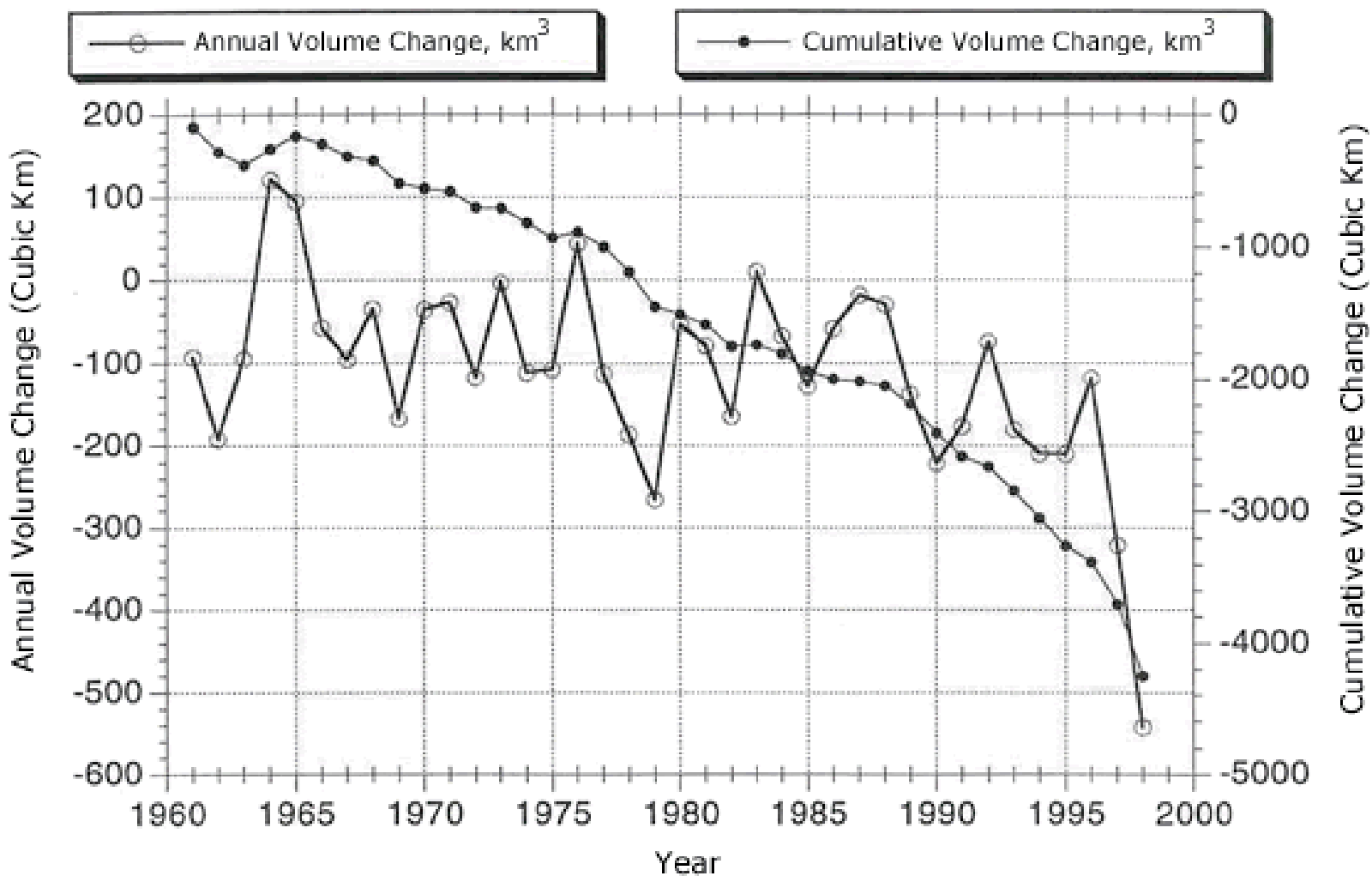
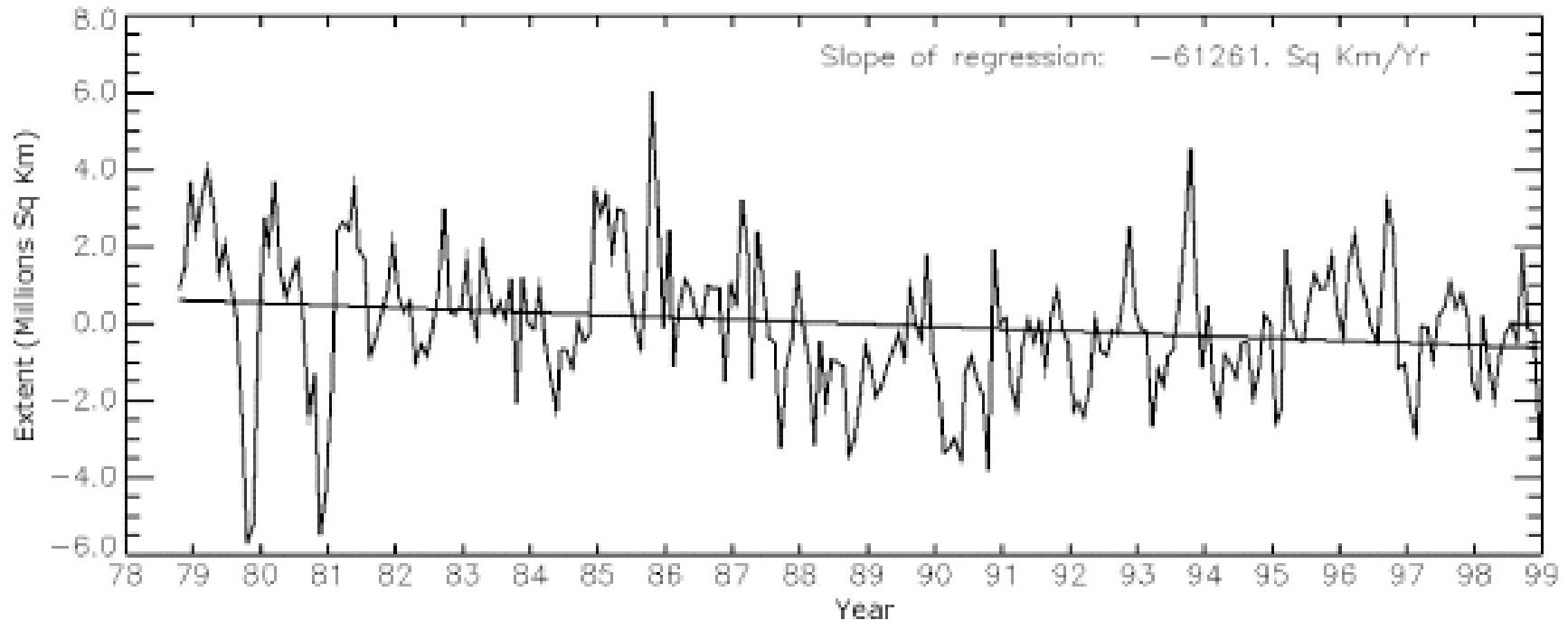


Image created by Mark Dyurgerov, U of Colorado, Boulder.

Visible-derived Snow-covered Area



Northern hemisphere snow cover is also decreasing.
(Armstrong and Brodzik 1999)

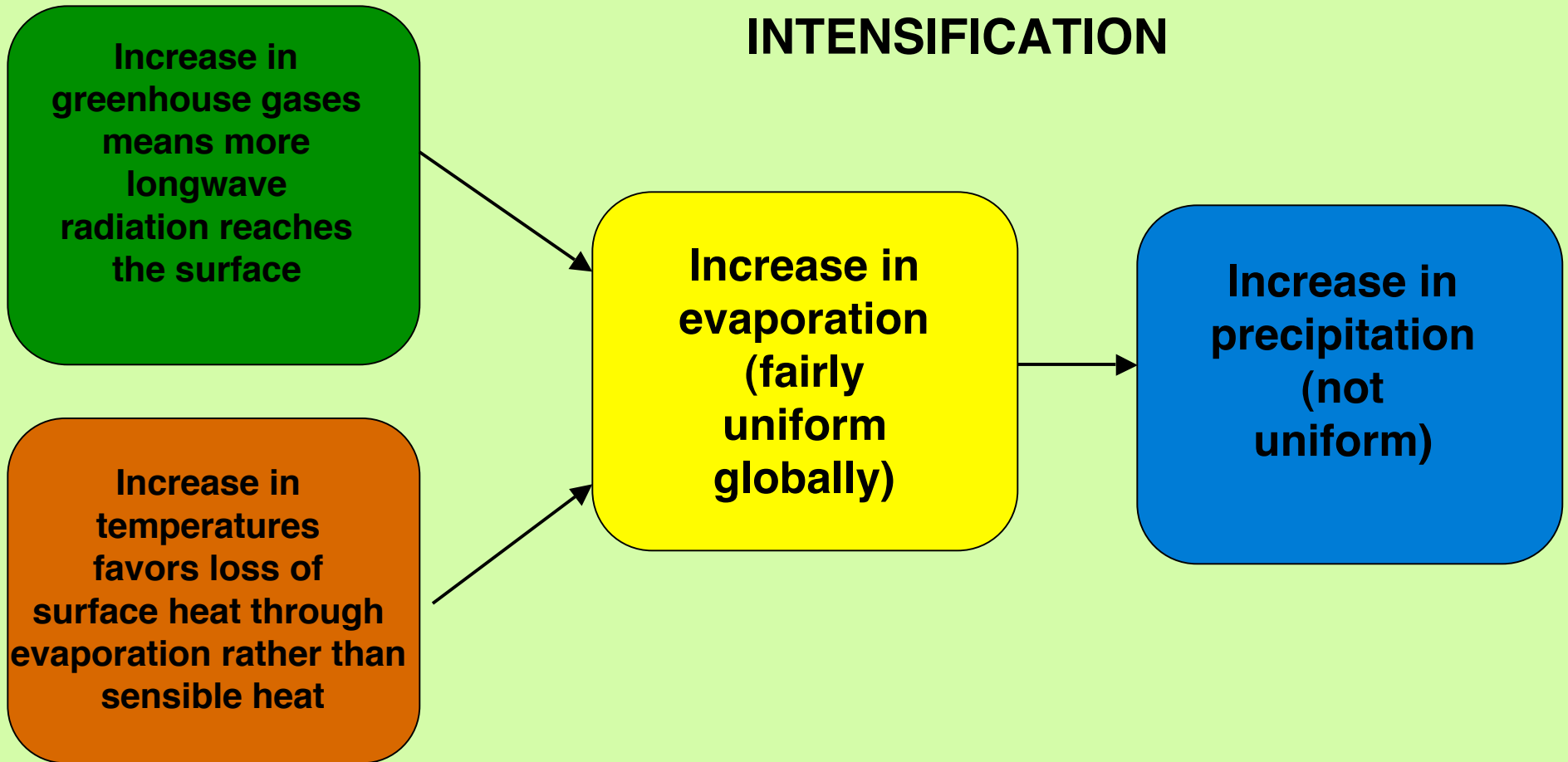
A landscape photograph of a savanna with a tree in the center, overlaid with text about climate change effects. The background shows a vast, open plain with scattered trees and a cloudy sky. The text is white and bold, providing information about the effects of climate change.

There are two main effects associated with climate change:

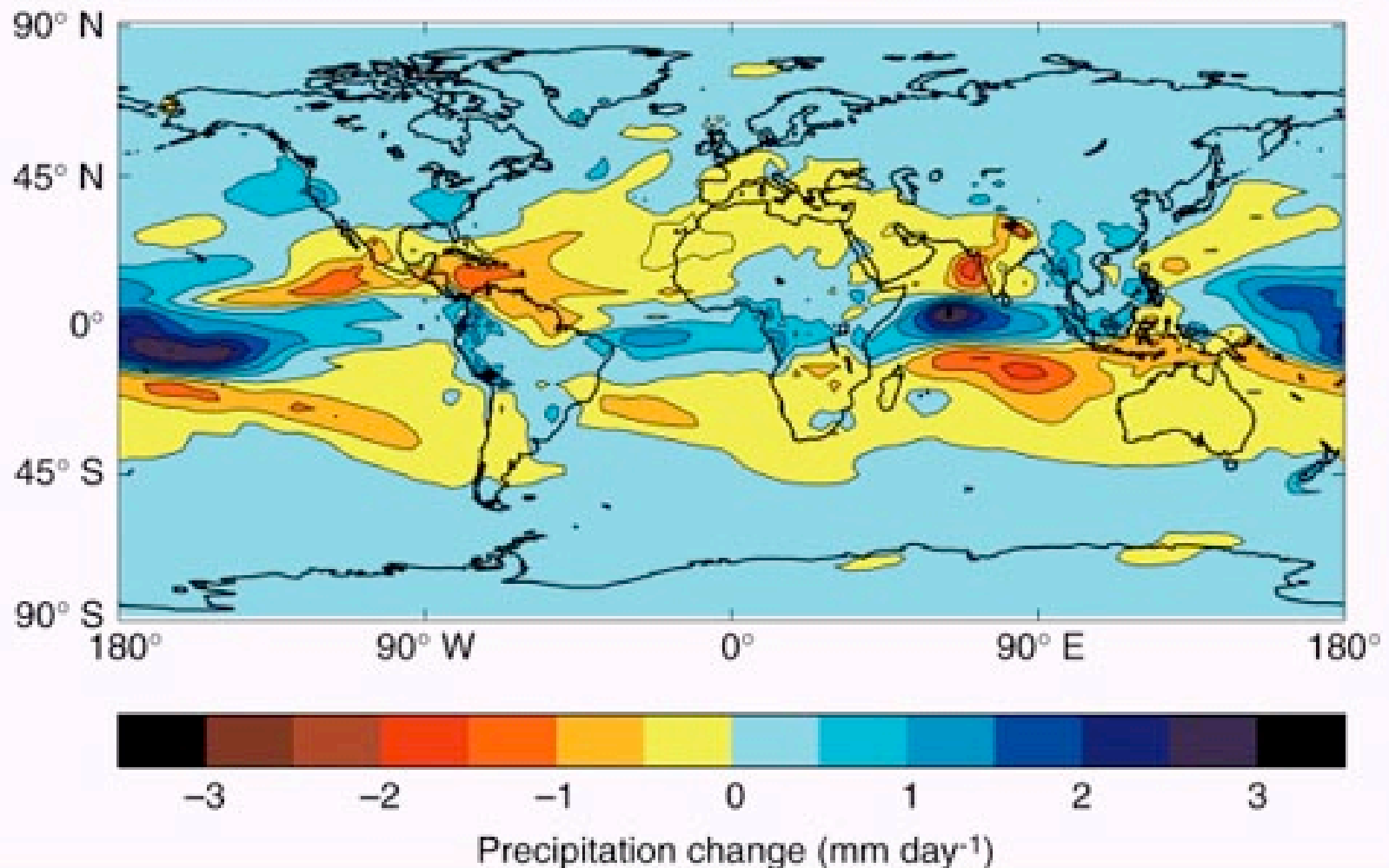
(1) An increase in global mean temperature, which we have discussed already.

(2) An increase in evaporation everywhere, driven by increased greenhouse gas concentrations and increased temperatures. The increase in evaporation also implies an increase in precipitation, because the atmosphere can't store water vapor indefinitely. There is no clear consensus on how the increase in precipitation will be distributed. However, we do know that it will not be distributed uniformly. This increase in evaporation and precipitation is known as the intensification of the hydrologic cycle.

HYDROLOGIC CYCLE INTENSIFICATION

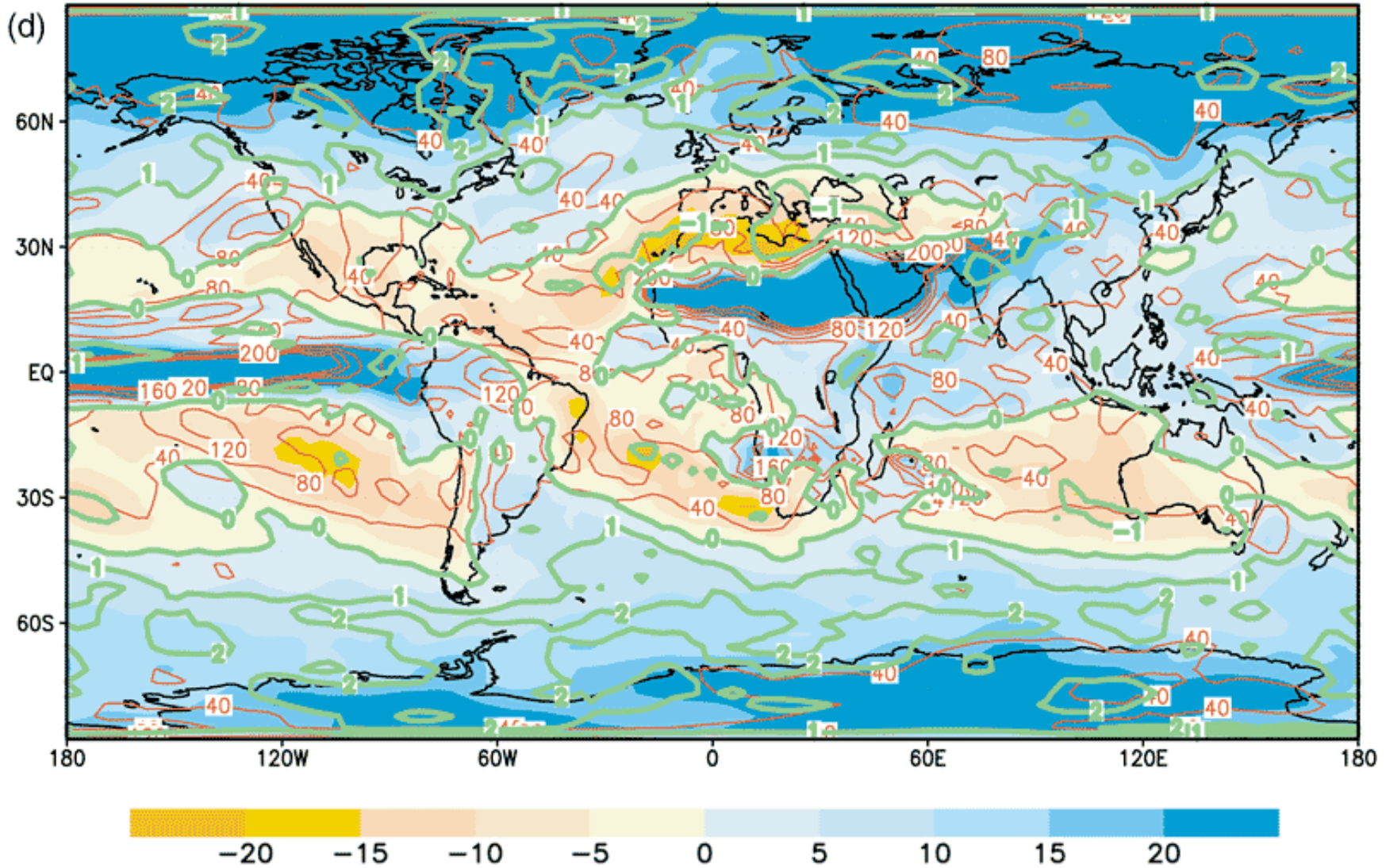


Precipitation for the 2050s



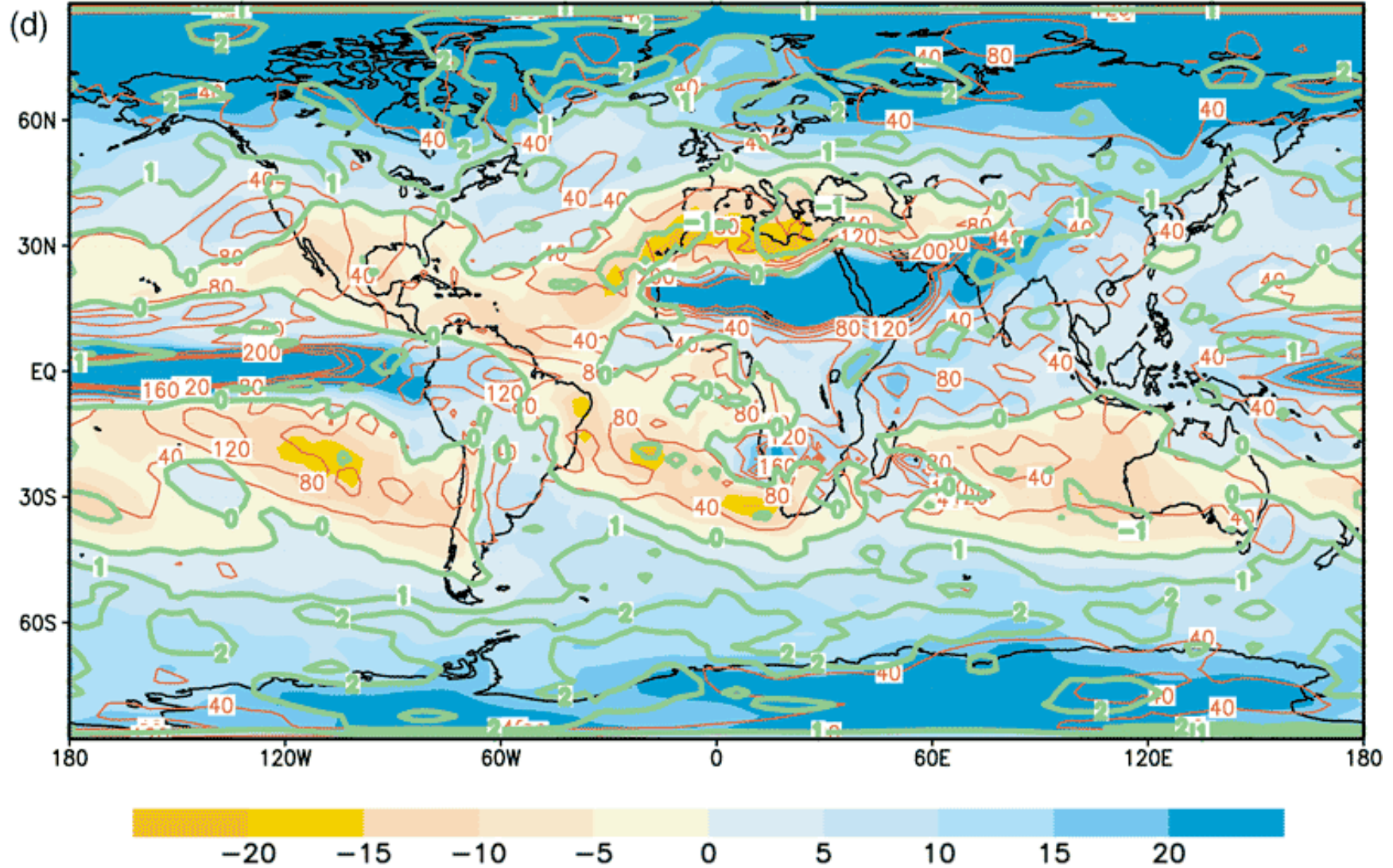
The projected change in annual precipitation for the 2050s compared with the present day, when the climate model is driven with an increase in greenhouse gas concentrations equivalent to about a 1% increase per year in CO₂.

SRES A2



Colors show the simulated 21st century percent change in precipitation averaged over the simulations of the UN Intergovernmental Panel on Climate Change 3rd assessment report.

SRES A2



The red lines show the range in the percent increase in precipitation.

A photograph of a dense forest with a stream flowing over rocks. The water is clear and the surrounding vegetation is vibrant green. The text is overlaid on the upper right portion of the image.

Effect on ecosystems

Ecosystems will be forced to adapt to climate change for two reasons:

- (1) temperatures will be warmer.**
- (2) precipitation will be distributed differently.**

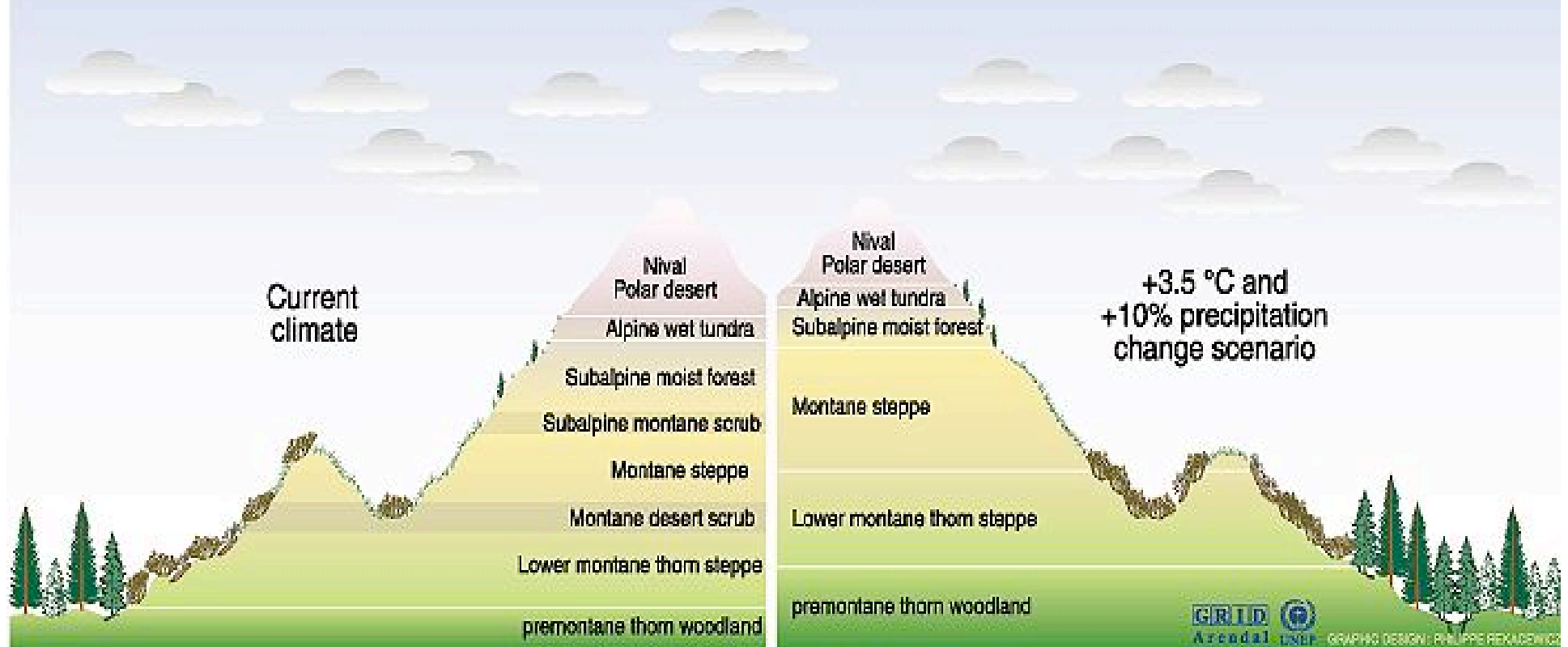
One easily anticipated effect of climate change is **species migration** to higher latitudes. For example, a warmer climate may have significant effect on forests composition. Deciduous forests will probably move northwards and to higher altitudes, replacing coniferous forests in many areas. Some tree species will probably be replaced altogether, jeopardizing biological diversity.

Forest composition current and projected ranges of beech trees in North America



GRAPHIC DESIGN : PHILIPPE REKACIEWICZ

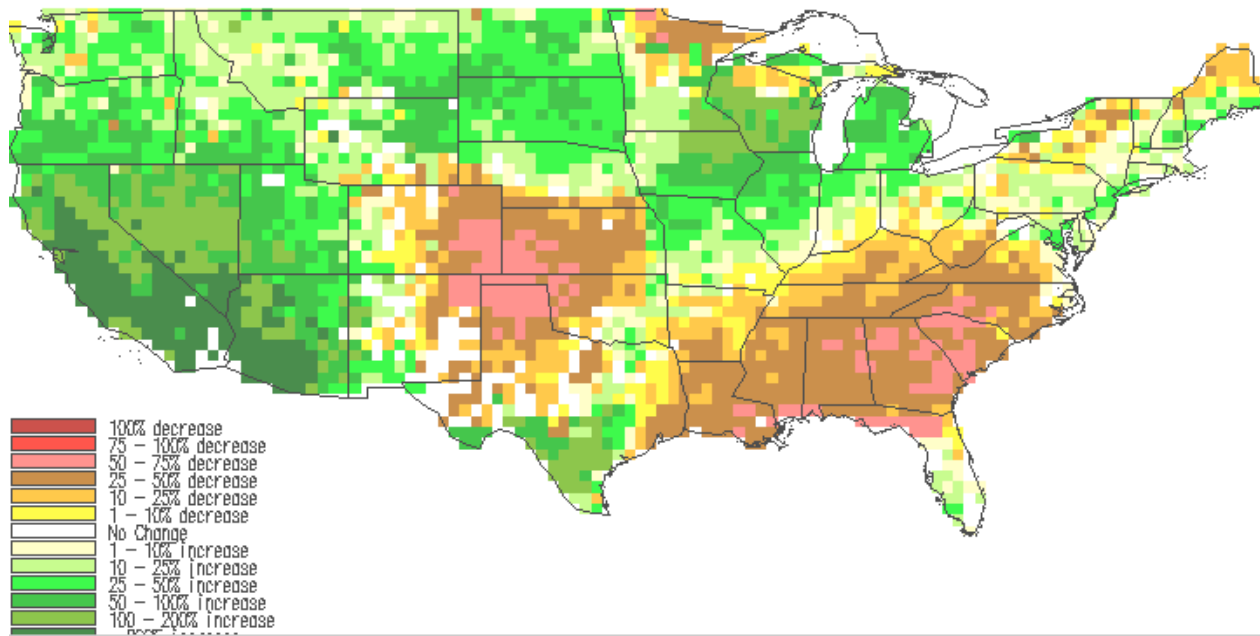
Impact on mountain vegetation zones



Sources: Martin Beniston, Mountain environments in changing climates, Routledge, London, 1994; Climate change 1995, Impacts, adaptations and migration of climate change, contribution of working group 2 to the second assessment report of the Intergovernmental panel on climate change (IPCC), UNEP and WMO, Cambridge press university, 1996.

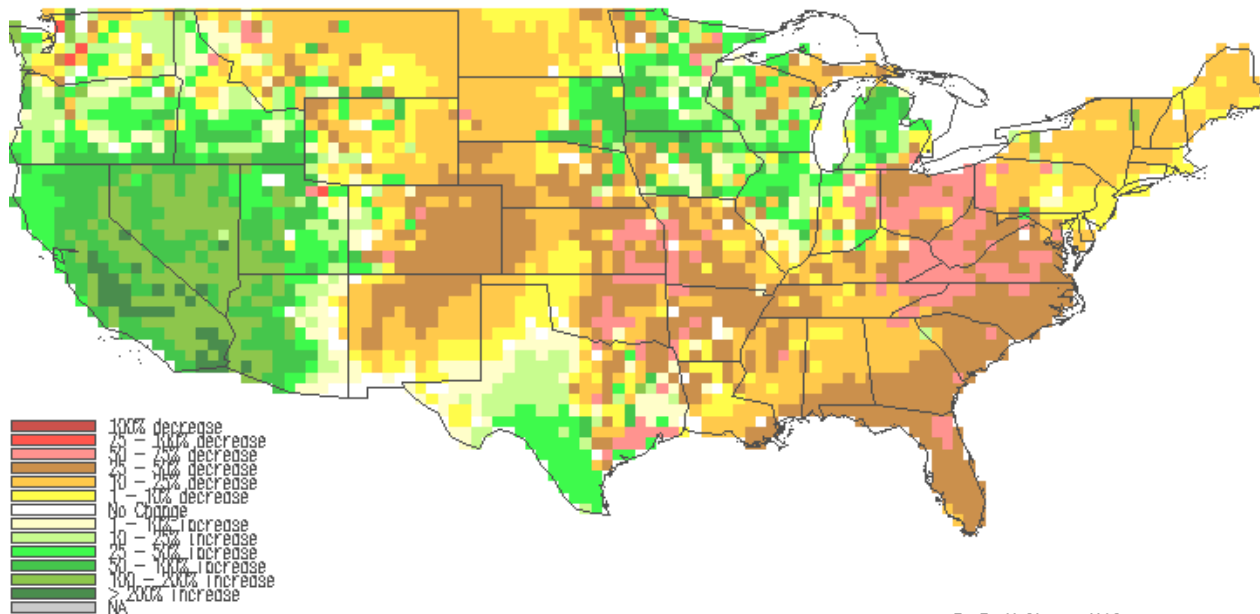
Species would also migrate to higher altitudes. The figure shows a comparison of current vegetation zones at a hypothetical dry temperate mountain site with simulated vegetation zones under a climate-warming scenario. Species and ecosystems with limited climatic ranges could disappear.

MAPSS delta LAI - CGCM1



MC1 delta Veg. C

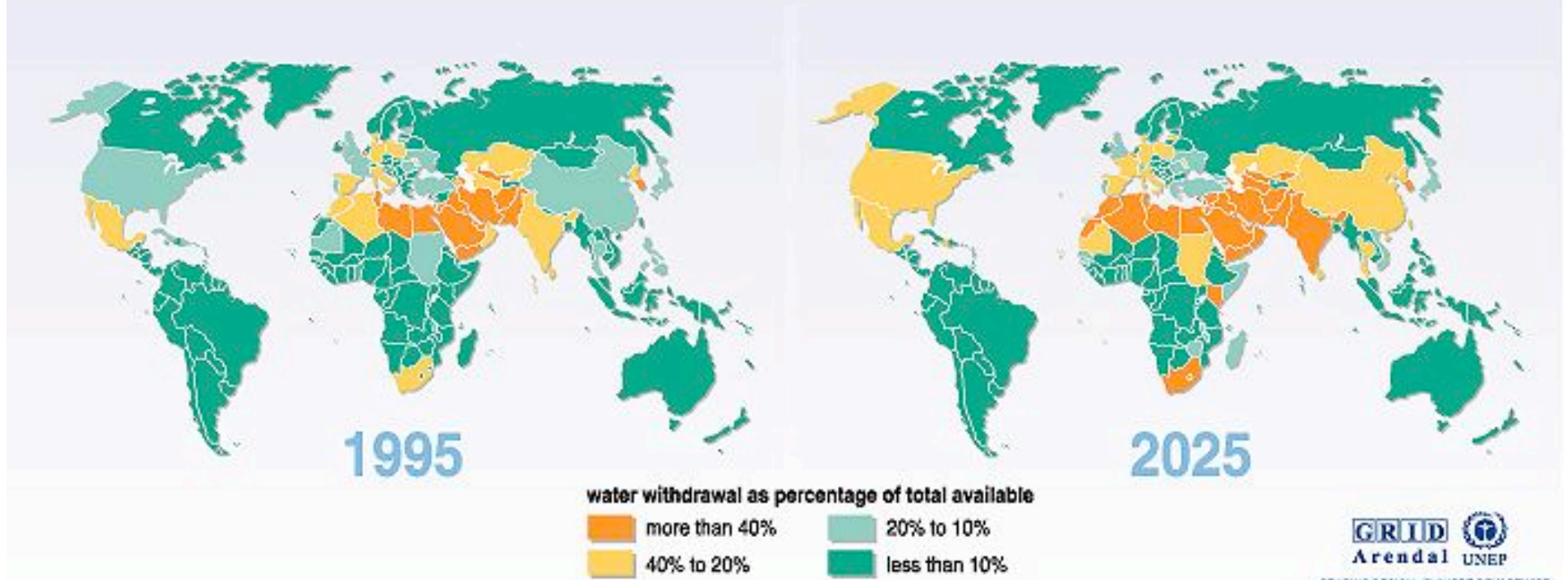
Aug 13 14:18 1999



The change in distribution of precipitation will have a significant effect on total biomass. This of course will also affect species composition and diversity significantly. Some of these effects can be estimated by coupling vegetation models to global climate models during climate change experiments. This plot shows the change in simulated total live vegetation (biomass) between last decade of the 21st century and 1961-1990 from two different climate models (Bachelet et al. 2001)

The increase in evaporation everywhere and the increase in precipitation in some regions means that **water resources will be redistributed**. This, combined with the pressure of increasing population, makes water resources a key issue for the coming century. This is a particularly important issue in the western United States.

Freshwater stress



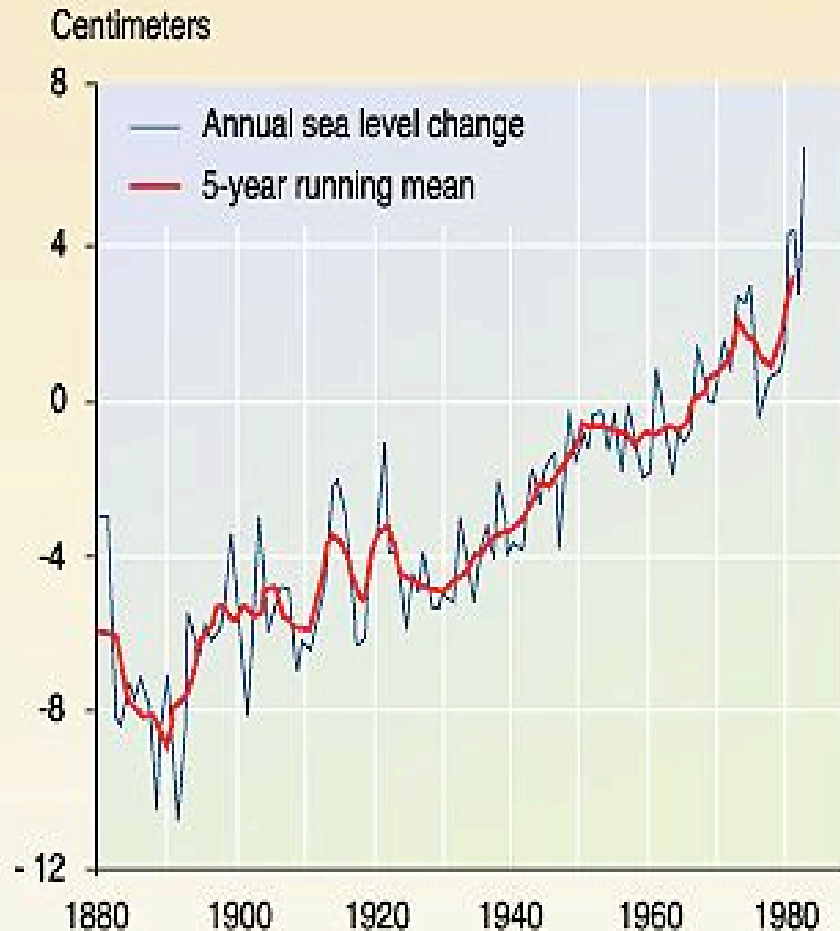
Why will sea level rise as the climate warms?

We discussed the effect of changes in the size of glaciers and ice sheets on sea level in the context of the 100,000 year glacial-interglacial cycles that have characterized earth's climate over the past 1 million years.

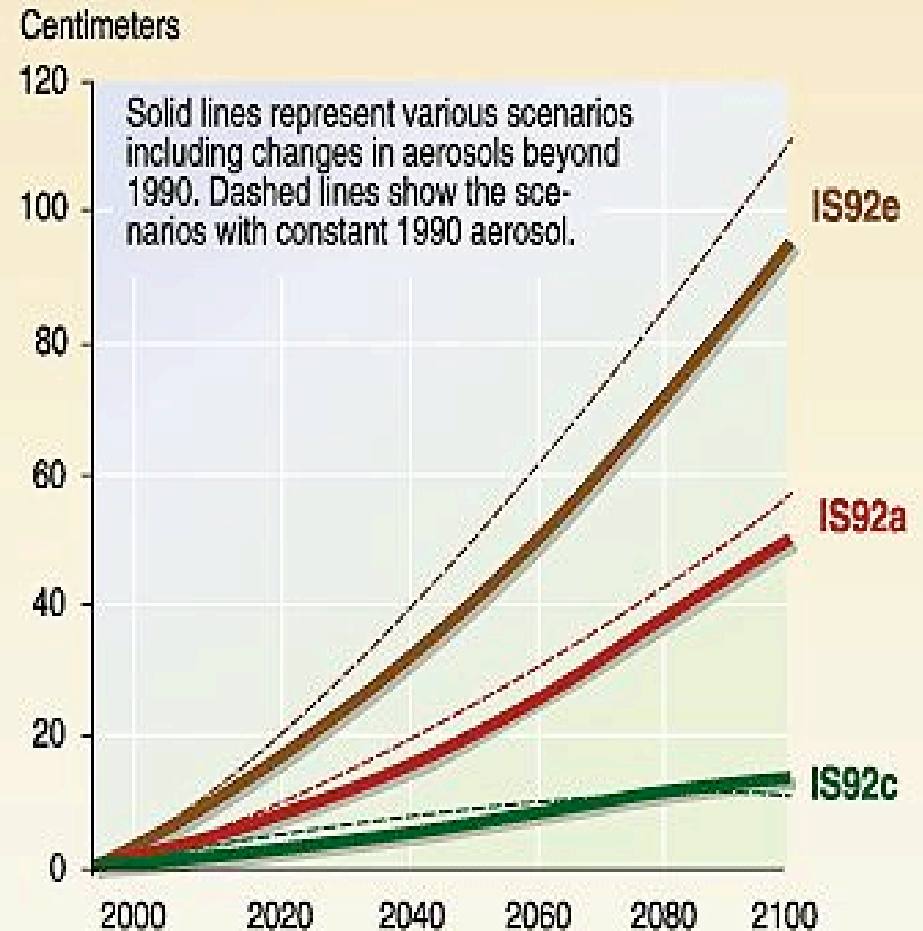
In addition, sea level will rise as the climate warms due to the thermal expansion of seawater-- i.e. the fact that seawater expands as it warms.

Sea level rise due to global warming

Sea level rise over the last century

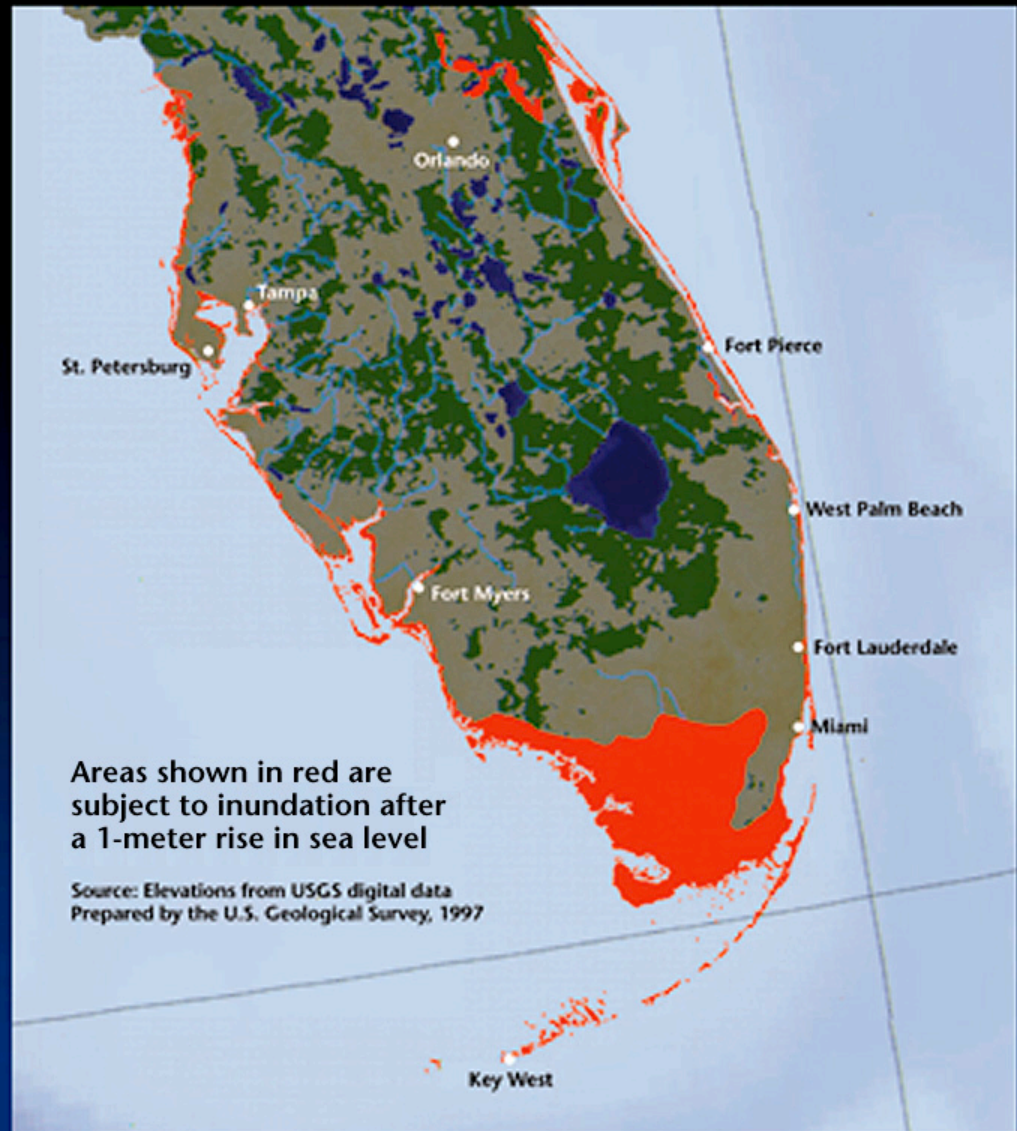


Sea level rise scenarios for 2100



About 2/3 of the observed sea level rise is probably attributable to thermal expansion of seawater; the remainder is due to melting of glaciers

South Florida Shoreline Change after a 1-Meter Rise in Sea Level



Potential impact of sea-level rise on Bangladesh

Bangladesh, one of the world's poorest nations, is also the country most vulnerable to sea-level rise. The population is already severely affected by storm surges. Catastrophic events in the past have caused damage up to 100 km inland.



Today

Total population: 112 Million

Total land area: 134,000 km²



1.5 m - Impact

Total population affected: 17 Million (15%)

Total land area affected: 22,000 km² (16%)

At present expected rates of sea level rise, this scenario would occur something like 150 years from now.

Coastal Erosion from El-Niño Winter Storms



**Washington/Oregon border
October 1997**

Coastal Erosion from El-Niño Winter Storms

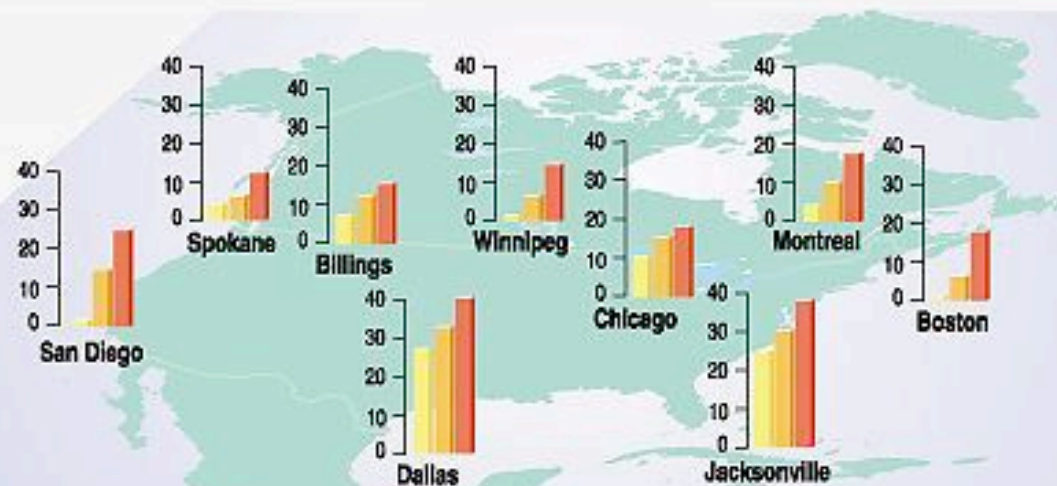
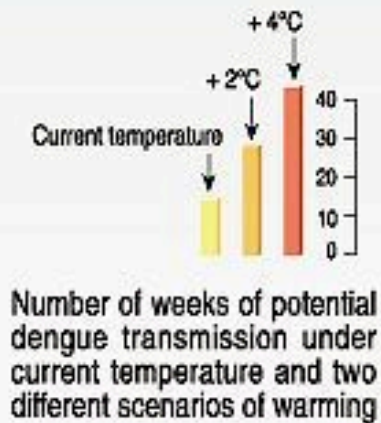


Washington/Oregon border
April 1998

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A changed climate also implies changes in the distribution of vector-borne diseases...

Potential dengue transmission in case of temperature rise



GRAPHIC DESIGN
PHILIPPE REDAGEWICZ
GRID 
Arendal UNEP

Source: Focks et al. 1995, Jeken and Fockx, 1997; "The Regional Impacts of Climate Change", IPCC, 1998.

Note: Presence of dengue virus mosquito vector and exposed human populations are required for disease transmission.