Global Impacts of Climate Change on Freshwater

Katie Hein
Wisconsin Department of Natural Resources

ESA's Rosetta spacecraft in 2009
Wisconsin was COLD this winter!

‘how about that climate change?’
Broader Perspective
A hot start to 2014 for Anchorage weather
Craig Medred | January 21, 2014

Alaska's largest city is off to a hot start in the new year. Temperatures along the Anchorage Hillside pushed into the upper 40s on Tuesday, with some locations threatening 50 on Tuesday as yet another warm gush of
Jan-Feb Global Surface Mean Temp Anomalies
NCDC/NESDIS/NOAA
Analysis is based upon Smith et al. (2008) methodology.

11th Warmest Jan-Feb
Long-term data give context

Days of ice cover on Lake Mendota
Changes in temperature, sea level and Northern Hemisphere snow cover

(a) Global average surface temperature

(b) Global average sea level

(c) Northern Hemisphere snow cover
Glaciers Retreating

Example: Honeycomb Glacier in the Cascades
Northern Hemisphere
Ice Coverage

18,000 Years Before Present

Modern Day (August)

Legend
- Continental Ice
- Sea Ice
- Land Above Sea Level

Note: Modern sea ice coverage represents summer months.
Why is the earth warming?

Human contributions to greenhouse gases

IPCC 2007

Climate Change Attribution

Modeled
Observed
Greenhouse Gases
Solar
Ozone
Volcanic
Sulfate

Temperature Change (°C)

Modeled Forcing Response (°C)

1900 1930 1960 1990

IPCC 2007

CO₂ fossil fuel use 56.6%
CO₂ (other) 2.8%
CO₂ (deforestation, decay of biomass, etc) 17.3%
CH₄ 14.3%
N₂O 7.9%
F-gases 1.1%
Average temperature on earth is +15°C, but would be -18°C if there were not greenhouse gases in the atmosphere.

http://www.ecy.wa.gov/climatechange/whatis.htm
The concentration of CO₂ is at a record high compared to the past 650,000 years.

The rate of increase in CO₂ is faster than before at 80ppm over the past 100 years compared to 80 ppm over 5,000 years following previous ice ages.
Future Climate Projections Based on Emissions Scenarios

Global surface warming (°C)

Year

1900 2000 2100

IPCC 2007
Degree of change depends on location
Stories from around the globe
Permafrost earth material that remains at or below 0°C for at least 2 consecutive years
Permafrost covers 24% of the Northern Hemisphere

Forecast: 20% of the permafrost will degrade in the next 80 yrs.
What will be the effects of thawed permafrost?

- Subsidence changes lake formations
- Release and transport of organic matter, nutrients, and salts

Mackenzie River Delta, Northwest Territories, Canada
Mackenzie River Delta, Northwest Territories, Canada
Climate Impacts Research Centre

Abisko Scientific Research Station, Sweden
Will melting permafrost release methane?
Warmer Temperatures

Methane Release

Permafrost Melting
Swedish lakes may become “browner” as concentrations of dissolved organic carbon increase.
Challenge: treating drinking water
Lake Mälaren provides drinking water for 2 million people in Stockholm
Puerto Rico

3400 mi²
3.89 million people
Precipitation provides drinking water
Declines in rainfall threaten water supply

Caribbean Temperature Change

Caribbean Precipitation Change

USGCRP (2009) Global Climate Change Impacts in the United States
Global Climate Change

- Rate of warming is faster than any known period in the past 650,000 years
- Weather ≠ Climate
- Broad perspective in space and time
- Projected temperature change greatest near the poles
- The past century is no longer a reasonable guide to the future for water management
Climate Change in Wisconsin
Disappearing Lake Chad
Perspective in Space

Selected Significant Climate Anomalies and Events
February 2014

February 2014 average land and ocean temperature tied with 2001 as the 21st warmest February since records began in 1880.

Arctic Sea Ice Extent
February 2014 sea ice extent was 5.9 percent below the 1981–2010 average—the fourth smallest sea ice extent since satellite records began in 1979.

North America
Below-average temperatures dominated across much of North America during February 2014. Some locations experienced temperatures as low as 3°F below the 1981–2010 average. Across the U.S., Illinois, Iowa, and Wisconsin experienced a top ten cold February. No states were record cold.

United Kingdom
Precipitation was above average during February 2014. This was the fourth wettest February since national records began in 1910.

Argentina
Persistent high temperatures during 28 January through 12 February across the northeastern region caused several locations to experience the warmest maximum temperatures since the summer (December–February) of 1981.

Europe
Most of Europe experienced above-average temperatures, with some locations reporting temperatures as high as 5°C above average. Some countries experienced their top 6 warmest February: Norway (2nd), Denmark (6th), The Netherlands (4th), and Germany (6th).

Australia
Heavy rainfall affected Adelaide on February 14th. As much as 75.2 mm in a 24-hour period. This was the wettest day in over 45 years and the fifth wettest day on record.

Antarctic Sea Ice Extent
February 2014 sea ice extent was 26.3 percent above the 1981–2010 average—the fourth largest sea ice extent on record.

Please Note: Material provided in this map was compiled from NOAA’s NCDC State of the Climate Reports. For more information please visit: http://www.ncdc.noaa.gov/sotc