

WILL CLIMATE CHANGE AFFECT GROUNDWATER IN THE CENTRAL AND WEST COAST BASINS?

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Introduction

The debate as to whether or not global climate change (a.k.a. global warming) is occurring appears to be over. The vast consensus of the scientific community agrees that the earth's temperatures are rising. It is well documented that global warming has been occurring for a long time, with one significant impact being the melting of glaciers all over the world (**Figure 1**).

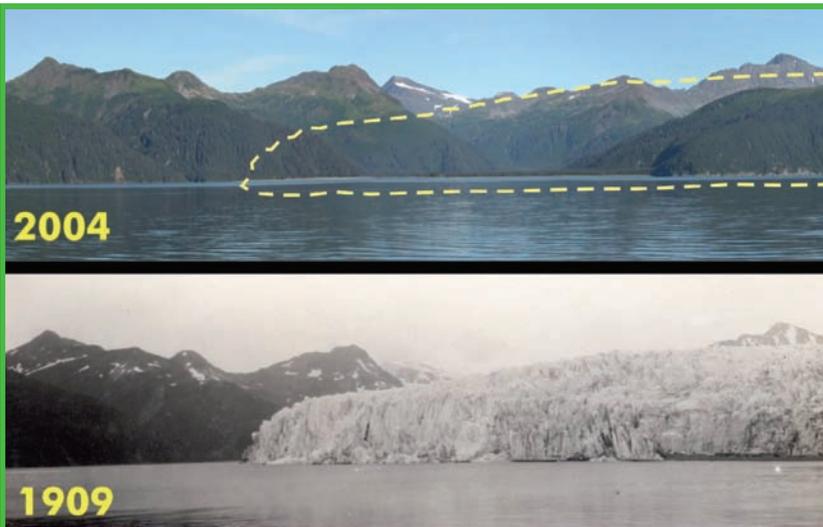


Figure 1—McCarty Glacier in Alaska. Evidence of global warming. Modified from Ref. #5

Even politicians are acknowledging this fact. California Governor Arnold Schwarzenegger said before the United Nations World Environment Day in June 2005, "... California is going to be the leader in the fight against global warming... I say the debate is over. We know the science. We see the threat. And we know the time for action is now." (DWR, 2006). And, in his State of the Union address on January 23, 2007, President George W. Bush stated that technological breakthroughs will "... help us to confront the serious challenge of global climate change."

But, global warming shouldn't be a surprise. As a geologist, I was taught that the earth has never been at a constant temperature. It is either cooling (glacial

periods) or warming (interglacial periods) naturally for reasons not completely understood. Sea levels rise and fall in response to massive ice sheets forming and melting over cycles of tens of thousands of years or more. Over the past 800,000 years, there have been 20 different glacial/interglacial periods defined resulting in sea level highs and lows (**Figure 2**).

During the chilly peak of the last ice age 18,000 to 20,000 years ago, geologic evidence indicates that the sea level was 400 feet lower than it is today (DWR, 2006). Since then, the earth has been warming, the ice has been melting, and sea levels have been rising at the rate of about 2 inches per century (DWR, 2006).

Until recently, another debate was whether or not climate change was being caused in part by human activities. However, as stated recently by the EPA (Ref. #4) and in a February 2007 report by the United Nations (Ref. #2), it is recognized that most of the warming in recent decades has probably been caused by human activities. Over the past 200 years since the industrial revolution, the burning of fossil fuels and deforestation have caused the concentrations of heat-trapping "greenhouse gases" (such as carbon dioxide, methane, and nitrous oxide) to increase significantly in our atmosphere, preventing heat from escaping to space, thus warming the earth somewhat like the glass panels of a greenhouse. This extra heating

has contributed to the normal heating cycle of the earth, and model predictions are for California to have temperature increases of 2.5 to 9 degrees Celsius by the year 2100 (DWR, 2006).

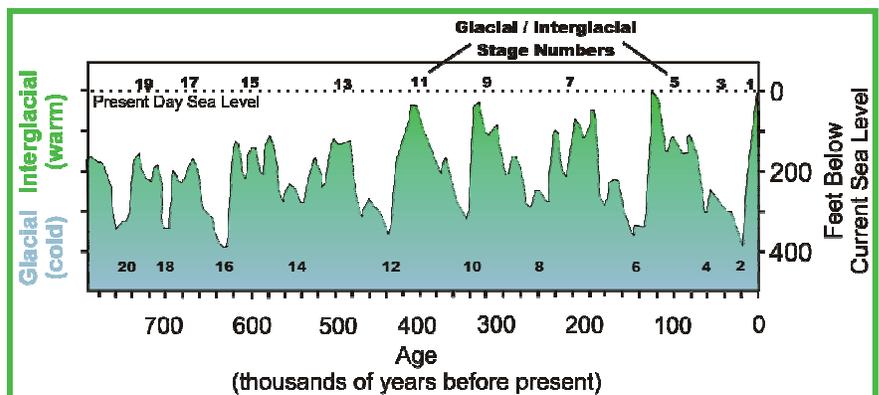


Figure 2— Global Changes in Sea Level over past 800,000 Years. Modified from Ref.#1

Impact on Groundwater Resources

A report by the DWR (2006) provides an excellent discussion on the potential impacts of warming on our state's water supply. **Table 1** is an excerpt from that report which lists the potential impacts and consequences of climate change.

But, will climate change affect the groundwater supplies in the Central and West Coast Basins, which provides about 40% of the total water demand for this area? Very simply, no one knows for sure, but close monitoring, planning, and responses to changes will likely be necessary. Warmer summers may cause drought, an increase in water demand, and a decrease in water supply. Warmer winters may result in precipitation falling as rain instead of snow, reducing the snow pack that is a natural reservoir for spring and summer snow melt, and may increase the intensity of storm runoff that may overflow stream channels, cause flooding, and cause more runoff losses to the oceans.

Northern California sea level rises may threaten the Bay Delta freshwater supplies, reducing our imported water availability in Southern California. And, sea level rises down here could threaten the Central and West Coast Basins with increased salt water intrusion.

So What Do We Do About It?

Water managers, water providers, and elected officials at the local, state, and federal level are working together towards solutions. Additional scientific information and modeling is needed to reduce the climate change uncertainties so that planning can be performed to implement the necessary projects to meet future water needs (Ref #3). The importance of maintaining and expanding the use of the Central and West Coast Basins as water supply reservoirs is crucial. New and improved spreading grounds and conservation pools will help capture as much storm water as possible to ensure a local supply of replenishment water. Finding ways to

Potential Water Resource Impact	Expected Consequence
Reduction of the State's average annual snowpack	<ul style="list-style-type: none"> • Potential loss of 5 million acre-feet or more of average annual water storage in the State's snowpack • Increased challenges for reservoir management and balancing the competing concerns of flood protection and water supply
Changes in the timing, intensity, location, amount, and variability of precipitation	<ul style="list-style-type: none"> • Potential increased storm intensity and increased potential for flooding • Possible increased potential for droughts
Long-term changes in watershed vegetation and increased incidence of wildfires	<ul style="list-style-type: none"> • Changes in the intensity and timing of runoff • Possible increased incidence of flooding and increased sedimentation
Sea level rise	<ul style="list-style-type: none"> • Inundation of coastal marshes and estuaries • Increased salinity intrusion into the Sacramento-San Joaquin River Delta • Increased potential for Delta levee failure • Increased potential for salinity intrusion into coastal aquifers (groundwater) • Increased potential for flooding near the mouths of rivers due to backwater effects
Increased water temperatures	<ul style="list-style-type: none"> • Possible critical effects on listed and endangered aquatic species • Increased environmental water demand for temperature control • Possible increased problems with foreign invasive species in aquatic ecosystems • Potential adverse changes in water quality, including the reduction of dissolved oxygen levels
Changes in urban and agricultural water demand	Changes in demand patterns and evapotranspiration rates

Table 1—Potential Impacts to California's Water Supply due to Climate Change—Ref. #1

decrease our reliance on imported water, increasing the use of recycled water, maximizing groundwater storage, conserving water, and protecting the basins from contamination due to salt water intrusion or other pollutants will ensure a reliable supply of locally-derived groundwater. As the groundwater steward for the Central and West Coast Basins, WRD is committed to working with others to find practical and optimum solutions to ensure the future reliability of the local groundwater supplies in the face of climate change.

Reference Information used for this Technical Bulletin:

1. California Department of Water Resources, July 2006, Technical Memorandum Report, "Progress on Incorporating Climate Change into Management of California's Water Resources"
2. Intergovernmental Panel on Climate Change, February 2007, "Climate Change 2007: The Physical Science Basis—Summary for Policymakers"
3. Southwest Hydrology, January/February 2007, Volume6/Number 1, published by NSF Center for Sustainability of semi-Arid Hydrology and Riparian Areas, University of Arizona.
4. USEPA web site (<http://www.epa.gov/climatechange/basicinfo.html>)
5. USGS photo library, Robert A. Rohde, and Global Warming Art (www.globalwarmingart.com).