Overview of the 2014 National Climate Assessment
Water Resources Chapter

October 7, 2014
Seattle, WA

Paul Fleming
Seattle Public Utilities
Co-Convening Lead Author
Water Resources Chapter
3rd National Climate Assessment
Outline

• Groundwater messages and findings from the NCA water chapter
• Overview of other key messages from NCA water chapter
Weather Summary

- Foggy mornings and warm, sunny afternoons through Thursday
- Chance of light rain Fri-Sat
- Increasing chance of storminess Sun-Mon (NWS: 1.25”/48hrs citywide, 2.15-2.83”/48hrs watersheds)
- Yesterday’s high of 78 broke the daily record and was the warmest October day since 1996
- Full weekend outlook to be published tomorrow
NCA topline messages

• Human-induced climate change has moved into the present

• Americans are already feeling the effect of increases in some types of extreme weather and sea level rise

• Impacts are evident in every region and important sectors

• There are many actions we can take to reduce future climate change and its impacts and to prepare for impacts we can’t avoid
Climate Change Impacts in the United States

CHAPTER 3
WATER RESOURCES

Convening Lead Authors
Aris Georgakakos, Georgia Institute of Technology
Paul Fleming, Seattle Public Utilities

Lead Authors
Michael Dettinger, U.S. Geological Survey
Christa Peters-Lidard, National Aeronautics and Space Administration
Terese (T.C.) Richmond, Van Ness Feldman, LLP
Ken Reckhow, Duke University
Kathleen White, U.S. Army Corps of Engineers
David Yates, University Corporation for Atmospheric Research
Water Resources Chapter Themes

- **Water Cycle Changes:** Observed and projected.
  
  **Fluxes:** Precipitation (Averages, Extremes)
  Evapotranspiration
  Runoff, Streamflow,
  GW Recharge

  **Storages:** Snow Cover, SWE
  Lakes/Reservoirs/Wetlands
  Soil Moisture
  Groundwater

  **Water Quality:**
  Water Temp, Sediment,
  Nutrient Loads, DO, Pollutants

- **Water Demand/Use Changes:** Observed and projected.
  
  - *Freshwater withdrawals from streams, rivers, lakes, and aquifers (off-stream water uses):*
    Municipal, industrial, and agricultural water supply; Cooling of re-circulating power plants
  
  - *In-stream, lake, and wetland water flows, levels, and quality:*
    Hydropower production; Cooling of once-through power plants, Navigation, Recreation, Waste assimilation, Ecosystem services.

- **Key Water Resources Vulnerabilities.**

- **Management, Adaptation, and Institutional Responses.**
Groundwater key messages

• “Climate is expected to affect water demand, groundwater withdrawals, and aquifer recharge, reducing groundwater availability in some areas”

• “Sea level rise, storms and storm surges, and changes in surface and groundwater use patterns are expected to compromise the sustainability of coastal freshwater aquifers and wetlands”

• “Changes in precipitation and runoff, combined with changes in consumption and withdrawal, have reduced surface and groundwater supplies in many areas. These trends are expected to continue, increasing the likelihood of water shortages for many uses.”
Groundwater findings

• Precise responses of groundwater storage and flow to climate change are not well understood nor readily generalizable

• Precipitation is the key driver of recharge in water-limited environments; ET is the key driver in energy-limited environments

• Climate impacts depend on several factors (e.g., basin geology, frequency/intensity of high rainfall periods, etc.)

• Changes in recharge rates are amplified relative to changes in total precipitation
Groundwater findings

• Aquifers are not generally well monitored; near all monitoring is done in areas dominated by gw pumping

• Changing demands likely to have the most immediate effect on gw availability

• In mountainous areas where snowmelt infiltration generates significant recharge, loss snowpack will affect recharge rates and patterns

• Opportunities for augmentation strategies and conjunctive use, though institutional and management frameworks may present limitations
Interrelationships between ET, soil moisture, temp and gw recharge
Seasonal soil moisture changes are a key driver for aquifer recharge
Figure 3.6. (a) Groundwater aquifers are found throughout the U.S., but they vary widely in terms of ability to store and recharge water. The colors on this map illustrate aquifer location and geology. Blue colors indicate unconsolidated sand and gravel, yellow is semi-consolidated sand, green is sandstone, blue or purple is sandstone and carbonate-rock, browns are carbonate-rock, red is igneous and metamorphic rock, and white is other aquifer types. (Figure source: USGS). (b) Ratio of groundwater withdrawals to total water withdrawals from all surface and groundwater sources by county. The map illustrates that aquifers are the main (and often exclusive) water supply source for many U.S. regions, especially in the Great Plains, Mississippi Valley, east central U.S., Great Lakes region, Florida, and other coastal areas. Groundwater aquifers in these regions are prone to impacts due to combined climate and water-use change. (Data from USGS 2009).

Figure 3.10. Based on the most recent USGS water withdrawal data (2005), this figure illustrates water withdrawals at the U.S. county level. (a) total withdrawals (surface and groundwater) in thousands of gallons per day per square mile; (b) municipal and industrial (including golf course irrigation) withdrawals as percent of total; (c) irrigation, livestock, and aquaculture withdrawals as percent of total; (d) thermoelectric plant cooling withdrawals as percent of total; (e) counties with large surface water withdrawals; and (f) counties with large groundwater withdrawals. The largest withdrawals occur in the drier western states for crop irrigation. In the east, water withdrawals mainly serve municipal, industrial, and thermoelectric uses. Groundwater withdrawals are intense in parts of the Southwest and Northwest, the Great Plains, Mississippi Valley, Florida and South Georgia, and near the Great Lakes. (Figure source: Georgia Water Resources Institute, Georgia Institute of Technology. Data from Kenny et al. 2009, USGS 2013).
Very heavy precipitation [1% of all daily events] has increased and is expected to increase further in all US regions.

Events with 1:20 year frequencies are expected to occur 1:15 to 1:5 by 2100.

Trends are larger than natural variations for Northeast, Midwest, Southeast, Great Plains, Alaska, and Puerto Rico.
• Con. US in the transition zone between drier subtropics and wetter north.
• Precipitation projections show consistent spring reductions in the Southwest and increases in the Northeast, Midwest, and Alaska.
• Dry spells are expected to increase in most regions.
Significant increasing trends in Midwest and Northeast.
Significant decreasing trends in Southwest.
Local flooding trends and projections depend on many factors.
Streamflow increases are observed and projected in northern states.
Streamflow decreases are observed and projected in southern states.
Flow peaks occur earlier due to earlier snowmelt, declines of spring snowpack, and more rain than snow. Cool season increases, warm season decreases.
By 2070, projected changes exceed historical variability.
Climate Change Impacts on Water Management
3rd NCA Water Chapter

- Water resources managers will encounter new risks that may not be managed with existing practices [California, Southwest, Southeast, Northwest, Great Plains, Great Lakes, etc.].

**Historical and Projected Water Supply and Demand for the Colorado River Basin**

- Median water demand exceeds supply by **3.2 MAF** by 2060.
  [Colorado River Basin WS&D Study, USBR 2012]

**Projected Hydrologic and Water Resources Impacts for the ACF River Basin**

- Runoff has been and is projected to **decrease** [Reservoir Mgt/ WS/ Env Impacts].
- Soil moisture has been and is projected to **decrease**, esp. in summer [Impacts for Ag.]
- Droughts and floods projected to **intensify**.
  [Georgakakos and Zhang, 2011]

- Increasing resilience and enhancing adaptive capacity provide opportunities to strengthen water resource management and plan for climate impacts.

- Effective climate adaptation strategies may include: Conservation programs; more flexible, risk- based, and adaptive operating rules for reservoirs; integrated SW-GW mgt; better monitoring and assessment of statewide water use; better coordination among all relevant stakeholders.
Thank You

Paul Fleming
Climate Resiliency Group
Seattle Public Utilities
Paul.fleming@seattle.gov