Overview of the Process and Findings of the Water Resources Chapter

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Aris Georgakakos
Georgia Institute of Technology
Convening Lead Author, Water Resources Chapter

Paul Fleming
Seattle Public Utilities
Convening Lead Author, Water Resources Chapter
Outline

• Primary messages
• NCA structure and process
• Water Resources chapter key messages and findings
• Discussion
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
Vision of the NCA

Advance an **inclusive, broad-based, and sustained process** for assessing and communicating scientific knowledge of the impacts, risks, and vulnerabilities associated with a changing global climate **in support of decision-making** across the United States.

**Goal 3** from the US Global Change Research Program (USGCRP) Strategic Plan: **Conduct Sustained Assessments**

Build sustained assessment capacity that improves the Nation’s ability to **understand, anticipate, and respond** to global change impacts and vulnerabilities.
NCA Structure

Committee on Environment, Natural Resources & Sustainability / Office of Science and Technology Policy

CENRS/OSTP

13+ Federal Agencies,

Interagency NCA Working Group

Fed Gov’t Stakeholders

National Climate Assessment

100+ Partners

NCAnet

~10 staff

NCA Office

~10 staff

Technical Support Unit (NOAA NCDC)

NCADAC

(NCA and Development Advisory Committee)

240 authors

44 Non-Federal Members: public, private, and academic sectors

16 Federal Ex Officio Members

NCADAC Working Groups

Chapter Author Teams

External Stakeholders
Sectors

- Water Resources
- Energy Supply and Use
- Transportation
- Agriculture
- Forests
- Ecosystems and Biodiversity
- Human Health
Cross-Cuts

- Energy, Water and Land
- Urban Systems, Infrastructure, & Vulnerability
- Indigenous Peoples
- Land Use & Land Cover Change
- Rural Communities
- Biogeochemical Cycles
- Oceans
- Coasts
NCA Products

- Full synthesis document
- Stand alone chapters
- Highlights document
- Dynamic website
What is new about the Third NCA

- Update of impacts assessment
- Confidence levels and traceable accounts – “line of sight” between data and conclusions
- Decision-making support in a “risk-based” framework
- Assesses progress in response activities
  - adaptation (preparedness)
  - mitigation (managing emissions of heat-trapping gases)
- Fosters sustained scientific process
- Web-based and transparent
Sustained Assessment

• Special report of the NCADAC
• Goal: Enhance the ability of decision-makers at multiple scales throughout the United States to anticipate, mitigate and adapt to changes in the global environment
• Four elements:
  o Establish mechanisms to support enduring collaborative partnerships
  o Enhance scientific foundations for managing risks and opportunities of climate change
  o Provide infrastructure to support a sustained process
  o Diversify resource base and set priorities
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, 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, 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.**
Key indicators measured globally over many decades consistently show that the Earth’s climate is warming.
Global temperature increases are highly unusual in recent decades.
2000-2009 was the warmest decade in at least 1300 years.

Natural factors (solar forcing, volcanoes) cannot explain warming.
Changes are consistent with human-caused emissions.
Models reproduce warming only when emissions are included.
Global temperatures are projected to increase by 2.5 °F (RCP 2.6) to 8 °F (RCP 8.5) by the end of the century.
Global Sea Level Rise
3rd NCA, Climate and Coastal Chapters

- Sea level has risen by **8 inches** since 1880, and it is projected to increase by **1 to 4 feet** by 2100.

- SLR has **critical flooding implications** for many US coastal regions with up to 2 feet SLR by 2050.
Recent decades are warmer in every US region.
2001 to 2012 was warmer than any previous decade in every region.
Most US regions experience wetter conditions (0.16 inches / decade).
US temperature projections indicate consistent warming in the coming decades across all models in the range 3 to 10 °F.

Projected temperature increase is higher than model- to- model range.
- 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.
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.
Soil Moisture Trends [1988-2012]
3rd NCA Water Chapter

- Annual surface soil moisture changes: **Drying** trends in many US regions.
- Seasonal changes: Potential impacts on streamflow, flooding, GW recharge, and agriculture.

[Dorigo et al., 2012]
Evapotranspiration
3rd NCA Water Chapter

- Second largest component of the water cycle, after precipitation.
- Regulates soil moisture, groundwater recharge, and runoff.
- Transpiration ~ 80-90% of total ET on land.
- Depends on temperature, solar energy, winds, humidity, and moisture availability.

- Regional ET estimation and projections are uncertain.
- Potential ET is expected to increase with temperature.
- Actual ET will depend on regional soil moisture changes.
Projected Changes in SWE, Runoff, & Soil Moisture

3rd NCA Water Chapter

- Projections indicate major losses in snowpack water content (SWE);
- significant reductions in runoff in California, Arizona, central Rockies;
- reductions in soil moisture across the Southwest.

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. Increases in cold season, decreases in warm season.
By 2070, projected changes exceed historical variability.
Flood Types and Expected Trends
3rd NCA Water Chapter

- **Flash and Urban Flooding:** *Expected to Increase.*
- **Riverine Flooding:** *Uncertain,* as it depends on several factors [basin size, spatial precipitation structure, soil moisture, time of year, snow cover, land use, terrain, etc.]
- **Coastal Flooding:** *Expected to increase* in many coastal areas.

- Floods threaten lives and disrupt critical infrastructure.
- In the US, from 1959 to 2005, floods caused 4,585 *deaths* and property and crop damage averaging 8.22 *billion dollars per year* [Ashley and Ashley, 2008, NOAA 2013].
Flood Magnitude Trends [1920 – 2008]
3rd NCA Water Chapter

- Significant increasing trends in Midwest and Northeast.
- Significant decreasing trends in Southwest.
- Local flooding trends and projections depend on many factors.

Peterson et al., 2013
Dorigo et al., 2012
Groundwater is the main water supply source for many US regions. [Great Plains, Mississippi Valley, east central US, Great Lakes region, Florida, etc.]

- GW provides buffer against droughts.
- GW is susceptible to the combined stresses of climate change (slow to manifest) and water use changes (more immediate impacts).
- Climate change impacts depend on several factors [geology, frequency and intensity of rainfall, seasonal timing of recharge events, GW-SW interactions, etc.]
- Coastal aquifers are vulnerable to inland droughts/floods, increased withdrawals, and SLR.
- GW is poorly monitored; Need for national groundwater monitoring framework.
Climate change is expected to impact several water quality factors:

- Water temperature
- Sediment generation and transport
- Nutrient concentrations and residence times
- Algal blooms and oxygen conditions
- Contaminant loads

Strategies aiming to reduce sediment, nutrient, and contaminant loads at the source remain the most effective management responses.
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 SE, SW, NW, GPs, Miss. Valley, FL, GA.
Water demand is projected to increase substantially across the US.

(a) Projected water demand change (%) from 2005 to 2060 assuming change in population and socioeconomic conditions consistent with the A1B emissions scenario, but with no change in climate.

(b) Projected water demand change (%) due to combined changes in population, socioeconomic conditions, and climate change consistent with the A1B emissions scenario.
Water resources managers will encounter new risks that may not be managed with existing practices [California, Southwest, Southeast, Northwest, Great Plains, Great Lakes, etc.].

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

- 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 planning 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; more effective engagement of all relevant stakeholders.
Water Resources: Priority Research Areas

- Develop more specific regional information about soil moisture, groundwater recharge and storage, and evapotranspiration, and their role in the hydrologic cycle and water supply availability.

- Understand how hydrological drivers of water supply interact with changing patterns of water demand and evolving water management practices to increase risks of drought, or influence the effectiveness of adaptation options.

- Support risk-based decision approaches, including more effective means to communicate interactions of multiple stresses and levels of scientific confidence and uncertainty.

- Research alternative institutional strategies to support integrated management, including possible revisions to legal codes and policy practices.

- Provide scenario-based guidance to stakeholders to understand climate variability and change in the near- and longer-term in order to support them in their decisions and policies.

- Develop indicators that allow for timely reporting and enhanced public understanding of climate change impacts, including abrupt changes and extreme events.
Questions

Thank you

Aris Georgakakos, Georgia Institute of Technology
Aris.Georgakakos@ce.gatech.edu

Paul Fleming, Seattle Public Utilities
Paul.Fleming@seattle.gov

NCA:  http://nca2014.globalchange.gov/
NCAnet:  http://ncanet.usgcrp.gov/home
Indicators: http://www.globalchange.gov/what-we-do/assessment/indicators