

Current Climate Studies 9:

CLIMATE CHANGE IMPACTS ON U.S. WATER RESOURCES

1. Print this file. Also answer the "Concept of the Week" questions in the *Weekly Climate News File*. (Check for additional *News* updates during the week.)
2. Complete the Investigation by responding to the *Chapter Progress Questions (Study Guide)* and the Investigations 9A and 9B from the *Climate Studies Investigations Manual*, and this *Current Climate Study*.

Climate Change Impacts on Water Resources:

Essential to all life forms, water affects all ecosystems. The term *water resources* refers to water in all phases (liquid, solid, vapor) in storage or in flux within the water cycle which is necessary for a sustainable quality of life as well as for sustaining the natural environment [*Glossary of Meteorology*, AMS]. Plants and animals, including humans, and their ecosystems are susceptible to variations in the storage, flow and quality of water in the Earth environment, all of which are impacted by climate change. These impacts include alterations in the water cycle that can result in too little or too much water and degradation of water quality.

The water cycle plays a crucial role in climate variability and climate change. Through countless interactions within the Earth system, the global water cycle integrates physical, chemical, and biological processes that sustain ecosystems and influence climate. In addition to the challenges of responding to the impacts of climate change on already stressed water systems, anticipation of future water resource requirements must also consider the increasing demands for water for sustainable development (preserving the environment so that human needs are met in the present and for generations to come).

1. The term *water resources* as defined above refers to water for _____.
 - a sustainable quality of life
 - sustaining the natural environment
 - both of these

To focus on NCA3 Findings on water, access NCA3 *Highlights* by going to your bookmarked *Highlights* address, going to the course website and clicking on "National Climate Assessment Highlights", or going directly to the *Highlights* report at http://www.globalchange.gov/sites/globalchange/files/NCA3_Highlights_LowRes-small-FINAL_posting.pdf.

Go to page 42. There, NCA3's ***Finding 7: Water*** is stated: "Water quality and water supply reliability are jeopardized by climate change in a variety of ways that affect ecosystems and livelihoods."

2. Under the heading *Key Messages: Water Resources* are three sub-headings. The first, *Climate Change Impacts on the Water Cycle*, contains observation-based evidence consistent with climate change and projections of climate change. First, it states "Annual precipitation and river-flow increases are observed now in the _____. [A map on page iv delineates and labels U.S. geographical regions as employed by the NCA3.]

- Northwest and Southeast
- Midwest and Northeast
- Northeast and Southwest

3. It continues, "Very heavy precipitation events have increased nationally and are expected to increase in _____."

- the Northwest
- the Midwest
- the Northeast
- all regions

4. Continuing on, "The length of dry spells is projected to increase in most areas, especially the _____ portions of the contiguous United States."

- northwestern and southeastern
- midwestern and northeastern
- southern and northwestern

5. "Short-term (seasonal or shorter) droughts are expected to intensify in most U.S. regions. Longer-term droughts are expected to intensify in large areas of the _____."

- Southeast
- Southern Great Plains
- Southwest
- all of these

6. _____ is (are) expected to imperil the sustainability of coastal freshwater aquifers and wetlands.

- Sea level rise
- Storm and storm surges
- Changes in surface and groundwater use patterns
- All of these

7. Under the sub-heading, *Climate Change Impacts on Water Resources Use and Management*, it is stated, “Climate change affects water demand and the ways water is used.” All of the following except the _____ “are particularly vulnerable to changes in water supply and demand.”

- Northwest
- Southwest
- Great Plains
- Southeast

8. Under the same sub-heading, it is stated that “Increasing flooding risk affects human safety and health, property, infrastructure, economies and ecology in _____ across the United States.”

- many basins
- high drought areas
- high temperature areas

9. On page 43, under the heading *Changes to Water Demand and Use*, it is stated “Climate change, acting concurrently with demographic, land-use, energy generation and use, and socioeconomic changes, is challenging existing water management practices by affecting water availability and demand and by exacerbating competition among uses and users.” Nationally, among the contiguous U.S. states, consumptive water use is dominated by _____ uses. This is because of the use of water for this purpose in the western states. In the east, water withdrawals mainly serve other uses.

- municipal
- industrial
- irrigation
- thermoelectric

10. On the maps at the bottom of page 43 are projected percentage changes in water withdrawals from 2005 to 2060 in the contiguous U.S. as calculated in two emissions scenarios; (a) Without Climate Change, and (b) With Climate Change. Both scenarios include the same anticipated changes in population and socioeconomic conditions, but (b) has projected climate change included. With climate change added, areas with greater than 50% increase in water withdrawals are found in _____.

- nearly every region of the country
- only the Great Plains
- only the Northwest

11. While the maps on the bottom of page 43 deal with the projected increases in water demand, the maps on the bottom of page 44 describe the projected declines in water supplies by county due to climate change essentially through the first half of the 21st century. Comparison of maps (a) and (b) on page 44 reveals the projected impact of

climate change on water supply decline. According to the text below the maps, “Compared to the 10% of counties today, by 2050, _____% of counties will be at high or extreme risk of water shortages.”

- 32
- 42
- 52

12. Map (b) on page 44 shows most regions of the contiguous U.S. are projected to have at least some declines in water supply due to climate change. The least impacted region is expected to be the _____.

- Northwest
- Great Plains
- Northeast
- all regions

Fundamental to water supply, but not the only factor, is the amount of precipitation received. Refer to the figure in the lower portion of page 21 of the *Highlights* report, entitled “Observed U.S. Precipitation Change”. Annual total precipitation changes for 1991-2012 are compared to the 1901-1960 time period. In the figure, green shadings identify precipitation increases and brown denotes decreases in terms of percentage change.

13. The coloration of the map suggests and the bar graph insert in the figure explicitly reveals that the average annual precipitation over the contiguous U.S. has already generally _____ in recent decades.

- increased
- decreased
- remained about the same

14. At the same time, the map shows that a large portion of the Southwest, the western Great Plains, and the Southeast _____ experience areas of lowered precipitation.

- did
- did not

These observed trends, when compared to the “(b) Climate Change Effects” water supply map on page 44 shows some similarity. This infers that the recent trends in precipitation appear generally to be consistent with the projected changes in water supply in the decades ahead.

Water Quality:

Among the Key Messages listed on page 42 is the statement, “Increasing air and water temperatures, more intense precipitation and runoff, and intensifying droughts can decrease

river and lake water quality in many ways, including increases in sediment, nitrogen, and other pollutant loads.”

15. On page 44, various ways in which projected climate change attributes described above degrade water quality are identified. Explicitly mentioned is that changing land cover, flood frequencies and flood magnitudes are expected to increase the movements of sediments in _____.

- lakes
- saturated soils
- large river basins

The U.S. Climate Resilience Toolkit:

The *U.S. Climate Resilience Toolkit* builds on the findings of NCA3 and related climate change scientific publications by providing access to data and information directed towards boosting resilience to the impacts of climate change. The *Toolkit* is a website that provides centralized, authoritative, easy-to-use information, tools, and best practices from across the federal government. Its purpose is to enable individuals, businesses, and communities to respond to their climate-related risks and opportunities, and to improve their resilience to extreme events. It provides guidance through the process of planning and implementing resilience-building projects. The *Toolkit* is continuously evolving and updating based upon the information needs of various sectors.

16. Go to <https://toolkit.climate.gov/>. There, click on “Steps to Resilience” at the top of the screen. In the view that appears, a framework is presented that can guide you through the process of planning and implementing climate resilient projects. The process includes the step(s) shown in the boxes to the right to _____. Click on the five steps to resilience in sequence to learn how they can help you identify climate vulnerabilities and select actions to address them.

- explore climate threats
- assess vulnerabilities and risks
- investigate options
- prioritize actions
- take action
- all of these

Go to <https://toolkit.climate.gov/topics/water-resources> to explore the *Climate Resilience Toolkit's* treatment of a particular topic, Water. After reading the information adapted from NCA3 and other sources, scroll down and click on the sub-topic “Flooding” under the Learn More heading. Then, under the heading Taking Action: to the right, click on “Building Smart in the Floodplain” for an example of using the Toolbox process.

17. The example given describes a potential flooding situation in _____. Read how this city found a solution to abandoned property in a flood plain by working with a private sector company and a National Weather Service River Forecast Center.

- Charleston, SC
- Fargo, ND
- Fort Collins, CO

On the [Building Smart in the Floodplain](#) web page, click on “Step 1. Explore Climate Threats” at the upper right. Read, and then click on Step 2”. Continue to click on and read each step through “Step 5” to become acquainted with the overall process of initiating, planning and implementing a climate resilient project.

18. “Step 5, Take Action” calls for implementation of the plan and asking if your actions are increasing climate resiliency. Scroll down to [5.2 Monitor your results](#). This section calls for measuring the effectiveness of each step by _____.

- seeking input and feedback
- paying attention to factors beyond your control
- measuring the effectiveness of each step
- making adjustments necessary before moving to the next phase
- all of these

This introduction to the *U.S. Climate Resilience Toolkit* by looking at the water resources sector demonstrates the *Toolkit's* usefulness in meeting the information needs of communities, interested citizens, businesses, resource managers, planners, and policy leaders in addressing the impacts of climate change.

Summary:

If you wish more information on climate change impacts on water resources, you can go to the NCA3 Full Report Water Resources chapter. [Go to <http://www.globalchange.gov/nca3-downloads-materials>. Scroll down to [Introduction to the Sectors](#), click on “3. Water Resources”, and open. The more precise projections available in the NCA3 full report will better inform water resources managers and planners as they attempt to increase resilience and adaptive capacity in the face of climate change.

Observed and projected changes show widespread increases in very heavy precipitation events as well as longer dry spells, meaning more variability in the water supply. Also, land use changes and population increases imply a fairly steady increased demand for water use. Water managers will need to balance these two sides of the equation.

Climate-related water-resource changes will likely accelerate in the decades to come, particularly in coastal and river basin locations that are susceptible to flooding, arid areas where water scarcity is an ongoing issue, and areas where the economy is climate sensitive.

Instructions for Communications with Mentor:

Transmit this week's work to your LIT mentor by Monday, 7 November 2016, or as coordinated with your mentor. Include:

- **Chapter Progress Response Form** from the *Study Guide* or the *RealTime Climate Portal* course website.
- **Investigations Answer Form** for 9A and 9B from the *Study Guide* or *RealTime Climate Portal* website.
- **Current Climate Studies Answer Form** from *RealTime Climate Portal* website.

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