Case Studies: Extreme Events and Water Utilities in Six Local Watersheds

Karen Metchis
EPA Office of Water
Office of Wastewater Management

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Project Team

- NOAA: Nancy Bellar-Simms
- EPA: Karen Metchis
- *WERF: Lauren Filmore
- *WaterRF: Kenan Ozekin
- CTC: Claudio Ternieden
- Noblis: Erica Brown

- Facilitators: Rob Greenwood & Nancy Tosta, Ross Strategic
- Contractors: Caroline Hemenway & Miriam Heller

*Water Environment Research Foundation
*Water Research Foundation

Project Objectives

- Conduct workshops in communities that have already experience an extreme event(s)
- Understand how water, wastewater & stormwater utilities and their communities were affected
- Learn how they planned and responded and how they are planning for future extreme events
- Identify information needs and gaps to improve preparedness

- 2-page case studies for each available as we go
- Synthesis report Summer 2013

Communities

- Russian River Basin - Sonoma County, CA
- Apalachicola-Chattahoochee-Flint River Basin – Gwinnett County, GA
- Tidewater Virginia – Norfolk, VA
- National Capital Region - Washington, D.C.
- Lower Missouri River Basin - Johnson County, KS
- Lower Colorado River Basin – Travis County, TX

- Synthesis Workshop

Preliminary Observations

- Water utilities and communities must embrace both emergency response and long term preparedness
- The complex array of decision makers affecting water resources within a watershed require communication (and innovation) beyond boundaries to manage surprises
- Multi-jurisdictional fragmentation creates community patterns and vulnerabilities that are more difficult to address
- Water utility managers are competently taking action within their span of control – but confronting real long term vulnerability is likely to require broader community action.
- Managers need better access to local information to manage resources for impending extreme events

Russian River Basin
Sonoma County, California

- 2006 New Year's Day flood
- 2007-2009 drought
- Spring 2008 an unusually intense period of frosts
- Must manage flood risk, water supply and environmental needs.

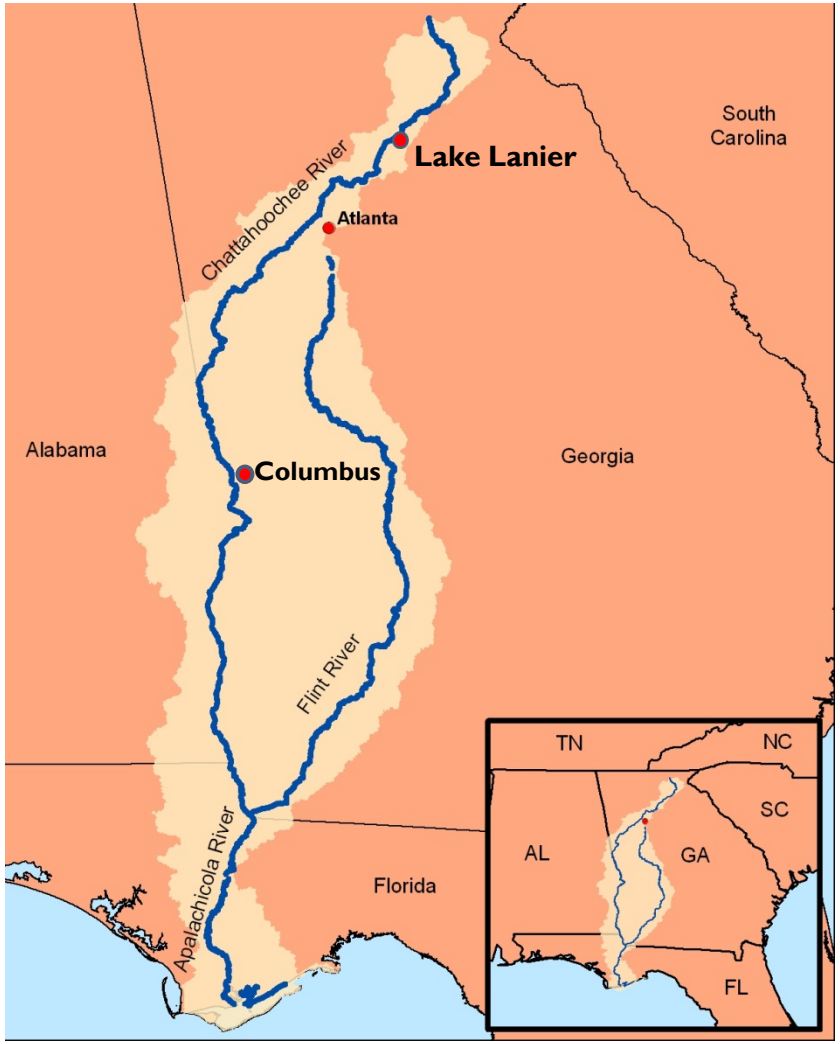
Impacts of 2006 Flood

- Near-record rainfall caused river to rise, cresting more than ten feet above its 32-foot flood stage.
  - >100 roadways blocked due to flooding and landslides.
  - Stormwater systems overwhelmed
  - 2,100 business and residential properties inundated
  - Severe flooding, overbanking, erosion, and sedimentation in the wetlands designed to protect Santa Rosa
  - Laguna WWTP flooded, releasing partially treated wastewater.
  - Structural damage to roadways limited access for plant personnel during recovery operations.
  - Business and residential damages estimated at $104 million.

Impacts of 2007-2006 Drought + 2008 Frost

- Drought plus Surface water and groundwater recharge declined.
- A major reservoir (L. Mendocino), close to drying up.
- To preserve water supplies, State allowed reduced releases from the lake below min. stream flow requirement
- Spring 2008: unusual frost prompted grape growers to spray grapes for protection, creating high water demand
- River flows, typically 500 - 1000 cfs or more, and already low due to drought, dropped to 168 cfs. causing death of protected juvenile coho and steelhead trout

Apalachicola-Chattahoochee-Flint Gwinnett County, Georgia



- Chattahoochee, its tributaries, and Lake Lanier provide water to Atlanta & Columbus – 4 million population
- The river is the most heavily used water resource in GA
- Lake Lanier Reservoir, operated by the Army Corps of Engineers, stores 65% of the basin's water, fed by the Chattahoochee River.

Extreme Events

- Four consecutive extreme weather events
- In the last 50 years, all major GA river basins had intensified droughts and declining rainfall - this trend is expected to continue.
  - Drought of 2007-08
  - Drought of 2011-12
- The region experienced two 500- year floods between 2007 and 2012 as a result of record rainfall
  - September 2009, intense and prolonged precipitation in N Georgia;
  - Winter of 2009-2010, heavy rain caused more flooding from over-saturation

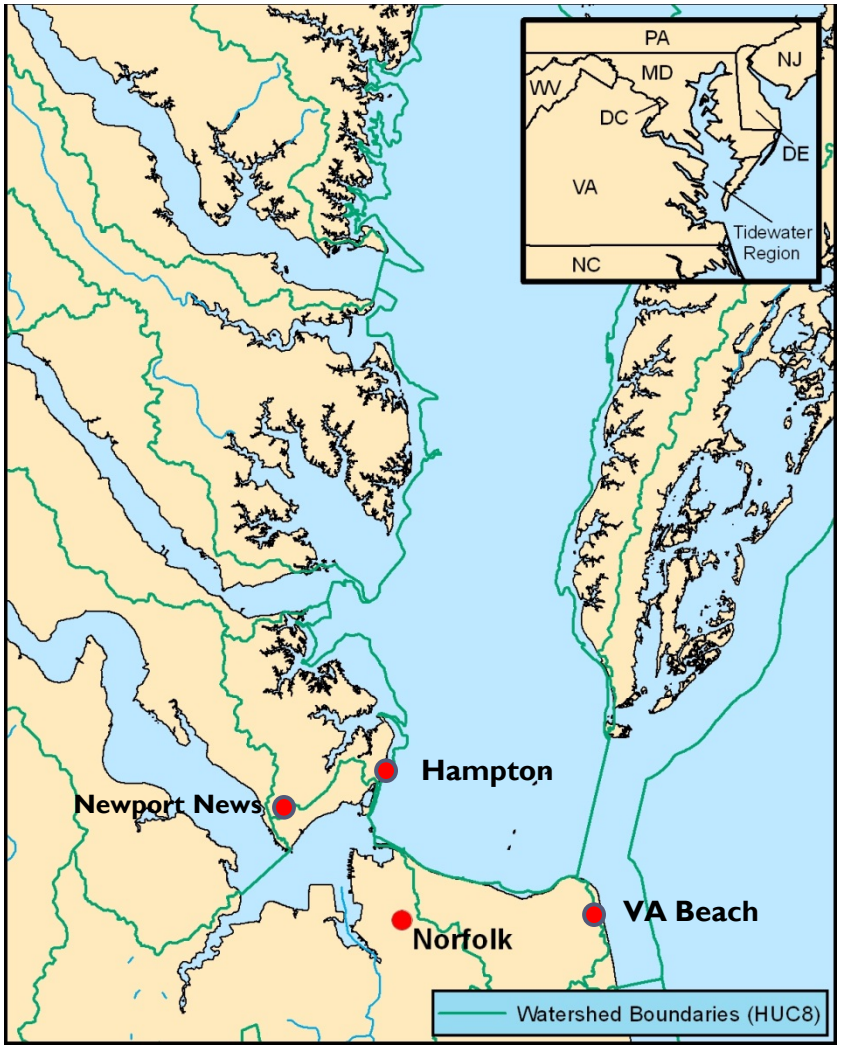
Impacts (Drought 2007-2008)

- Water utilities in Gwinnett, Cobb, and DeKalb counties faced with two challenges: ensuring adequate water supply and complying with environmental regulations.
  - Lost revenue when water restrictions were imposed, and drinking water treatment costs rose due to increased turbidity from water sources.
  - Army Corps reduced releases from the Dam to preserve supply for the coming summer - below Atlanta's 750 cfs discharge permit standard.
- Competing demands:
  - Municipal supply
  - Recharge of the reservoir
  - Agricultural production
  - Hydropower
  - Ecological needs

Impacts (Flood 2009-2010)

- Gwinnett Co.: 11 inches of rain fell in 18 hours – costing $7.5 million just for stormwater infrastructure evaluation and repairs
  - 28 storm culverts under roads collapsed
  - two wastewater pumping stations were shut down
  - water and wastewater treatment plants were flooded
  - sewers and floodways were inundated..
- Cobb Co.: Sutton WWTP
  - lost tertiary treatment, excessive damage to lift stations and underground infrastructure, collapsed structures and fallen trees.
- Atlanta: costs totaled $55 million
  - Clayton Water Reclamation Center had severe flooding and damage to primary clarifiers, biological nutrient removal basins, electrical gear, and the blower building. Power outages disrupted treatment processes.
  - Despite extensive recovery efforts, damage remained as of mid-2012.

Tidewater Virginia - Norfolk, VA



- James, Rappahannock, and York Rivers join the Chesapeake Bay
- Cities of Hampton, Newport News, Norfolk, Virginia Beach
- Norfolk Naval Base - world's largest naval station
- 3 metropolitan drinking water utilities and one sanitation district serving 1.7 million population
- SLR threatens potential loss of 50% – 70% of wetlands.
- 85% of Virginia's shoreline is privately owned

- Average 33 feet above sea level

Extreme Events

- Relative Sea Level has risen 14.5 inches since the 1920s
  - Additional 1.5-foot predicted by 2050; 3-feet by 2100.
- Since 1970, there have been ten significant storms, the majority since 2003.
  - 2003 Hurricane Isabel: record high storm surges & massive power outages
  - 2009 Nor'easter Ida: water rose above the 4.5-foot flood stage, creating surges over 6.7 feet (worst damage ever experienced in the area)
  - Aug 2011 Hurricane Irene: storm surges over 7.5
  - Aug 25 and 28, 2012: two nor'easters each exceeding a "hundred-year" event hit the same 30-square-mile area
- Significant storms predicted to become more frequent

Impacts at Utilities

- Isabel caused 250 of 400 small wastewater pump stations to lose power.
- Uprooted trees caused water line breaks.
- Ida caused 60% of Virginia Beach's outfalls to fill with silt and caused a partial dam failure on the Chickahominy River.
- Coastal erosion is affecting water/wastewater infrastructure.
- SLR is causing salinity of inland water sources - utilities are recording salt water at their intakes.
- Newport News raised its reservoir water level one foot to keep freshwater upstream and brackish tidal water downstream.
- SLR inhibits drainage, raising risks from disease vectors like mosquitoes.

National Capital Region Washington, D.C.

- Potomac River provides 90% of the drinking water supply
- Elevation from sea level along the Anacostia and Potomac, including along the US Capital mall, to ~ 400 feet above sea level in Tenleytown

Extreme Events

- Two extreme events in 2012
- June 29 , 2012: The Derecho windstorm
  - arose with no warning and left a swathe of power outages
  - hit at the start of the July 4 holiday when staff were gone, amidst record high temperatures, with unexpected winds that hit 85 mph with less than a day's notice.
- Oct. 2012: Superstorm Sandy
  - allowed a relatively long time for preparation and had the potential for widespread damage that did not materialize
- The region is exposed to increasing number & intensity of tropical storms, Nor'easters, snowmelt and heavy rain
  - Models show the frequency and severity of extreme events is likely to increase

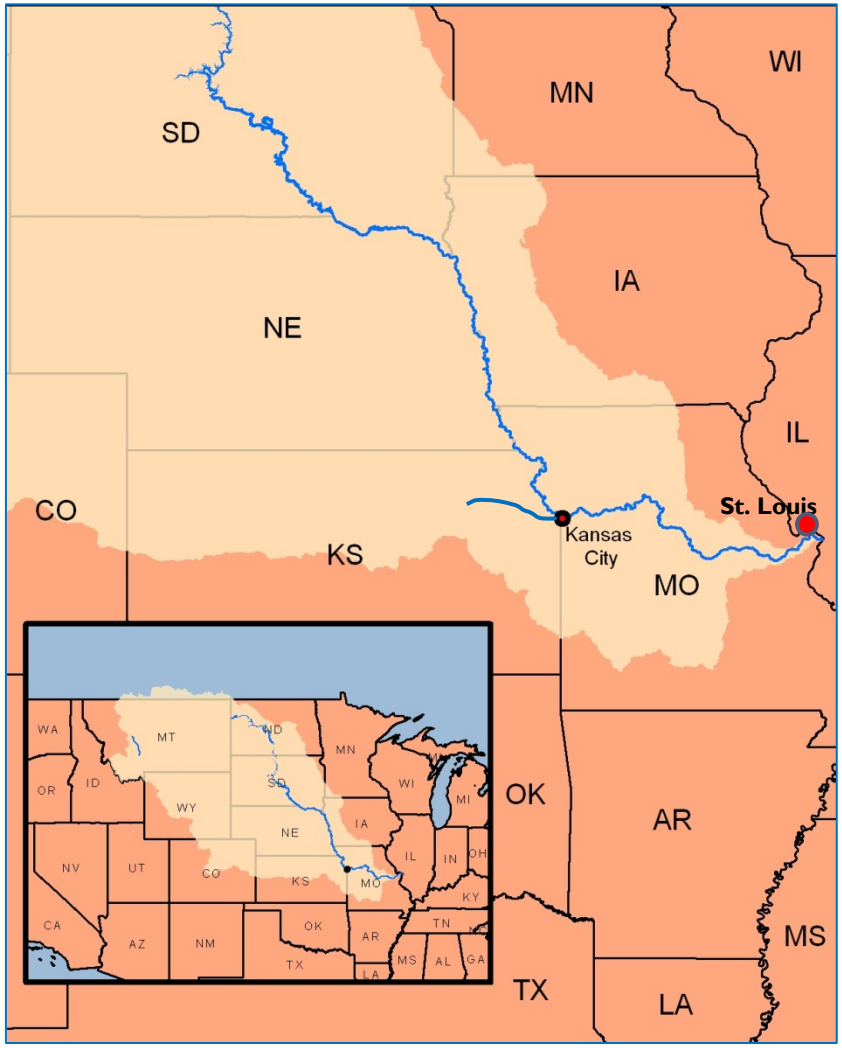
Impacts of Derecho

- Power Outages
  - Phone systems went down
  - WSSC lost both power feeders at the Potomac and Patuxent filtration plants due to downed trees; 50 other facilities lost power
- Water storage tanks had not been filled so were at only 65% capacity
  - Water restrictions imposed
- Downed Trees
  - Moving and fueling mobile generators and moving staff hampered by closed streets.
  - On the plus side, the follow-up trimming of trees probably helped forestall similar issues when Hurricane Sandy arrives 4 months later.

Impacts of Superstorm Sandy

- October 22 - October 29 emergency managers prepared for Sandy
- Fortunate to not be directly hit, but some impacts:
  - Water utilities in the area experienced short power outages and a few sewer overflows
  - Flooding in a few communities, mainly in Fairfax County in low-lying communities along the Occoquan River
  - Costs were related mostly to overtime pay for planning and maintaining "alert" status plus deploying backup generators
  - National Gallery of Art and American History Museum threatened by flooding from clogged storm drains
- Greatest impact and lessons learned were due to the extended time for preparation for emergency response

Lower Missouri River Basin Johnson County, Kansas



- Six dams on the Missouri River, of which 3 are the largest in the U.S.
  - Army Corps manages dams for drinking water supply; navigation; ag irrigation; ecosystem; etc.
- KS is a water rights state. MO is a riparian state
- 28 Tribes upriver with water rights
- Historically, flooding and drought have been the norm

Extreme Event – 2011 Flood

- 1951 was the flood of record, but 1997 was 20% higher!
- They thought this was the maximum runoff the basin was able to produce but 2011 was 20% higher still! (257% higher than normal)
- ***Surprised that a 2011 flood could still occur***
- Wettest May-July in record and June was a record for the single wettest month ever – ***15 maf runoff in one month vs. 25 maf in one year.***
- Massive flooding even in Kansas City where there was no particular record rain

Extreme Event – Drought 2012-201?

- 2012 Drought - Projected to persist thru 2013
  - Extremely dry soil – need 3”-9” of rain to bring soil moisture to normal
  - No significant change is expected
  - Increased temperature = increase evaporative demand, even if there is more precipitation
- Complicated set of interactions and management issues
  - Releases for navigation, power generation, water supply, water quality, endangered species, plus evaporation = declining reservoirs
- Stream Bed Degradation (Missouri River) has lowered the bed below drinking water intakes
  - Had to release more water in 2012 than wanted to keep water intakes operational – but the Corps may not do so in 2014.
- Kansas River and tributaries declining
  - 24 reservoirs in KS, all below normal reservoir level
  - 3 lakes on tributaries feeding KR at record lows

Impacts on Utilities

- Drought:
  - Water intakes below water level
  - Dry soil causing pipes to break
  - Taste & odor problems
- Flood:
  - Facility flooding
  - Power failures
  - Flash flooding
  - Sewer backups
- 2002 Ice Storm Event
  - Icing of Intakes

Lower Colorado River Basin
Travis County, Texas

- Workshop in March 2013
- Drought is the Major Issue to be examined
- But area has also experienced flooding
- *Stay tuned!*

Info Needs

- Regional and local forecasting and decision support tools
  - Forecasts for short-term, e.g. <7 days; less-intense storms; and drought
  - Updated FEMA flood maps and more accurate and localized flood data (block by block)
  - Translating what river elevation data means to water utilities- photos to show what river stage means.
  - Data dashboard that can be designed for a manager's specific needs; data aggregation to support decision making
- Monitoring
  - Additional flow monitoring data and use of new technologies; e.g., light detection and ranging (LIDAR), radar, collaborative monitoring
  - Real-time data and monitoring, for soil moisture, rain gages, and water level monitors in key locations.
  - Snow pack/soil moisture data inadequate
  - Reliable USGS flow data points for winter and low flow conditions
- Pipes
  - Soil moisture monitoring technology, tools
  - Sensors or other tools to assess condition of pipes
  - Comparison of life-cycle of different types of pipes relative to each other

Info Needs, continued

- Guidance on how to incorporate new information in planning
  - SLR estimates
  - Scientists indicating design goal, e.g. 2011 flood x15%, and water level, consequences and risk level□
  - Updated engineering design manuals
- Water supply, demand and use estimates
  - Improved understanding of groundwater/surface water interaction
- Socioeconomic studies
  - Methods for determining long-term costs and benefits of adaptation investments
- Public education and Information
  - Risks and differences between different types and causes of flooding
  - Residual risk and floodplains
  - Information and incentives to help land- and home-buyers make educated decisions about their investments
  - Communicating uncertainty: Science vs. stakeholders; what is the acceptable level of uncertainty useable by stakeholders?
- Grants to help smaller communities plan

For More Information:

- NOAA Sectoral Applications Research Program:

  http://www.cpo.noaa.gov/ClimatePrograms/ClimateSocietalInteractionsCSI/SARPProgram/ExtremeEventsCaseStudies.aspx

- EPA Climate Change And Water Web Site:

  http://water.epa.gov/scitech/climatechange/

- WaterRF Climate Clearinghouse:

  http://www.theclimatechangeclearinghouse.org/ClimateChangeScience/default.aspx