

Research & Data at the Energy-Water Nexus: Update on U.S. Dept of Energy & Federal Agency Activity

Roundtable on Science and Technology for Sustainability

Presented by National Research Council

June 6, 2013

Holmes Hummel

Senior Policy Advisor

Office of the Undersecretary for Energy

U.S. Department of Energy

Federal Partners in Energy-Water Nexus Research & Data

- **National Interests in Intelligence in the Energy Water Nexus**
- **U.S. Department of Energy's Water-Energy Technology Team**
- **Interagency – Intergovernmental Engagement on Data**
- **Preparing for Hazards and Recovering from Disaster**

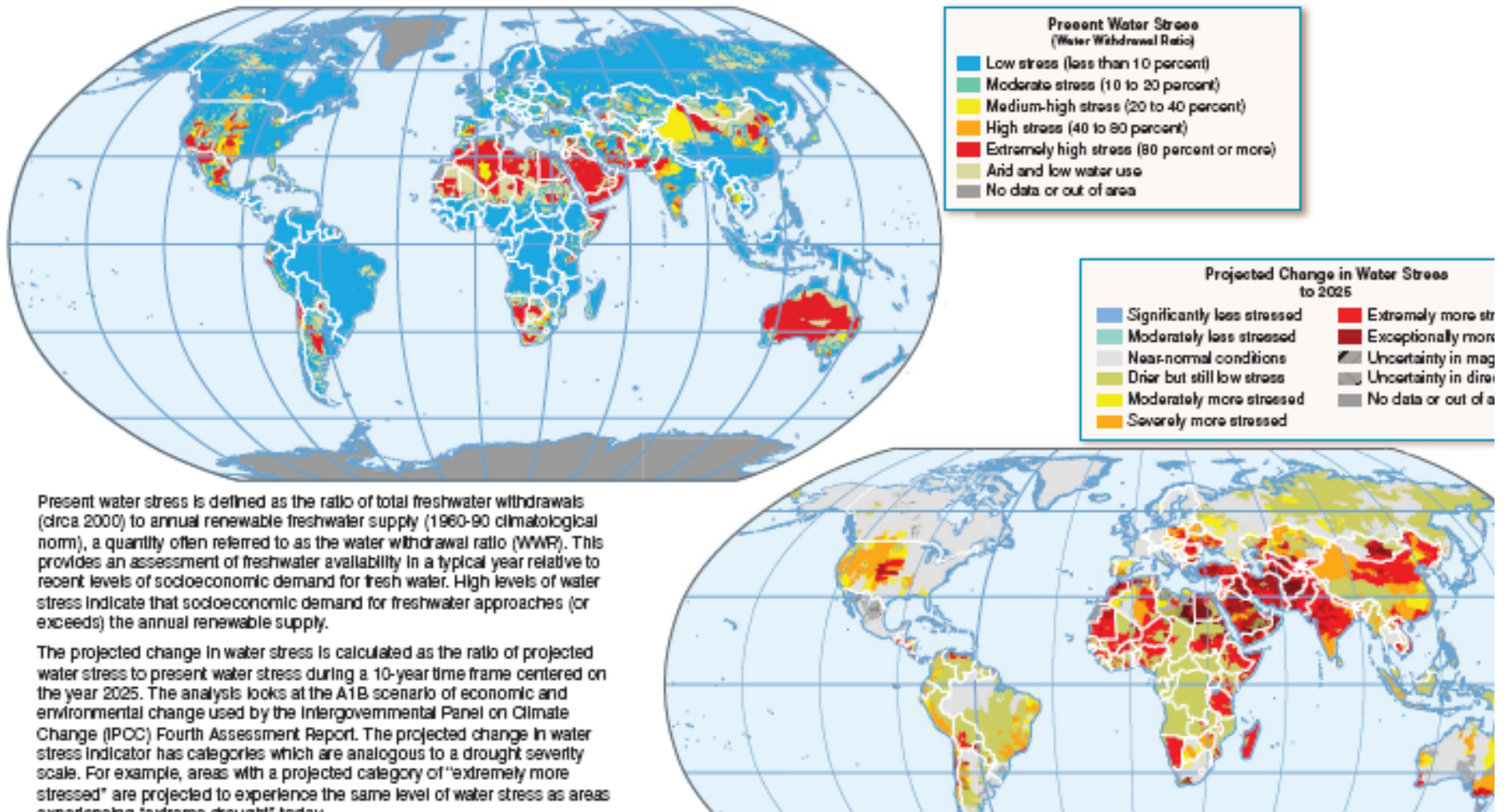


Global Water Security

INTELLIGENCE COMMUNITY ASSESSMENT

ICA 2012-08, 2 February 2012

Global Water: Present to 2025



U.S. water withdrawals by category: 2005

Surface water 328,000 Mgal/d (80%), 82% freshwater
Groundwater: 82,600 Mgal/d (20%), 96% freshwater
 Total: 410,000 Mgal/d

Livestock



Less than 1 percent

Self-Supplied Domestic



1 percent

Public Supply



11 percent

Thermoelectric Power



49 percent

1 percent



Mining

2 percent



Aquaculture

4 percent

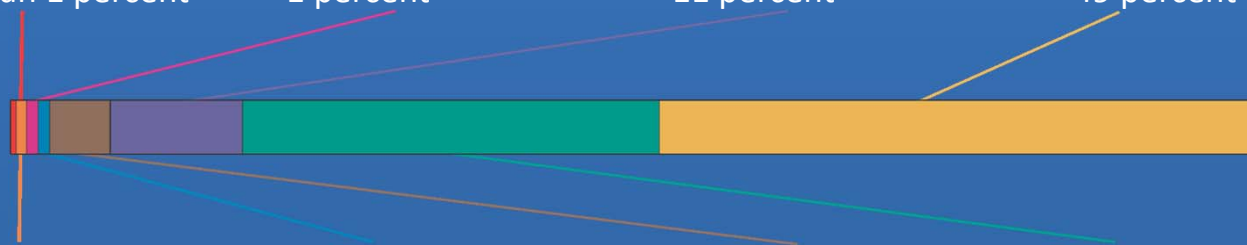


Self-Supplied Industrial

31 percent



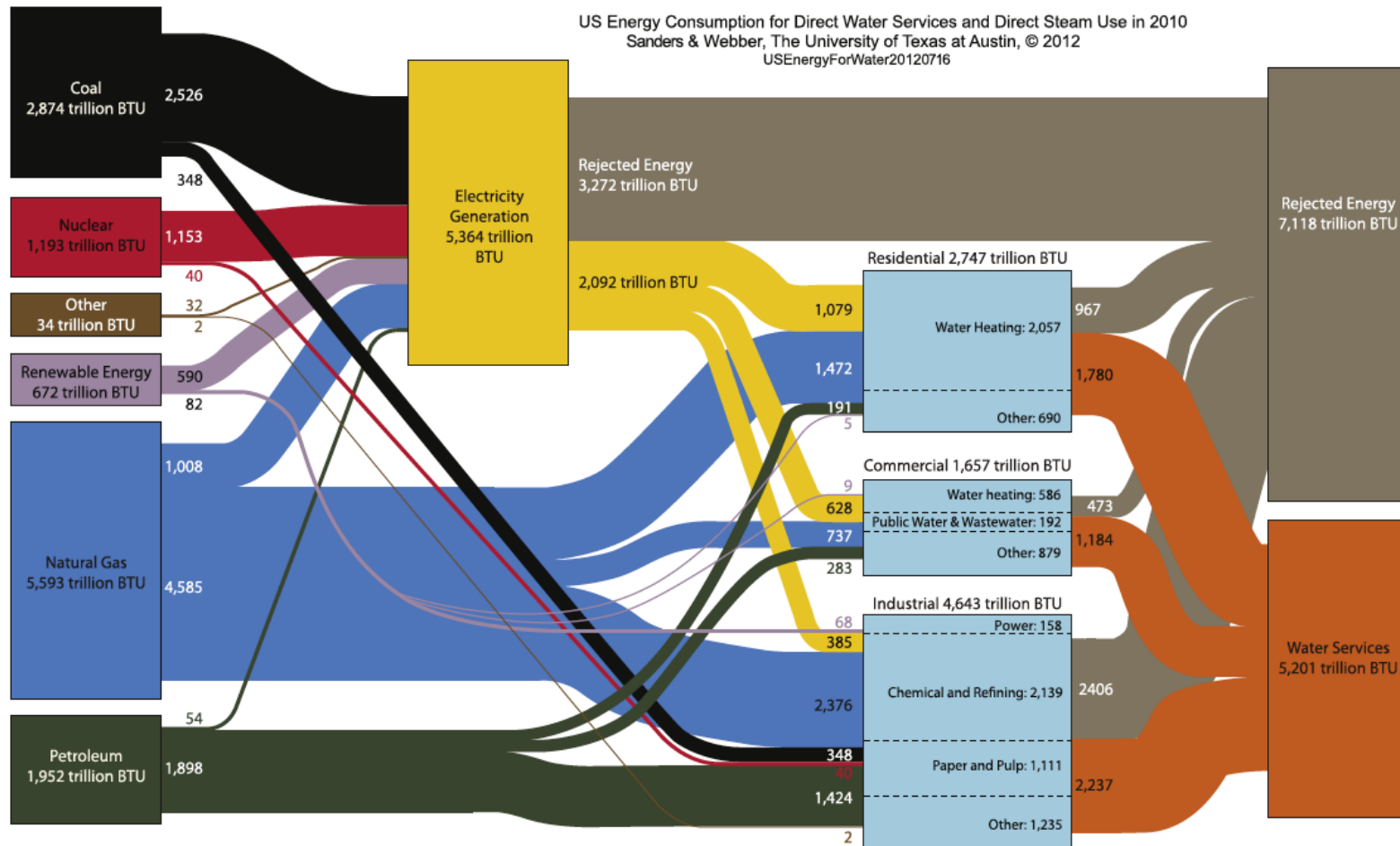
Irrigation



Source: Kenny et al., *Estimated Use of Water in the United States in 2005: U.S. Geological Survey Circular 1344*, 2009

Slide: Presented by Robin Newmark, National Renewable Energy Lab, to Nat'l Academy of Sciences workshop, April 2013.

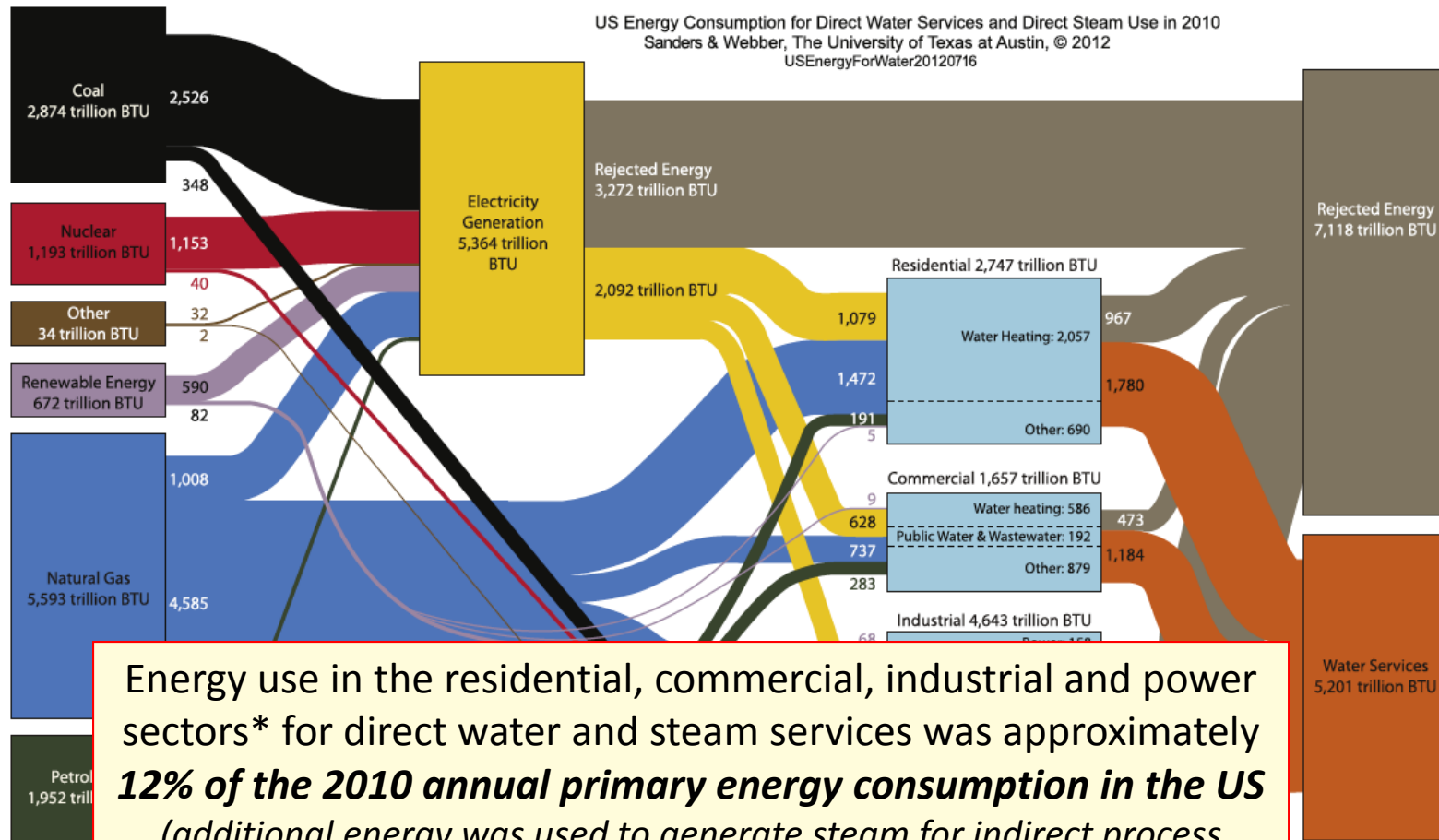
Primary energy embedded in water*: US national-level



*Residential, Commercial, Industrial and Power sectors, (~70% of total US primary energy consumption). Transportation sector not included.

Source: Sanders and Webber, 2012

Primary energy embedded in water*: US national-level



Energy use in the residential, commercial, industrial and power sectors* for direct water and steam services was approximately **12% of the 2010 annual primary energy consumption in the US** (additional energy was used to generate steam for indirect process heating, space heating and electricity generation)

*Residential, Commercial, Industrial and Power sectors, (~70% of total US primary energy consumption). Transportation sector not included.

Source: Sanders and Webber, 2012

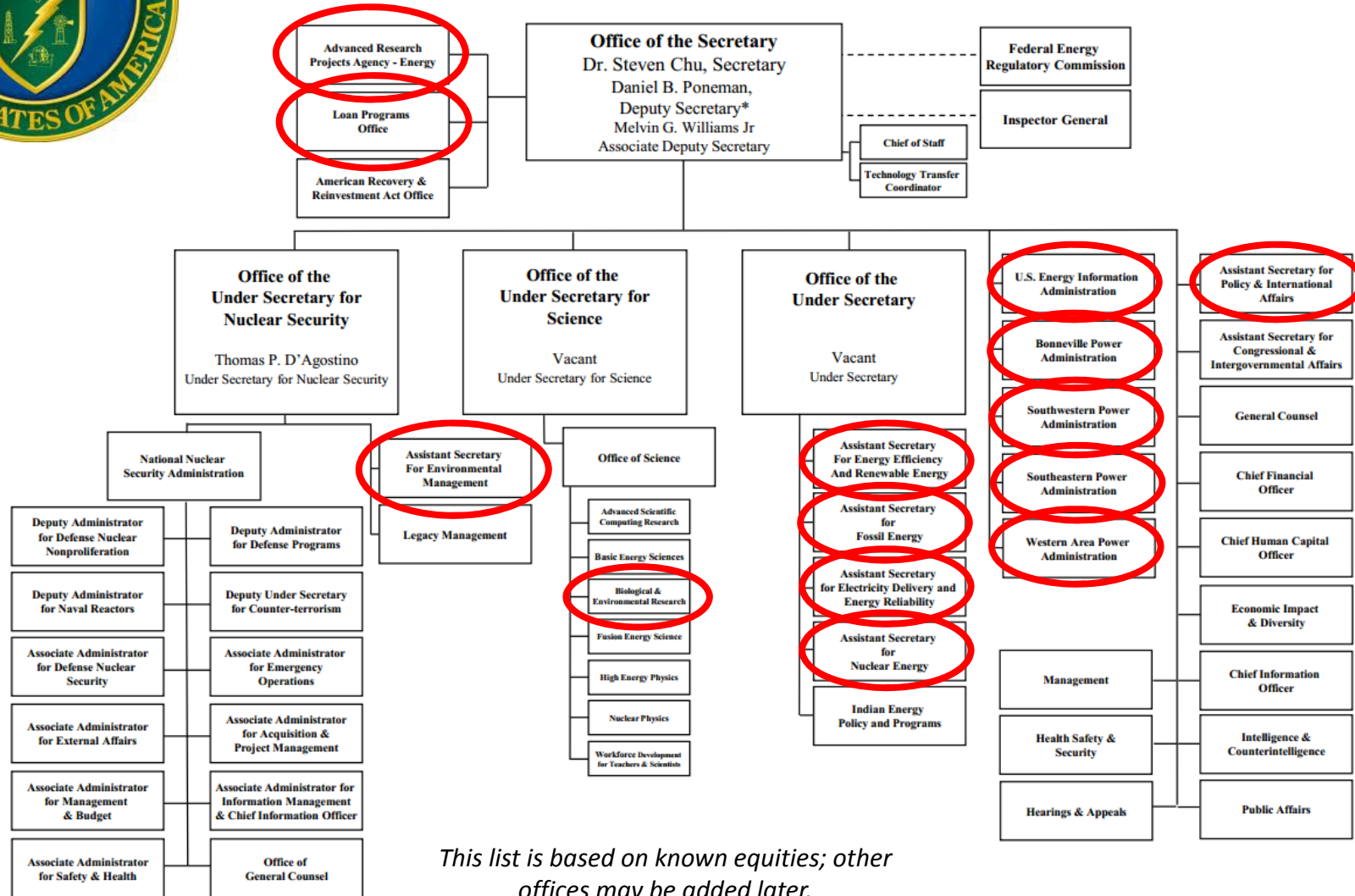
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DOE Offices with Water-Energy Equities



DEPARTMENT OF ENERGY



This list is based on known equities; other offices may be added later.

**DOE Water-Energy
Technology Team**
50+ experts in 20+ programs



**Cooling
Technologies**

**Water in Fuels
Production**

**Monitoring,
Modeling and
Forecasting**

**Three working groups to start,
plus delegation to support EPA on wastewater treatment.**

DOE Cooling Technologies Working Group

- **Reject less heat**
 - Improve plant efficiency
 - Use waste heat in other processes
- **Improve dry and hybrid wet/dry cooling**
 - Thermal barrier coatings
 - Rotating heat exchanger, novel heat sinks
- **Recover cooling tower water with minimal efficiency penalties**
- **Develop materials resistant to scaling, corrosion, and biofouling to enable use of degraded waters for cooling**
- **Alternative high temperature working fluids**
 - e.g. supercritical CO₂



DOE **Water in Fuels Production** Working Group

- **Look before drilling: High resolution seismic imaging**
 - Identify/avoid naturally-occurring fracture zones
- **Improve wellbore integrity sensors**
 - High temperature, high pressure, real-time telemetry
- **Use alternatives to water as hydraulic fracturing fluid**
 - Also non or less toxic additives
- **Improve hydraulic fracturing fluid life cycle management**
- **Treat produced water at lower cost, lower energy**
 - Forward osmosis, membrane distillation, dewvaporation, capacitive deionization
 - Suitable for highly saline waters (e.g. Marcellus shale)
 - Utilize waste heat where feasible
 - Enhanced membrane separations



EPA + USGS + DOE
MOU on R&D for
Unconventional Gas

DOE Monitoring, Modeling, and Forecasting Working Group



- **Water availability and temperature**
- **Assess power plants vulnerabilities to extreme weather**
 - Thermoelectric
 - Hydropower
- **Integrated assessment of future water uses and availability**
 - Climate change
 - Population shifts
 - Alternative usages scenarios
 - Competing demands (e.g. agriculture, municipal, industrial, energy)
- **Integrate water into biofuels production models/assessments**

**DOE Water-Energy
Technology Team**
50+ experts in 20+ programs



**Cooling
Technologies**

**Water in Fuels
Production**

**Monitoring,
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Forecasting**

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plus delegation to support EPA on wastewater treatment.**

Energy in Water Treatment and Distribution

- **Improve energy efficiency in wastewater treatment**
 - Membrane technologies
 - Update efficiency standards for pumps
- **Energy and resource extraction from wastewater streams**
 - Municipal biogas
- **Management of water and energy as integrated system**
 - Demand response in municipal wastewater treatment
 - Coupling desalination, municipal wastewater/storm water, and renewable generation
- **Energy assurance for water infrastructure**

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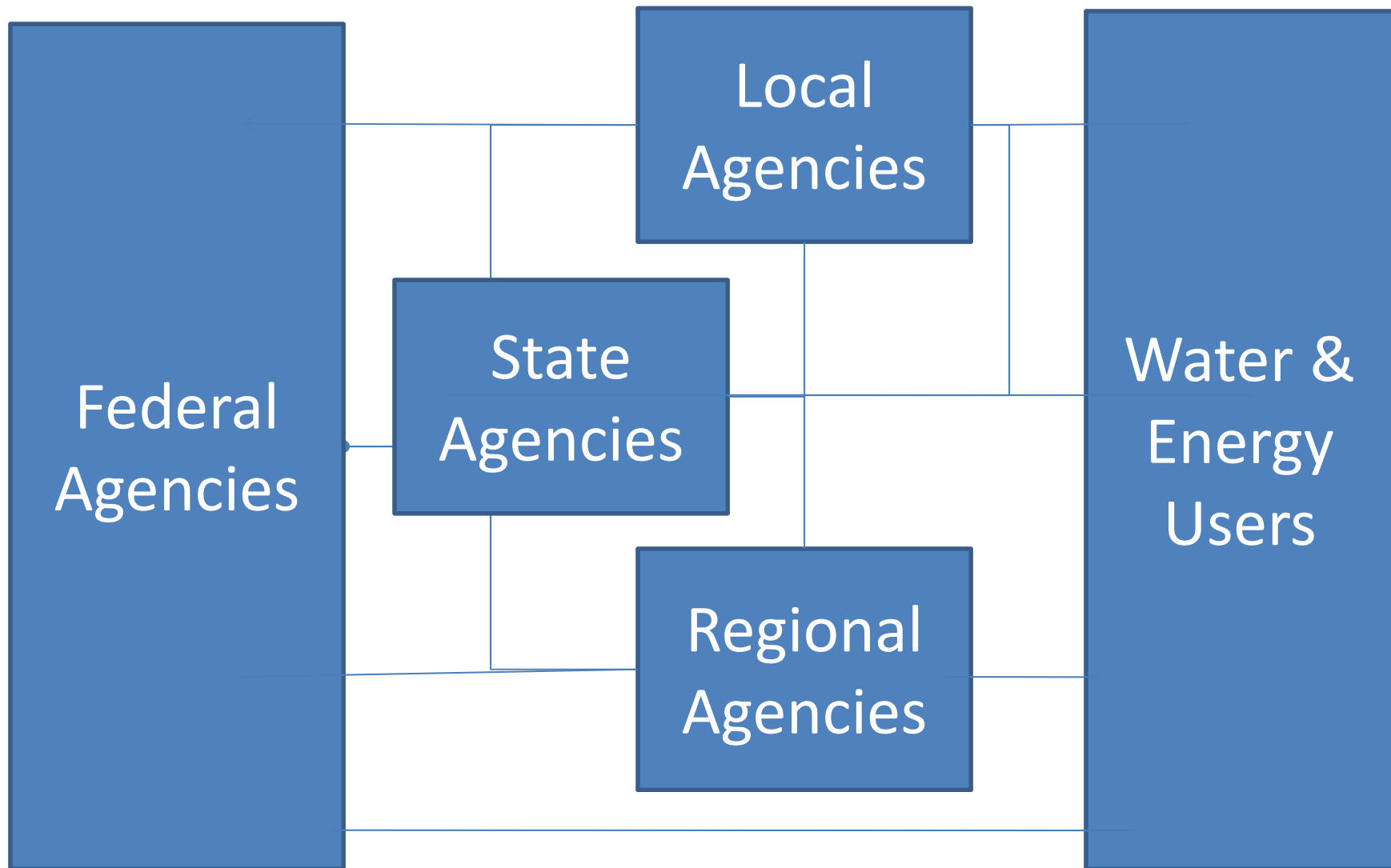
Federal Participants in the Energy-Water Landscape of Activity (partial view)



**US Army Corps
of Engineers®**



Energy-Water Landscape of Activity (partial view)





WaterToolBox.US

DATABASES, TOOLS & MODELS

Access water resources management programs, databases and models created by the U.S. federal government, states, Tribal Nations and non-governmental organizations by keyword or map search

- [Search active databases](#) for water management
- [Access models](#) that facilitate analysis & predictions
- [Acquire new tools and technologies](#)
- [Search by location](#) for data, models and programs

COLLABORATION & COMMUNITY

Contribute and take advantage of water resource solutions

- [View existing collaborations & partnerships](#)
- [Be aware of needs](#) within the water resources community
- Visit the [water resources forum](#) to learn about water activities and issues
- Find out how to become a [Federal Support Toolbox partner](#)

GET INVOLVED

Become a part of the Water Toolbox community

- [Become a Federal Support Toolbox partner](#)
- Stay informed about the latest [headline news and upcoming events](#)
- Join in the [discussion forums](#)

WATER RESOURCES MANAGEMENT

Effective water resources management depends on acquiring deep knowledge and astute skills

- Search the list of [legislative resources](#)
- Locate specific [policies and guidance](#)
- Review [best management practices](#)
- View the [list of agencies](#)

Water and energy studies

From Open Energy Information

Author	Year	Title	External	Topic
UC Berkeley/M. Kiparsky	2013	Regulation of Hydraulic Fracturing in California: A Wastewater and Water Quality Perspective	Report 	Hydraulic fracturing
EPRI/Revis James,R. Breckenridge	2013	Water Management Technology (P185) Program Overview	Program overview	Water management, electric power plants
IEA/Coal Industry Advisory Board	2013	21st Century Coal: Advanced Technology and Global Energy Solution	Report 	Coal energy water use
CRS/K. Bracmort	2013	Hydropower: Federal and Nonfederal Investment	R42579 	Hydropower
ANL/C. Harto	2013	Geothermal Energy: The Energy-Water Nexus	38th Workshop on Engineering 	Water intensity of energy
U. Alberta/Evan G.R. Davies	2013	An integrated assessment of global and regional water demands for electricity generation to 2095	ADVANCES IN WATER (2013) 	Energy intensity of water water intensity of energy planning
CPUC/R. White	2013	Rethinking the Water Energy Nexus: Moving toward Portfolio Management of the Nexus	Report 	Energy intensity of water water intensity of energy planning
Carbon Disclosure Project	2012	Collective responses to rising water challenges	Report 	Energy intensity of water water intensity of energy planning
Pacific Institute	2012	Hydraulic Fracturing and Water Resources: Separating the Frack from the Fiction	Report 	Hydraulic fracturing
PNNL/R. Skaggs	2012	Climate and Energy-Water-Land System Interactions: Technical Report to the U.S. Department of Energy in Support of the National Climate Assessment	PNNL-21185 	Planning
AGU	2012	Water-Energy Nexus: Solutions to Meet a Growing Demand	Report 	Water intensity of energy energy intensity of water

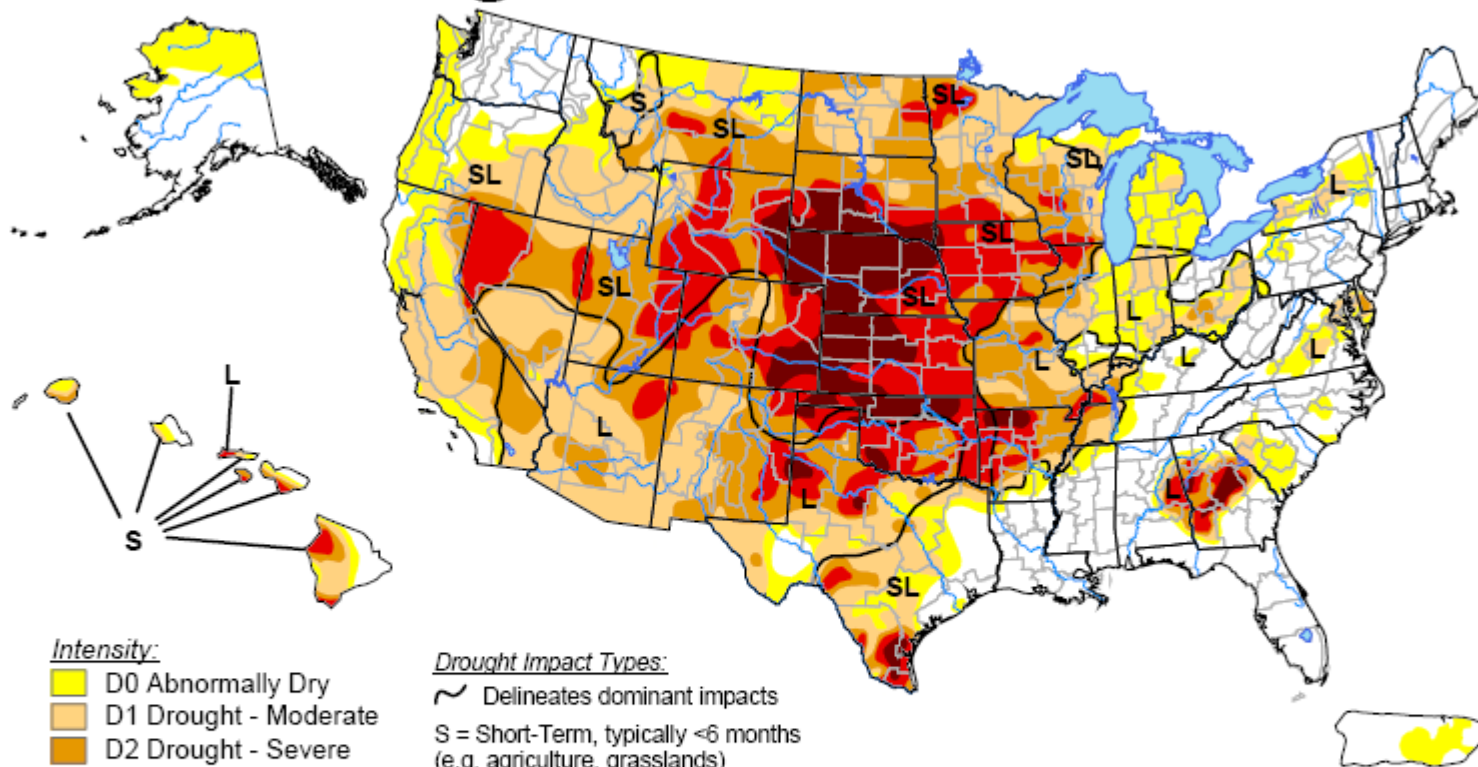
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U.S. Drought Monitor

October 9, 2012


Valid 7 a.m. EDT



Intensity:

-  D0 Abnormally Dry
-  D1 Drought - Moderate
-  D2 Drought - Severe
-  D3 Drought - Extreme
-  D4 Drought - Exceptional

Drought Impact Types:

-  Delineates dominant impacts
- S = Short-Term, typically <6 months
(e.g. agriculture, grasslands)
- L = Long-Term, typically >6 months
(e.g. hydrology, ecology)

The Drought Monitor focuses on broad-scale conditions.
Local conditions may vary. See accompanying text summary
for forecast statements.

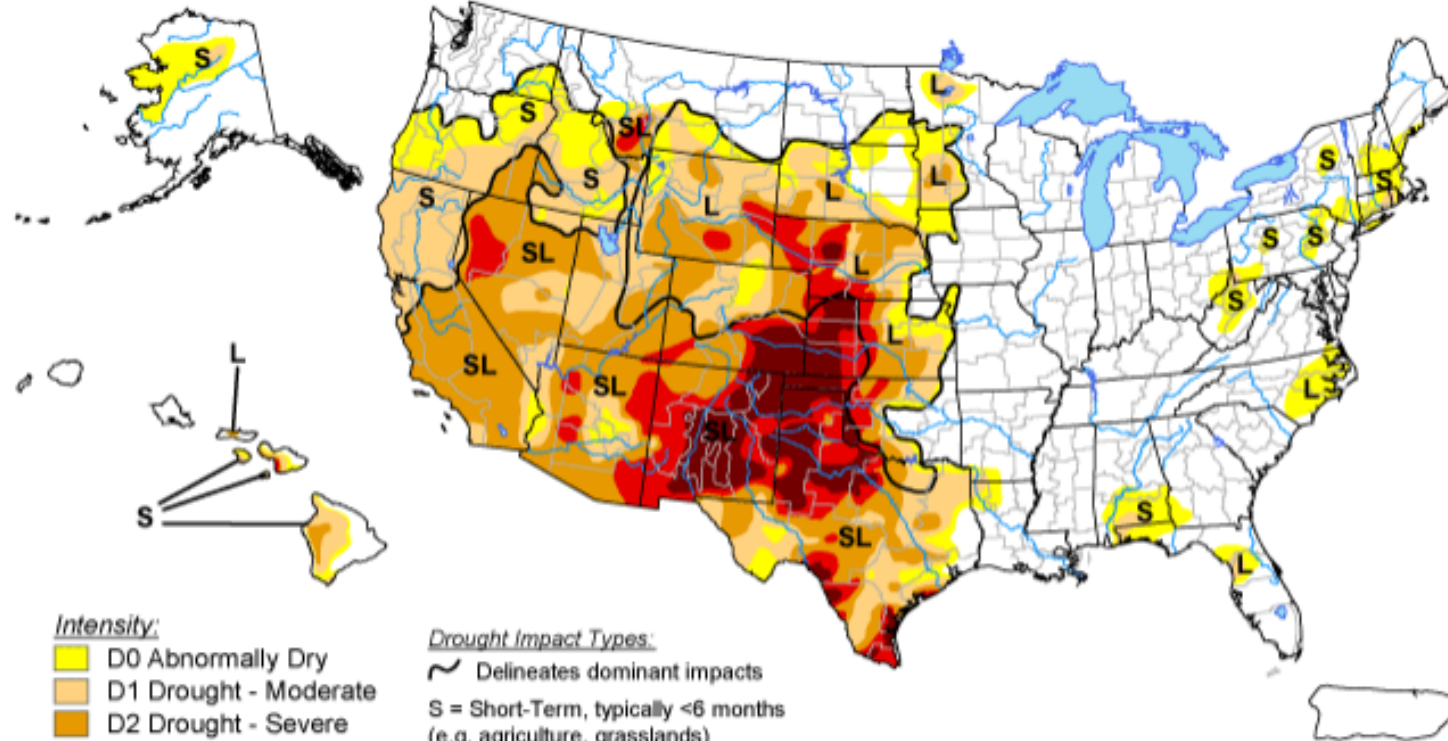
<http://droughtmonitor.unl.edu/>



Released Thursday, October 11, 2012
Author: Matthew Rosencrans, NOAA/NWS/NCEP/CPC

U.S. Drought Monitor

June 4, 2013
Valid 7 a.m. EDT



Intensity:

- D0 Abnormally Dry
- D1 Drought - Moderate
- D2 Drought - Severe
- D3 Drought - Extreme
- D4 Drought - Exceptional

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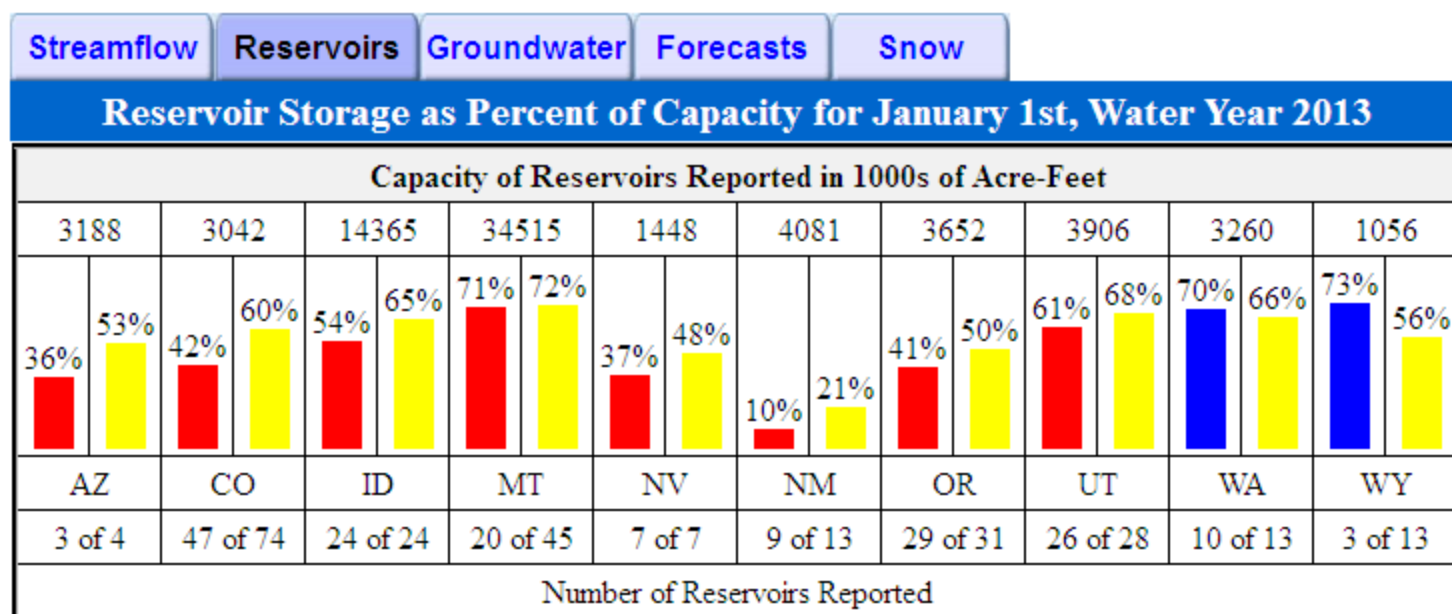


Released Thursday, June 6, 2013

Author: David Simeral, Western Regional Climate Center

U.S. Water Monitor -- A Portal To Federal Water Information -April 30, 2013

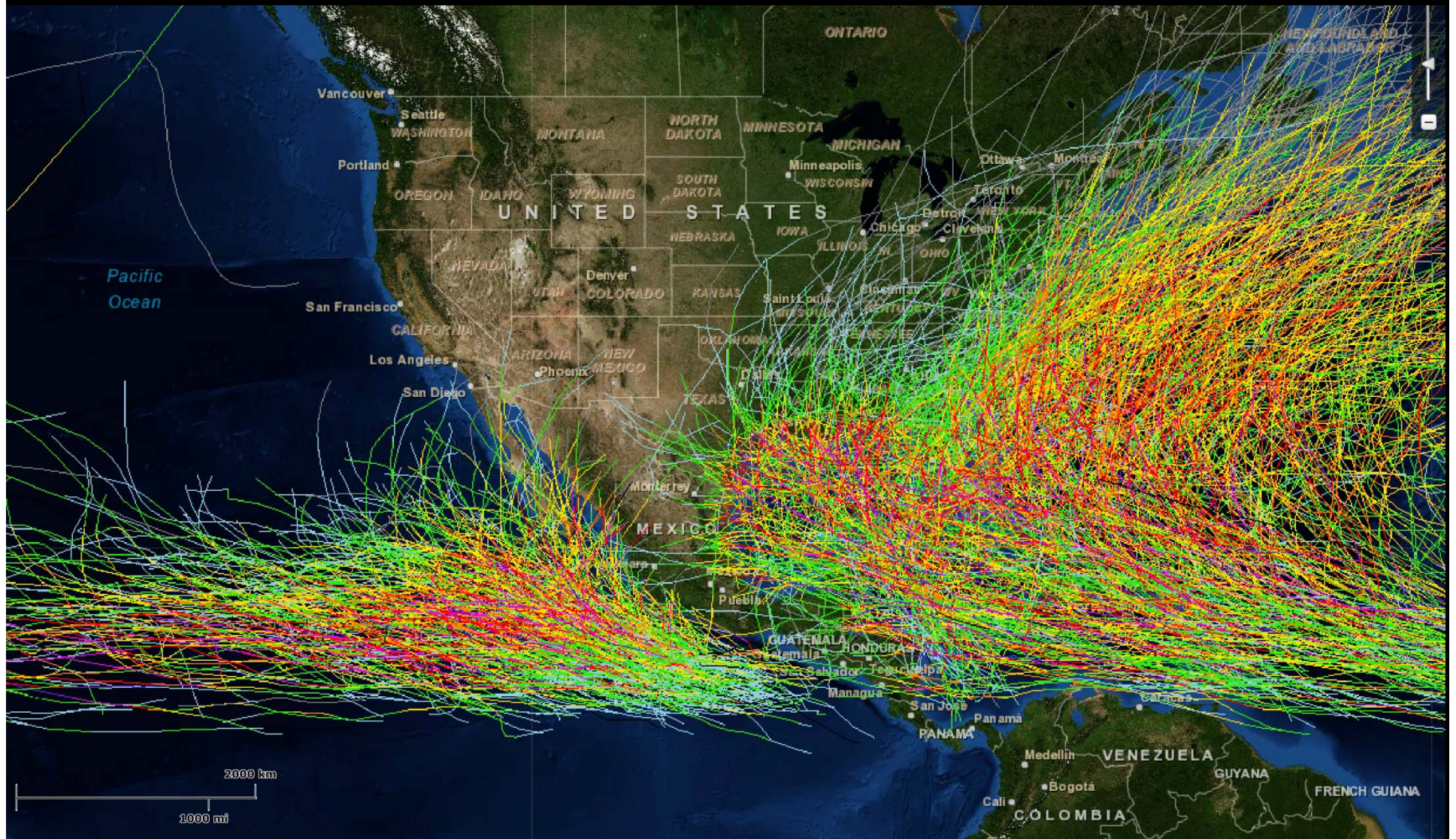
Companion to the *U.S. Drought Monitor* and the *Drought Impact Reporter*



- Storage is Below Average (% of Capacity)
- Storage is At or Above Average (% of Capacity)
- Average Storage as % of Capacity

* = Data are not available for this state.

Hurricane Tracks for Last 150 Years



<http://www.commerce.gov/sites/default/files/images/2012/august/noaa-hurricane-tracker.jpg>

Presidential Policy Directive #8 (PPD-8): National Preparedness

Prepare for Hazards, Respond to Disaster, and Recover:

Mitigation: the capabilities necessary to reduce the loss of life and property by lessening the impact of disasters.

Response: the capabilities necessary to save lives, protect property and the environment, and meet basic human needs after an incident has occurred.

Recovery: the core capabilities necessary to assist communities affected by an incident to recover effectively.



National Mitigation Framework

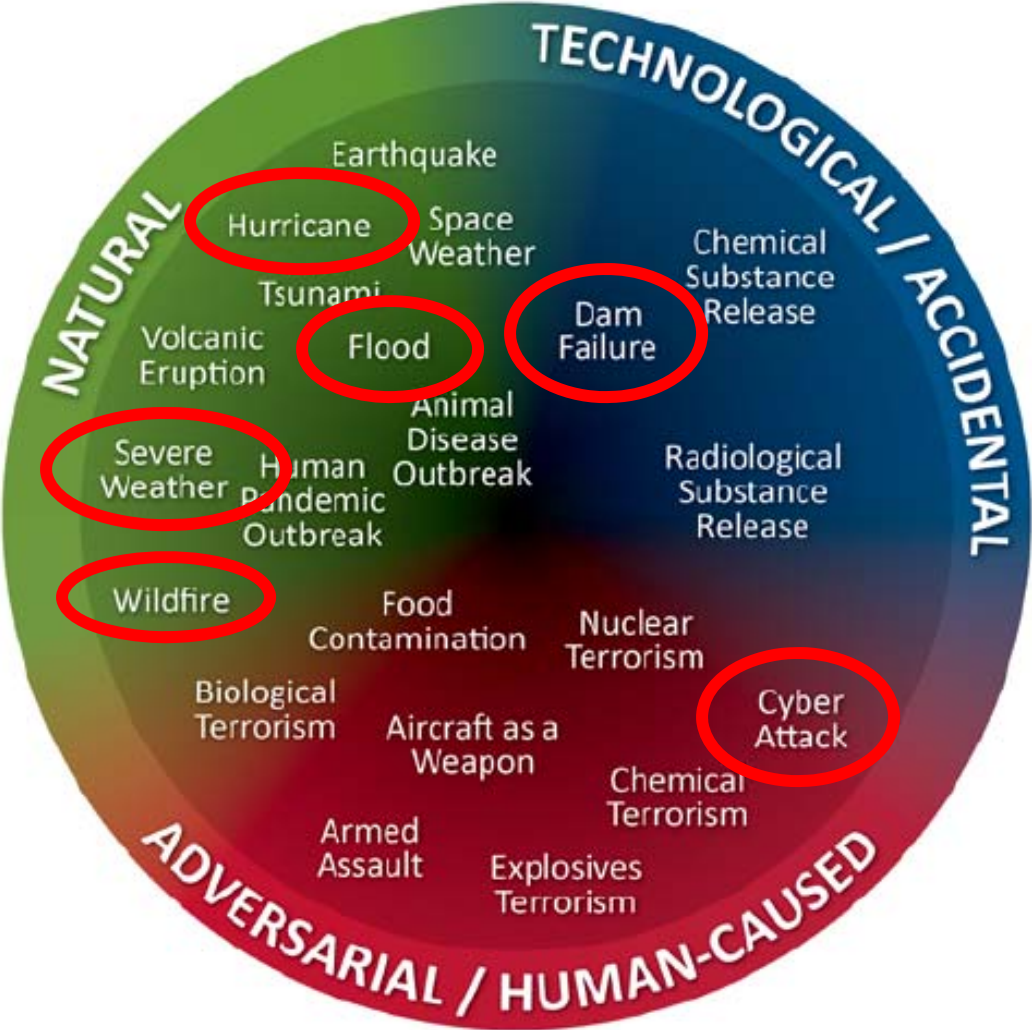
May 2013

Mitigation requires systemically anticipating and adjusting to trends that could endanger the future of the community.

Appropriate choices made before an event can help to manage or reduce long-term risk and potentially reduce response requirements.

Mitigation during the recovery phase helps strengthen and build a more resilient community to withstand future disasters.

Examples of Threats and Hazards by Category



Composition of the Whole Community



Comprehensive Mitigation Includes Strategies for All Community Systems



Mitigation Core Capabilities



1 Mitigation: “the capabilities necessary to reduce the loss of life and property by lessening the impact of disasters.”

**Presidential Policy Directive #8:
National Preparedness**

PPD-8

2 Response: “the capabilities necessary to save lives, protect property and the environment, and meet basic human needs after an incident has occurred.”

3 Recovery: “the core capabilities necessary to assist communities affected by an incident to recover effectively.”

1 Mitigation: “the capabilities necessary to reduce the loss of life and property by lessening the impact of disasters.”

Core Capabilities

- Planning
- Public Information and Warning
- Operational Coordination
- Community Resilience
- Long-Term Vulnerability Reduction
- Risk and Disaster Resilience Assessment
- Threats and Hazard Identification

3 Recovery: “the core capabilities necessary to assist communities affected by an incident to recover effectively.”

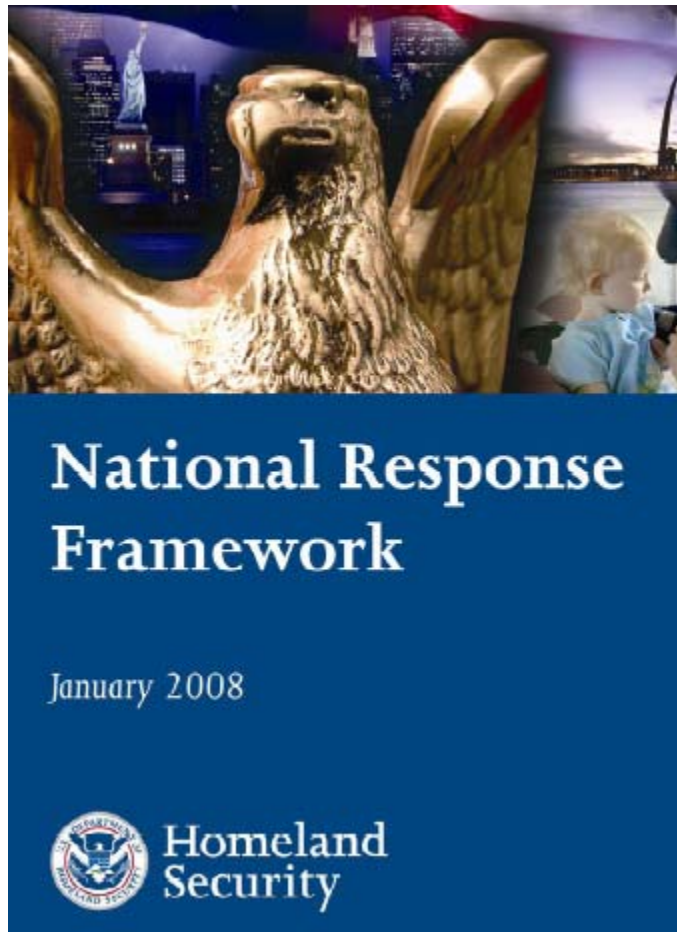
- Planning
- Public Information and Warning
- Operational Coordination
- Economic Recovery
- Health and Social Services
- Housing
- Infrastructure Systems
- Natural and Cultural Resources

Presidential Policy Directive #8: National Preparedness

PPD-8

2 Response: “the capabilities necessary to save lives, protect property and the environment, and meet basic human needs after an incident has occurred.”

- Planning
- Public Information and Warning
- Operational Coordination
- Critical Transportation
- Environmental Response/Health and Safety
- Fatality Management Services
- Infrastructure Systems
- Mass Care Services
- Mass Search and Rescue Operations
- On-Scene Security and Protection
- Operational Communications
- Public and Private Services and Resources
- Public Health and Medical Services
- Situational Assessment



*During Superstorm Sandy,
428 Drinking Water Plants and
120 Wastewater Treatment Plants
sustained damage.*

Emergency Support Function #3: Public Works

ESF Coordinator:

Department of Defense/U.S. Army Corps of Engineers

Primary Agencies:

Department of Defense/U.S. Army Corps of Engineers
Department of Homeland Security/Federal Emergency Management Agency

Support Agencies:

Department of Agriculture
Department of Commerce
Department of Defense
Department of Energy
Department of Health and Human Services
Department of Homeland Security
Department of the Interior
Department of Labor
Department of State
Department of Transportation
Department of Veterans Affairs
Environmental Protection Agency
General Services Administration
Nuclear Regulatory Commission
Tennessee Valley Authority
American Red Cross
Corporation for National and Community Service

National Disaster Recovery Framework

Strengthening Disaster Recovery for the Nation

September 2011



RSF: INFRASTRUCTURE SYSTEMS

Coordinating Agency: DOD/USACE

Primary Agencies: DHS (FEMA & NPPD), DOD/USACE, DOE, DOT

Supporting Organizations: DHS, DOC, DOD, DOI, ED, EPA, FCC, GSA, HHS, NRC, TREAS, USDA, TVA

Provides the coordinating structures, framework and guidance to ensure:

- Resilience, sustainability, and mitigation are incorporated as part of the design for infrastructure systems and as part of the community's capital planning process.

Pre-Disaster:

- Works with partners to identify critical facilities and help reduce risk.

Post-Disaster:

- Promotes rebuilding infrastructure in a way that will reduce vulnerability to future disasters.

Comprehensive Mitigation Includes Strategies for All Community Systems



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