

Produced Water Recycling & Reuse Impacts on the Hydrologic Cycle

National Science Foundation (NSF) Industry University Cooperative Research Centers Program (IUCRC)

Clary Advanced Resource Recovery Site (CARRS):
energy, water, power, atmosphere and a digital platform

White Star, Chesapeake, AECOM, Siemens and Pitney Bowes

NRC: meta-research lab for technology to market research initiatives

University of Wyoming Center for Excellence in Produced Water Management

University of Colorado Boulder Renewable and Sustainable Energy Institute

Oklahoma State University Boone Pickens School of Geology

National Renewable Energy Lab – Technology Systems & Impacts Group, Strategic Energy Analysis Center



Water Day

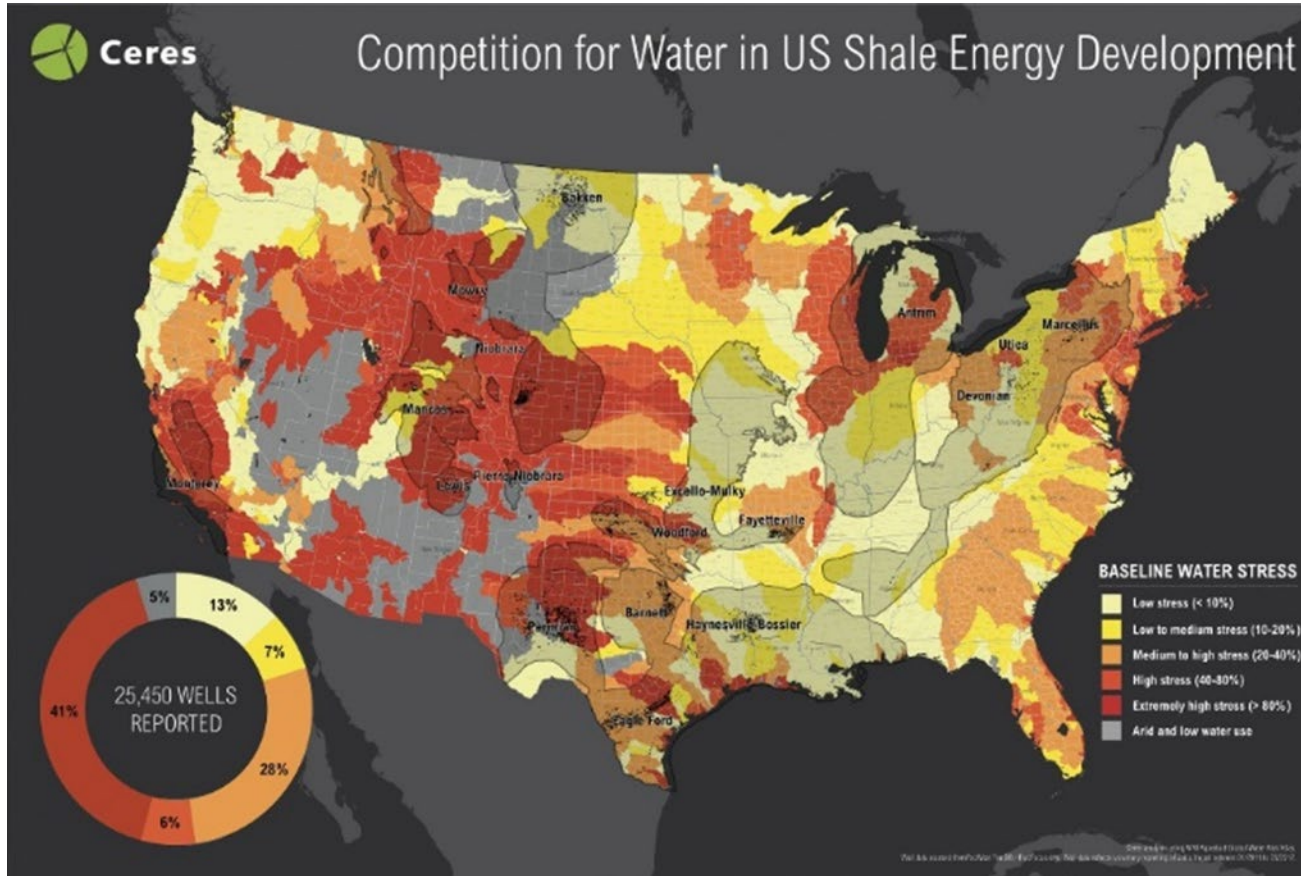
November 16, 2018



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Water Stress in the Oil & Gas Sector



The intensification of the water footprint of hydraulic fracturing, 15 Aug 2018

Water per well increased up to 770% from 2011 -2016

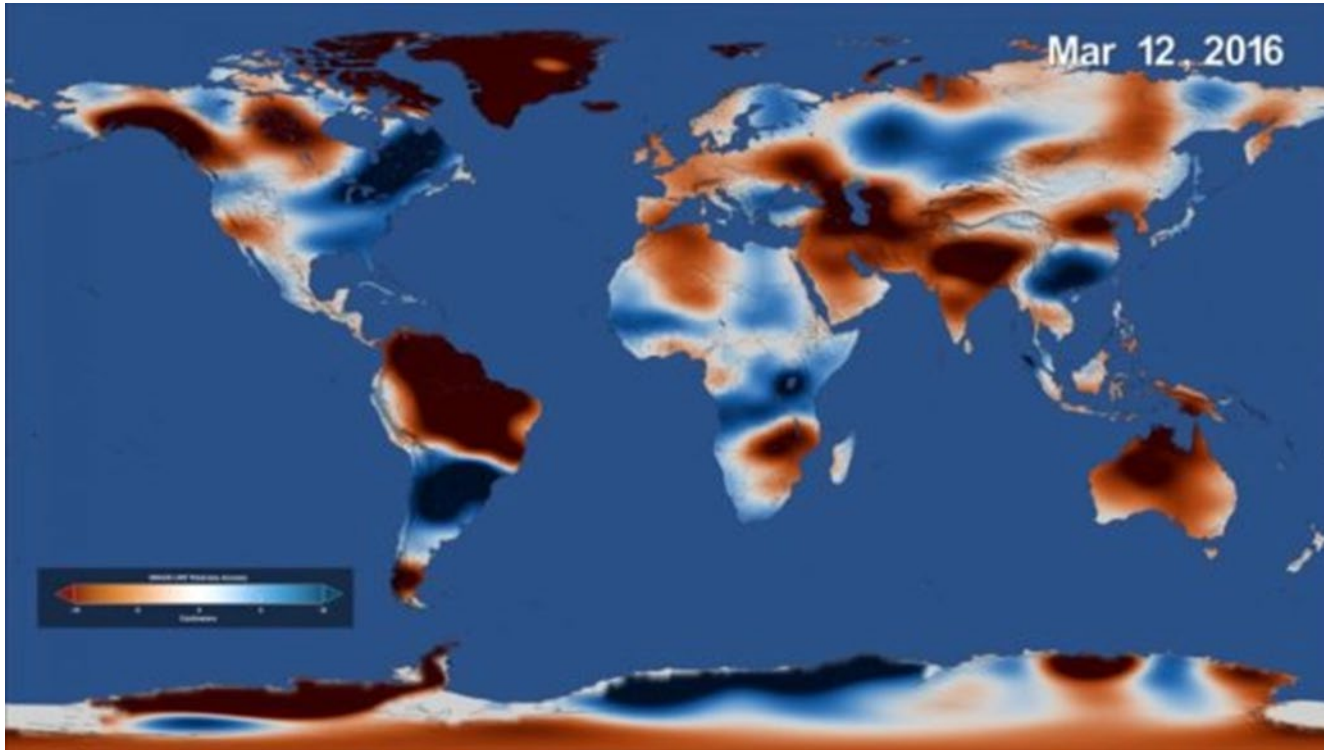
Flowback and produced water volumes in first year of production increased up to 1440%

Ubiquitous increases in all shale basins: Permian high, Marcellus low

Rapidly diminishing global water resources



Gravity Recovery and Climate Experiment (GRACE)



Jet Propulsion Laboratory
California Institute of Technology

Emerging trends in global freshwater availability, *nature*, 16 May 2018

Quantifies 34 regional trends in terrestrial water storage from 2002-2016

Factors: water management practices, climate change, natural climate cycles

Outcomes: drought plus groundwater withdrawals from 2002-2014 = 4 gigatons of annual freshwater loss in Southern California



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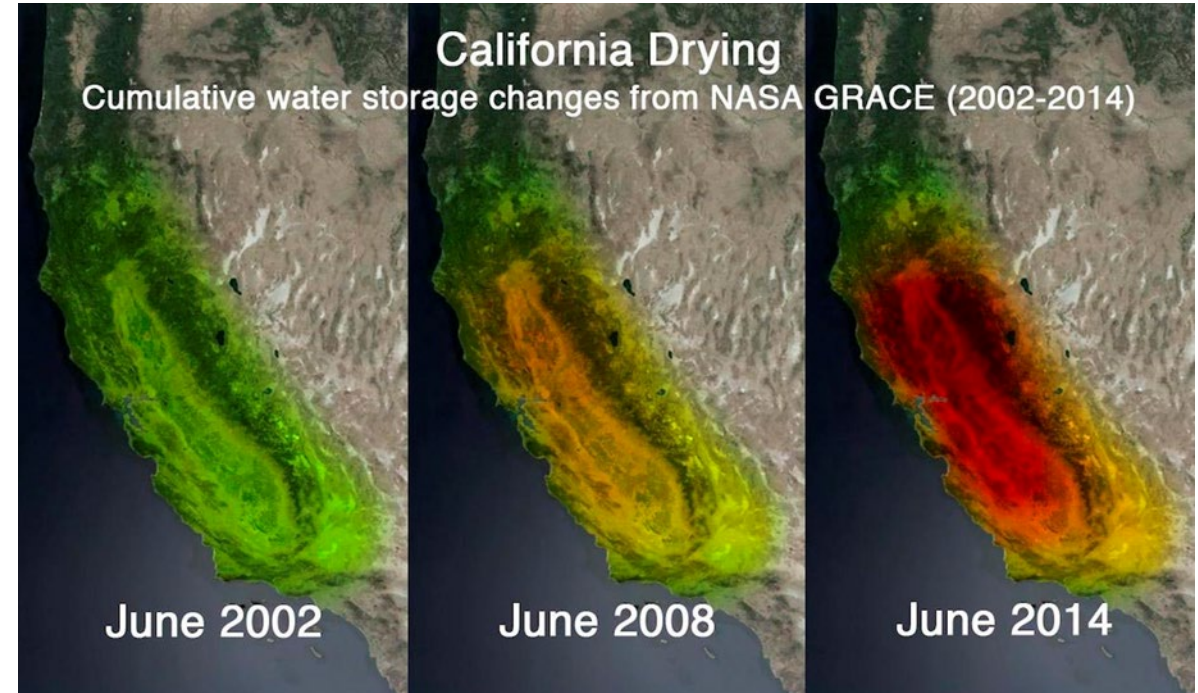


GRACE Follow-On (FO)

Water Storage
Ice Sheets & Glaciers
Sea Level
Solid Earth



Jet Propulsion Laboratory
California Institute of Technology



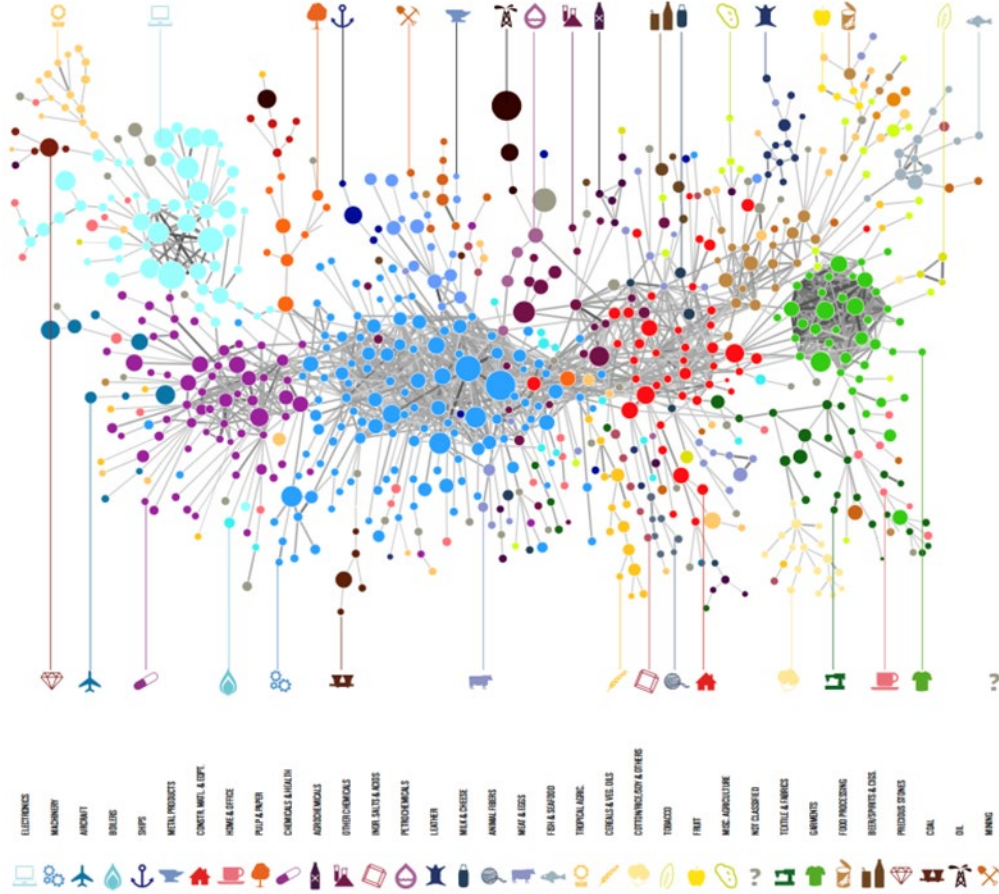
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AI and Advanced Analytics Platform

ATLAS
OF ECONOMIC COMPLEXITY



Water profile: organics, inorganics, vocs, phantom chemicals, latency

Existing infrastructure: power, pipelines, siting, proximity

Resource valuation: water, minerals, salt

Asset valuation: water reserves & reuse, stress, intensity, projections

Market analysis: local, regional, national & global



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Collaborative Partners and Stakeholders

Oklahoma Governor's Office – National Clean Energy Week Proclamation

Oklahoma Secretary of Energy & Environment

Oklahoma Water Resources Board

Oklahoma Department of Environmental Quality

Oka' Institute East Central University

Groundwater Protection Council, Produced Water as a Resource Working Group

Environmental Defense Fund



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