Emerging Trends In Freshwater Availability As Viewed From Space: Implications for Water, Food and Human Security

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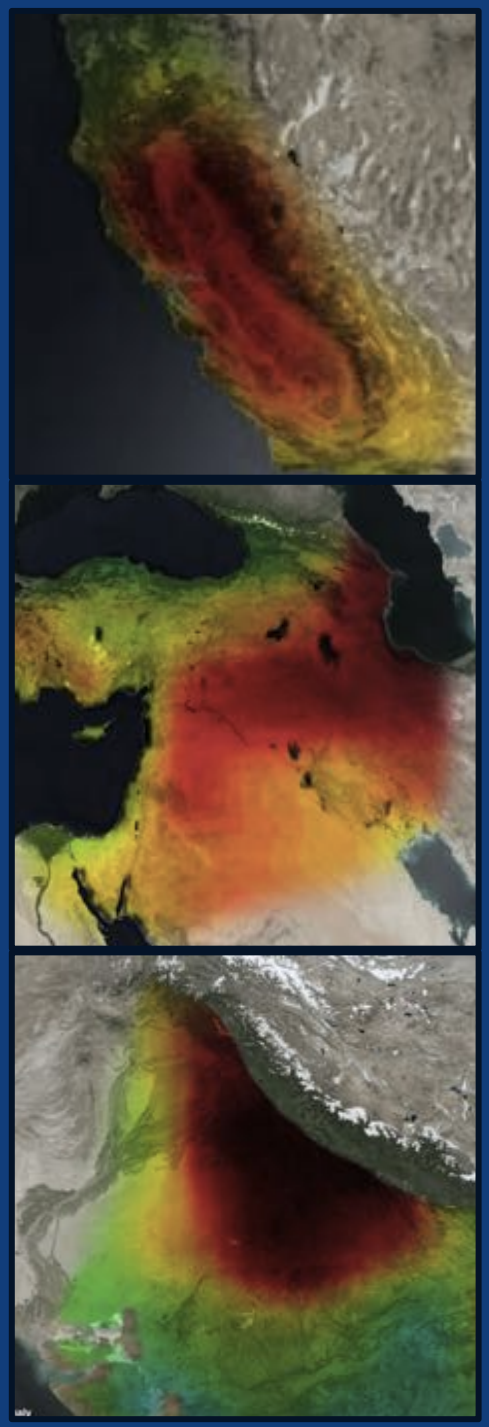

Overview

- GRACE and GRACE-FO
- What has GRACE told us about water availability?
- What are the implications for water, food and human security
- What should we be doing about it as a community?

Photo by Matt Black

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Gravity Recovery and Climate Experiment (GRACE Mission)

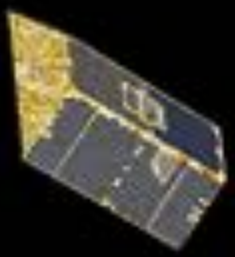
- Launched on March 17, 2002
- "Scale in the sky"
- Measures *changes* in *total water storage*

hly

km^2

quivalent water height

(GRACE-FO) to launch



JPL

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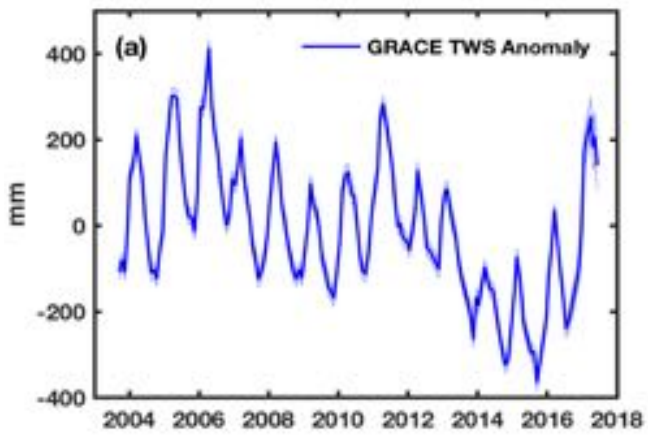
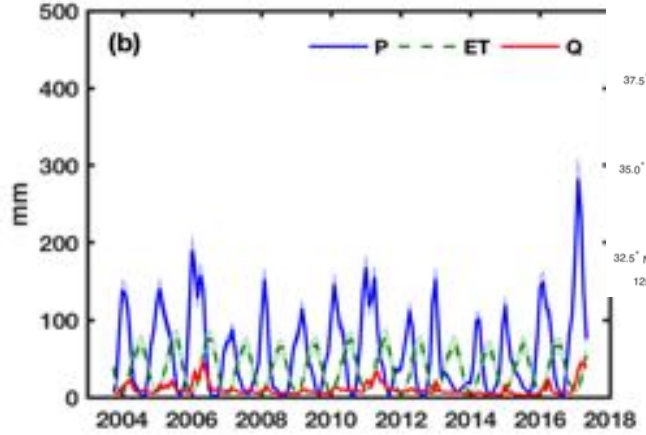
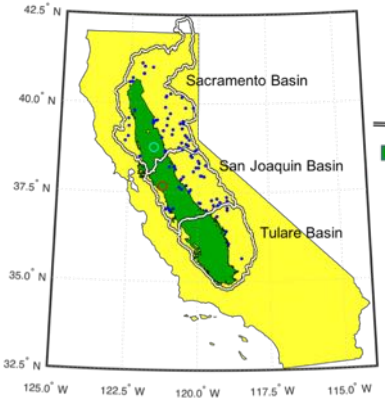
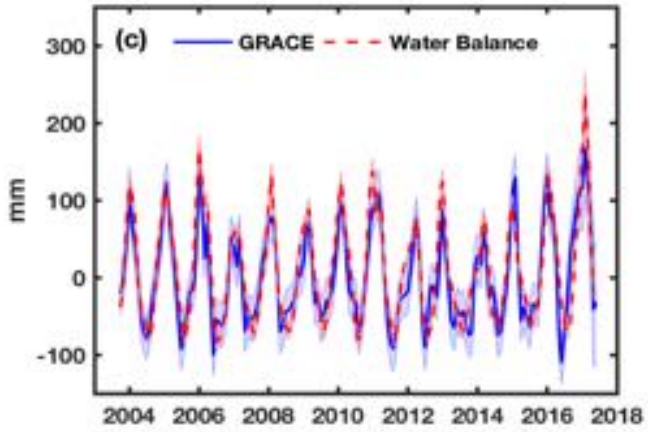
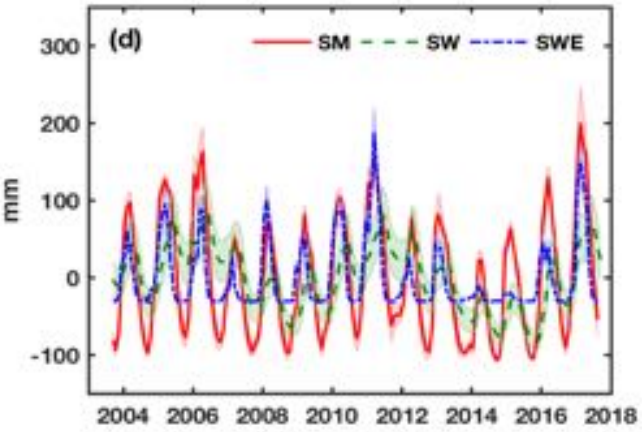
Changes in Total Water Storage in California, 2003-2017





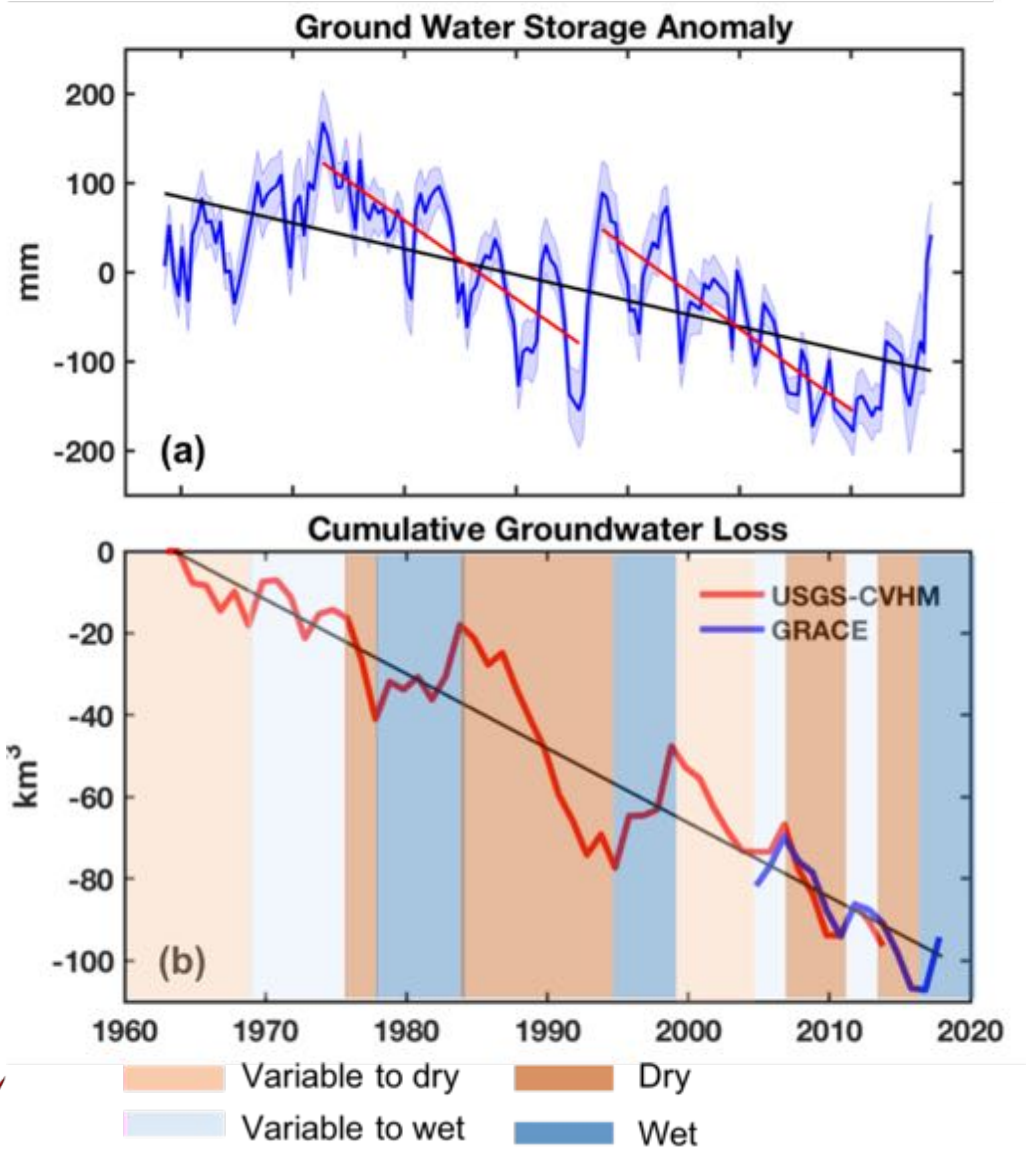






Liu et al., in preparation

Changes in Groundwater Storage in California's Central Valley, 2003-2017



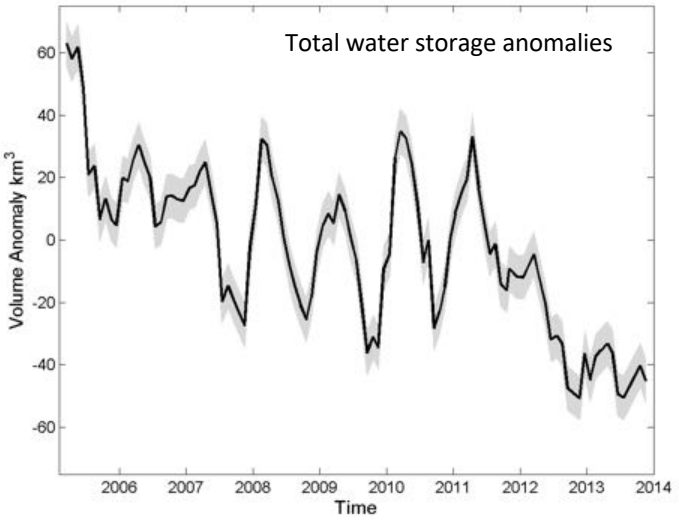
Long term GW loss rate ~2 km^3/yr

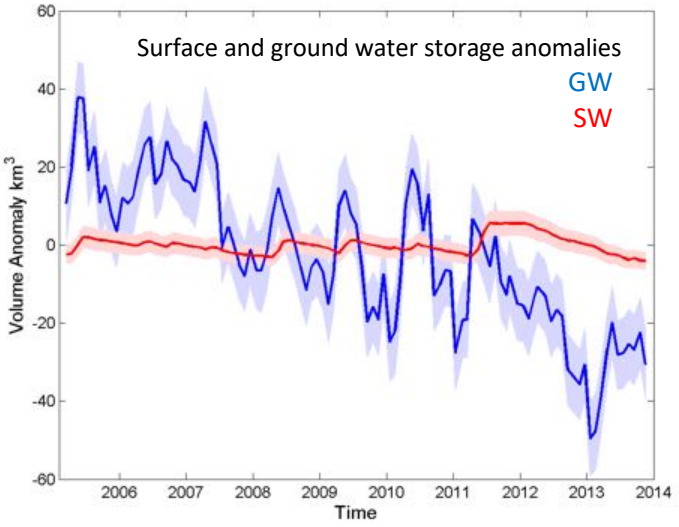
Consequences:
- Unsustainable
- Major subsidence
- Many SoCal streams are dry
- Depth to water ~2500'
- A 2500' well costs $250K

Liu et al., in preparation

Groundwater Depletion During Drought Threatens Water Security of the Western U. S.

Castle et al., 2014

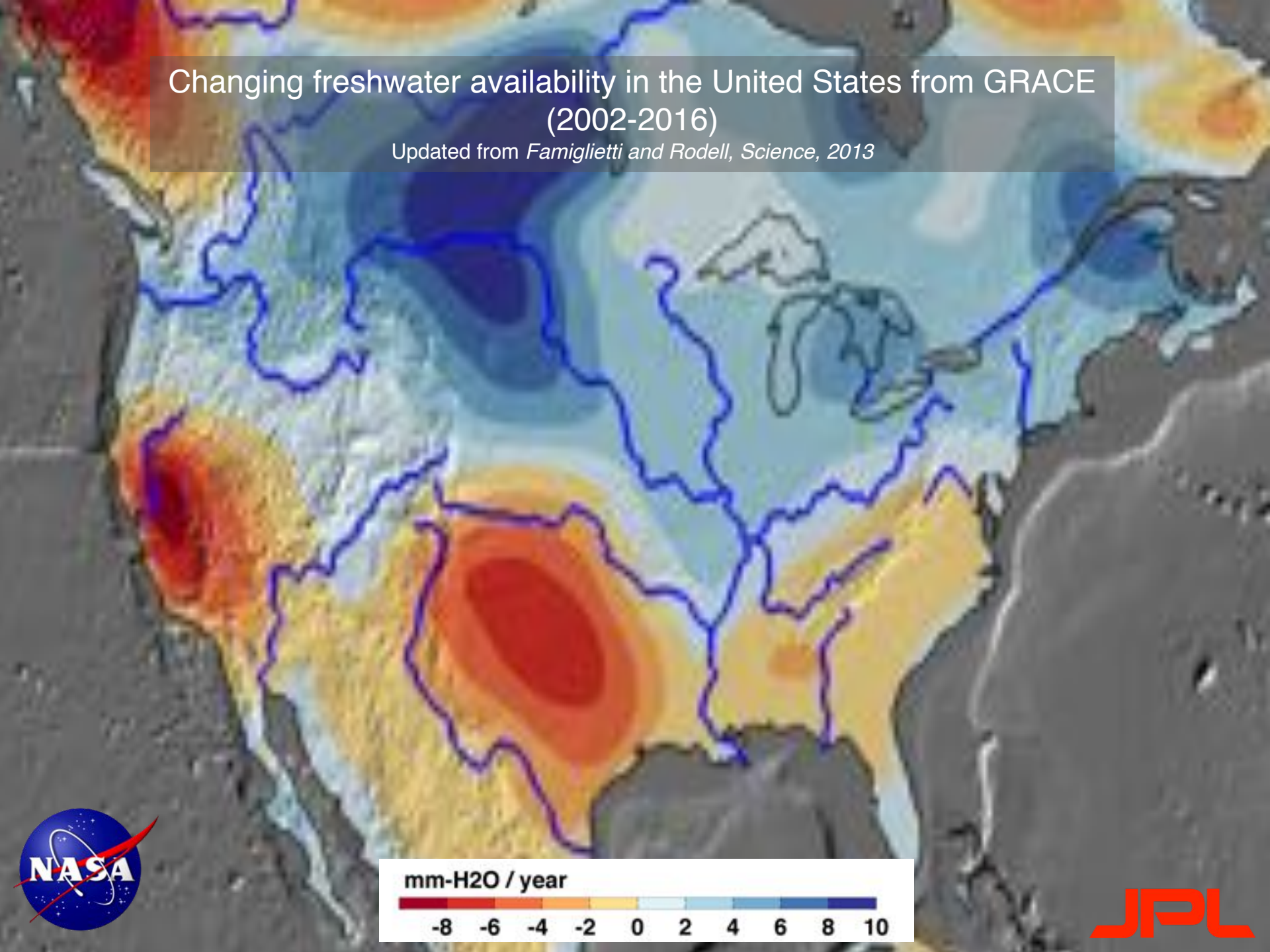




Groundwater, mostly from the lower basin, is depleting much faster than the surface reservoirs

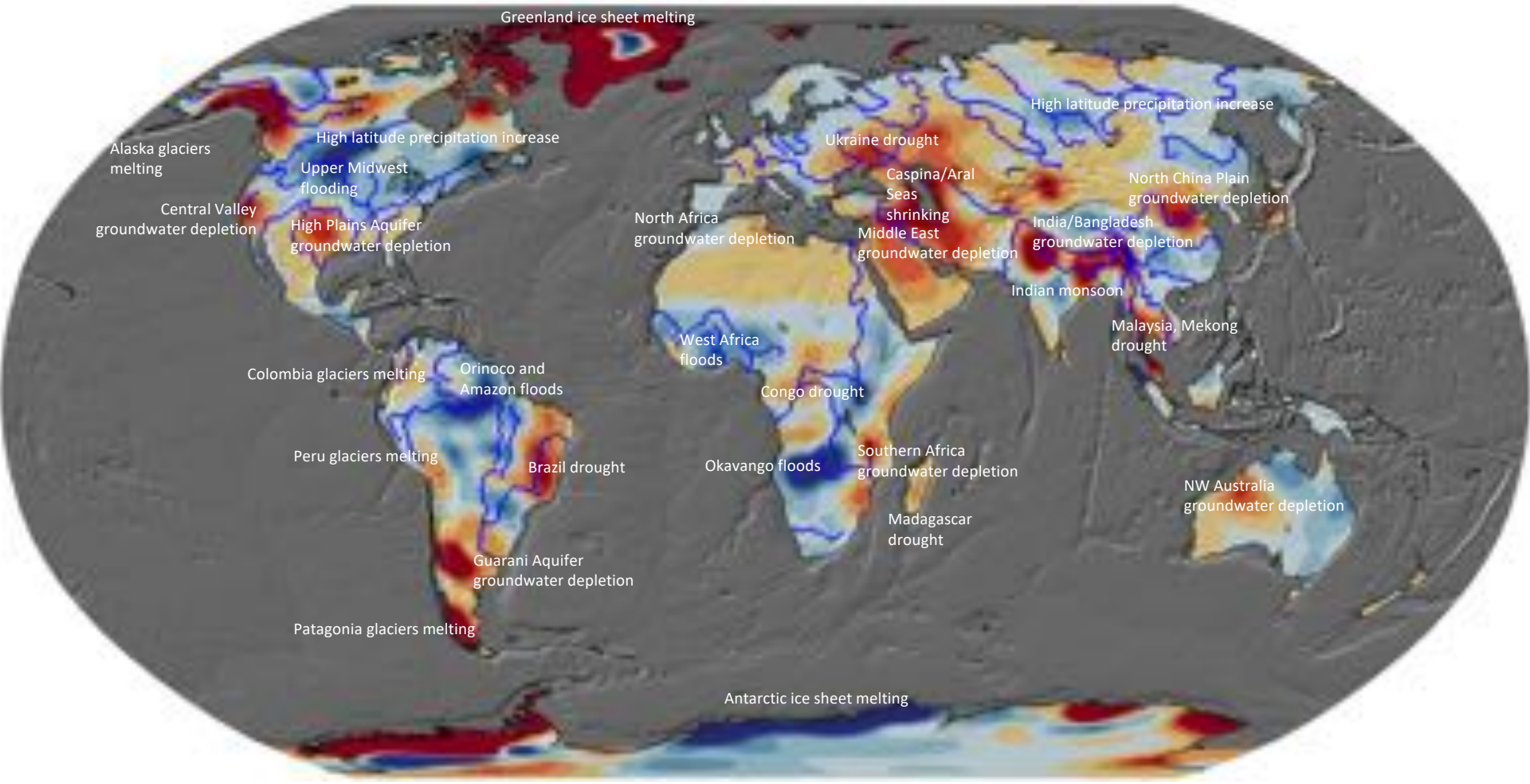
Changing freshwater availability in the United States from GRACE (2002-2016)

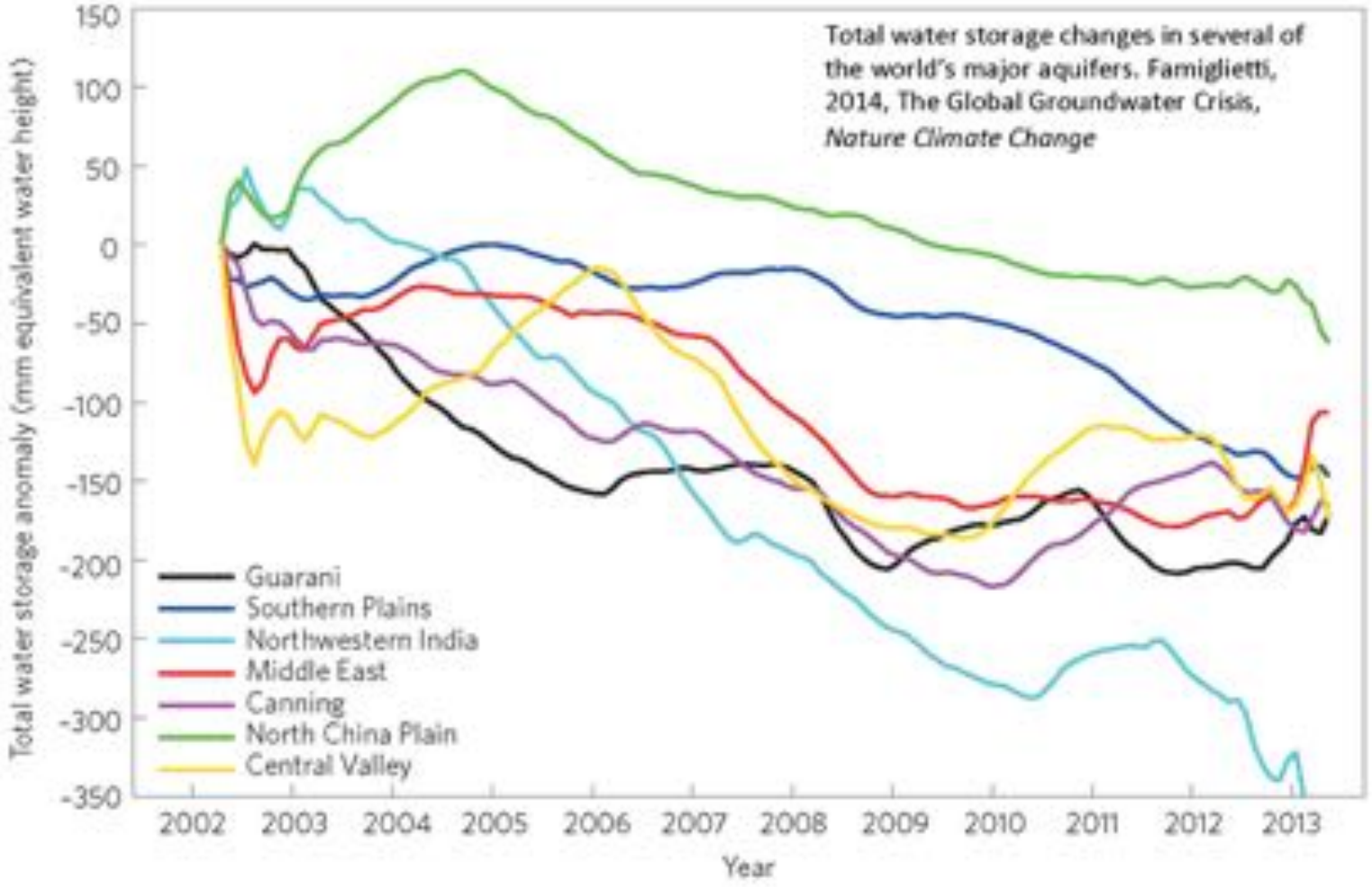
Updated from *Famiglietti and Rodell, Science, 2013*



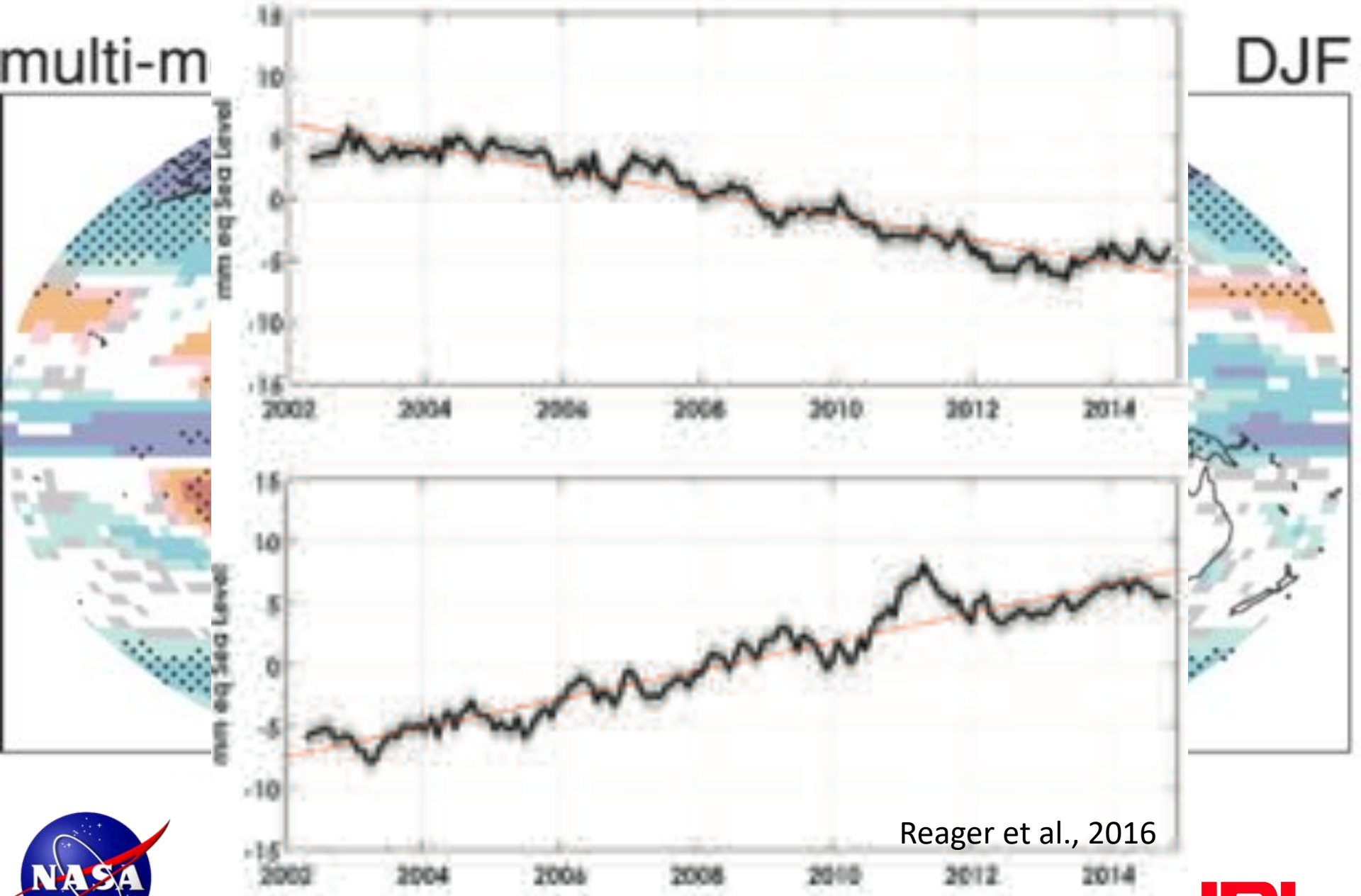
Changing freshwater availability from GRACE (2002-2016)

Rodell, Famiglietti et al., Nature, to appear 16 May 2018





Of the 37 major WHYMAP aquifers, 20 are 'past sustainability tipping points' meaning that more is being pumped than is being replenished annually, i.e., depletion.



Reager et al., 2016

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Photo by Matt Black

Implications for food producing regions

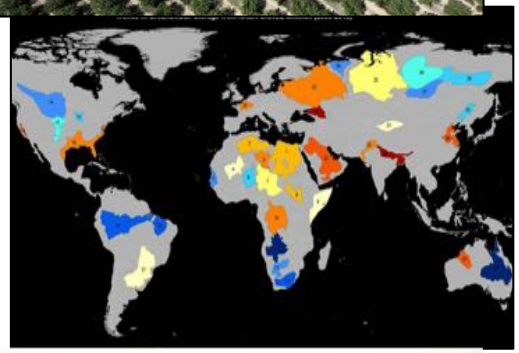
Most are in a state of *chronic water scarcity*

- This persistent state is exacerbated and exposed by drought
- It is primarily due to exceptional water needs of the food industry
- It is important for the public to grasp this state of affairs because in constrast to drought, there is no end in sight

There are many 'solutions' for our metropolitan regions but fewer for agriculture. It simply uses too much water.

- Agricultural conservation, efficiency, water pricing and innovation are the key for now.
- Either we move water to the food producing regions like the Central Valley or the southern High Plains of the US, or we move agriculture out over time.
- We have new groundwater legislation in California, but it is going to take another 25 years to implement.
- Food production due to water scarcity is going to be a major, global problem that needs our immediate attention

In the US, given that the southern High Plains and the Central Valley grow food for the nation, it may be time to recognize these *regional* water problems as *national* problems.



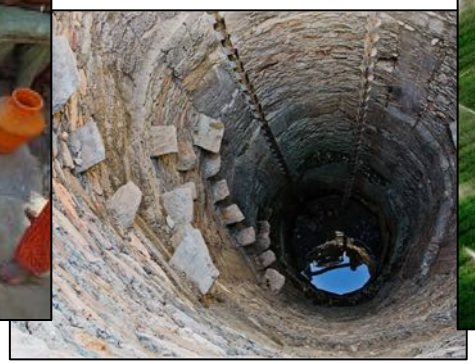
Societal implications

- We are living in an era of rapid climate change and with it, major changes in the water cycle

- Our nation, our society and our world are not really prepared for the water, food and energy future that the work presented today suggests and that population growth will only exacerbate

- Distinct classes of water ‘haves and have nots’ are emerging due to
  - Wet-getting-Wetter, Dry-getting-Drier
  - Falling water tables

- Are we prepared to address the
  - Social inequites?
  - Increased potential for violent conflict and climate refugees?
  - Necessary revisions to archaic and arcane domestic water law?
  - Need for international, transboundary, legal and civil infrastructure?

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nature climate change

29 October 2014

opinion & comment

COMMENTARY:

The global groundwater crisis

J. S. Famiglietti

Groundwater depletion the world over poses a far greater threat to global water security than is currently acknowledged.

Groundwater — the water stored beneath Earth's surface in soil and porous rock aquifers — accounts for as much as 33% of total water withdrawals worldwide[1]. Over two billion people rely on groundwater as their primary water source[2], while half or more of the irrigation water used to grow the world's food is supplied from underground sources[3].

Groundwater also acts as the key strategic reserve in times of drought[4], in particular during prolonged events such as those in progress across the western United States (Fig. 1), northeastern Brazil and Australia. Like money in the bank, groundwater sustains societies through the lean times of little incoming rain and snow. Hence, without a sustainable groundwater reserve, global water security is at far greater risk than is currently recognized.