Complexities Associated with Climate Change, Water, and Agriculture

Introduction

Lou Swanson, Vice President for Engagement, Colorado State University

Session Moderator

Reagan Waskom, Director, Colorado Water Institute, Colorado State University

Climate Smart Agriculture on the Colorado River System

Brad Udall, Senior Scientist, Colorado Water Institute, Colorado State University

Increasing Climate Resilience in Agriculture

Nick Brozović, Director of Policy, Daugherty Water for Food Global Institute, University of Nebraska

Reflections on International Dimensions of Climate Smart Agriculture

Peter G. McCornick, Executive Director, Daugherty Water for Food Global Institute, University of Nebraska

Discussion

Colorado State University

Water for Food
DAUGHERTY GLOBAL INSTITUTE
at the University of Nebraska

Climate Smart Agriculture in the Colorado River Basin

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Stockholm, SWE

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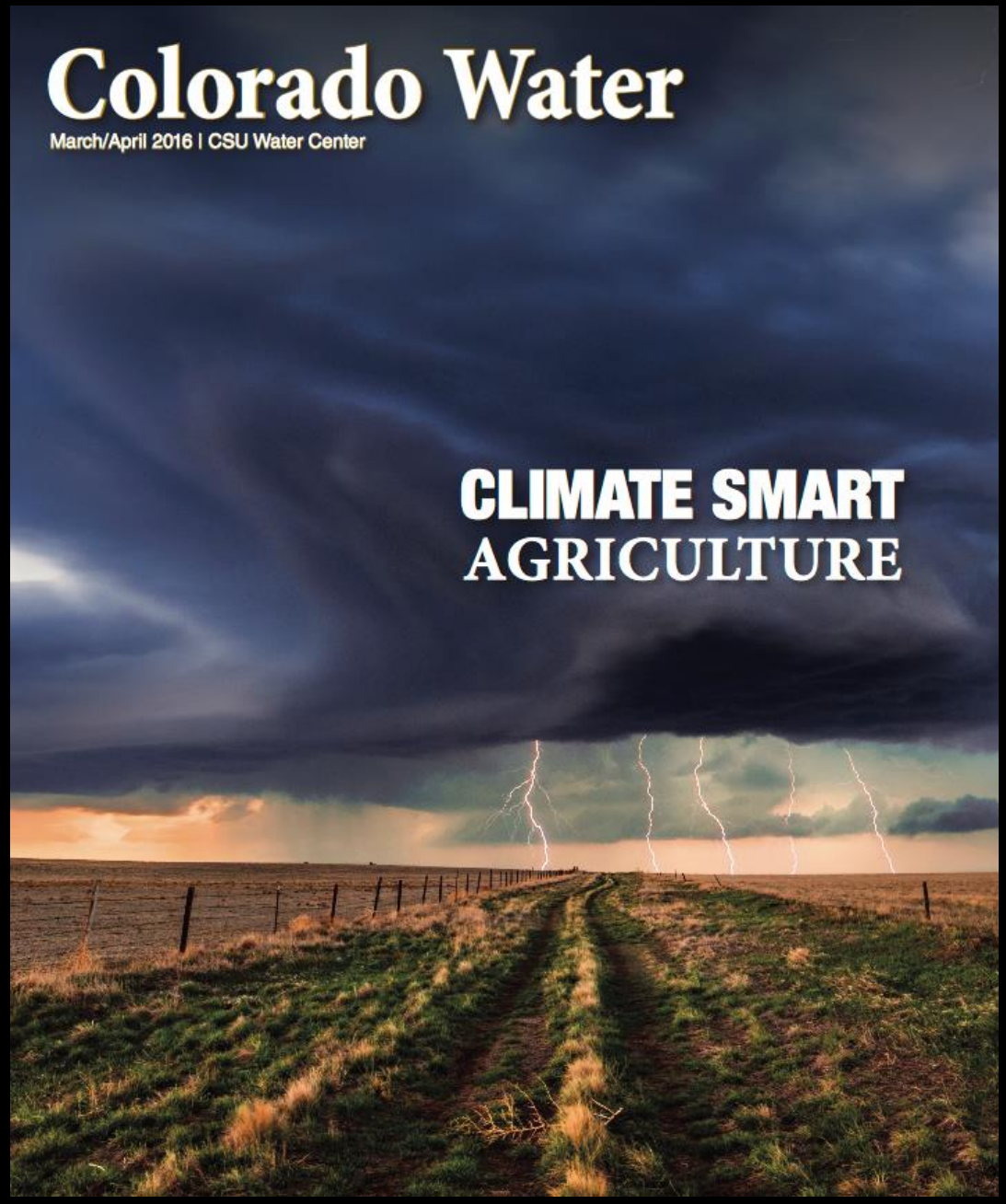
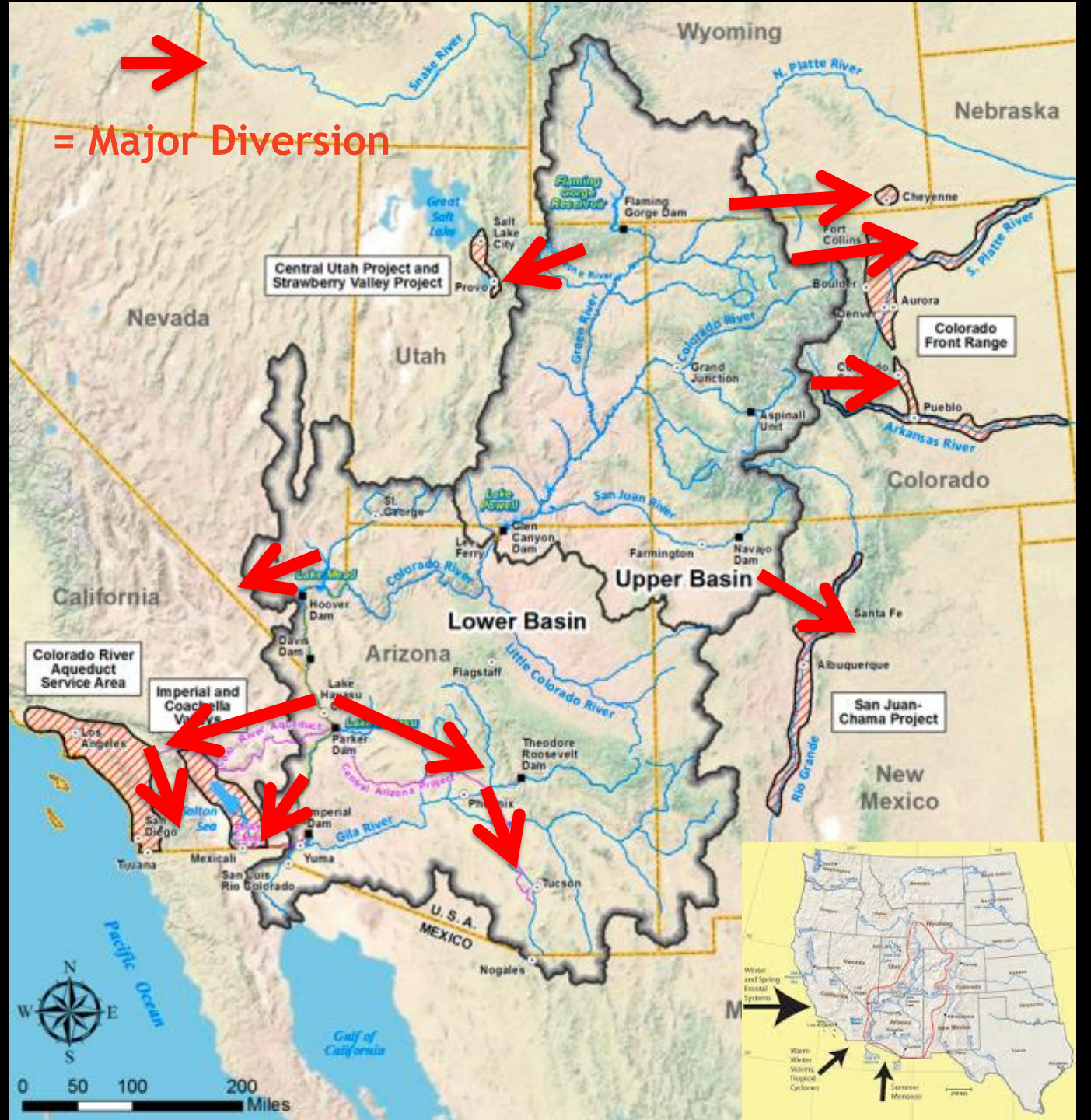


Colorado River

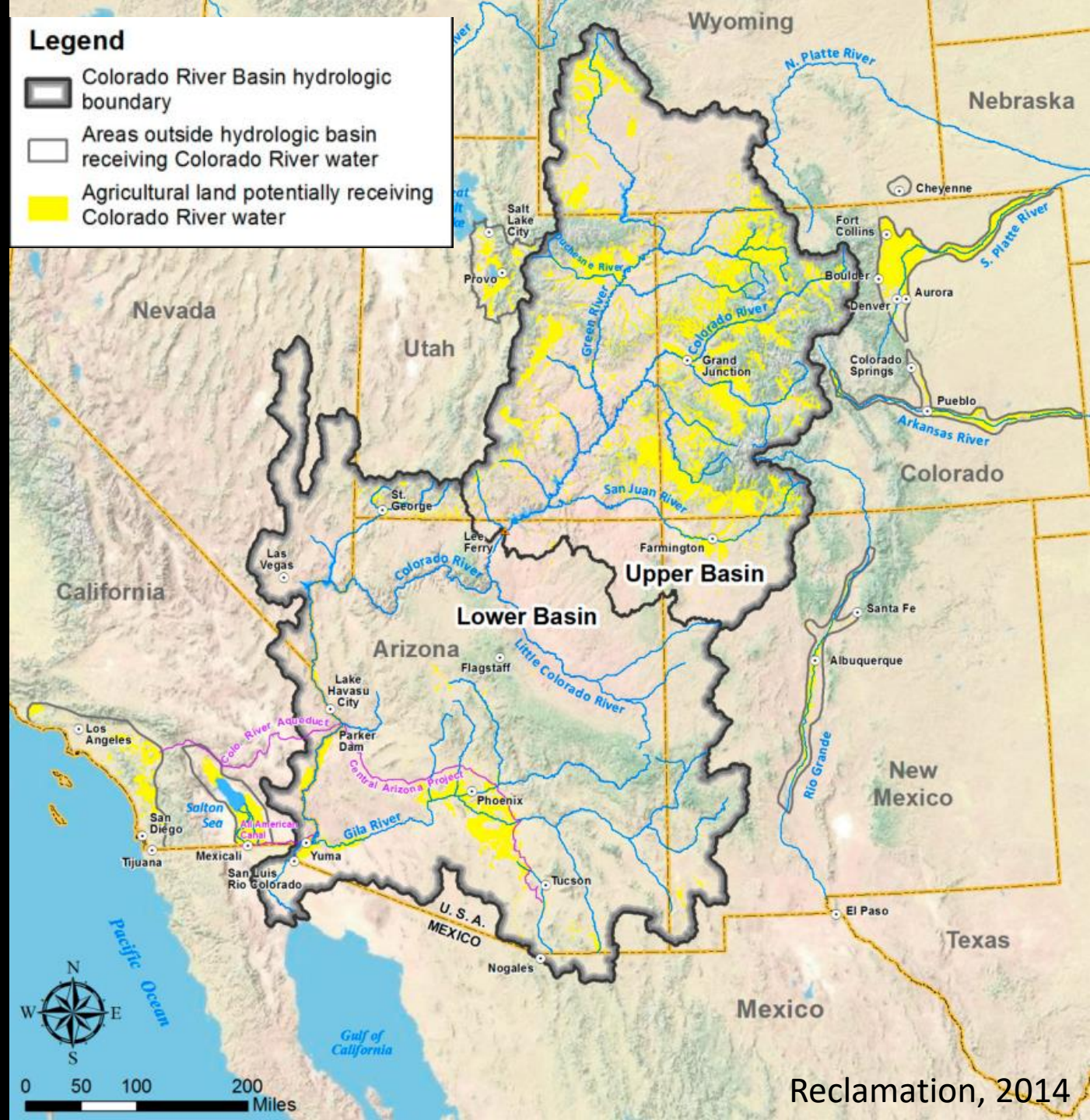
- 7 States, 2 Nations
- Annual Flow 20 BCM (16.4 MAF)
- 40 M People
- Key supply for all Major Cities in Southwest
- 2.25m hectares irrigated (4.5m acres)
- Huge Topographic and climatic variability
- 90 Years of Agreements known as ‘Law of the River’
- Basic Allocation: 50/50 Split Upper Basin – Lower Basin



Colorado River Basin Agriculture

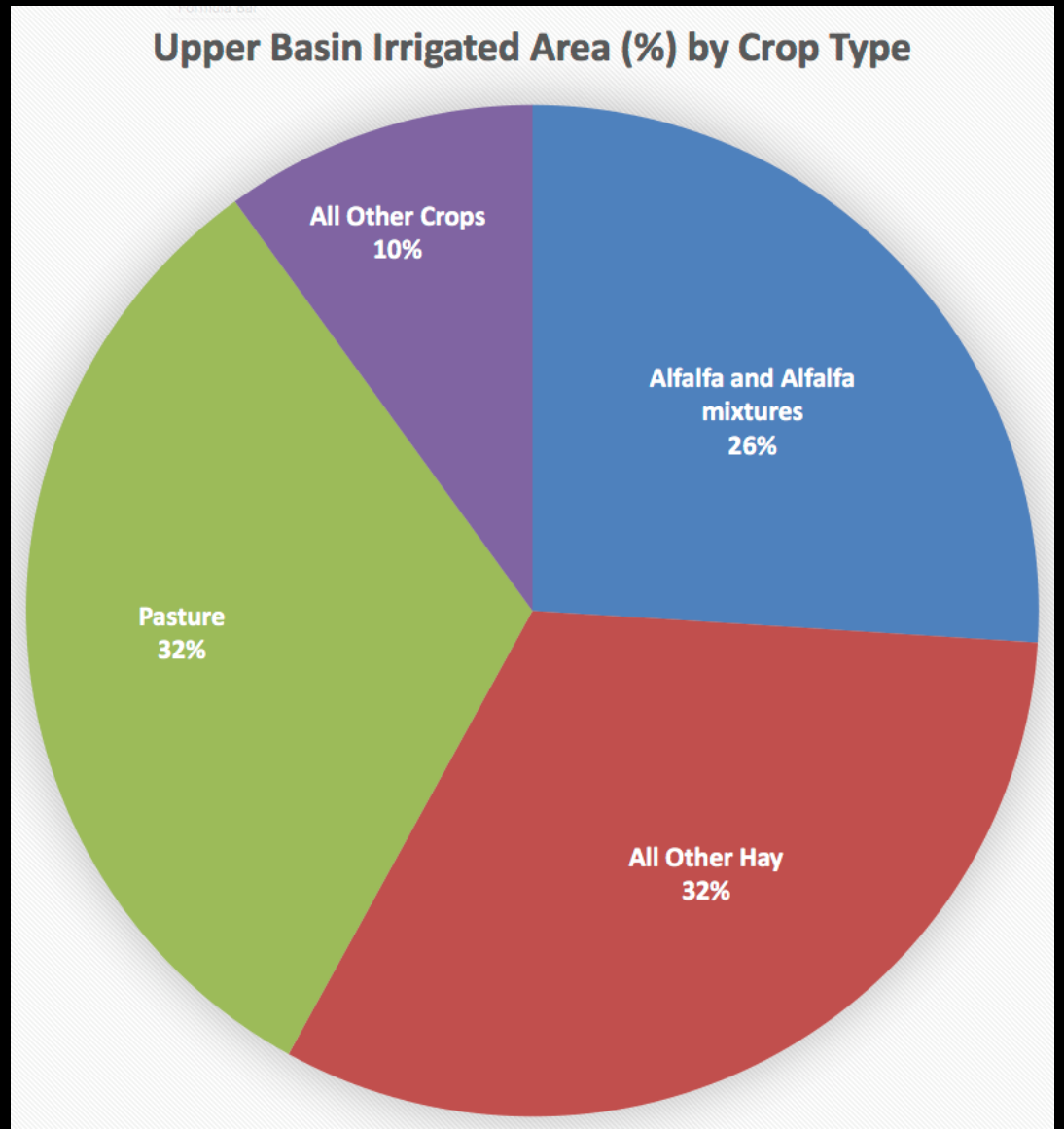
Upper Basin Facts
- Mid to High Elevation
- Cool, Semi-Arid to Wet
- Few Crops
- Shorter Growing Season

Lower Basin Facts
- Low Elevation
- Arid, Hot
- Many Crops
- Year-Round Growing Season

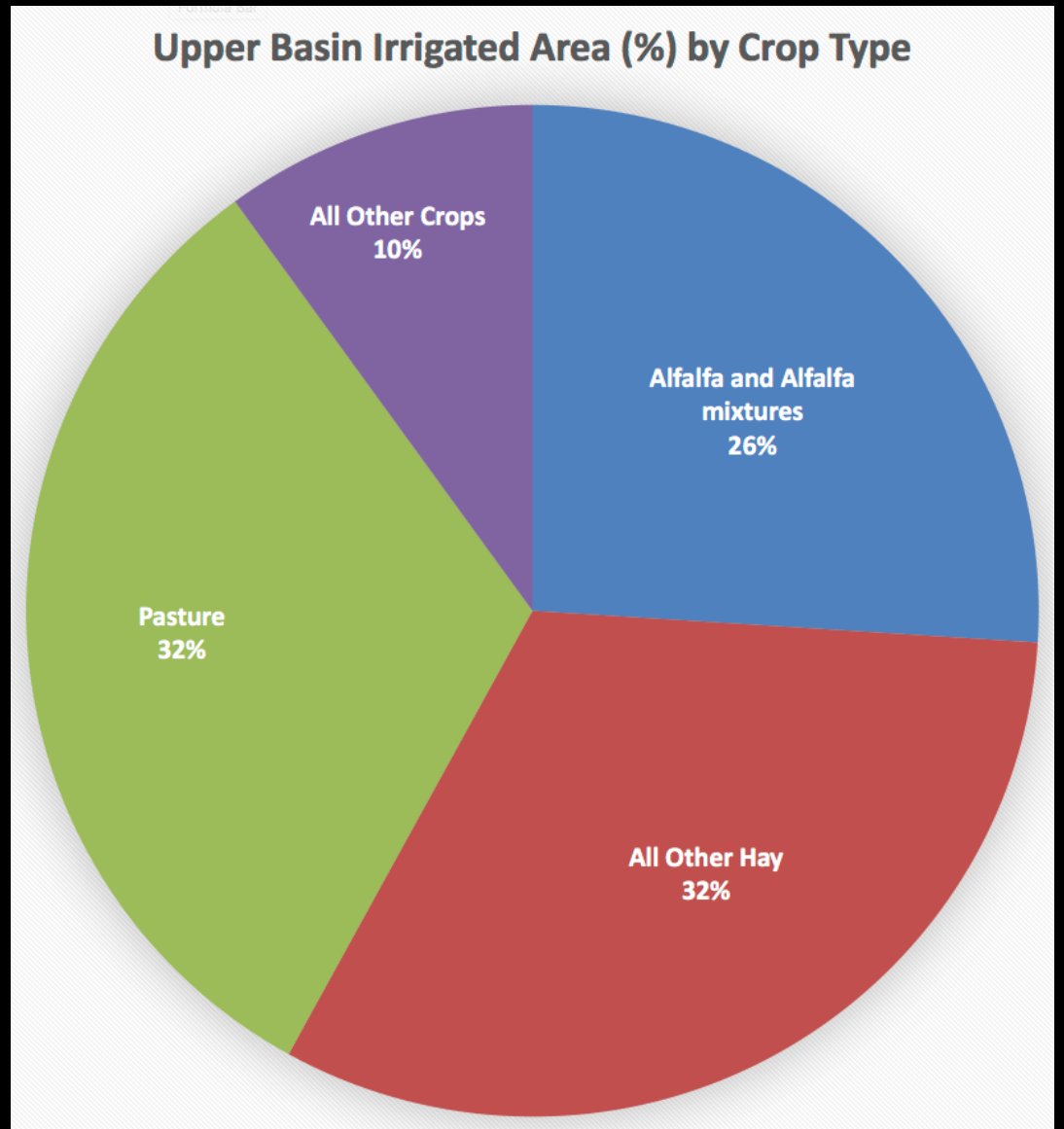


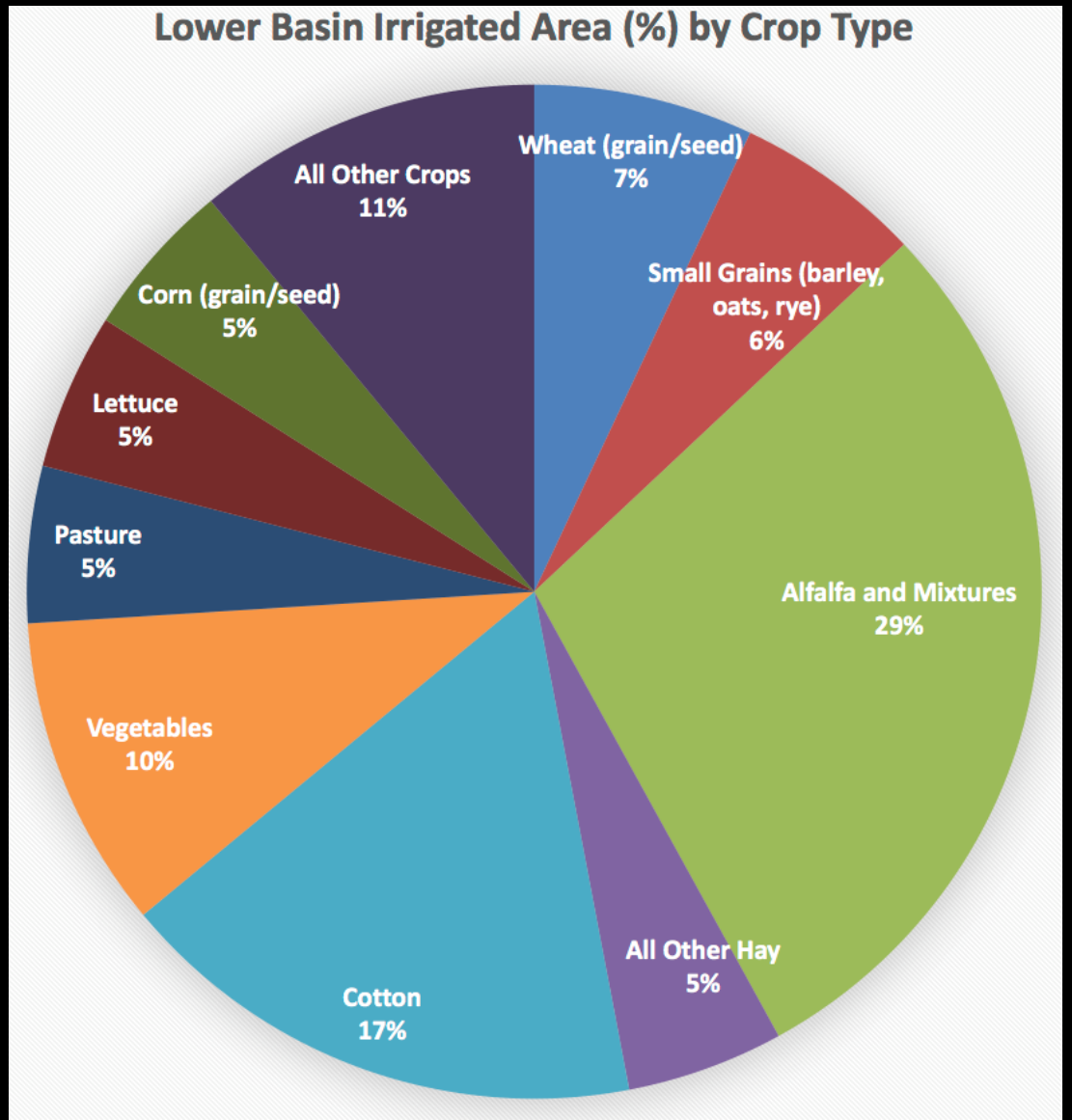
Reclamation, 2014

Colorado River Basin Agriculture



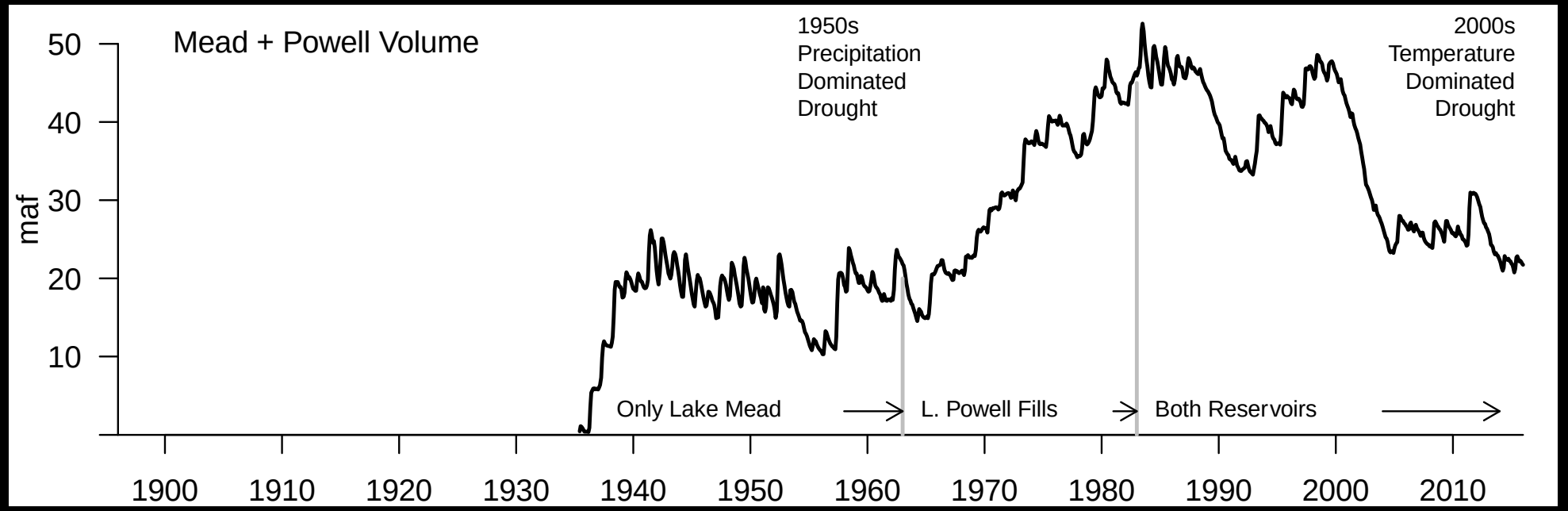
Colorado River Basin Agriculture





Colorado River Drought 2000-2014

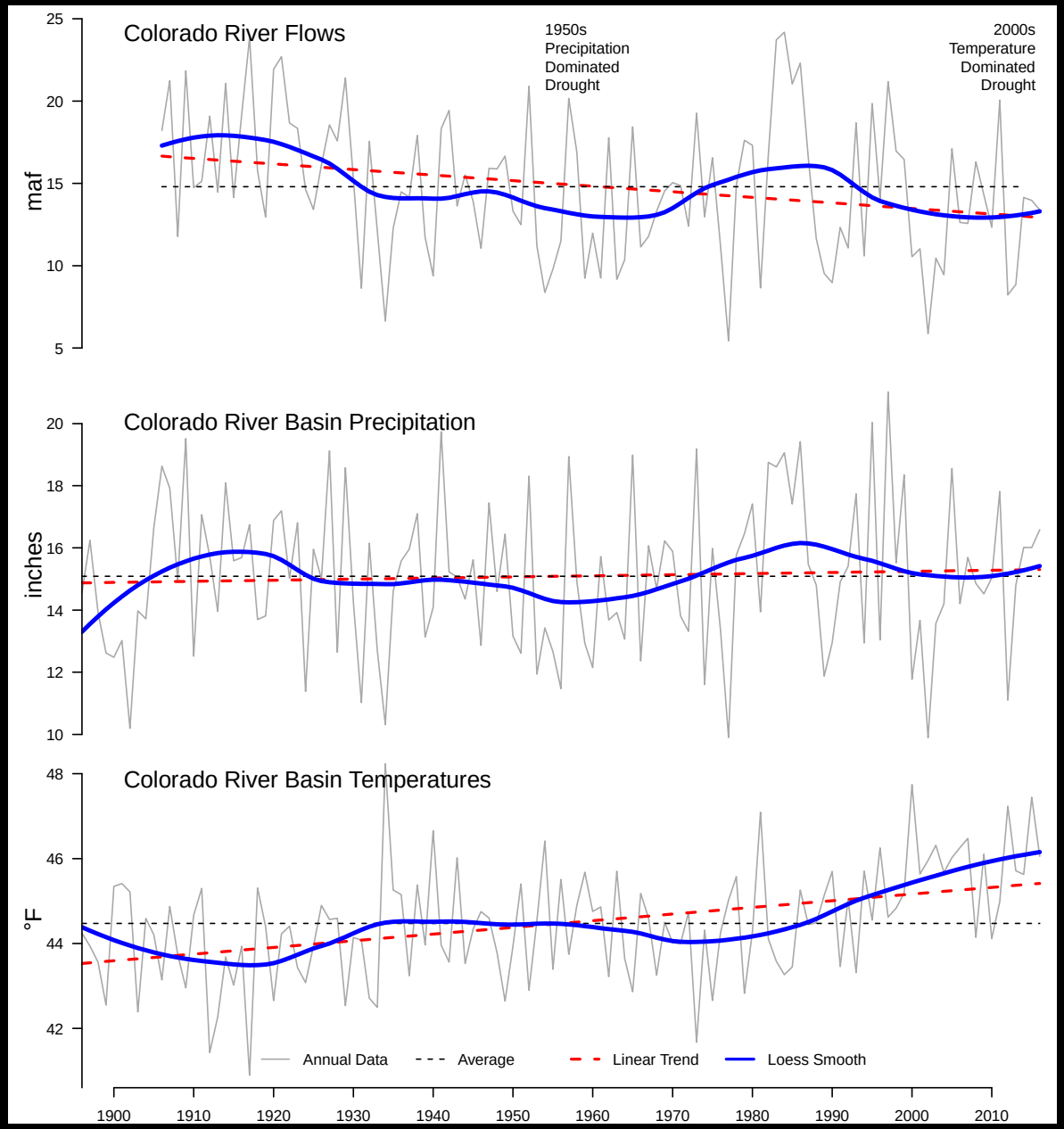
- 2000-2014 Worst Drought in Colorado River Gage Record



Sources: Udall and Overpeck, 2017; Woodhouse et al., 2016

Colorado River Drought 2000-2014

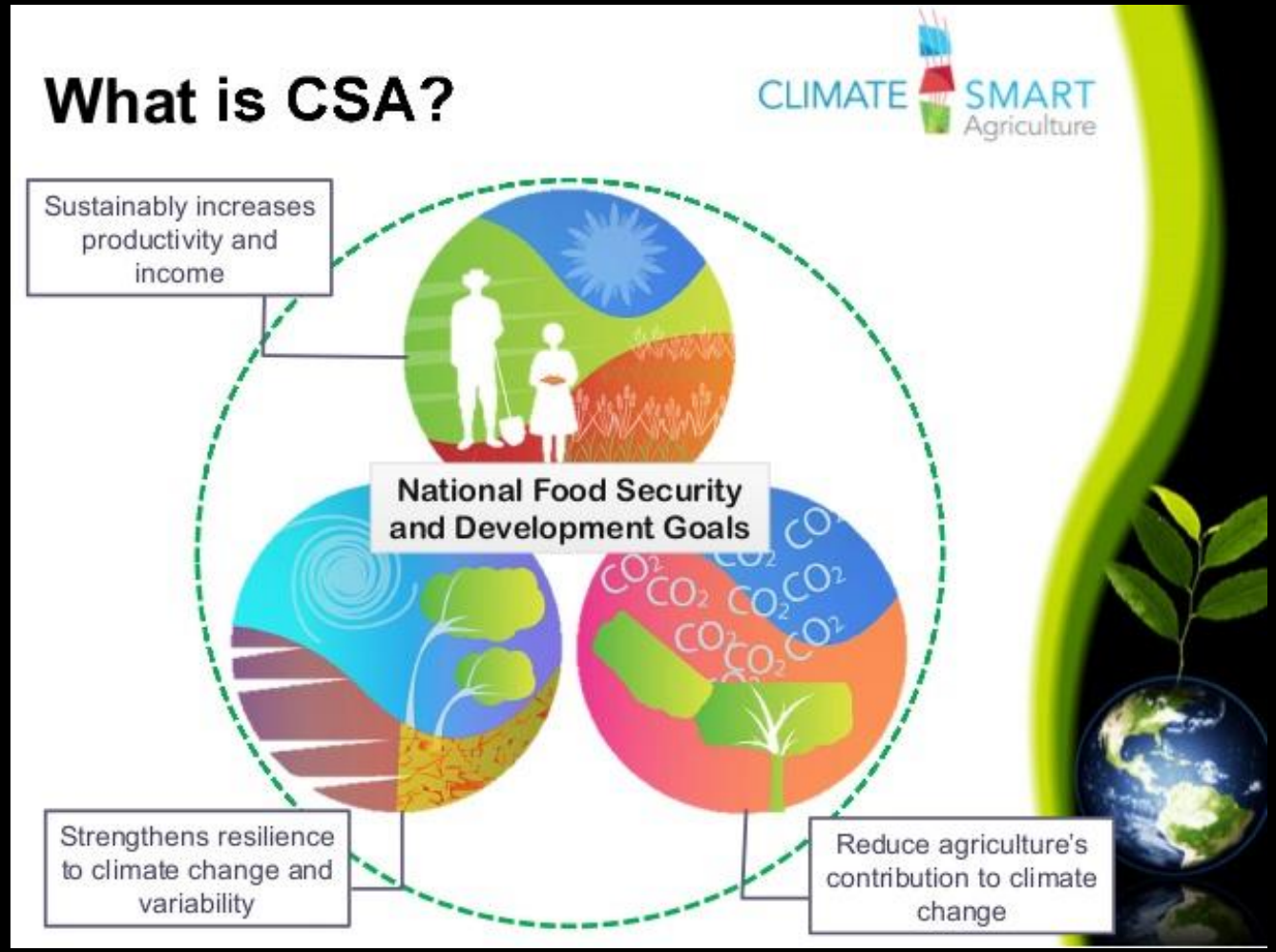
- ~ 1/3 of the Decline due to Higher Temperatures
- 20% Loss by 2050 Possible due to higher temperatures
- Increases in precipitation may counteract losses somewhat
- Increased risk of megadrought in 21st century reinforces loss potential



Sources: Udall and Overpeck, 2017; Woodhouse et al., 2016

Climate Smart Agriculture

- FAO 2013, Lipper et al., 2014
- 3 Pillars
  - Sustainable Intensification
  - Adaptation to climate variability and change
  - Mitigation of GHGs



Pillar 1: Adaptation

Alternative Transfer Mechanisms

- "ATMs"
- Colorado Water Plan Target
- Good Idea but many Issues
  - Cities
  - Farmers

ATM =	Agricultural Water Supply Method
	Water Transfer Method
Agricultural Water Supply Methods (Free Up Water)	Fallowing
	Deficit Irrigation
	Crop Switching
	Irrigation Efficiency
	Water Conservation
Water Transfer Methods (Legal Technique)	Water Bank
	Interruptible Option
	Temporary Purchase
	Lease to Fix
After Bovee, 2016	Buy and Lease Back

Castle et al, 2017;
Udall and Peterson, 2017

Pillar 1: Adaptation

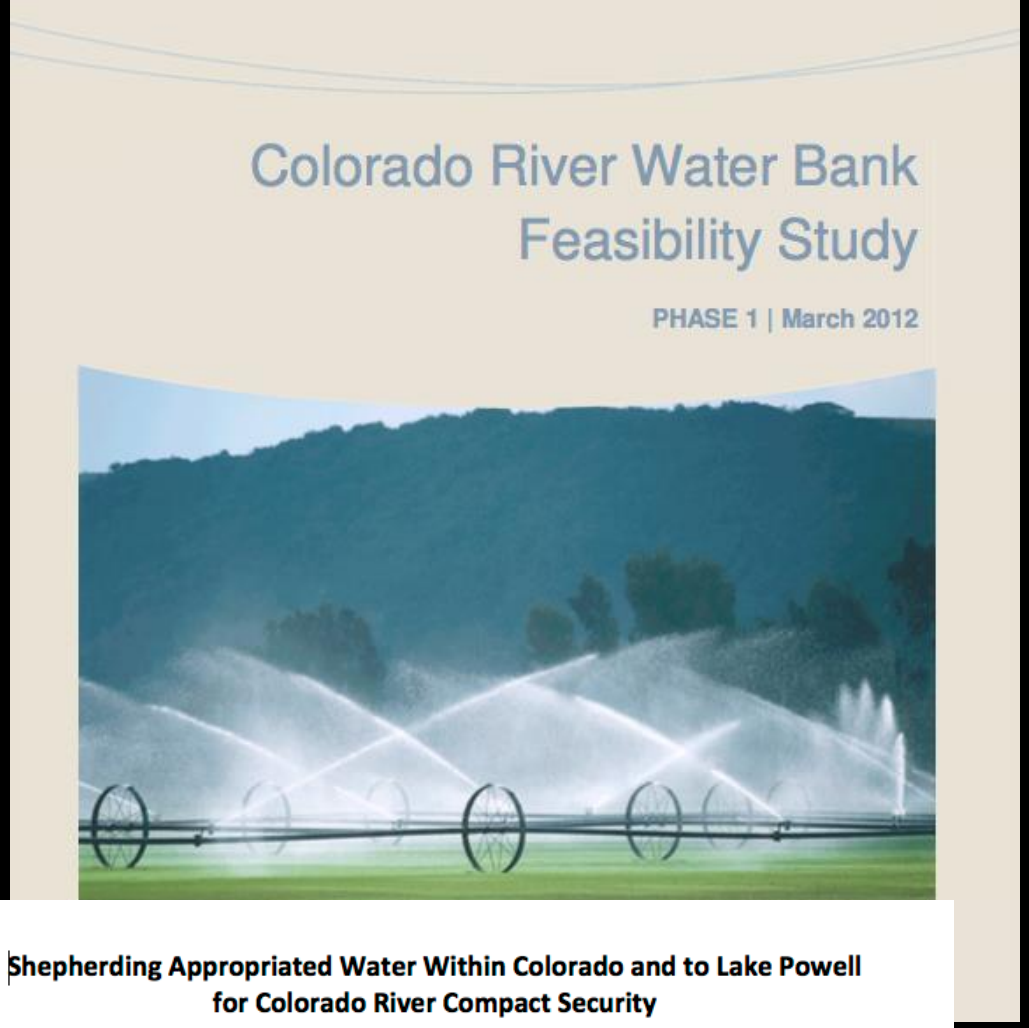
Drought Contingency Plan

- Deal fixes long-term ’structural deficit’ (overuse)
- Lower Basin + Mexico all agree to cuts in use
- Solves part of recent reservoir declines

Hoover Dam +Lake Mead

Pillar 1: Adaptation
Compact Banking / Shepherding

- Drought created concern that Upper Basin might not make required deliveries to Lower Basin
- Water Bank Concept to Protect 'Post-Compact' Diverters in state of Colorado (Upper Basin)
  - Includes most cities
- Legal Changes Needed to allow purposefully conserved water to flow to Lake Powell



Shepherding Appropriated Water Within Colorado and to Lake Powell for Colorado River Compact Security

Lawrence J. MacDonnell and Anne J. Castle

Colorado and the other states in the Upper Basin of the Colorado River - New Mexico, Utah, and Wyoming - are facing difficult water challenges. A prolonged drought beginning in 2000 has increased the risk of future curtailment of water uses in these states to meet obligations to states in the Lower Basin under the 1922 Colorado River Compact. A recent study attributes the significant measurable declines in water flows that the basin has already experienced to warming temperatures, and conservatively estimates that there will be 20 to 35% less water available during the remainder of the 21st century. All of the Colorado River Basin states and the Bureau of Reclamation have been conducting "Drought Contingency Planning" to explore appropriate responses to these changes.

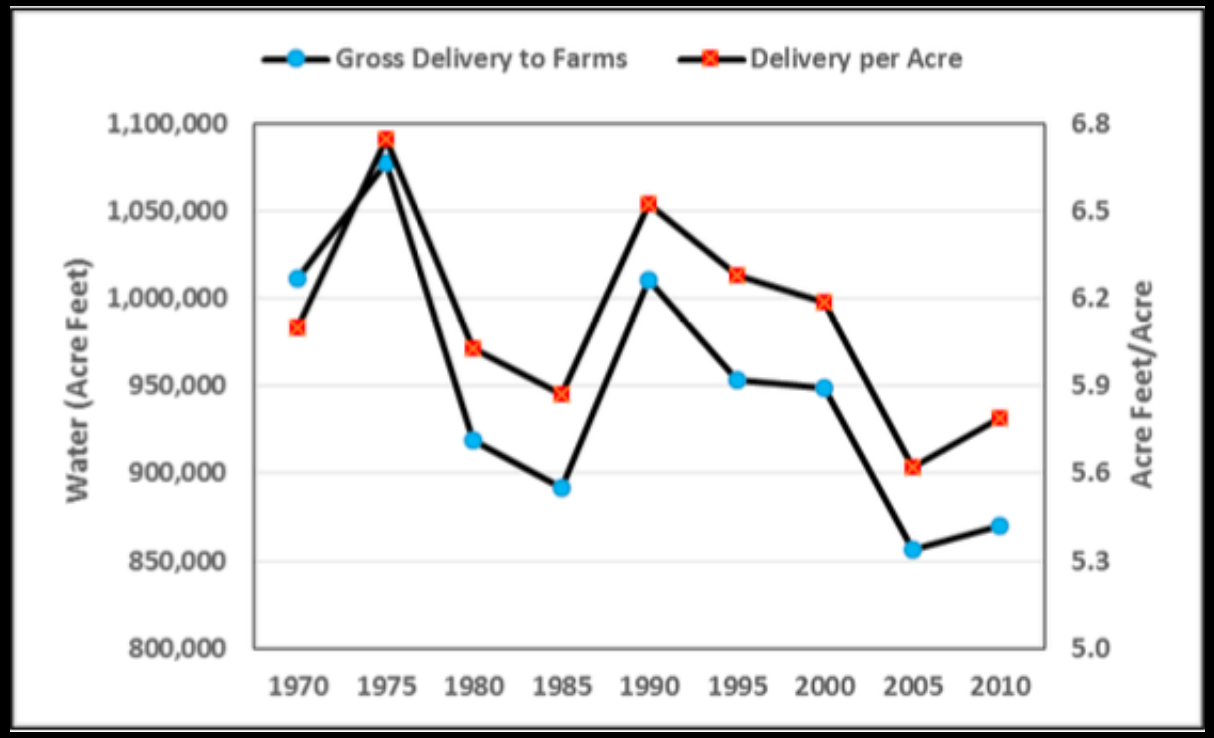
Pillar 2: Sustainable Intensification

Yuma, Arizona

Pillar 2: Sustainable Intensification

Yuma, Arizona

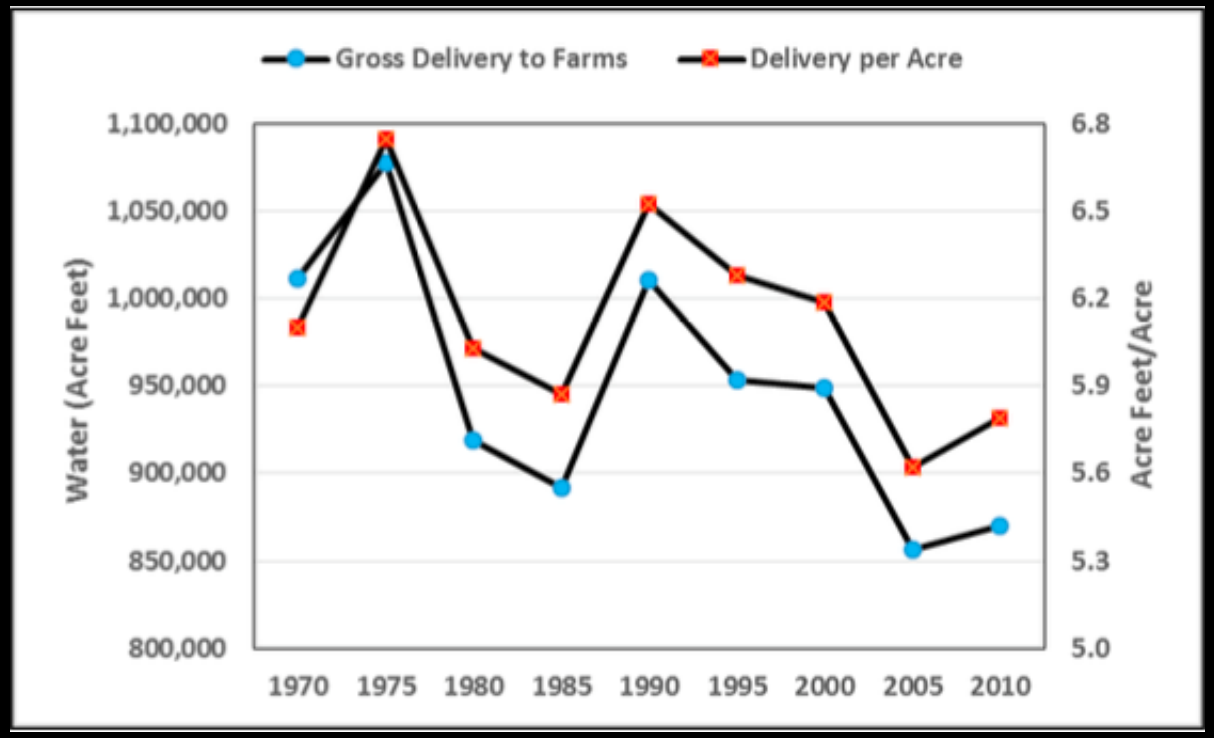
- Declines in Water Use

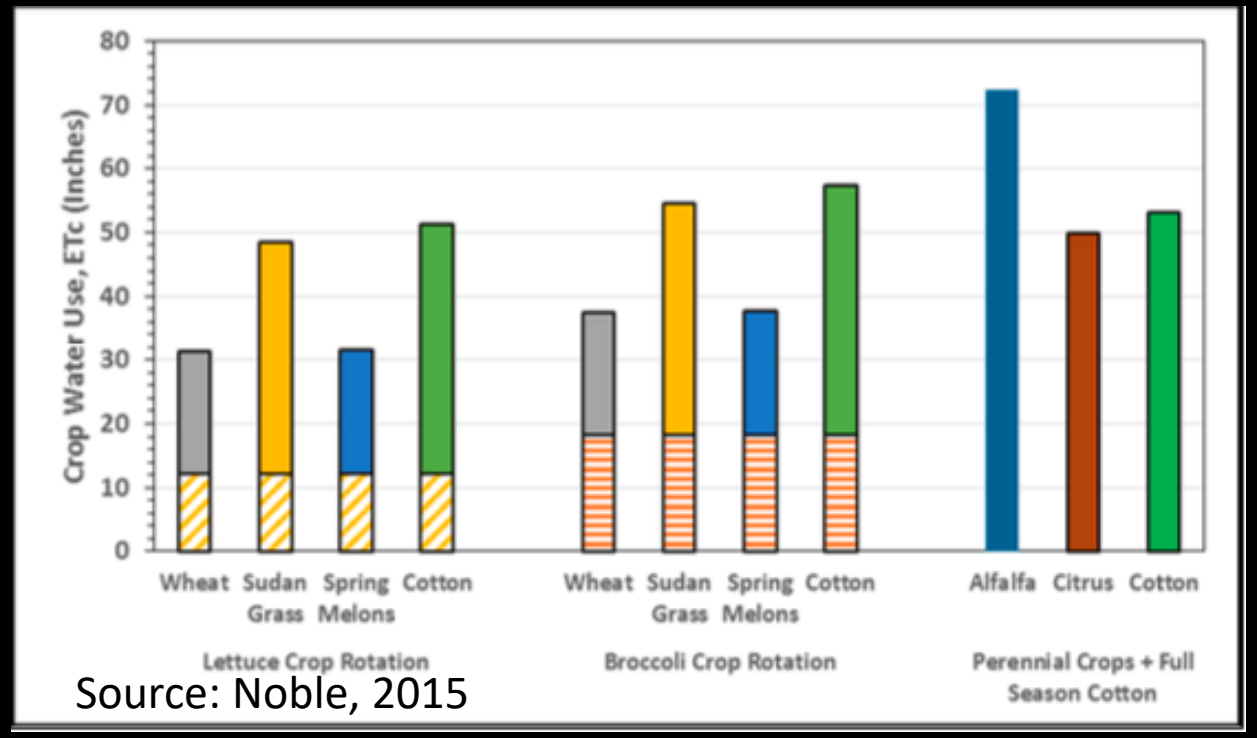


Pillar 2: Sustainable Intensification

Yuma, Arizona

- Declines in Water Use
- Move to Winter Vegetables & Multi-Cropping



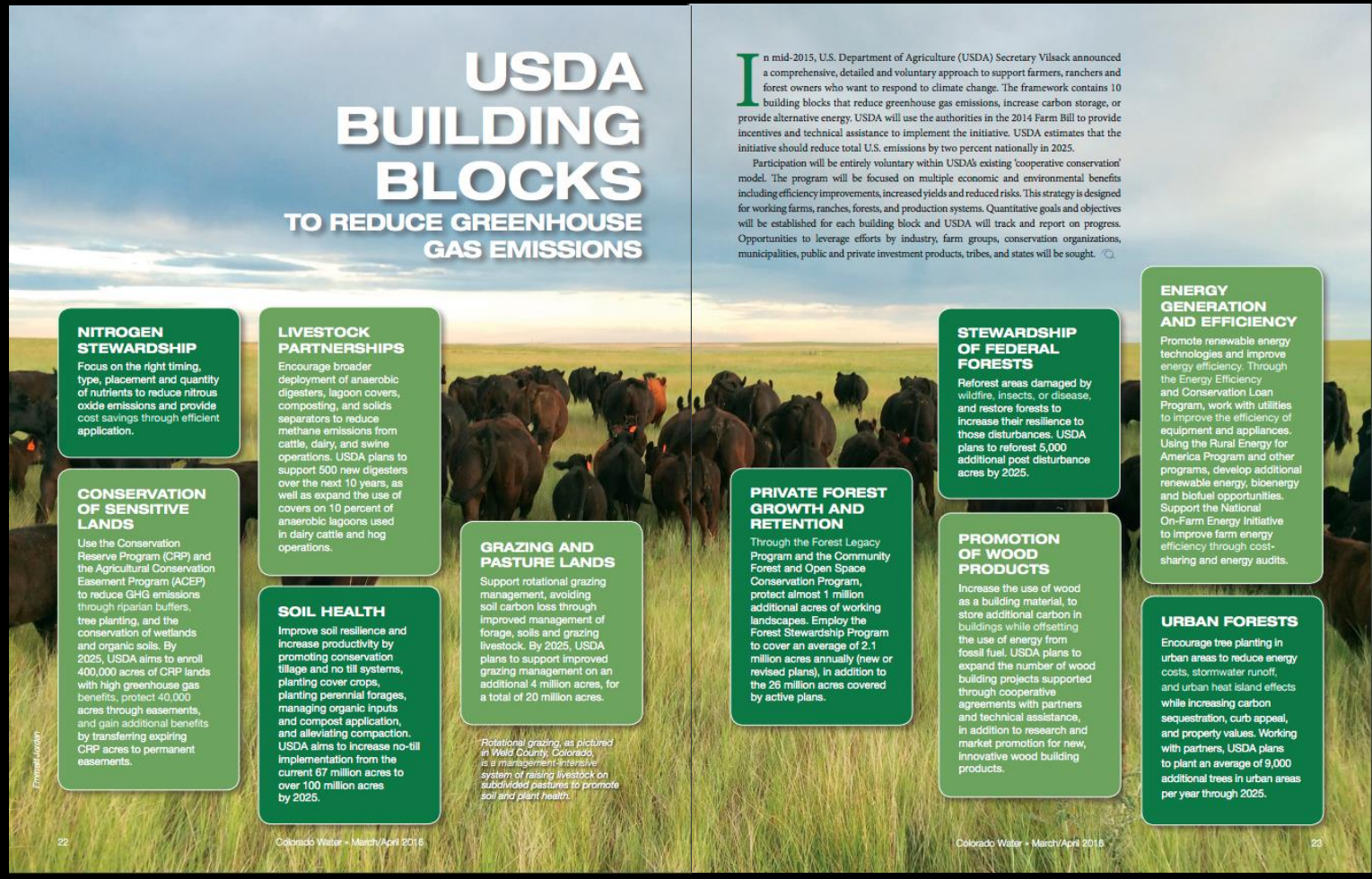


Source: Noble, 2015

Pillar 3: GHG Mitigation

USDA Building Blocks?

- US Agriculture GHGs are ~10% of US Total
- USDA Building Blocks part of US Paris NDC
- Status Unknown



USDA BUILDING BLOCKS

TO REDUCE GREENHOUSE GAS EMISSIONS

In mid-2015, U.S. Department of Agriculture (USDA) Secretary Vilsack announced a comprehensive, detailed and voluntary approach to support farmers, ranchers and forest owners who want to respond to climate change. The framework contains 10 building blocks that reduce greenhouse gas emissions, increase carbon storage, or provide alternative energy. USDA will use the authorities in the 2014 Farm Bill to provide incentives and technical assistance to implement the initiative. USDA estimates that the initiative should reduce total U.S. emissions by two percent nationally in 2025.

Participation will be entirely voluntary within USDA's existing 'cooperative conservation' model. The program will be focused on multiple economic and environmental benefits including efficiency improvements, increased yields and reduced risks. This strategy is designed for working farms, ranches, forests, and production systems. Quantitative goals and objectives will be established for each building block and USDA will track and report on progress. Opportunities to leverage efforts by industry, farm groups, conservation organizations, municipalities, public and private investment products, tribes, and states will be sought.

NITROGEN STEWARDSHIP

Focus on the right timing, type, placement and quantity of nutrients to reduce nitrous oxide emissions and provide cost savings through efficient application.

CONSERVATION OF SENSITIVE LANDS

Use the Conservation Reserve Program (CRP) and the Agricultural Conservation Easement Program (ACEP) to reduce GHG emissions through riparian buffers, tree planting, and the conservation of wetlands and organic soils. By 2025, USDA aims to enroll 400,000 acres of CRP lands with high greenhouse gas benefits, protect 40,000 acres through easements, and gain additional benefits by transferring expiring CRP acres to permanent easements.

LIVESTOCK PARTNERSHIPS

Encourage broader deployment of anaerobic digesters, lagoon covers, composting, and solids separators to reduce methane emissions from cattle, dairy, and swine operations. USDA plans to support 500 new digesters over the next 10 years, as well as expand the use of covers on 10 percent of anaerobic lagoons used in dairy cattle and hog operations.

SOIL HEALTH

Improve soil resilience and increase productivity by promoting conservation tillage and no till systems, planting cover crops, planting perennial forages, managing organic inputs and compost application, and alleviating compaction. USDA aims to increase no-till implementation from the current 67 million acres to over 100 million acres by 2025.

GRAZING AND PASTURE LANDS

Support rotational grazing management, avoiding soil carbon loss through improved management of forage, soils and grazing livestock. By 2025, USDA plans to support improved grazing management on an additional 4 million acres, for a total of 20 million acres.

Rotational grazing, as pictured in Weld County, Colorado, is a management-intensive system of raising livestock on subdivided pastures to promote soil and plant health.

Emmett Jordan

PRIVATE FOREST GROWTH AND RETENTION

Through the Forest Legacy Program and the Community Forest and Open Space Conservation Program, protect almost 1 million additional acres of working landscapes. Employ the Forest Stewardship Program to cover an average of 2.1 million acres annually (new or revised plans), in addition to the 26 million acres covered by active plans.

STEWARDSHIP OF FEDERAL FORESTS

Reforest areas damaged by wildfire, insects, or disease, and restore forests to increase their resilience to those disturbances. USDA plans to reforest 5,000 additional post disturbance acres by 2025.

PROMOTION OF WOOD PRODUCTS

Increase the use of wood as a building material, to store additional carbon in buildings while offsetting the use of energy from fossil fuel. USDA plans to expand the number of wood building projects supported through cooperative agreements with partners and technical assistance, in addition to research and market promotion for new, innovative wood building products.

ENERGY GENERATION AND EFFICIENCY

Promote renewable energy technologies and improve energy efficiency. Through the Energy Efficiency and Conservation Loan Program, work with utilities to improve the efficiency of equipment and appliances. Using the Rural Energy for America Program and other programs, develop additional renewable energy, bioenergy and biofuel opportunities. Support the National On-Farm Energy Initiative to improve farm energy efficiency through cost-sharing and energy audits.

URBAN FORESTS

Encourage tree planting in urban areas to reduce energy costs, stormwater runoff, and urban heat island effects while increasing carbon sequestration, curb appeal, and property values. Working with partners, USDA plans to plant an average of 9,000 additional trees in urban areas per year through 2025.

Resources

- CSU Online CSA Modules
  - Coming soon
- Colorado Water Institute
  - http://www.cwi.colostate.edu
- Colorado
  - http://engagement.colostate.edu/climate-smart-agriculture

Colorado Water Institute
A division of the Office of Engagement
Colorado State University

Increasing Climate Resilience in Agriculture

Nick Brozović, Director of Policy
Daugherty Water for Food Global Institute

Context

- Focus on role of
  - Governance in building climate smart agriculture
  - Groundwater to support economic development
- The same issues with groundwater occur everywhere
  - Physical: depletion, surface water impacts, water quality impacts, subsidence
  - Economic: loss of drought mitigation potential, economic productivity
- Local context is extremely important for governance
- Challenge is how to learn and translate best practices

GRIPP

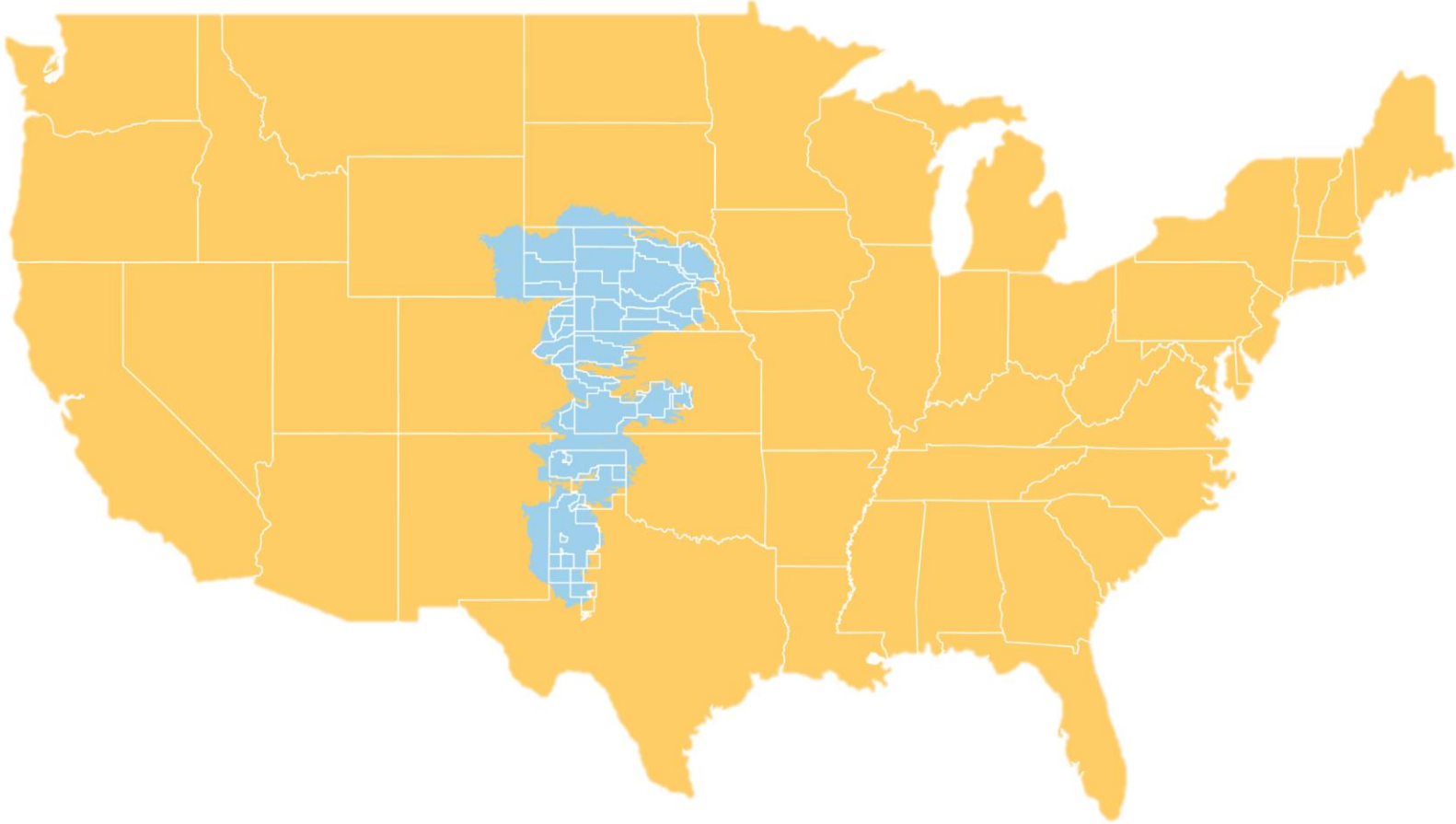
GROUNDWATER SOLUTIONS INITIATIVE FOR POLICY AND PRACTICE

Water for Food
DAUGHERTY GLOBAL INSTITUTE
at the University of Nebraska

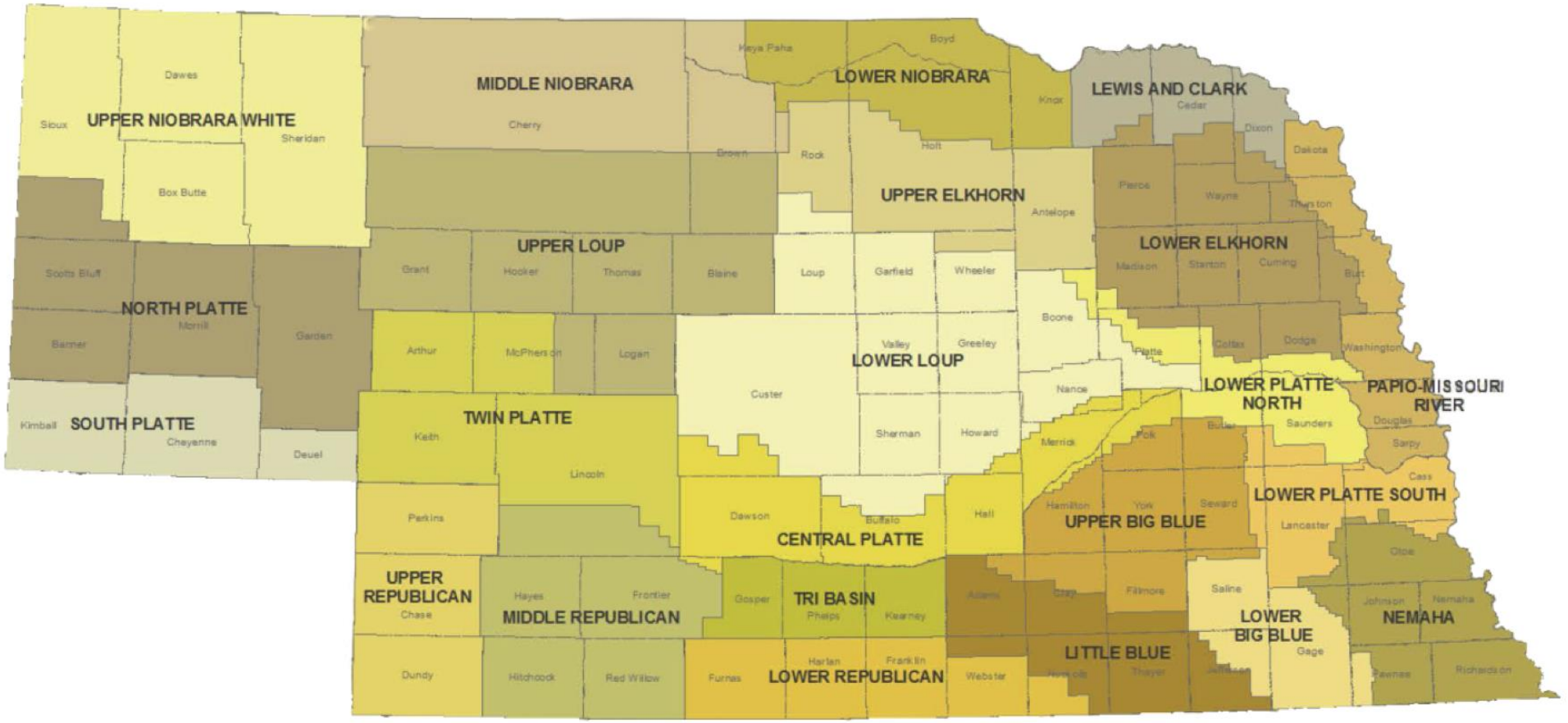
Key lessons learned from the western US

1. Building trust
2. The need for data
3. Using a portfolio of approaches
4. Assuring performance
5. Funding

Example: Nebraska's groundwater



Nebraska's 23 Natural Resources Districts



Nebraska's Natural Resources Districts

- Local governance
- Ability and willingness to set and enforce rules
- Appropriate budget
- *Enough* state oversight

Nebraska application of lessons learned

1. Building trust
2. The need for data
3. Using a portfolio of approaches
4. Assuring performance
5. Funding

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Reflections on Climate Smart Agricultural Water Management in Developing Economies

Peter G. McCornick, Executive Director
Robert B. Daugherty Water for Food Global Institute (DWFI)
Stockholm Water Week, August 2017

CLIMATE SMART AGRICULTURE (CCAFS)

Integrative approach to address interlinked challenges of food security and climate change, that explicitly aims for three objectives:

- sustainably increasing agricultural productivity, to support equitable increases in farm incomes, food security and development;
- adapting and building resilience of agricultural and food security systems to climate change at multiple levels; and
- reducing greenhouse gas emissions from agriculture (including crops, livestock and fisheries).

Climate Smart Agriculture

- “CSA is not a set of practices that can be universally applied.” FAO
- Farmer families are key. Having lived with climate variability farmers, farmers adapt, generally with limited to no external support. Used to coping with inter seasonal variation, farmers can delay planting, change to more suitable cropping patterns, diversifying crops, or use water conservation practices or develop irrigation

Context

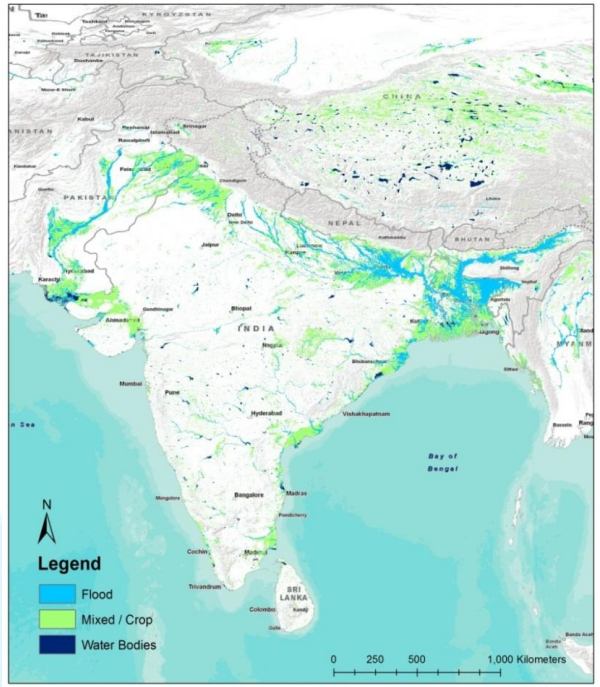
- Producing enough food for a growing, urbanizing and wealthier human population requires more water and land, and placing more pressure on already degraded ecosystems.
- The number of people living in water scarce conditions (<500 m^3 per capita per year) is projected to increase by 40%, and variability in water availability expected to be exacerbated by climate change.
- Many of the countries where water scarcity is already an emerging challenge are in the developing world, where there is a need for economies to grow most rapidly and where there are ambitious plans to increase agricultural production to meet the present and future needs of the population.
- For example, agricultural areas of the major river basins of South Asia, large deltas, highlands of East Africa, etc.

BUILDING RESILIENCE IN AGRICULTURAL SYSTEMS

- There are many aspects to increasing resilience in agriculture
- Increase access to markets, and improve their transparency and competitiveness
- Provide financial safety nets (credit, crop insurance, and crop mortgages) to mitigate risk
- Provide secure tenure to land and **water** rights, and ensuring access.
- Develop disaster plans for extreme events, such as droughts, floods, and cyclones
- Developing knowledge and capacity at the farm level

WATER & CLIMATE CHANGE

- Enhancing resilience is primarily about water.
- Warming temperatures, and more frequent and severe extreme events (droughts and floods), increase the risk of food insecurity, population displacement, and, in some cases, migration.
- Accessing water requires energy, and power generation consumes water and generates carbon.



(Giriraj et al, 2012)

WATER IS CRITICAL TO ENHANCING AGRICULTURAL RESILIENCE

- Securing access to reliable water supplies
- Encourage small-scale affordable agricultural water management technologies and practices
- Improve performance and flexibility of large scale irrigation systems
- Diversify and expand water storage (e.g. soils, ponds, small tanks, groundwater, reservoirs)

Increase productivity, ensure sustainability, build resilience, and develop capacity to cope

- Transform water governance. Include stakeholders, and manage locally. Support the governance.
- Produce more with less consumptive use, manage variability, manage demand, boost rainfed
- Assess the water resources (water accounting and allocation
- Assess the risk, and the energy.
- Rethink water storage: soil moisture, managed aquifer recharge, bank groundwater, revisit (large) dams.

(Adapted from McCornick et al, 2013)

Global Framework for Water Scarcity in Agriculture (WASAG).
http://www.fao.org/land-water/overview/global-framework/en/

Groundwater Solutions Initiative for Policy & Practice (GRIPP)

- http://www.iwmi.cgiar.org/issues/groundwater/gripp/

Climate Change, Agriculture and Food Security (CCAFS)

- https://ccafs.cgiar.org

Daugherty Water for Food Global Institute at the University of Nebraska

- http://waterforfood.nebraska.edu

Complexities Associated with Climate Change, Water, and Agriculture

Panel Discussion

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