COLORADO RIVER – *Connecting Actions with Consequences*

Anne J Castle
Getches-Wilkinson Center
University of Colorado

THE PROBLEM

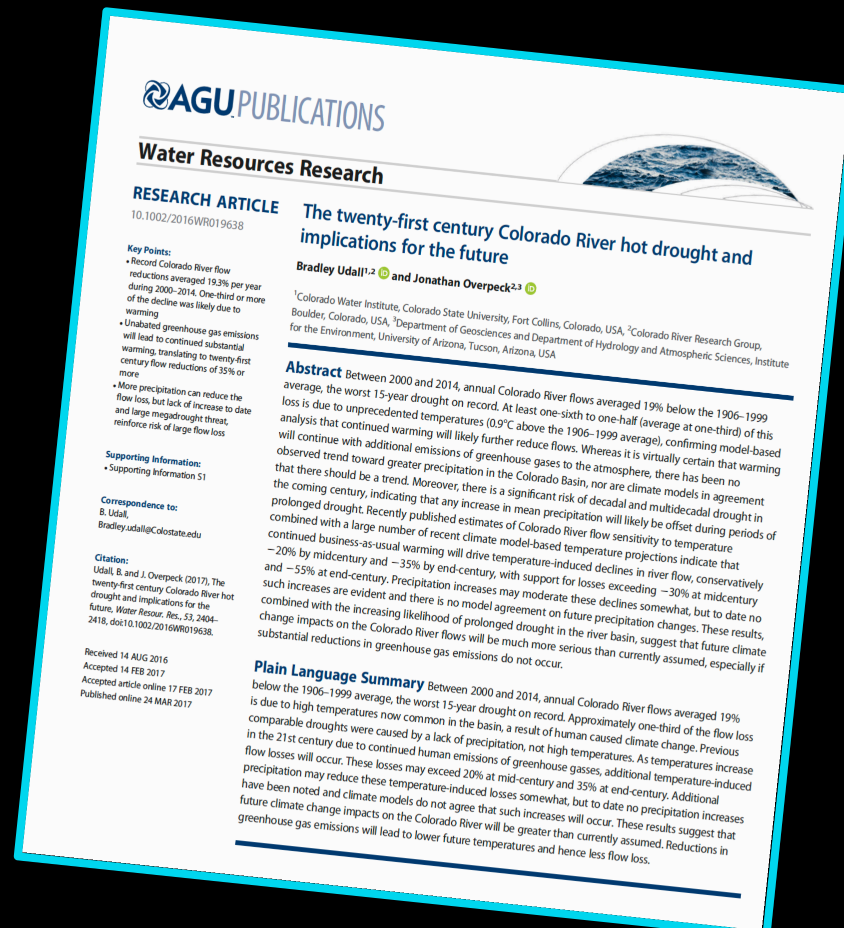
Natural Flow (2000-2018)		13.2 MAF
Outflows		15.1-15.6 MAF
UB uses	4.4	
LB contracts	7.0-7.5	
Evap & losses	1.0+	
Gila and tribs	~1.2	
Mexico	1.5	
Balance		1.9-2.4 MAF

LIKELY TO GET WORSE

Udall/Overpeck 2017

20-30% reduction in river flows by mid-century

35-55% reduction by 2100



AGU PUBLICATIONS

Water Resources Research

RESEARCH ARTICLE

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Key Points:

- Record Colorado River flow reductions averaged 19.3% per year during 2000–2014. One-third or more of the decline was likely due to warming
- Unabated greenhouse gas emissions will lead to continued substantial warming, translating to twenty-first century flow reductions of 35% or more
- More precipitation can reduce the flow loss, but lack of increase to date and large megadrought threat, reinforce risk of large flow loss

Supporting Information:

- Supporting Information S1

Correspondence to:

B. Udall,
Bradley.udall@Colostate.edu

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The twenty-first century Colorado River hot drought and implications for the future

Bradley Udall[1,2] and Jonathan Overpeck[2,3]

[1]Colorado Water Institute, Colorado State University, Fort Collins, Colorado, USA, [2]Colorado River Research Group, Boulder, Colorado, USA, [3]Department of Geosciences and Department of Hydrology and Atmospheric Sciences, Institute for the Environment, University of Arizona, Tucson, Arizona, USA

Abstract Between 2000 and 2014, annual Colorado River flows averaged 19% below the 1906–1999 average, the worst 15-year drought on record. At least one-sixth to one-half (average at one-third) of this loss is due to unprecedented temperatures (0.9°C above the 1906–1999 average), confirming model-based analysis that continued warming will likely further reduce flows. Whereas it is virtually certain that warming will continue with additional emissions of greenhouse gases to the atmosphere, there has been no observed trend toward greater precipitation in the Colorado Basin, nor are climate models in agreement that there should be a trend. Moreover, there is a significant risk of decadal and multidecadal drought in the coming century, indicating that any increase in mean precipitation will likely be offset during periods of prolonged drought. Recently published estimates of Colorado River flow sensitivity to temperature combined with a large number of recent climate model-based temperature projections indicate that continued business-as-usual warming will drive temperature-induced declines in river flow, conservatively −20% by midcentury and −35% by end-century, with support for losses exceeding −30% at midcentury and −55% at end-century. Precipitation increases may moderate these declines somewhat, but to date no such increases are evident and there is no model agreement on future precipitation changes. These results, combined with the increasing likelihood of prolonged drought in the river basin, suggest that future climate change impacts on the Colorado River flows will be much more serious than currently assumed, especially if substantial reductions in greenhouse gas emissions do not occur.

Plain Language Summary Between 2000 and 2014, annual Colorado River flows averaged 19% below the 1906–1999 average, the worst 15-year drought on record. Approximately one-third of the flow loss is due to high temperatures now common in the basin, a result of human caused climate change. Previous comparable droughts were caused by a lack of precipitation, not high temperatures. As temperatures increase in the 21st century due to continued human emissions of greenhouse gasses, additional temperature-induced flow losses will occur. These losses may exceed 20% at mid-century and 35% at end-century. Additional precipitation may reduce these temperature-induced losses somewhat, but to date no precipitation increases have been noted and climate models do not agree that such increases will occur. These results suggest that future climate change impacts on the Colorado River will be greater than currently assumed. Reductions in greenhouse gas emissions will lead to lower future temperatures and hence less flow loss.

CHALLENGES

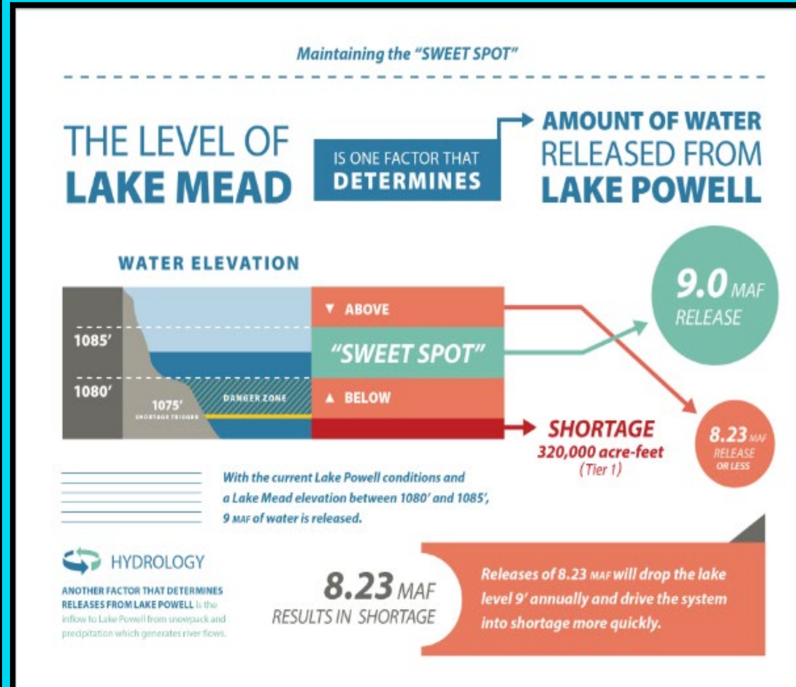
- Well established uses of water in excess of inflows
- Declining water availability
- Growing, or at best static, demand
- Tribal development
- Environmental needs

GOALS

- Bring the system into balance
- Phase out subsidies
- Let states decide how risk averse or risk taking they want to be
- Connect actions with consequences

ACTIONS ≠ CONSEQUENCES

- Lower Basin
  - Structural Deficit = LB water users consume more than inflow
  - Lake Mead drops
  - Balancing requires greater release from Lake Powell



RESULT

- Lower Basin overuse is subsidized
- Upper Basin savings in Lake Powell don’t benefit Upper Basin
  - Partially mitigated by Demand Management Storage Agreement
- Lower Basin states don’t bear the full cost of their actions

ACTIONS ≠ CONSEQUENCES

- Upper Basin

- New projects increase risk of curtailment for all water users
- Risk Study Phase 3- Increase in annual UB consumptive use of 11.5% roughly doubles the risk

RESULT

- Part of cost of new projects spread around the basin
    - Increased risk
    - Demand management
- New projects are subsidized

ACTIONS ☞ CONSEQUENCES

- New development in UB pays its own way, offsetting additional risk
- Principle #3 of Conceptual Framework:

  Need to ensure that diversions by a new TMD do not unacceptably increase the risk of a Compact deficit, or increase the amount of water existing users would have to provide through a demand management program.

ACTIONS ☞ CONSEQUENCES

- If LB uses more than allocation, consequences occur there
  - Question: What exactly is the LB allocation???
- Balancing to distribute extraordinary inflows, not to offset overuse

ACTIONS ☞ CONSEQUENCES

- Controlled slide to sustainability
- Can’t suddenly undermine economic sectors or geographic areas
- Agree on incremental steps over time to get there

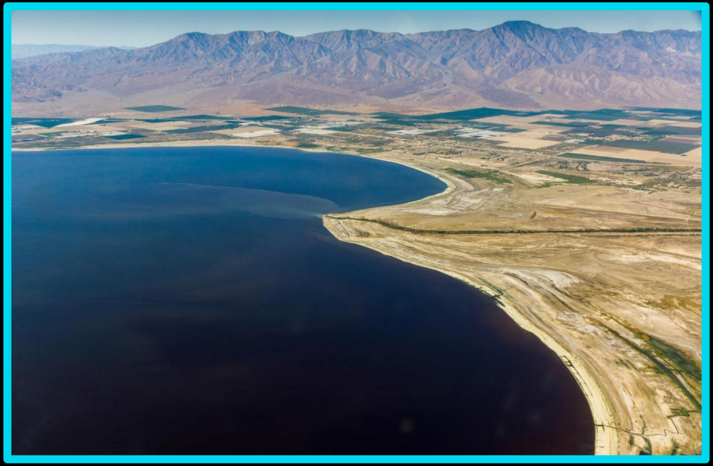
GRAND BARGAIN IDEAS

- Bank (bigger) in Lake Powell free of balancing
- Both lakes used to store ICS or demand management savings
- Triggers for delivery reductions based on hydrology, not Lake Mead levels
- Tradeoffs that recognize climate change impacts

ESSENTIAL COMPONENTS

- Development of tribal rights and protection of tribal water values
- Protection of ecological values, including in the delta
- Salton Sea progress


Colorado River Delta


Salton Sea

GOALS AND PROCESS

- Reduce externalities
- Design for future conditions based on best science available
- Include non-traditional stakeholders

GUIDING PRINCIPLES

- Both basins manage supplies and live within their hydrological means
- Each basin or state decides how risk averse or risk taking it wishes to be
- Consequences occur in the basin or state where the actions are taken

DISCUSSION