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Water Rights, Water Quality & Water Solutions in the West

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WATER QUALITY TRADING & ADAPTIVE MANAGEMENT

NEW DEVELOPMENTS PROMOTE REGULATORY INNOVATION

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INTRODUCTION

The United States and the world face multisystemic environmental problems that threaten our quality of life. Answers to these problems require innovative, multifaceted, solutions. Success will depend on the meaningful involvement of the maximum number of stakeholders and pathways to efficiently producing reliable results. Environmental market systems can satisfy these criteria.

Environmental markets have been employed around the world to address environmental issues ranging from cap and trade carbon markets, to endangered species banks, to wetland mitigation. These markets constantly evolve. Participants, practitioners, and regulatory oversight agencies must guide them forward, implementing adaptations in response to both lessons learned and feedback from diverse stakeholders.

Water quality trading (WQT) is one such market mechanism. The command and control approach adopted in our early environmental legal system sets necessary floors for health and environmental protections. The approach has led to many great results, but time has also revealed its many undesirable inefficiencies.

WQT has the potential to improve watersheds while lowering the overall burdens on market participants and regulators. It can be used to effectively and efficiently remove collectively-generated, large-scale pollutants (e.g., nitrogen, phosphorous, heat) that arise from both point and nonpoint sources.

With few exceptions, where clear WQT standards have been implemented both environmental groups and businesses have liked WQT. Businesses have recognized that they can often achieve required standards at lower costs by engaging in trading, and environmental groups have recognized that addressing upstream issues instead of just downstream point sources can truly benefit the overall water ecosystem.

Beginning with the Clean Air Act and then the Clean Water Act, regulatory agencies have added market mechanisms to more easily or efficiently achieve environmental and resource goals. The Clean Water Act's Total Maximum Daily Loads (TMDLs) cap the most pollution allowable for a stream segment. Achieving compliance under TMDL caps can facilitate WQT.

Over the last two decades, the US Environmental Protection Agency (EPA) has released guidance on successful implementation of WQT. WQT markets, however, have not developed as quickly as might be expected, but that could be changing.

On February 6, 2019, EPA released new recommendations ("the 2019 Policy Document") for states and watersheds to implement water quality trading programs. This latest round of guidance focuses on flexible, market-based principles that aim to incentivize implementation of technologies and land use practices that reduce nonpoint pollution in our nation's water through WQT.[1] Currently, the EPA is taking comment on this guidance before taking its next steps.

Water Quality Trading

Valuation

Economic Markets

Supply & Demand

As in any other market system, knowledge is key. Ideally, credits generated in an ecosystem market would be based on a clear and unchanging regulatory goal and have a defined and permanent quantification for purchase. But that is often not the case in ecosystem valuation. Instead, regulatory trading goals need to be dynamic and adaptive. Credit quantification requires consistent monitoring to ensure ecosystem benefits.[2] As acknowledged by EPA, stormwater and nonpoint source discharges can be "subject to confounding natural variability not typically seen with traditional point source" — making them difficult to estimate.[3] Further, though benefits of these pollutant reductions may be significant, they may not be immediately or precisely measurable.[4] EPA has therefore recommended increased flexibility and the adoption of adaptive management strategies.

This article will look at the history of WQT and EPA guidance, as well as responses to that guidance. We then consider the adaptive management principle as it relates to the EPA's call for flexibility and the use of the principle in current WQT programs. We then discuss a newer, working, WQT framework that has seemingly adopted many of the EPA's recommendations.

ECO-MARKETS: A BRIEF INTRODUCTION

Markets for ecosystem services or environmental resources (here, "ecosystem markets") — such as wetland mitigation or CO2e (carbon dioxide equivalent) offsets or endangered species banks — are economic markets. An economic market is "an actual or nominal place where forces of demand and supply operate, and where buyers and sellers interact (directly or through intermediaries) to trade goods, services, contracts or instruments, for money or barter. Markets include mechanisms or means for: 1) determining price of the traded item; 2) communicating the price information; 3) facilitating deals and transactions; and 4) effecting distribution. The market for a particular item is made up of existing and potential customers who need it and have the ability and willingness to pay for it."[5] Ecosystem markets or environmental markets have the same general requirements and elements as any other economic market.[6]

Each ecosystem market, like all economic markets, must have both supply and demand mechanisms, defined as "[e]conomic forces fundamental to the price mechanism in a free market system. They determine the price of a good or service offered, and are in turn determined by the price obtainable. It is a largely self-regulatory mechanism generally resulting in market equilibrium where products demanded at a price are equaled by products supplied at that price."[7]

Editors' Sidebar: Total Maximum Daily Loads

Under federal Clean Water Act (CWA) section 303(d), a water body determined to be unable to meet water quality standards set to be protective of its designated beneficial uses due to pollution is identified as "water quality impaired" in terms of the associated pollutants and placed on a "303(d) list." A Total Maximum Daily Load (TMDL) is subsequently set for the 303(d)-listed water body based on a determination of that water body's capacity to assimilate a limited amount of each problematic pollutant and still provide for beneficial use(s). The TMDL allocates allowable pollutant discharge levels. These allocations are divided into two types: 1) Waste Load Allocations (WLAs) which aim at equitably distributing water-protective effluent discharge limits among "end-of-pipe" dischargers (point sources); and 2) Load Allocations (LAs), which are set for more diffuse "nonpoint" sources, such as runoff from agricultural lands. Typically there is also a "reserved capacity" set-aside to accommodate effluent from anticipated growth. WLAs have specific point-of-discharge effluent monitoring and compliance requirements which are written into a point source discharger's National Pollution Discharge Elimination System (NPDES) permit. LAs, on the other hand, typically require only the implementation of **b**est **m**anagement **p**ractices (BMPs) by affected parties — though these BMP requirements may change over time in response to subsequent water quality assessments and determinations as to BMP efficacy.

NPDES permits

Originally developed separately from any TMDL process, NPDES permits were initially aimed at end-of-pipe discharges — for instance industrial and municipal wastewater effluent. These types of NPDES permits typically include numeric limits on the amount of regulated pollutants the permittee's effluent can contain, which must be monitored for at end-of-pipe outfalls. When a TMDL is developed for the water body into which these permittees discharge a problematic pollutant, WLAs for that pollutant are applied to the numeric limits in their NPDES permits.

NPDES Stormwater Permits

1987 amendments to the CWA initiated NPDES stormwater programs, and permits were developed to regulate stormwater discharges from three types of sources: municipal separate storm sewer systems (MS4s); construction site activities; and certain industrial activities (10 categories). In part due to stormwater's more diffuse origins, stormwater permits have relied on implementing BMPs and have not included numeric limits. Generally speaking, NPDES stormwater permits are designed to implement BMPs which control stormwater runoff to the "**m**aximum **e**xtent **p**racticable" (MEP). The MEP standard was purposely left flexible and adaptable to local conditions and evolving BMPs.

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Water Quality Trading

US ENVIRONMENTAL MARKETS

Regulatory Requirements

At the level of actual efficacy, demand and supply forces in eco-markets come from regulatory requirements. The Clean Water Act as enforced by EPA and many states and tribes drives the WQT market.[8] Importantly, such regulatory agencies can be either or both market drivers and market obstacles. Regulatory agencies can be market drivers by:

- enforcing mitigation requirements and creating demand for a credit market
- accepting market credits as an alternative to traditional mitigation or offsets
- creating certainty that reduces the risk to the purchaser and makes the credits more marketable

Regulatory agencies can impede markets by:

- failing to quickly respond to requests or approvals
- being uncertain of any required approvals
- lacking appropriate resources
- increasing transaction costs for approvals
- failing to address fee-in-lieu program fees that are less costly

Key Participants

Any ecosystem market has three key participants (and perhaps a fourth):

1) Regulatory Agencies — creating the demand for the market
2) Landowners/Sellers — providing the supply for the market
3) Developers/Purchasers — buying the credits the market provides; and perhaps
4) a separate entity that creates and/or manages the credit bank

Buyer Needs

In this context, an environmental market Buyer typically needs: regulatory certainty; low or comparable transaction costs to other forms of mitigation or offset; limitation or elimination of liability; speed; and preauthorized or streamlined regulatory approval. And both the Buyer and the relevant agency need: (a) Demonstrated Stability of Bank — requiring careful due diligence but providing safeguards for buyer and agency that bank can meet the credit obligations; and (b) Demonstrated Plan for Management — ensuring that long-term mitigation plans will be acceptable to the agency so that the permit holder (buyer or seller) will not be required to perform additional mitigation. An environmental market must provide: regulatory certainty; reduced transaction costs; reduced risk of liability; efficient and cost-effective actual mitigation; and the potential for management of mitigation in perpetuity or over the life of the credit.

Market Provisions

Environmental Benefits

As the US Department of Agriculture states: "Natural assets such as rivers, forests, grasslands and wetlands benefit society through the ecosystem services they provide, including water purification, air quality improvements, and flood protection, among other benefits. However, these services are frequently left out of resource management decisions because they aren't easily quantified or assigned a monetary value. As a result, society undervalues these environmental benefits, contributing to the loss of natural systems. Environmental markets can provide incentives to preserve ecosystems and the services they provide."[9]

Legal Drivers

The laws that drive the economic levers for environmental markets in the United States include the Clean Water Act,[10] the Clean Air Act,[11] the Endangered Species Act,[12] CERCLA and Natural Resources Damages,[13] other federal laws, and many more similar laws at state, tribal, or local levels. These laws are diverse and overlapping, and at times almost contradictory. For example, just with respect to the now-developing natural resource damage banks, relevant federal laws include: Section 1321 of the Clean Water Act[14] (liability for costs to restore or replace natural resources damaged/destroyed), Section 107(a) and (f) of CERCLA[15] (liability and recovery for natural resource damages), Section 1002 of the Oil Pollution Act ("OPA")[16] (liability and recovery for natural resource damages), the Park System Resource Protection Act,[17] the National Marine Protection, Research and Sanctuaries Act,[18] the Department of the Interior CERCLA regulations[19] (Type A and B assessments), and the National Oceanic and Atmospheric Administration ("NOAA") regulations regarding OPA.[20]

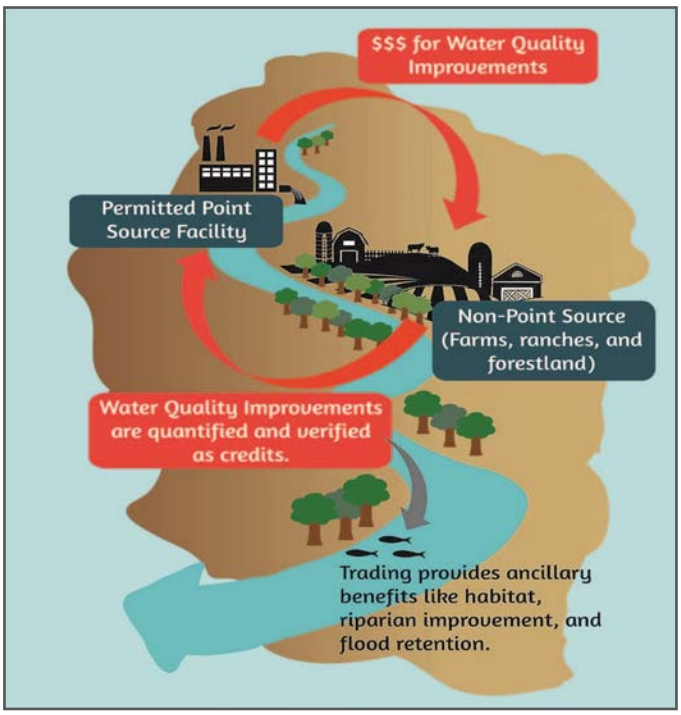
WATER QUALITY TRADING

Abatement Costs

As described above, WQT is a market-based mechanism that allows the exchange of pollution reduction costs that differ based on size, location, scale, management, and overall efficiency of the individual polluting entities.[21] Trading essentially allows those with high abatement costs to purchase pollution discharge reductions from sources that have lower abatement costs.[22] Participants with lower abatement costs are able to economically lower their pollution discharges beyond regulated or permitted levels, which enables them to create credits that can be sold to those entities with higher costs.[23] WQT is most commonly used for large-scale impact nutrients like phosphorus and nitrogen, but it has also been applied to temperature, selenium, and sediment.[24]

Credit Creation

Water Quality Trading



[25]Breaking Down Barriers, *supra* note 23, at 6. Image reproduced with permission. *See id*. at 2.

Nonpoint Sources

Trading programs can be defined in a permit system or in a state policy.[26] WQT manifests in many forms: trades between regulated point sources[27]; trading between a regulated point source and unregulated nonpoint source;[28] or trading between two nonpoint sources.[29] Nutrient pollution tends to originate from nonpoint, principally agricultural, sources.[30] WQT is therefore an important tool for "leveraging point-source regulatory requirements to generate reductions from unregulated nonpoint sources."[31]

RECENT DEVELOPMENTS IN WATER QUALITY TRADING

WQT History

EPA initially proposed WQT in a policy document from 2003 ("2003 Policy Document").[32] The purpose of this policy was "to encourage states, interstate agencies and tribes to develop and implement water quality trading programs for nutrients, sediments and other pollutants where opportunities exist to achieve water quality improvements at reduced costs."[33] While this was the finalized document proposing that states, interstate agencies, and tribes develop a WQT system, the idea dated back to EPA's February 1996 Effluent Trading in Watersheds Policy Statement[34] and EPA's May 1996 Draft Framework for Watershed-based Trading.[35] These two earlier policy documents flowed from President Clinton and Vice President Gore's document tiled "Reinventing Environmental Regulation,"[36] which listed out 25 "high priority actions" to move forward in the next 25 years — top amongst them being effluent trading in watersheds. The 2003 Policy Document intended to address open issues and limitations from these earlier draft frameworks[37] and guidance, and provide a clear path forward.[38]

CWA Requirements

EPA's 2003 Policy Document emphasized that any proposed WQT program must be consistent with the Clean Water Act and that EPA will review each proposed WQT program on a case-by-case basis.[39] In order to comply with CWA requirements, EPA listed out the provisions that programs developed by states, tribes, and interstate agencies must, at a minimum, consider from the CWA.

EPA's 2003 WQT Provisions were:

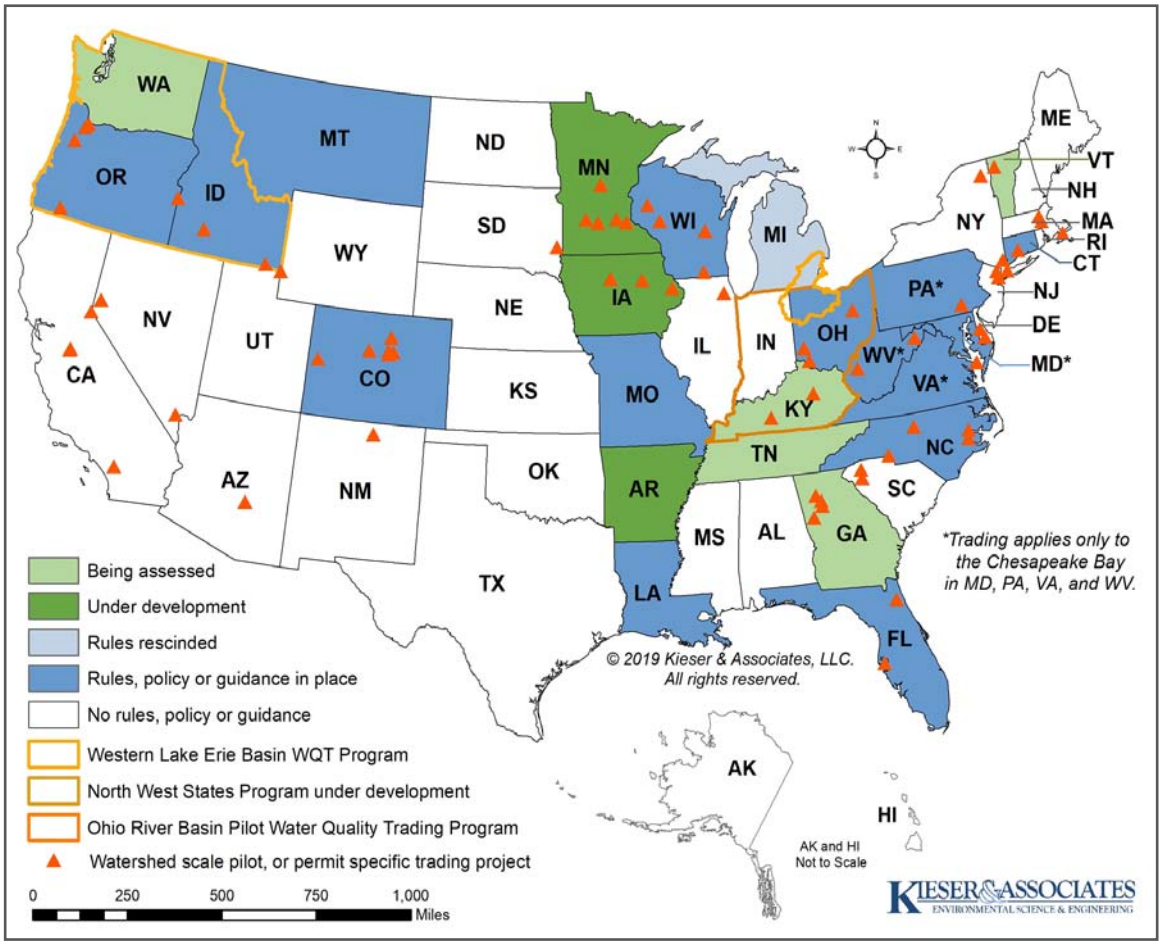
- Requirements to obtain permits pursuant to CWA Section 402 (permitting under the CWA National Pollutant Discharge Elimination System (NPDES) program)[40] or Section 404 (permitting for the discharge or dredged or fill material into waters of the United States)[41] of the CWA
- Incorporating provisions for trading into permits granted under Section 402 and 404 of the CWA
- The public notice, comment and opportunity for hearing — specifically required for all NPDES permits[42]
- Consistency with standard methods that may be specified in federal regulations or in NPDES permits
- Protecting designated uses — no use of credits or trading activity should cause an impairment of existing or designated use or water quality
- Antibacksliding provisions (specified in Section 303(d)(4) of the CWA) must be satisfied

Water Quality Trading

Policy Development

At the time the 2003 Policy was released, a detailed and prescriptive set of recommendations may have been preferred.[43] However, EPA later acknowledged that its 2003 Policy may have been "interpreted by many states, tribes, and stakeholders as having the force and effect of law, mandating certain actions or outcomes, and containing standards or requirements with which a market-based program must comply,"[44] while the goal was intended to provide ideas and opportunities for states, tribes, and other participants as they developed market-based water quality improvement policies.[45] As a result, between 2003 and the 2019 guidance, participation and investment in WQT programs have not reached EPA's anticipated levels. The map below represents the frequency of these programs.

Water Quality Trading Activities in the United States[46]



Similar issues and concerns were recognized by multiple stakeholder studies examining WQT policies. In 2009, the World Resources Institute conducted an extensive study of 57 WQT programs worldwide.[47] Of the 57 programs: 26 were active; 21 were in consideration; and 10 were completed pilots with no plans for future trading.[48]

Key Success Factors

The World Resources Institute study identified five key factors that led to successful WQT programs:

- strong regulatory and/or non-regulatory drivers that help create a demand for water quality credits
- minimal potential liability risks to the regulated community from meeting applicable regulations through water quality trading
- robust, consistent, and standardized methods for estimating nonpoint source actions
- minimization of transaction costs through standardized tools, transparent processes, and online registries
- demonstration of buy-in from local and state stakeholders.[49]

In October 2018, the National Network on Water Quality Trading (the Network) — which includes diverse organizations representing agriculture, wastewater utilities, environmental groups, regulatory agencies, and the practitioners delivering water quality trading programs[50] — finalized a multi-stakeholder dialogue that investigated what is keeping WQT on "the sidelines."[51] The study included a detailed action plan to implement WQT into more watersheds across the United States.[52]

Water Quality Trading

Market Needs

Credit Quantification

CWA/WQT Alignment

Demand Role

Regulator's Role

Liability Protection

Market Principles

Economics & Flexibility

Suggestions from the Network's dialogue with stakeholders were comparable to the key factors identified by the World Resources Institute's 2009 study.
Similar findings from both studies include the need to:

- identify and address risks for buyers
- identify and address risks of litigation
- create guidance
- ensure regulatory agencies have capacity and resources to engage in WQT
- build stakeholder relationships and trust[53]

Clearly, in the approximately eight years between the two studies, not much has changed with respect to the issues preventing participation and implementation of WQT. The Network's dialogue produced some additional recommendations as well. For instance, the report recommends that EPA and each Presidential administration clarify their positions on WQT.[54] The report also specifically endorses simpler and more reliable credit quantification methods to reduce fear amongst participants.[55]

The Network's clarification recommendation highlights a primary concern that, since EPA's WQT is not integrated into the Clean Water Act, it is not always clear whether the government's approach to WQT will vary from one administration to the next. To that end, some stakeholders have suggested that EPA incorporate their WQT program into the text of the Clean Water Act. Such action would still allow states, tribal entities, and interstate agencies to engage in watershed-specific WQT programs, but with the oversight and approval of the EPA. Incorporating WQT into the actual text of the CWA would require congressional approval. However, EPA has the discretion to make proposed rules to implement portions of the CWA, which can potentially be utilized in this case. For example, Section 303 of the CWA outlines states' responsibility in achieving water quality standards. EPA could introduce a proposed rulemaking — based on Section 303 — that would allow states to develop a WQT program as part of their implementation plan.

The Network compared its results with lessons learned from other environmental markets. One primary focus of this comparison was the role demand plays in setting the pace and success of an environmental market. For example, the report highlighted the success of California's conservation banking market because the presence of imperiled species co-occurs with high rates of development and steep land prices.[56] "Expensive property values mean that developers have limited options in shifting development to another site and are motivated to move quickly through the permitting process."[57] The Network concluded that for WQT credits will occur more often in places "where there are numeric water quality criteria, the technology required to meet limits is expensive or available technology is unable to reach limits, and potential credit buyers have support from their regulatory agency to pursue trading."[58]

The regulator's role in designing the rules and shaping the interest is critical — regulations shape demand for WQT.[59] "State regulatory agencies administer clean water standards, [TMDL], and NPDES programs under the Clean Water Act, which determine how stringent permit requirements will be, and when and how trading can be used for permit compliance."[60]

Other lessons learned from other markets included the need for simplicity and predictability, and a mechanism to allow the transfer of regulatory liability away from NPDES permit holders. Unless addressed, the buyer of a credit could be subject to enforcement actions and fines if the credit-generating project failed.[61]

With the current administration, EPA has revised its policy on WQT for the first time since it's 2003 Policy Document.[62] EPA's 2019 Policy Document was issued on February 6, 2019 and identified six market-based principles that make up the core of the revised policy, with the intent of encouraging "creativity and innovation." The 2019 Policy Document "believes that market-based programs, including water quality trading, as well as incentive- and community-based programs can be used more effectively than they have to date to achieve water quality improvements."[63]
EPA's 2019 Policy encourages and endorses the following:

- States, tribes, and stakeholders should consider implementing water quality trading and other market-based programs on a watershed scale.
- EPA encourages the use of adaptive management strategies for implementing market-based programs.
- Water quality credits and offsets may be banked for future use.
- EPA encourages simplicity and flexibility in implementing baseline concepts.
- A single project may generate credits for multiple markets.
- Financing opportunities exist to assist with deployment of nonpoint land use practices.[64]

The high-level difference between the 2003 and 2019 Policy Documents is the focus on economics and flexibility in the developing party's WQT program. While the 2003 Policy Document revealed intensive study of the potential effects and impacts of allowing a WQT program, EPA's current guidance is based on building off the experience and knowledge gained in the intervening years.[65] In the 2019 Policy Document, EPA emphasized that — as nonpoint pollution reduction technologies and practices have improved — research has helped inform the effectiveness and performance of many nonpoint practices. Technical mapping and robust modeling programs have become capable of evaluating resources at the edge-of-field,

Water Quality Trading

Simplicity

Watershed-Based

Designed Adaptation

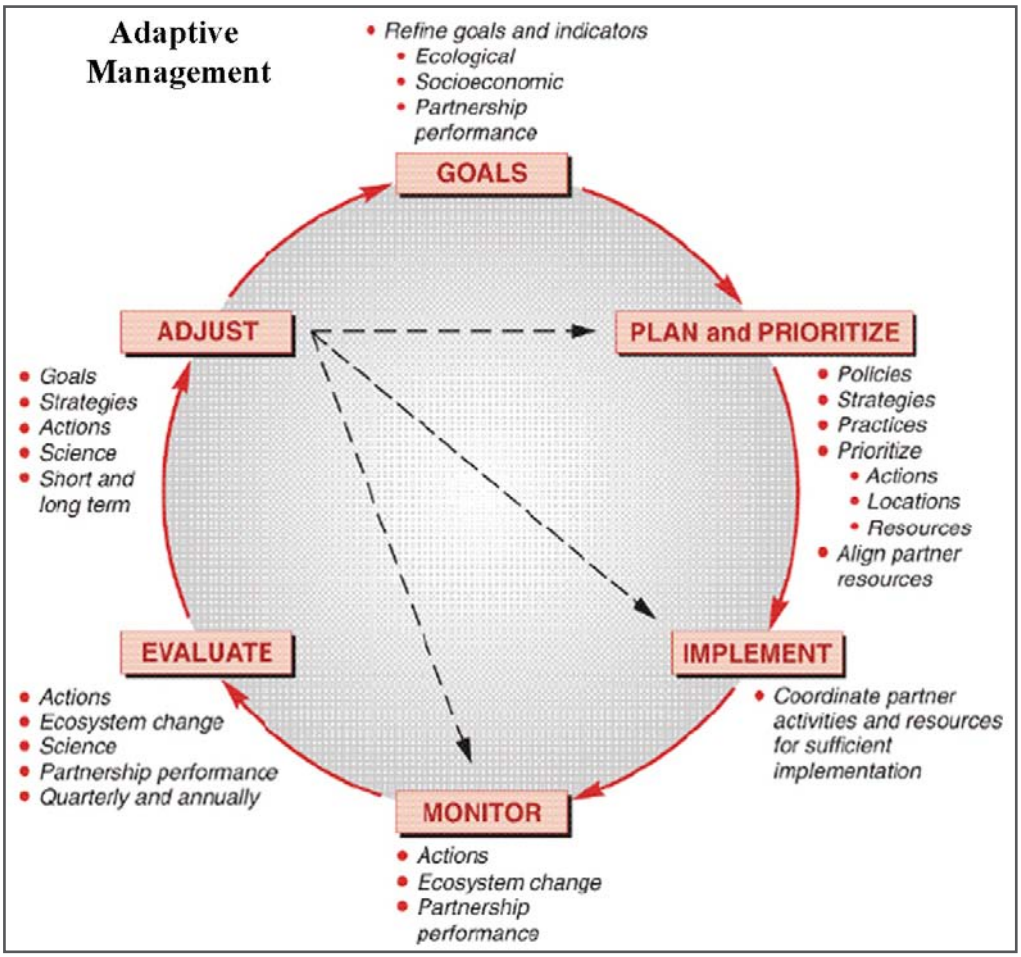
and instream. Other monitoring techniques have expanded the understanding of the resources.[66] EPA concluded that with these advancements, WQT programs could be adaptable and implemented on a greater scale.

Further, EPA stressed that the 2019 Policy Document was only guidance and does not "mandate any specific regulatory action, outcome or requirement without first going through the rulemaking process."[67] Currently, EPA characterizes the 2019 Policy Document as "the next step in modernizing the EPA's approach to market-based programs and water quality trading."[68] Moving forward with public comment, the EPA is focusing on the fourth principle in the 2019 Memorandum — "simplicity and flexibility in implementing baseline concepts."[69] Further, EPA's September 19, 2019 Federal Register notice requests comments on proposed recommendations to baselines for nonpoint sources in watersheds covered by a TMDL. EPA recognizes that in many TMDLs, where the load allocation and/or baseline may be a substantial portion of reductions necessary in the overall watershed, achieving the necessary level of reduction may be "costly and a barrier to entry to a trading or offset market."[70]

According to the Environmental Trading Network, which documents information on state, interstate, and tribal WQT programs, approximately 36 states currently have WQT programs in place, with many of these being watershed-based. Many states having multiple programs.[71] These watershed-based programs can range from the small (e.g., the Beaver Creek watershed in western Tennessee which drains 86 square miles of urbanizing land)[72] to the large (e.g., Ohio River Basin Pilot Water Quality Trading Program, which drains over 203,000 square miles).[73] Some larger projects are also in development, such as a "Northwest States Program," which includes Washington, Oregon and Idaho.[74] These existing trading programs typically focus on trading within a particular watershed and entail watershed-based trading which is calculated based on a TMDL.

ADAPTIVE MANAGEMENT

Adaptive management involves "the implementation of carefully designed, quasi-experimental management intervention and monitoring programs" to gain improved overall ecological knowledge and adapt remediation/restoration efforts accordingly.[75] It embraces the idea that managed natural resources will change as a result of human intervention, and there will always be surprises and new uncertainties.[76] If management decisions are treated as experiments, and the results are carefully monitored or evaluated, then learning can occur.[77]



Water Quality Trading

Adaptive Elements

Uncertainty

Instream v. Effluent

Phosphorus Reduction

Treatment Options

Trading v. Adaptation

Permanent Credits

Key Adaptive Management elements include:

- Management objectives that are regularly revisited and revised
- A model of the system being managed with clear understanding that the model system is limited
- A range of management choices
- Evaluation or monitoring of the management outcomes with incorporation of feedback in later models

If these techniques are employed correctly, they could both improve water quality and lower overall costs.[78]

Adaptive management has the potential to play a large role in the EPA's goals. It is particularly relevant where there is substantial uncertainty. Uncertainty can be addressed by structured decision-making and the use of evolving targets. This allows water quality goals and objectives to grow over time.[79] EPA recommends that WQT programs use adaptive management strategies when generating credits. Such strategies may also be useful in considering the flexible baselines approach, as well as in implementing credit banking and multiple environmental market crediting. To accomplish these goals, clear and consistent adaptive management goals will be necessary.

Along with the commitment to flexibility and increased participation, adaptive management is a part of EPA's 2019 Policy Document. However, "adaptive management" can come off as "buzz words" lacking sufficient direction for the monitoring and implementing feedback necessary to actually improve water quality.[80] Different WQT programs have adopted adaptive management objectives with a range of varied details and levels of follow through.[81] Experience has now shown that proper implementation of adaptive management can lead to successful WQT and improved ecological benefits.[82]

This article highlights two schemes that have adopted adaptive management strategies that are commonly referenced — i.e., Wisconsin's and Idaho's. Then the article will detail a newer water quality scheme in Northern California that encompasses many of the EPA's guidance recommendations.

Wisconsin Example

Wisconsin employs an adaptive management scheme that is separate from its WQT program. It allows point source phosphorus dischargers to use lower cost methods that reduce pollution in their whole watershed to achieve compliance and meet water quality standards.[83] The adaptive management program differs from Wisconsin's WQT in that it focuses on compliance with the instream phosphorus limitation rather than offsetting the amount in the effluent.[84] It is more flexible than the water quality trading program because the field-by-field management practices used in adaptive management do not need to be specified in the Wisconsin Pollutant Elimination permit.[85] This allows the adjustment of pollutant management practices throughout the permit term.[86] The program also allows a 15-year compliance period. The program requires that instream monitoring occur to demonstrate water quality improvements over time[87] (whereas the WQT program uses modeling and trade ratios to estimate phosphorus reductions from nonpoint sources).[88] The adaptive management program has been generally more successful than Wisconsin's WQT program at lowering phosphorus levels and overall costs.[89]

Wisconsin's Lower Fox River Pilot Plan switched from trading to adaptive management because of these benefits. The Fox River is a major source of phosphorous in the Great Lakes Basin.[90] The Lower Fox is subject to a TMDL.[91] Nonpoint sources of phosphorous include "runoff from barnyards, areas winter-spread with livestock manure, eroding agricultural lands and streambank erosion, cattle accessing the streams and other poor land use practices."[92] Initially, trading focused on reducing phosphorous in the Great Lakes and the Fox River.

The point source buyer — NEW Water wastewater treatment — had three choices: 1) upgrade the plant; 2) trade for credits; or 3) choose adaptive management and select a segment of stream upstream from them and work with upstream landowners on establishing phosphorus-related remediation projects (see below). (The American Farmland Trust case study also noted a fourth option involving a discharge variance charge. But applying the variance was described as too cumbersome and complicated.)

While the adaptive management option is similar to the water quality trading (both involve point sources working with nonpoint or other point sources in a watershed to reduce the overall phosphorus load) the two options are not the same.[93] "Trading requires a facility to acquire environmentally equivalent (or superior) pollutant reduction credits to offset enough of a facility's phosphorus load to demonstrate compliance with a phosphorus water quality-based effluent limitation."[94] Adaptive management focuses on improving water quality so that the applicable phosphorus criterion is met.[95]

NEW Water was ultimately interested in permanent credits, but "[t]rading policies in Wisconsin made it difficult to get permanent credits."[96] Under Wisconsin's water quality trading, credits are only permanent if the phosphorous is reduced above TMDL goals.[97] Water quality trading achieves its goals by offsetting phosphorus from a point source discharge to comply with a permit limit.[98] Adaptive management, on the other hand, focuses on achieving phosphorus surface water quality criteria.[99] The more flexible option,

Water Quality Trading

Permit Terms

Credit Duration

Inflexible Rules

Banking Credits

Credit Quantification

Trading Requirements

Monitoring

adaptive management allows less restrictive interim phosphorus limits, which can be permanent if the adaptive management is successful.[100] The adaptive management option can extend over three five-year permit terms, giving participants time to create new partnerships, install phosphorus reduction practices, and measure success.[101] While trading requires that credits be generated before they can be used to offset a phosphorus discharge, adaptive management allows installation over the permit term.[102]

NEW Water commented on the need to have permanent practices that offered substantial credits and for an acceptable delivery rate based on specific practices.[103] With adaptive management credit duration depending on whether the long-stream water quality goals are being achieved, there is less focus on the management measures and locations of the changes.[104] NEW Water participants also complained that the WQT regulations were onerous and made the trading a "top-heavy" process. This complaint is consistent with other critics of Wisconsin's water quality trading program, who have similarly blamed low participation on inflexible rules and trouble connecting buyers and sellers.[105] Despite the complaints, it appears that water quality trading is used just as often, or even more often, than adaptive management. *See* Wis. Dep't of Nat. Res., *Adaptive Management and Water Quality Trading Project Locations*, https://dnr.wi.gov/topic/SurfaceWater/AmWqtMap.html (last visited Dec. 2, 2019). This could be because, currently, only phosphorus is eligible for adaptive management.

NEW Water is now involved in an adaptive management program with a goal to improve water quality in a selected watershed to meet the state water quality standards.[106] In 2013, it created a pilot team to test the waters of adaptive management in Silver Creek, just west of Green Bay.[107] NEW Water's Silver Creek Project uses best management practices to improve water quality and a monitoring program to provide data about the impact of these practices.[108] "By planting cover crops, installing grassed waterways, and greening up shores with buffer strips, New Water has prevented 689 pounds of phosphorus and 2,270,000 pounds of sediment from entering area water-ways."[109] Through this program, NEW Water is exploring the feasibility of banking credits to be used in the future.[110]

Idaho Example

Idaho's 2016 WQT program emphasizes scientific foundation and accountability and uses adaptive management principles.[111] Trading must be memorialized in the NPDES permit and account for effectiveness through trading ratios and other mechanisms.[112] Credit quantification requirements are not specific, but they must be "designed and managed in a consistent manager" to ensure watershed results.[113] Credit life is project-specific, must be tied to science, and cannot be banked.[114] The program requires a consistent and reliable watershed monitoring program aside from the already required point source monitoring.[115] Verification of nonpoint sources should be conducted by third-party organizations.[116] Each permit application for trading credits should include an adaptive management portion that addresses how to improve the science, operation, and effectiveness of the pollution reducing activities over time.[117]

Idaho's Lower Boise River Implementation Plan for total phosphorus allows pollutant trading pursuant to Idaho's Water Quality Standards.[118] The trades must be implemented so that the overall water quality of the watershed covered by the TMDL is protected.[119] The plan requires a period of adaptive management marked by focused monitoring.[120] The adaptive management strategy allows on-the-ground implementation to proceed even where uncertainty exists about how and when reduction targets will be met.[121] It provides for focused monitoring at four levels (*see* sidebar) to: evaluate the effectiveness of various BMPs; fill data gaps at different reaches; and enlarge understanding of changes and trends in the system.[122] Monitoring is to occur at the mouth of key tributaries to assess "how well nonpoint source improvements are performing."[123] Idaho's Lower Boise plan has been described as an adaptive management approach that generates the necessary information to better effectuate the WQT.[124] As of 2017, water quality monitoring of the river showed phosphorus reduced by one-third.[125]

2008 Lower Boise Implementation Plan Monitoring

THE PLAN STATES THAT MONITORING SHOULD TAKE PLACE AT FOUR LEVELS:

1. SR-HC Reach. IDEQ has committed to monitoring this reach as stipulated in the SR-HC TMDL. In addition to the conditions stipulated in the SR-HC TMDL, an equally important monitoring objective is to assess whether beneficial uses are being attained, especially as related to the phosphorus loading and progress toward the target.
2. Lower Boise River Reach. Continued monitoring at key monitoring locations in the lower Boise River (Glenwood, Middleton, and Parma) and at the mouth of key tributaries will provide an indication of how well nonpoint source improvements are performing.
3. BMP Effectiveness Monitoring. Monitoring will be focused on evaluating specific treatment to verify BMPs are properly installed, maintained, and working as designed; evaluating the effectiveness of implementation actions for reducing pollutant loading; gathering information to fill data gaps; and making effectiveness monitoring results available to the public.
4. NPDES Permit Monitoring. Monitoring will be conducted to comply with WWTF discharge limits and municipal separate storm sewer system (MS4) requirements not addressed above.

Water Quality Trading

California Example

The Laguna Water Quality Trading Project will be an important project to watch in part because it was recently implemented (2018) and incorporates many of the new EPA principles. The Laguna de Santa Rosa watershed is the largest freshwater wetlands complex on the northern California coast and the largest tributary to the Russian River.[126] The City of Santa Rosa (City) owns and operates the Santa Rosa Subregional Water Reclamation System, which is permitted to discharge into the Laguna de Santa Rosa or Santa Rosa Creek on a seasonal basis.[127] The Town of Windsor owns and operates the Windsor Wastewater Treatment, Reclamation and Disposal Facility that discharges into the Mark West Creek, a primary sub basin of the watershed.[128]

Nutrient Offset

In 2006, due to nutrient levels that exceeded water quality standards in the Laguna de Santa Rosa and an apparent lack of assimilative capacity for additional nutrient loads, the Regional Water Board adopted "no net loading" final effluent limitations for total nitrogen and phosphorus into a NPDES permit.[129] One of the compliance options was to use "off-site nutrient load reductions" carried out according to an approved nutrient offset program.[130] In 2008, the City worked with the Regional Water Board staff to develop the Santa Rosa Nutrient Offset Program, which gives the City the option to offset its nitrogen and phosphorus discharges by conducting work that either prevents or removes equal (or greater) amounts of these nutrients from unregulated sources elsewhere in the Laguna watershed.[131] It implemented three nutrient offset projects, and offset nitrogen and phosphorus discharges consistent with the "no net loading" limitations in its NPDES permit. The first project involved sediment reduction on unpaved roads.[132] Improvements in water quality and fisheries were linked to the reductions in phosphorous.[133] Second, dairy farmers: improved a livestock crossing area to avoid contact with surface water; reconfigured a pasture and installed changes in fencing to keep a heavy use area away from the stream; and installed a concrete area to handle solids from manure ponds.[134] Third, another dairy site was closed and the City paid to remove big manure ponds that were a threat to water quality.[135] The City was able to obtain credits that more than covered all of their reduction needs. The trading program also allowed for credit banking and the City was able to start banking credits to cover future discharge.[136]

Three Projects

Banking Allowed

Framework (Expansion)

The NPDES permit for the Laguna de Santa Rosa watershed was renewed in 2013.[137] At that time, the nutrient-trading scheme did not apply to the Town of Windsor (Town). Through a three-year process, local stakeholders for the Town put forth recommendations for WQT in the watershed.[138] The Regional Water Board then created the Laguna Water Quality Trading Framework (Framework) for the Santa Rosa Watershed, which accommodated the stakeholder recommendations, considered the terms of the NPDES permit, and promoted consistency between the new trading scheme and the City's nutrient offset program.[139] The resulting Framework was a revised and expanded version of the Santa Rosa Nutrient Offset Program. The Framework was designed to maximize the environmental benefits derived from the expenditure of limited funding.

Framework elements included:

- Expanding the use of nutrient offsets as a compliance option to both the City and the Town
- Promoting restoration actions that will improve the Laguna de Santa Rosa's ability to assimilate pollutants of concern
- Testing a set of new and improved WQT framework elements that can be expanded to greater scale and effect once TMDLs for the watershed are adopted[140]

Credits' Terms

Credits developed under the program will have a one-year credit life and three- to five-year credit banking allowance. According to the plan, this accounting is appropriate because phosphorus is a non-toxic pollutant, therefore the magnitude of total phosphorus discharge is the predominant water quality concern not the timing.[141]

Trading Ratio

Section five of the Framework specifies a default trading ratio of 2.5:1, which is the sum of two factors: a 2:1 uncertainty ratio and a 0.5:1 retirement ratio.[142] The uncertainty ratio is consistent with the uncertainty ratio established by the EPA for WQT in the Chesapeake Bay watershed and used in other trading programs across the country.[143] It requires that a discharger that wishes to use a water quality credit must generate or purchase water quality credits equivalent to 2.5 times the amount of total phosphorus that it discharges.[144] The retirement ratio also adds a margin of safety to ensure that activities conducted under the Framework will result in net water quality benefits. This is consistent with the Idaho plan, but as mentioned above the Wisconsin plan does not use trade ratios. The Framework also includes incentives for developers who implement restoration actions that are large-scale, long-term, multi-benefit restoration actions. Incentives include reduced trading ratios, longer project lives, and extended credit banking allowances.[145] Unlike the more ambiguous Idaho regulations, the Framework requires that all submitted credit-quantification support describe what monitoring will occur to verify the accuracy of the claimed credits.[146]

Developer Incentives

Water Quality Trading

Baseline Requirements

"Credit Stacking"

Quantification Mechanisms

Uncertainty Barrier

Adaptation Guidelines

Nonpoint Source Baselines

"Incremental" Baseline

Water Quality Information

Aside from those mentioned above, the Framework includes several of the market-based principles outlined in the 2019 Policy Document. In the Framework, baseline requirements must "at least correspond to the minimum requirements of any applicable laws, regulatory requirements, or other affirmative obligations such as those established in permits, easements, deed restrictions, and/or other binding contracts."[147] If those requirements do not exist then baselines shall at least be equivalent to current conditions or practices at the project site, based on the prior three-year history.[148] The 2019 Policy Document encourages flexible baseline requirements and recommends that documented current conditions provide a simple and appropriate baseline.[149] The Framework also allows "credit stacking" — i.e., the generation of credits for multiple environmental markets — so long as it is accompanied by the appropriate accounting.[150] This is consistent with the EPA's guidance that a single project may generate credits for multiple markets.[151]

The Framework allows use of the following mechanisms for quantifying water credits: models that are calibrated to local conditions (mechanistic or empirical); pre-established pollution reduction rates (from experimentation or scientific literature); direct monitoring; or any combination of those mechanisms.[152] This too is consistent with the EPA guidance on adaptive management — i.e., credits should be generated based on "scientifically defensible estimates of pollutant reductions from applicable technologies and land-based practices."[153] Programs should further allow modeling and measurement methods that can evolve and improve over time.[154] The life of all credits generated under the Framework shall be one year, but, consistent with the EPA guidance, a participant may bank credits for up to five years for projects that are explicitly designed to enhance environmental values and up to three years for credits derived from all other projects.[155] This is also consistent with EPA guidance that recommends credits be bankable.[156]

CONCLUDING THOUGHTS

WQT is an effective way to improve water quality with lower overall costs. New EPA guidance recognizes that a major barrier to participation in WQT is uncertainty in reduction mechanisms and the need for flexibility and adaptability in various components of a successful WQT program. For the reasons discussed above, weighted and properly defined adaptive management principles have the potential to actualize these EPA objectives. Programs around the country have experienced success in utilizing adaptive management strategies. Further, new programs like the Laguna de Santa Rosa Watershed have provided detailed adaptive management guidelines, giving market participants more predictable expectations for how the strategies will be employed in the future. The Framework will also be a good example of how proper adaptive management implementation may lead to success in the EPA's other goals involving baseline flexibility, credit banking, and generation of credits for multiple markets. This will clearly be a program to watch in the future.[157]

Importantly, while the 2019 Policy Document takes steps in the right direction there are still un-addressed issues and possibly additional potential for adaptive management. For instance, EPA is currently seeking comment on a rule proposing a change in how to determine proper baselines for nonpoint sources.[158] The new 2019 recommendation endorses simplicity and flexibility.[159] WQT baselines operate as the basis for credit calculation. A buyer's baseline is its **w**ater **q**uality-**b**ased **e**ffluent **l**imit (WQBEL), and the buyer purchases credits to achieve that limit. A seller's baseline is the level of discharge it is otherwise required or expected to attain prior to generating credits. A nonpoint seller is expected to meet its TMDL load allocation, or if there is no TMDL, it is expected to meet any state and local requirements before it can generate credits.[160] The TMDL sets the stage for WQT, but there are many barriers throughout the process, including lengthy decision-making periods and legal challenges.[161] Further, requiring the nonpoint source to meet its TMDL before generating credits has hindered participation. The October 21, 2019 public listening session presented an "incremental baseline approach" that divides nonpoint source reductions into "(1) immediately available tradeable credits; and (2) reductions assigned towards meeting the load allocation."[162] The plan also considers whether TMDL loads should be applied uniformly or differentially to some nonpoint sources based on geography or some other basis.[163] While flexible and lower baselines may encourage more participation, a WQT must also maintain an effective cap or limit to drive the pollutant reduction.[164] Moving forward, EPA will need to reconcile these concerns and adaptive management may offer a solution.

Adaptive management could be applied to TMDL allocations by allowing a watershed to employ certain controls to move the watershed in the direction of reducing pollutant loads while also providing information on their effectiveness in improving water quality.[165] "With new knowledge, the original watershed analysis, water quality analyses, and models can be revised to update the estimates of current and future pollutant loads and the resulting water quality in the impaired water body."[166] The new information is then used to revise and modify the TMDL.[167] Previous WQT policies have not supported an application

Water Quality Trading

Ratio Uncertainty

of adaptive management to the TMDL process, but the 2019 commitment to flexibility could change that.[168] This is an area that warrants further investigation.

Finally, proper implementation of feedback gained through adaptive management could be used to reduce the uncertainty ratios employed by many WQT programs because credits could be traded with greater certainty over time. Further, a better understanding of the credits will better facilitate trading across multiple, interacting ecosystem markets and create more reliable credit banking, both of which could lead to a reduction in trading ratios. Again, these areas should be explored further. Ultimately, the 2019 Policy Objectives have the potential to lead to more WQT participation, greater ecosystem benefits, and lower costs, and, in appropriate situations, properly implemented adaptive management principles could help WQT programs implement these objectives.

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Tom Lindley: Recognized for "innovative solutions to seemingly intractable problems, Tom Lindley's "firsts" achieved for his clients include: helping to conceive and create our nation's first watershed-wide Clean Water Act permit (NPDES/MS4: included multiple sources and water quality and quantity trading); first multi-species, multi-party Candidate Conservation Agreement (ESA CCA); and first statutory Prospective Purchaser protections. From 2007-2016 Tom led and is now Of Counsel with Perkins Coie's Environment Energy & Resources National Practice Group; he has worked extensively with clients on ESA, NRD, and other ecosystem markets."

Footnotes

1. David P. Ross, Envt'l Prot. Agency, Updating the Environmental Protection Agency' s (EPA) Water Quality Trading Policy to Promote Market-Based Mechanisms for Improving Water Quality 1 (Feb. 6, 2019), [hereinafter 2019 Policy Document], available at: https://www.epa.gov/sites/production/files/2019-02/documents/trading-policy-memo-2019.pdf
2. Adaptive Mgmt. Working Grp., U.S. DOI, Adaptive Management: The U.S. Department of the Interior Technical Guide 2 (2009), www.doi.gov/sites/doi.gov/files/migrated/ppa/upload/TechGuide.pdf
3. 2019 Policy Document, *supra* note 1, at 3
4. *Id.*
5. *Market*, Business Dictionary, www.businessdictionary.com/definition/market.html (last visited Nov. 19, 2019); *see also Market*, Wikipedia, https://en.wikipedia.org/wiki/Market_(economics) last edited Nov. 19, 2019)
6. We are using the terms "ecosystem market" and "environmental market" interchangeably. There are many instances where they might differ and there are other less market-oriented systems. *See Payments for Ecosystem Services*, Ecosystem Marketplace, www.ecosystemmarketplace.com/payments-ecosystem-services/ (last visited Nov. 20, 2019)
7. *Demand and supply*, Business Dictionary, www.businessdictionary.com/definition/demand-and-supply.html (last visited Nov. 19, 2019)
8. Water trading (or water quantity trading) is the buying, leasing, and selling of water access entitlements, also called water rights. Water quantity trading is generally not involved in water quality trading because the CWA does not address water rights, but it may be involved in a voluntary agreement, for example to help address flow issues. We do not address water quantity trading in this article.
9. U.S. Dep't of Agriculture, Office of the Chief Economist, Payments for Ecosystem Services, www.usda.gov/oce/environmental_markets/services.htm (last visited Nov. 19, 2019); *see also Tragedy of the Commons*, Wikipedia, https://en.wikipedia.org/wiki/Tragedy_of_the_commons (last edited Nov. 15, 2019
10. 33 U.S.C. §§ 1251 et seq.
11. 42 U.S.C. §§ 7401 et seq.
12. 16 U.S.C. §§ 1531 et seq.
13. 42 U.S.C. §§ 9601 et seq.
14. 33 U.S.C. § 1321.
15. 42 U.S.C. § 9607.

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16. 33 U.S.C. § 2702.
17. National Park Service and Related Programs, Pub. L. No. 113-287, 128 Stat. 3094 (2014)
18. 16 U.S.C. § 1431
19. 43 C.F.R. pt. 11
20. 15 C.F.R. pt. 990
21. Mindy Selman, et al., *Water Quality Trading Programs: An International Overview*, at 2, World Res. Inst. Issue Brief, March 2009, https://wriorg.s3.amazonaws.com/s3fs-public/pdf/water_trading_quality_programs_international_overview.pdf
22. *Id.*
23. *Id.*; Nat'l Network on Water Quality Trading Dialogue, Breaking Down Barriers: Priority Actions for Advancing Water Quality Trading 6 (October 2018), [hereinafter Breaking Down Barriers], http://nnwqt.org/wp-content/uploads/2018/10/Breaking-Down-Barriers_Priority-Actions-for-Advancing-WQT.pdf
24. Selman, et al. at 2
25. Breaking Down Barriers, *supra* note 23, at 6. Image reproduced with permission. *See id*. at 2
26. *Id.* at 6
27. *See, e.g.*, Selman, et al., *supra* note 21, at 6 (discussing the Long Island Sound Nitrogen Credit Exchange Program)
28. In these situations, point sources are often controlled by NPDES or other regulatory discharge permits, while nonpoint sources are not. *Id.* at 2
29. *Id.* at 7 (discussing Lake Taupo Nitrogen Trading Program in New Zealand, which allocates nitrogen discharge to all of the farms in the area, and they can trade amongst each other to maintain compliance or expand production)
30. *Id.*
31. *Id.*
32. U.S. Envt'l Prot. Agency, Office of Water, Water Quality Trading Policy (Jan. 13, 2003), [hereinafter 2003 Policy Document], https://archive.epa.gov/ncer/events/calendar/archive/web/pdf/finalpolicy2003.pdf
33. *Id*. at 2
34. Effluent Trading in Watersheds Policy Statement, 61 Fed. Reg. 4994, 4995 (Feb. 9, 1996), www.govinfo.gov/content/pkg/FR-1996-02-09/pdf/96-2920.pdf
35. U.S. Envt'l Prot. Agency, Draft Framework for Watershed-based Trading (May 1996), https://nepis.epa.gov/Exe/ZyPDF.cgi/20001QL1.PDF?Dockey=20001QL1.PDF
36. President Bill Clinton & Al Gore, Reinventing Environmental Regulation (Mar. 16, 1995), https://nepis.epa.gov/Exe/ZyPDF.cgi/9100TH76.PDF?Dockey=9100TH76.PDF
37. 2019 Policy Document, *supra* note 1, at 2
38. 2003 Policy Document, *supra* note 32. EPA's Trading Objectives in the 2003 Policy Document (at 5) included WQT by states, interstate agencies, and tribes where trading:
    A. Achieves early reductions and progress towards water quality standards pending development of TMDLs for impaired waters
    B. Reduces the cost of implementing TMDLs through greater efficiency and flexible approaches
    C. Establishes economic incentives for voluntary pollutant reductions from point and nonpoint sources within a watershed
    D. Reduces the cost of compliance with water quality-based requirements
    E. Offsets new or increased discharges resulting from growth in order to maintain levels of water quality that support all designated uses
    F. Achieves greater environmental benefits than those under existing regulatory programs. EPA supports the creation of water quality trading credits in ways that achieve ancillary environmental benefits beyond the required reductions in specific pollutant loads, such as the creation and restoration of wetlands, floodplains and wildlife and/or waterfowl habitat
    G. Secures long-term improvements in water quality through the purchase and retirement of credits by any entity
    H. Combines ecological services to achieve multiple environmental and economic benefits, such as wetland restoration or the implementation of management practices that improve water quality and habitat
39. 2019 Policy Document, *supra* note 1, at 3
40. *See generally* 33 U.S.C.A. § 1342
41. 33 U.S.C.A. § 1344
42. 33 U.S.C.A. § 1342(a)(1); 40 CFR 124
43. 2019 Policy Document, *supra* note 1, at 2
44. *Id.*
45. *Id.* at 2-3
46. Used with permission. *See* E-mail from Mark Kieser, Senior Scientist Kieser & Associates, to Christina Bonanni, co-author (Nov. 14, 2019, 14:32 EST) (on file with authors)
47. Selman, et al., *supra* note 21, at 1
48. *Id.*
49. *Id.*
50. *See* Breaking Down Barriers, *supra* note 23, at 1
51. *Id.* at 44
52. *Id.* at 9
53. *Id.* at 5
54. *Id.* at 13
55. *Id.*
56. *Id.*
57. *Id.* at 23
58. *Id.*
59. *Id.* at 24
60. *Id.*
61. *Id.* at 25
62. *See generally* 2019 Policy Document, *supra* note 1
63. *Id.* at 1
64. *Id.* at 3

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65. *Id.* at 2-3
66. *See id.* at 1
67. *Id.* at 2
68. Water Quality Trading Under the National Pollutant Discharge Elimination System Program, 84 Fed. Reg. 49293, 49295 (Sept. 19, 2019)
69. *Id*. at 49295
70. *Id.*
71. The Envt'l Trading Network, *State Programs*, ENVTN.org, www.envtn.org/water-quality-trading/state-programs#trading-programs-at-state-level (last visited Nov. 20, 2019)
72. U.S. Envt'l Prot. Agency, *Collaboration and Partnerships, Beaver Creek Watershed Initiative (TN), EPA Region 4 - Atlanta*, https://archive.epa.gov/publicinvolvement/web/html/beavercreekwatershedinitiative.html, (last visited Nov. 20, 2019)
73. Save Local Waters, *Ohio River Basin*, www.savelocalwaters.org/ohio-river-basin.html (last visited Nov. 20, 2019)
74. 2019 Policy Document, *supra* note 1
75. The Nat'l Academies Press, Achieving Nutrient and Sediment Reduction Goals in the Chesapeake Bay: An Evaluation of Program Strategies and Implementation 100 (2011), www.chesapeakebay.net/channel_files/21727/2011_nas_report.pdf
76. *Id.*
77. *Id.*
78. Melissa K. Scanlan, *Adaptive Trading: Experimenting with Unlikely Partners*, 62 Kan. L. Rev. 971, 986 (2014)
79. Adaptive Mgmt. Working Grp., *supra* note 2 at 2. While this article discusses the potential of adaptive management on a large scale compared to the broad goals of the 2019 Policy Documents, there are clearly some circumstances that will be more amenable to adaptive management strategies than others. The recommendation and analysis here are based on those situations that involve enough uncertainty that employing these strategies would lead to effective improvement.
80. Scanlan, *supra* note 78, at 98
81. *Id.* at 988
82. *Id.*
83. Wis. Dep't of Nat. Res., Adaptive Management Technical Handbook 8 (2013), https://dnr.wi.gov/topic/surfacewater/documents/AdaptiveManagementHandbooksigned.pdf
84. *Id.* at 10
85. *Id.* at 15
86. *Id.*
87. *Id.* at 15, 19
88. *Id.* at 15
89. *See, e.g.*, *Yahara Wins*, www.madsewer.org/Programs-Initiatives/Yahara-WINs (last visited November 19, 2019); Chuck Quirmbach, *EPA Gives Green Light to Revision of Wisconsin Phosphorus Plan*, WisCONTEXT (Feb. 7, 2017), www.wiscontext.org/epa-gives-green-light-revision-wisconsin-phosphorus-plan
90. Am. Farmland Tr., Handbook for Conservation Districts on Environmental Markets: Case Studies 45-47 (Jan. 2018), at 17; www.nacdnet.org/wp-content/uploads/2018/02/AFT-NACD-Environmental-Markets-web-final.pdf
91. *Id*.
92. *Id.*
93. Wis. Dep't of Nat. Res., Adaptive Management Technical Handbook: A Guidance Document for Stakeholders 10 (Jan. 7, 2013) [hereinafter Technical Handbook]
94. *Id*.
95. *Id*.
96. *Id*. at 19
97. *Id*.
98. Wis. Dep't of Nat. Res., *Water Quality Trading*, https://dnr.wi.gov/topic/surfacewater/waterqualitytrading.html (last visited Dec. 2, 2019)
99. Wis. Dep't of Nat. Res., Adaptive Management, https://dnr.wi.gov/topic/SurfaceWater/adaptivemanagement.html (last visited Dec. 2, 2019)
100. Technical Handbook, *supra* note 93, at 11
101. *Id*.
102. *Id*. at 15
103. Am. Farmlands Tr., *supra* note 90, at 19
104. Technical Handbook, *supra* note 93, at 15
105. Chris Lewis, *Building Demand in U.S. Water Quality Trading Markets*, Conservation Fin. Network, Sept. 25, 2019, at 4, www.conservationfinancenetwork.org/2019/09/25/building-demand-in-us-water-quality-trading-markets
106. Am. Farmland Tr., *supra* note 90, at 19
107. US Water Alliance, *NEW Water the Brand of the Green Bay Metropolitan Sewerage Dist*, One Water Spotlight, (November 2017), http://uswateralliance.org/sites/uswateralliance.org/files/uswa_spot_nov17_112717_a.pdf
108. *Id*.
109. *Id*.
110. Am. Farmlands Tr., *supra* note 90, at 19
111. Idaho Dep't of Envt'l. Quality, Water Quality Trading Guidance 20 (Oct. 2016), www.deq.idaho.gov/media/60179211/water-quality-trading-guidance-1016.pdf
112. *Id.* at 5
113. *Id.* at 5-6
114. *Id.* at 6
115. *Id.*
116. *Id.*
117. *Id.* at 11
118. *See* Lower Boise Watershed Council & Dep't of Envt'l Quality, Lower Boise River Implementation Plan Total Phosphorus 53 (Dec. 2008), www.deq.idaho.gov/media/451497_water_data_reports_surface_water_tmdls_boise_river_lower_lbr_total_phosphorus_plan_final.pdf

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119. *Id.* at 54
120. *Id.*
121. *Id.* at xxii
122. *Id.* at xxiii
123. *Id.*
124. Scanlan, *supra* note 78, at 992-93.
125. Lauren Perreault, *Monitoring Show Progress Towards Reducing Boise River Phosphorus Levels,* Boise River Enhancement Network, Sept. 25, 2017, www.boiseriverenhancement.org/monitoring-shows-progress-towards-reducing-boise-river-phosphorus-levels/. However, new entities have had a difficult time setting up certain remediation projects that require attaining new water rights because the Idaho Department of Water Resources requires a demonstration that the remediation will reduce the water phosphorus levels by 70%. Conversation between Janet Howe and Erika Malmen, Nov. 14, 2019
126. Cal. Reg'l Water Quality Control Bd. N. Coast Region, Resolution No. R1-2018-0025 Approving The Water Quality Trading Framework for the Laguna de Santa Rosa Watershed Sonoma County (July 11, 2018) [hereinafter Resolution], www.waterboards.ca.gov/northcoast/board_decisions/adopted_orders/pdf/2018/18_0025_Laguna_WQT_Resolution.pdf ; Am. Farmland Tr., *supra* note 91, at 33
127. Resolution, *supra* note 126, at 2
128. *Id.*
129. *Id.*
130. *Id.*
131. *Id.*
132. *Id.* at 3
133. *Id.*
134. *Id.*
135. *Id.*
136. *Id.* at 7
137. *Id.* at 3
138. *Id.* at 10
139. *Id.* at 4
140. *Id.* at 4-5
141. *Id.* at 6-7
142. *Id.* at 7
143. *Id.*
144. Cal. Reg'l Water Quality Control Bd. N. Coast Region, Water Quality Trading Framework for the Laguna de Santa Rosa Watershed 12 (July 11, 2018) [hereinafter Framework], www.waterboards.ca.gov/northcoast/board_decisions/adopted_orders/pdf/2018/18_0025_Laguna_WQT_Framework_approved.pdf
145. Resolution, *supra* note 126, at 7
146. Framework, *supra* note 144, at 7
147. *Id.* at 10
148. *Id.*
149. 2019 Policy Document, *supra* note 1, at 4
150. Framework, *supra* note 144, at 11
151. 2019 US Policy Document, *supra* note 1, at 5
152. Framework, *supra* note 144, at 12
153. 2019 Policy Document, *supra* note 1, at 4
154. *Id.*
155. Framework, *supra* note 144, at 14
156. 2019 Policy Document, *supra* note 1, at 4
157. Administrators of the Laguna de Santa Rosa watershed and the Framework were contacted but declined to comment on progress of the Framework at this time.
158. Original comment was due on Nov. 18, 2019, but the period has recently been extended to Dec. 18. E-mail from Amelia Letnes, Office of Wastewater Management, EPA, to Participants to October 21, Water Quality Trading Listening Session (Nov. 15, 2019 10:17 EST) (on file with authors)
159. 2019 Policy Document, *supra* note 1, at 4
160. U.S. Envt'l Prot. Agency, *Nat'l Pollutant Discharge Elimination System Frequently Asked Questions About Water Quality Trading*, www.epa.gov/npdes/frequently-asked-questions-about-water-quality-trading (last updated July 8, 2016)
161. Breaking Down Barriers, *supra* note 23, at 27
162. U.S. Envt'l Prot. Agency, Water Quality Trading Listening Session Presentation Slides 10 (Oct. 21, 2019), www.epa.gov/sites/production/files/2019-11/documents/water_quality_trading_under_npdes-listening_session_slides_0.pdf
163. *Id.* at 13 (this is referred to as disaggregation)
164. *See* Sara Walker, *After 15 Years, EPA Updates Water Quality Trading Policy. It Could Do More*, World Res. Inst. Blog, Feb. 22, 2019, www.wri.org/blog/2019/02/after-15-years-epa-updates-water-quality-trading-policy-it-could-do-more. These are issues to consider, as EPA moves forward in the comment process (noting the consensus that EPA's traditional regulatory programs must serve as the "regulatory driver[s]" of WQT); U.S. Envt'l Prot. Agency, Transcript, Water Quality Trading Under the Nat'l Pollutant Discharge Elimination System Listening Session Conducted by Christy Williams 32 (Oct. 21, 2019), www.epa.gov/sites/production/files/2019-11/documents/water_quality_trading_under_npdes-listening_session_transcript.pdf (public participant stating that there has to be a cap or TMDL or WQT will not work); *id.* at 48 (public participant noting the need to maintain "some degree of TMDL," but it should be a more flexible baseline)
165. The Nat'l Academies Press, *supra* note 75, at 119
166. *Id.* at 118
167. *Id.*
168. *Id.* at 119 (noting that previous guidance only applied adaptive management to the actual pollutant reduction activities and would only consider TMDL adjustments if there is new scientific understanding of the effects of climate change during the mid-course assessment)

Dust-on-Snow

Snowpack

Albedo Reduction

Bellwether

Climate Stations

High Elevation

DUST-ON-SNOW

IMPACTS ON SNOWMELT & STREAMFLOW

by Jeff Derry, Center for Snow and Avalanche Studies (Silverton, CO)

Introduction

In the Western United States, 70–80% of annual stream discharge originates from snowmelt. Colorado is a headwaters state. Most major rivers originate in the high Rocky Mountains and collectively account for 70% of Colorado's surface water. Mountain environments are known as responsive indicators of global and regional climate change. Mountain environments are warming at nearly twice the rate of lowland areas. Studies have shown that winters are warmer, we are receiving less snow, and the snowpack is melting earlier. The Intergovernmental Panel on Climate Change (IPCC) approved on September 24, 2019 its *Special Report on Ocean and Cryosphere in a Changing Climate* including implications for the mountain of the West, and these trends are expected to continue and worsen, affecting storage and delivery infrastructure. (*Report* available at: www.ipcc.ch/srocc/home/).

In addition to the influence of climate change, dust-on-snow events can have substantial effects. Because of the reduction of snow surface albedo (reflectance), these events can: advance snowmelt timing up to 50 days earlier; enhance snowmelt runoff intensity; and decrease snowmelt yields. The result is peak runoff is on average three weeks earlier than normal, with an estimated 5% reduction of annual streamflow in the Colorado River Basin. The movement of dust around the West has increased 300% in the last two decades alone with no signs of abating.

This article discusses the growing problem of dust-on-snow. It also covers efforts by the Center for Snow and Avalanche Studies (a Colorado non-profit) and it's Colorado Dust-on-Snow Program to monitor the high mountains for long-term climate driven changes as well as impacts from dust-on-snow on snowpack and water resources.

Center for Snow & Avalanche Studies and the Senator Beck Study Basin

Climate change researchers around the world have recognized mountains as a sensitive bellwether of global and regional change. In response, Center for Snow and Avalanche Studies was founded in 2003 to foster new research on snowpack processes and to monitor for and detect climate-driven and other changes in regional mountain snow environments. In that same year our high alpine Senator Beck Study Basin (SBB), located in the Western San Juan Mountains between the towns of Silverton and Telluride, was established. SBB is strategically located to enable monitoring and understanding of Upper Colorado River Basin (Upper CRB) warming, drought, dust-on-snow, and changes in precipitation phase. SBB is a vital science asset for: advancing snow research; development and validation of remote sensing technologies; improving hydrologic models; and informing water managers coping with year-to-year water supply variability and recently emerging system forcings.

Highlights of our activities include:

- **Monitoring:** Long-term climate and snowpack monitoring with our three climate stations, stream gauge and intense manual snow data collection. Our highly instrumented climate stations collect the entire energy budget of the snowpack — all incoming and outgoing radiation — necessary to understand affects of dust-on-snow, snowmelt, and to facilitate hydrologic modeling. Three climate stations in the Upper CRB collect this suite of information: two are located in SBB and one is located on Grand Mesa near Grand Junction. SBB is located at the headwaters of three major watersheds: the Uncompahgre which is a major tributary to the Gunnison River; the Animas River, a major tributary of the San Juan River; and the San Miguel River, a major tributary to the Dolores River, all of which are tributaries to the Colorado River. SBB is also approximately12 miles from the Rio Grande Basin.

  The high elevation of SBB (11,030' - 13,510') also distinguishes it from other experimental watersheds. The SNOTEL station network in Colorado that measures snow water equivalent of the snowpack is located in a relatively narrow band of elevation around 10,000' elevation. Given that approximately 50% of streamflow in the Upper CRB is generated above 10,000', this fact highlights the importance of monitoring higher elevations. Our snowpack and streamflow data are especially valuable when SNOTEL stations "go blind," or melt out, and there are no longer ground measurements to base streamflow estimations from the high alpine areas the remainder of melt season.
- **Hosting Interdisciplinary Research:** Much of present day research concerning snow comes out of SBB. For example, we hosted NASA's efforts to develop a snow sensing satellite, called SnowEx, in 2016 and will do so again in 2020. Other scientists in SBB are developing new snow measurement

Dust-on-Snow

Vulnerable Ecosystem

Colorado Water Plan

Dust Source

Development Disturbance

instrumentation, some are investigating the influence of dust on the microstructure of snow, and other folks are looking at the presence of microbes in the dust/snow and its impact on the ecosystem. A full list of publications out of SBB are available on our websites, codos.org/#lit and https://snowstudies.org/.

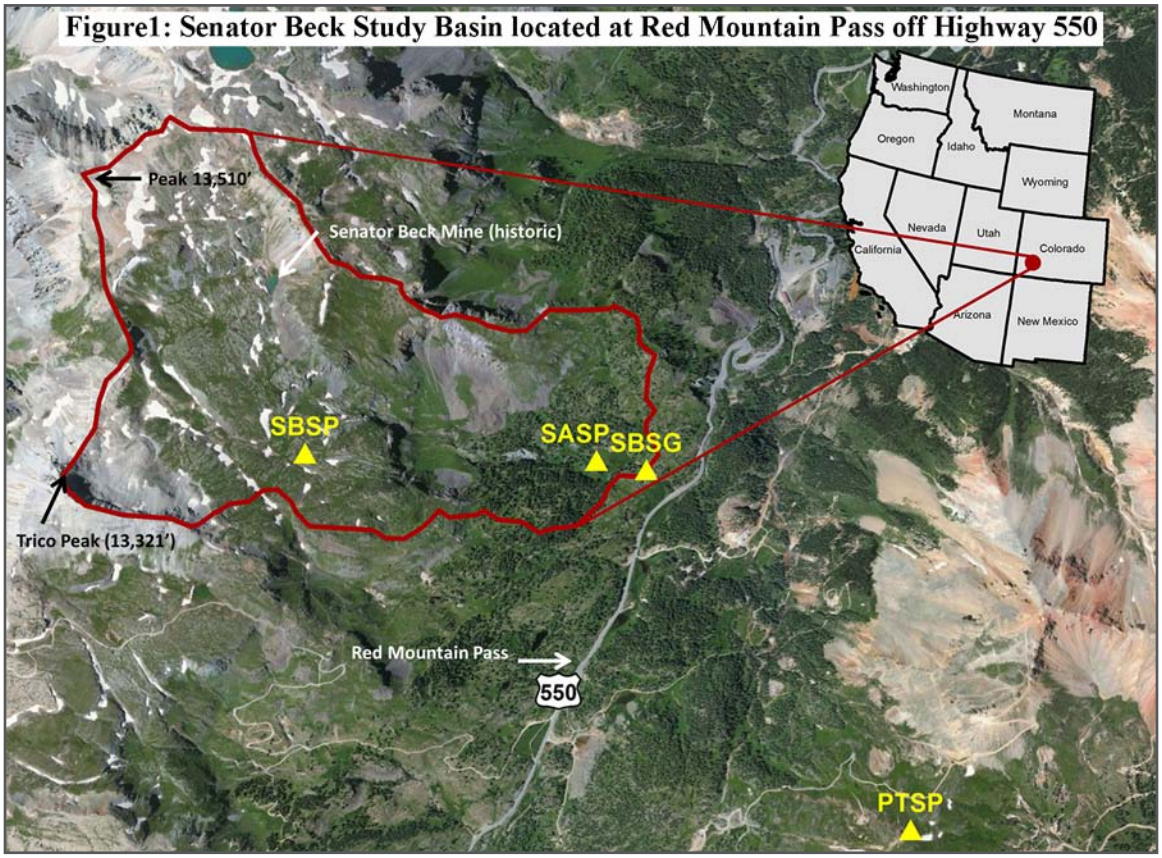
- **Long-Term Ecological Studies:** Seasonal snow amount and distribution greatly influences vegetation composition, abundance, and distribution. Alpine areas are considered one of the most vulnerable ecosystems in the face of climate change, yet there are very few sites with quantitative observations, complimented with climate and snowpack data, like exist in SBB.
- **Colorado Dust-on-Snow Program:** The Center for Snow and Avalanche Studies (CSAS) operates the Colorado Dust-on-Snow Program, an applied science program for stakeholders in the Upper CRB. Dust-on-snow is identified in the Colorado Water Plan as a major problem for reasons detailed below. (*See* www.colorado.gov/cowaterplan).

Background

This story starts not in Colorado, but in the desert Southwest. Specifically the Southern Colorado Plateau, encompassing the area of northwest New Mexico, Northern Arizona, and southeast Utah. This is the dust source area for the majority of **d**ust-**o**n-**s**now (DOS) events that occur in Colorado. Multiple lines of evidence demonstrate that disturbance of most dryland soil surfaces increases dust production both locally and regionally. While dryland soils are often relatively stable when intact, disturbances caused by recreational vehicles, energy exploration, grazing, increasing aridity, fire, and plowing, can increase sediment movement by up to several orders of magnitude, in some cases as much 40-fold. Dust emission and recovery is governed by the interaction of aridity, vegetation, soil stability, and land use.

The migration of settlers of European descent into the western US led to widespread expansion of grazing, mining, and agricultural activities in the 19th and 20th centuries. In the period following the development of railroad lines (and heavy transport capabilities for livestock) in the late 1860s, cattle and sheep grazing greatly intensified across the Western US. In the Navajo Nation tribal lands to the south and southwest of the San Juan Mountains, high-animal densities and impacts of overgrazing became a major issue by the early 1890s. By the early 1930s, two thirds of the land area in NE Arizona had been significantly disturbed by heavy livestock use. Overall, nearly 70% of the natural ecosystems of the western US have been affected by livestock grazing, resulting in the loss of soil stability and increases in wind erosion of soil.

Figure1: Senator Beck Study Basin located at Red Mountain Pass off Highway 550



Dust-on-Snow

Grazing Impact

Looking at high alpine lake sediment cores in Colorado, dust loading increased 500% with the arrival of large livestock herds and intensive agriculture at lower elevations of the western United States in the mid- to late-1800s. The extensive degradation of western US rangelands led to the Taylor Grazing Act of 1934 that imposed regulations and restrictions on grazing activities in these rangelands. As a result, dust production fell roughly a quarter as seen in lake-core samples over predisturbance accumulation amounts, coincident with a reduction in numbers of grazing animals.

Deposit Timing

During a typical winter season as storms track through this region there is potential — dependent on such factors as severity/direction of wind and soil moisture — to entrain dust and carry it towards Colorado. As the wind encounters the Colorado mountains it begins to deposit the dust on the landscape. Storms that track out of the Southwest are more common and typically more severe (and when soil conditions may be drying with approaching summer) going into the spring months of March, April, and May, as this is when we document the vast majority of DOS events. This timing is unfortunate since peak snow accumulation occurs around the April 1st timeframe, depositing the dust near/at the surface of the snowpack.

Dust Deposition

CSAS is the only entity that monitors DOS conditions on an operational basis for the water community, researchers, and stakeholders. SBB is the primary sentry site for the Colorado Dust-on-Snow Program (CODOS). Located in Southwest Colorado, it is situated in the first major mountain system downwind of the desert Southwest, making it the mountain range hit first and hardest by most DOS events. Hence, it is well-placed to monitor dust deposition on the Colorado snowpack. The CODOS program is a state-wide effort, with 11 monitoring sites throughout Colorado to assess DOS conditions and report on local snowmelt and streamflow impacts to a particular watershed.

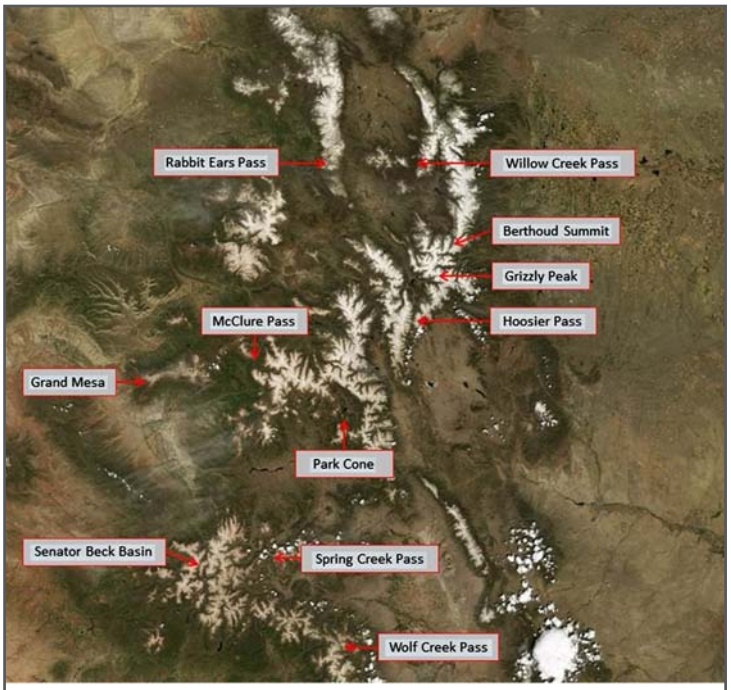


Figure 2: Arial image of CODOS sample locations.
Senator Beck Basin is our "sentry" site for DOS monitoring.
Note cleaner, more reflective snow surface north-to-south.
Southern mountains are first and hardest hit by storms containing dust.

Dust Effects on Snowmelt

Solar Radiation

The affect of DOS is dramatic. After a snow storm, typically the result is a clean, bright snow surface making us reach for our sunglasses to protect our eyes from the bright sun rays being reflected off the surface. Then in a few days after the snow grains naturally degrade, impurities have blown onto the snow surface or become exposed from underneath the surface, we notice the snow surface to be not as white and reflective. What we are witnessing is the change from a high albedo, or high reflective, to a low albedo (low reflective) snow surface. A high albedo snow surface reflects upwards to 90% of solar radiation back into space. A low albedo snow surface reflects around 30%-70% solar radiation back into space, with the rest absorbed into the snow contributing towards warming and melting the snowpack. This is significant because in Colorado solar radiation accounts for nearly all of the energy that goes towards melting the snow — as opposed to air temperature, which is a common misconception.

Low Reflective Surface

Figure 3: Snow-on-Dust-on-Snow
Every picture tells a story. A clump of snow fallen from the tree canopy rests on a dust-laden snow surface. The clean clump of snow is elevated — illustrating the different melting rates of clean and dust-laden snow.

USDA/NRCS National Engineering Handbook
Part 630 Hydrology

Chap. 11 - Snowmelt

Table 11-1
Relative Importance of Energy Balance Terms

'Heat' Term	%ΔH
SW Rad, LW Rad	60-90%
Sensible, Latent	5-40%
Ground	2-5%
Precipitation	0-1%

Figure 4. Snowmelt Energy Balance
In a continental radiative snow climate, such as Colorado, the vast majority of snow-melting energy comes from solar radiation.

This is the process that takes place across our mountain landscape when DOS occurs. A typical snow season involves hopefully many storms depositing snow in the Colorado mountains. Storms that track through a dust source area prior to entering Colorado may contain dust. It might be diffuse, intermixed with the new snow accumulation and therefore hard to see. Or it may be a definitive discreet layer, deposited just prior to snowfall on the leading edge of the storm. As the winter progresses the dust gets buried under a fresh blanket of snow. But when the dust layer nearest the surface is exposed on the surface from a lack of snowfall or spring melt, it increases the absorption of solar radiation and warms/melts the snowpack faster than it would have otherwise. This dust layer accelerates snowmelt down to the next dust layer. Since dust coalesces at the surface of the snow, the two dust layers merge at the surface and decrease albedo further, melting the snow even faster. And so on and so forth, with each dust layer merging at the snow surface with previous layers it keeps getting darker, absorbing more and more solar radiation.

The overall effect this has is making the snowpack melt earlier in the season and faster. How much earlier? Just considering dust forcing alone, depending on the number and severity of DOS events the snowpack melts 24 days early in milder dust seasons and up to 50 days early in high dust seasons. This early melt is largely *independent* of climate change, meaning the dust makes the snow melt faster in these modeled analyses, but climate change induced factors can affect soil stability in drylands and make dust storms more likely. Some studies have indicated that dust deposition increases with regional climate warming.

Dust impacts on the duration of snow cover, as well as the impacts of the dust itself, can have large effects on alpine ecosystems. Reduced snow cover duration affects plant phenology, soil processes, and fire regimes. Since stream discharge is earlier and more compressed, the result is reduced streamflow in latter summer causing increased water temperatures and stresses to aquatic life. Impacts from the dust itself can effect phenology, soil texture and processes; increase snow pH, conductivity, and ion concentration; and increase alpine lake nutrient loads by twofold to threefold. To try to understand the source and influence of dryland dust in the mountain ecosystem CODOS maintains a close relationship with the United States Geological Survet (USGS) and other researchers. CODOS collects dust samples from individual events as well as end-of-season concentrated totals for lab analyses that identify the mineral, microbe, and nutrient composition.

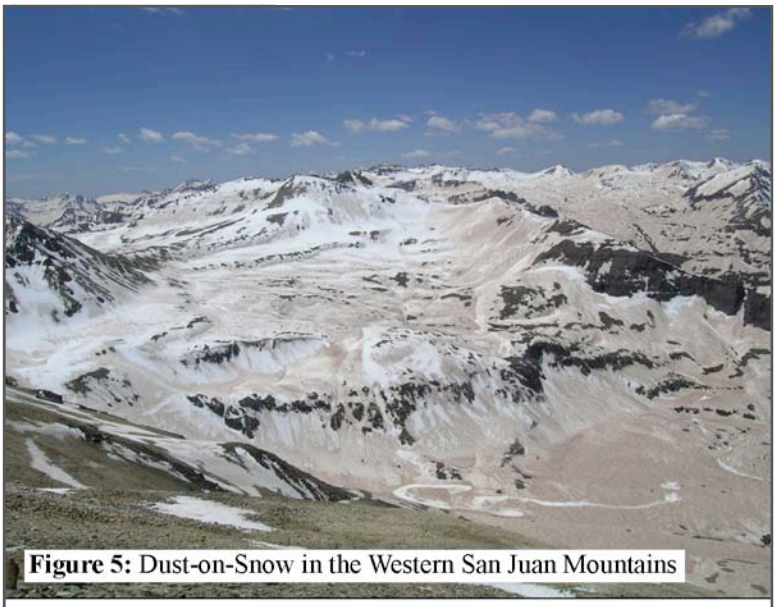


Figure 5: Dust-on-Snow in the Western San Juan Mountains

Figure 6: Storm bringing dust to Colorado. Main Street, Silverton

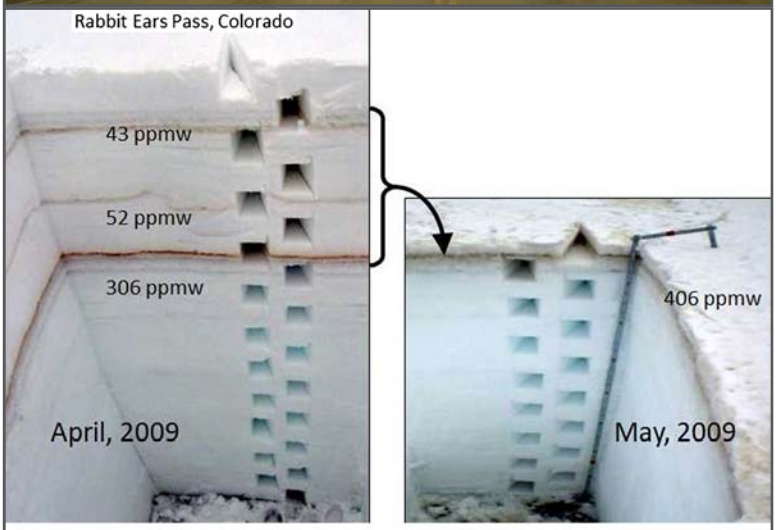


Figure 7: Impurities are strongly dominated by dust, which resist scavenging by liquid water and so coalesce on surface. Dust concentrations are linearly related to number of days of advanced melt. (Skiles & Painter, 2016)

Streamflow Response

The overall affects of DOS on streamflow are striking. Measured reductions in snow albedo have advanced Colorado snowmelt by one month on average and resulted in a higher amplitude and shorter duration hydrograph. One study looking at pre- and post-disturbance impacts of dust on albedo in the Upper Colorado River Basin across 1916-2003 found peak runoff at Lees Ferry, Arizona, has occurred on average three weeks earlier.

It would be a grave mistake to think that this is solely an Upper Colorado River Basin problem. [Editor's Note: The Upper Colorado River Basin is composed of the states of Colorado, New Mexico, Utah and Wyoming. The obligations for the Upper Basin to deliver water to Lower Basin states (Nevada, California and Arizona) are quantity specific — as long as water is delivered in the amounts required under the 1922 Colorado River Compact and various "Law of the River" agreements, their obligations are satisfied. *See* MacDonnell & Castle, *TWR* #167]. DOS can reduce the overall volume of water available for downstream users. As mentioned above, studies have shown DOS can melt the snowpack up to 50 days sooner, shortening snow cover duration. This accelerated melting exposes vegetation and soil earlier in spring. This means early season plant transpiration and increased evaporation from soils suck water into the atmosphere, water that would normally make its way into the streams and rivers. Early evapotranspiration of plants and soils decreases annual runoff in the Upper Colorado River Basin by 5% of the annual average. That's a lot of water — more than 250 billion gallons — enough to supply the Los Angeles region for 18 months. As the recently completed Drought Contingency Plans for the Upper and Lower Colorado River Basins highlight, less flows in the Colorado River will force all of us to make do with less. *See* Kowalski & Snyder, *TWR* #179 regarding Drought Contingency Plans for the Upper Basin and Lower Basin.

Dust-on-snow is a problem presenting additional complexities and uncertainties into managing water supplies. When, where, and how fast the snow melts determines streamflow response. Every winter season the snowpack amount and distribution is unique and every season the severity and location of dust across the mountain landscape and within the snowpack is unique. But each spring the variation in the Colorado snowmelt-dominated runoff hydrograph is controlled by dust radiative forcing. Dust on the surface reduces albedo, absorbs more solar radiation, and causes increased snowmelt rates resulting in an increase in streamflows. If dust gets covered by new snow accumulation and is beneath the snow surface (or non-existent) then snowmelt rates are lessened. If you view a graph of albedo (the ratio of incoming versus reflected solar radiation), you can determine what streamflow response to expect. If albedo goes up, streamflow goes down, and if albedo goes down, streamflow goes up. During a typical spring it is usually an interplay of dust exposure and weather. If it is a wet spring with regular snowfall this clean new blanket of snow provides an "albedo reset" — temporarily restoring a high albedo and hence reducing streamflows. If spring conditions are dry then when dust is exposed, it stays exposed, contributing to sustained spiking

Figure 8: May 2009 at Swamp Angel study site in SBB. Particurlarly bad Dust-on-Snow year.

streamflows. Colorado's recent back-to-back extreme winters illustrate this very well. In 2018, a very dry winter meant a very low snowpack. That spring dust quickly was exposed to the surface, and, because it was also a very dry spring, this accelerated snowmelt to where the snowpack melted at least a month earlier than normal and most rivers reached peak discharge the first half of May.

In contrast, in 2019 we had a lot of precipitation and large snowpack going into spring. These conditions continued throughout spring, not only adding to the snowpack but also providing regular "albedo resets" that kept the dust covered with a clean and highly reflective surface, resulting in a nice slow melt season that allowed streams to not get overwhelmed all at once with rapid snowmelt. In 2019 full snowmelt was approximately two weeks later than normal and many rivers peaked around June 10 but many others peaked around July l. Both years were similar in terms of the number and severity of dust layers but spring conditions greatly influenced its exposure and the roll it played in snowmelt.

Putting this into context is crucial. Knowing the magnitude and timing/intensity of snowmelt runoff requires knowing snow water equivalent *and* snow albedo. In other words, if you just want to get an idea of how much water is held in the snowpack you look at SNOTEL data, snow course data. Or you might be fortunate enough to afford LIDAR airborne measurements provided by the Airborne Snow Observatory that, when flights are done near peak snow accumulation, can provide an extremely accurate estimate of snow water volume. If, however, you want to know the timing and rate of snowmelt, you need to know the snow albedo, which is largely controlled by dust on the snow surface. The mountain snowpack is a natural reservoir. The consequences of earlier and faster snowmelt is water must sometimes be quickly passed through storage reservoirs, lessening water supply during the hottest parts of summer when water is most needed. Water managers need to know timing and rates to maximize storage, power generation, safe operations, and allocation of water.

The CODOS Program provides regular updates that contain near real-time observations and assessments on how dust will effect snowmelt and subsequent streamflows to water managers (i.e. Bureau of Reclamation, other reservoir operators, state engineers, ditch operators, municipalities, state and federal agencies), recreationalists, local community, and forecast centers (i.e. NRCS, Colorado Basin River Forecast Center). This information is an important tool of a suite of tools that the water community incorporates into their water management decision-making process.

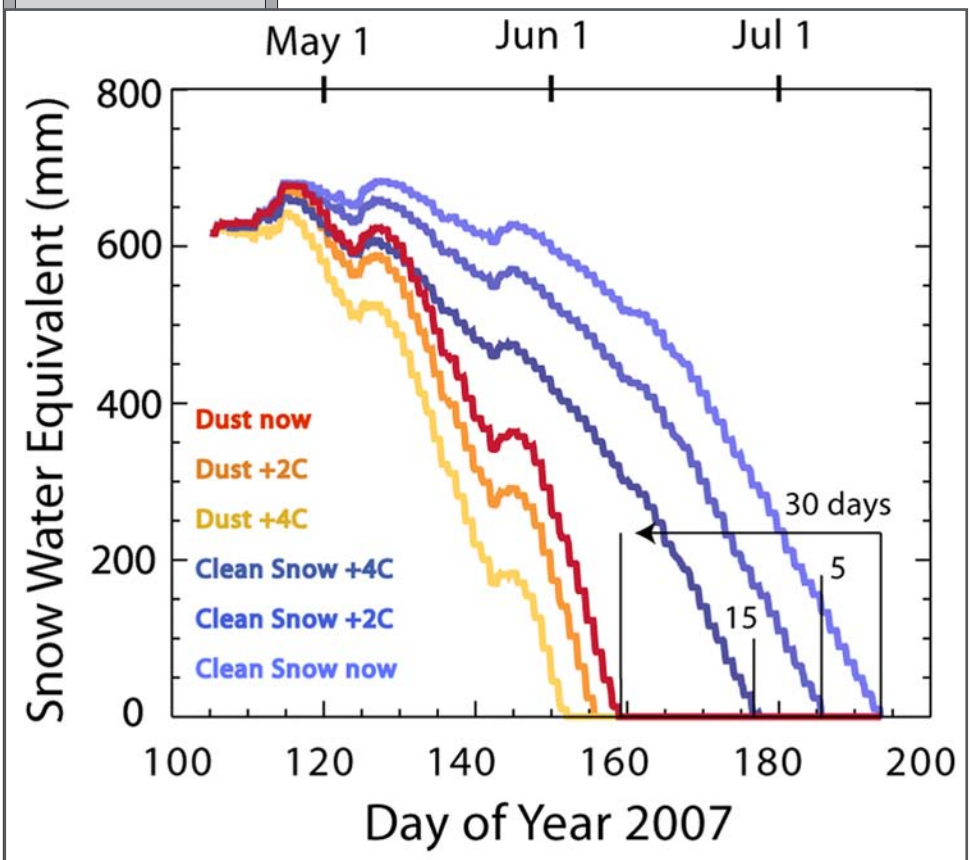


Figure 9: One study modeled snow ablation as it really happened with influence of DOS (red line). Then it tracked snow ablation as if there was no DOS (light blue line). Climate change scenarios (+2C and +4C) were also modeled. This was done for multiple years. The above example shows snow abaleted 30 days earlierr (average for the study). A climate change scenario shows ablation occuring earlier, though not as much as dust forcing alone.

Adapted from: Skiles, et al., (2012), *Dust Radiative Forcing in Snow of the Upper Colorado River Basin*:2. Water Resources Res., 48, W07522. doi:10.1019/2012WR011986.

Dust-on-Snow

Multiple Demands

Managing Flow

Informing Operations

Temperature Variable

Adjustment for DOS

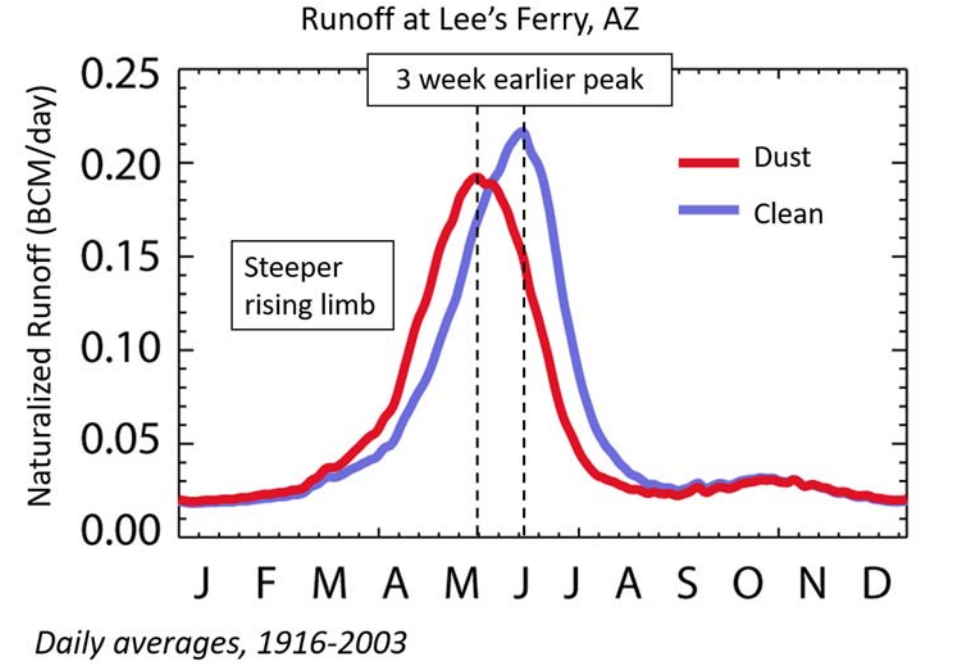
Field Operations

A clear example of the importance of SBB's station data and DOS observations was illustrated in the big snow year of 2019. DOS observations informed multiple operations. There was plenty of water held in the snowpack, but the challenge was to effectively manage flows in the face of multiple demands such as maximizing reservoir storage, maintaining environmental flows at certain thresholds, and sustaining flows for boaters. All of these demands required knowing when and how much water would be coming down the streams. By closely tracking the albedo with our climate stations, dust presence and emergence through our manual snow profiles, and our high elevation stream gauge observations, we were able to contribute to a very successful season. Our daily communications with water managers kept them abreast of what was happening and about to happen in the high country.

As mentioned, radiation and DOS information is one essential tool of many that translates to a successful season. Knowing how much snow, and where that snow exists in the watershed is, of course, another important tool. In the middle of June 2019, well after typical peak streamflow, our observations were still showing a very large snowpack at high elevations, observations not captured by lower elevation SNOTEL data. This allowed us to inform multiple reservoir operations of the large amount of remaining water in the high country that still needed to make its way into the streams and storage facilities. This information helped prevent unwanted reservoir management scenarios such as over-filling, releasing above safe-release capacity, flooding, etc. As an example, for Vallecito Reservoir near Durango, not over-filling the reservoir was attributed to three factors: new radar in the Durango area, a new stream gauge in the watershed, and CODOS observations in the high country.

Dust-on-snow melt forcings and radiation inputs are not typically captured in hydrologic models. With air temperature being a standard variable collected at weather stations it has been commonly used as a proxy for radiation. The temperature index-based SNOW17 snowmelt model the Colorado Basin River Forecast Center (CBRFC) uses is one such model. However CBRFC incorporates special remotely sensed product to calculate departure from average 2000-2015 dust conditions to come up with a dust radiative forcing adjustment to tweak air temperature inputs in the SNOW17 snow model. The more dust on the surface, the higher the air temperature adjustment. This is a big step forward when trying to account for dust on such a large scale as the Upper CRB. Remotely sensed observations, assuming there is no cloud cover blocking a clear view to the ground, only gives an idea of dust conditions at a particular point in time.

It is important to keep in mind the best way to understand dust-on-snow severity and extent is by direct field observations. Direct observations give predictive ability as to the presence of dust, when it may emerge at the surface, and dust layers merging together, further decreasing albedo. Technology is trending toward satellite and airborne data for some good reasons, but the best way to know snow and DOS is getting boots on the ground. There will always be a necessity, now more than ever I would argue, for ground-based networks given the ramifications for water managers, planning, and policy of our changing environment.



Painter, Deems, *et al.*, *PNAS (2010)*

Figure 10: One study found that DOS advances peak discharge at Lee's Ferry by three weeks, forces a steeper rising limb of the hydrograph, and reduces average annual Colorado River flows by 5%.

Solutions to the Dust-on-Snow Problem

River systems originating in the Colorado headwaters are stretched to the breaking point. Demand far exceeds supply. In natural systems there are few options in addressing the supply side of the water supply/demand equation.

Possible Supply Side actions include:

- Weather Modification (aka cloud seeding): possible extra 3-4% of Colorado River water
- Forest Treatments to improve forest health resulting in possible increased runoff
- Soil Stability prevention and remediation measures to prevent dust-on-snow: potential increase of 5% of Colorado River water

Dust-on-Snow

Soil Stability

Reducing Dust

Avoidance

In an attempt to address the water quantity side of the equation, addressing soil stability in the major source regions of the desert Southwest one would think is low hanging fruit. Improving soil stability also would have all the other benefits ranging from a healthier dryland ecosystem to counteracting some effects of climate change by snow sticking around longer thereby contributing to regional cooling.

We can do something about increasing soil stability and decreasing the amount of dust that becomes airborne. Cessation of disturbance generally results in stabilization of soil surfaces within days to years, depending on the type of stabilizers available. Physical soil crusts can reform with intense rains, and thus can stabilize surfaces quickly. Cyanobacterial crusts can reform within a few years after disturbance. Paleoclimate records show multiple examples of regional droughts and megadroughts during AD 900–1300, but lake sediment analysis does not indicate increased dust accumulation during these periods — emphasizing the importance of soil disturbance to dust emission. There are multiple options to reduce dust production. The first is protection of soil stabilizers such as biological and physical soil crusts, rocks, and perennial plants by altering the type, location, and intensity of destructive land use activates. The second is restoration, where treatments can range from drill seeding, physical barriers to control blowing dust, perennial grass restoration, and using lab-grown biological soil crusts for restoring disturbed areas. Whatever treatment is tried, it must recognize soil stability is a prerequisite for revegetation. Avoidance of soil disturbance is likely the most cost effective approach.

One of the big questions is — would this be a piecemeal endeavor or an organized concentrated effort, and if so who would organize and spearhead this effort? Land ownership in the Southwest desert is predominantly federal, including: Bureau of Land Management, Bureau of Indian Affairs, Department of Defense, and the National Park Service, to name the largest. A commitment can only come about by understanding the full causes and repercussions, becoming ever more critical in a warming climate. A sustained research, monitoring, and modeling effort is required to guide best practices for a given landscape, vegetation, and soil characteristics.

Dust & Streamflow Interaction

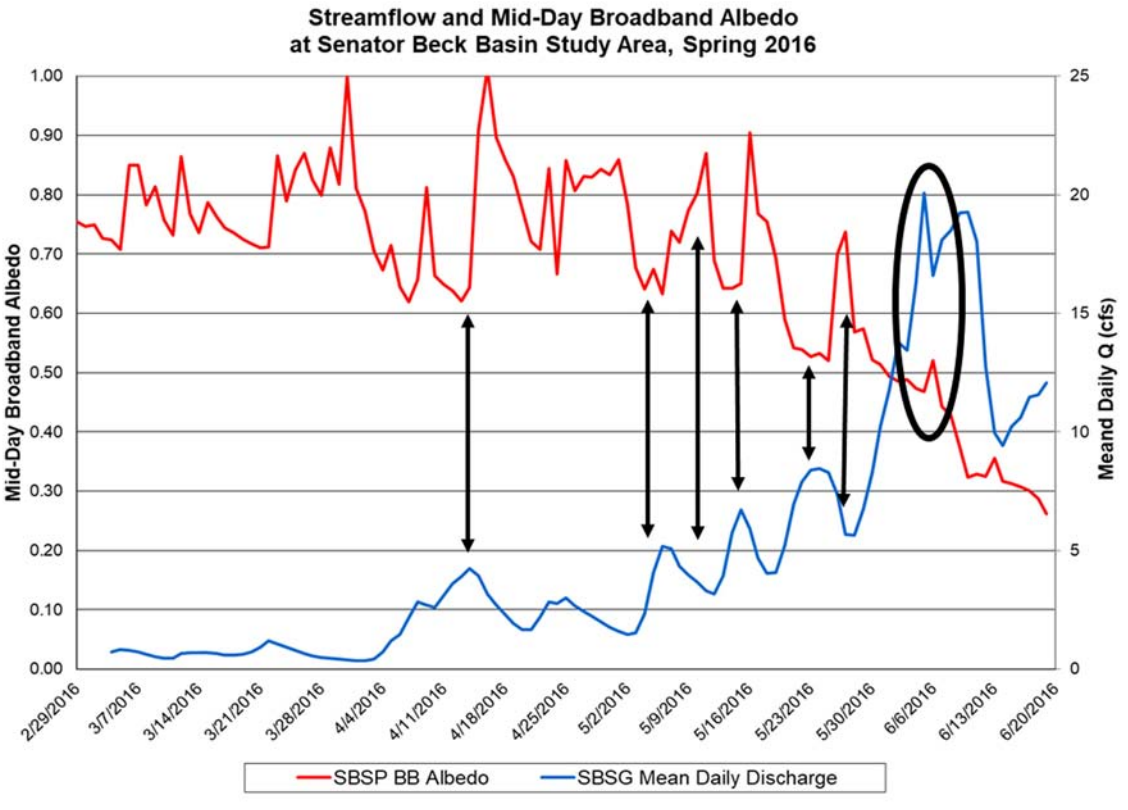


Figure 11: Plot of albedo (red line) and streamflow (blue line) in Senator Beck Study Basin in 2016. This is a good year to illustrate the interplay of dust exposure, albedo resets from new snow accumulation, and stream response. With a change in albedo there is usually a 1-2 day lag time (difficult to see in the above figure) before the repsonse is seen at the stream guage. This is fortunate, as it can give water managers a 1-2 day alert as to what direction streamflow will take.

Dust-on-Snow

Soil Stability

Snowpack Energy Measurement

Funding Uncertainty

Mitigation Priority

Monitoring Necessity

Land Use Impacts

The ill-informed view DOS as unavoidable or a natural process, so why do anything about it? This viewpoint is akin to knowing what causes a disease but not seeking a cure or alleviating its symptoms. The fact is the Southwest deserts are *not* naturally dusty — as long as the occurring crust that anchors the soils is intact. Most with this viewpoint are entities who for a variety of reasons simply do not want to dedicate resources to solving the problem. Though a few government agencies and communities are taking steps to address the problem, it is likely to get worse in the future.

For Colorado as a whole, radiation data within or near a particular watershed may be hard to come by, being non-existent or too spatially distant to be applicable. Analysis of melt forcing under dust, climate warming, or vegetation change scenarios are not possible without the type of measurements collected at the two energy balance towers at SBB and one on Grand Mesa. The predicted worsening of DOS in the future, climate warming, the need to advance the understanding of snow processes for modeling and forecasting requires measurement of the snowpack energy balance *throughout* Colorado's mountains. This is a basic requirement to support long-term climate and snow monitoring. Long-term monitoring is essential to document changes to our natural systems. Many climate stations have a brief existence due to funding challenges. Most funding entities support "projects" — i.e., specific research endeavors that usually last no more than a few years. If climate stations were part of the project, once the project is over so is the funding to support these stations. The nature of the short-sightedness of funding sources makes keeping stations operational a major challenge in the long term. CSAS has been able to keep our highly instrumented stations going nonstop for 15 years, amassing a very valuable dataset. But we are subject to the whims of funding cycles like any other non-profit. The future, beyond two to three years, is uncertain.

The extreme importance and over-allocated condition of water supplies in the CRB and the West in general, not to mention the forecast reductions in water supplies due to climate change, implies that mitigating dust producing lands that contribute to DOS will/should be a top priority in the near future. This emphasizes the crucial necessity of DOS monitoring conducted by the Colorado Dust-on-Snow Program to identify geographic and land-use sources of DOS to help target management and policy changes. And on a seasonal level, to inform water managers, water forecast centers, and researchers of immediate impacts DOS will have on snowmelt timing, rates, and potentially overall yield of the winter's snowpack. All of which is essential in order to efficiently manage and adapt to the DOS phenomena.

Conclusion

In an era of many challenges, unknowns, and pressures on our mountain systems and water resources the Center for Snow & Avalanche Studies was established to conduct high alpine climate and snowpack monitoring and research, as well as operate the applied science Colorado Dust-on-Snow Program. DOS forces the Colorado snowpack to melt earlier and faster presenting additional challenges and complexities to water managers. Dust causes the landscape to become snow free earlier in the season with large effects on alpine ecosystems, including increased evapotranspiration rates that result in a reduction of Colorado River flows by 5% on average.

The movement of dust around the West has increased 300% in the last two decades alone with no signs of abating. The primary dust source region for Colorado is the Southern Colorado Plateau — where land use impacts from off-road vehicles, oil/gas exploration, grazing, increased aridity, and fire to name just a few — has disturbed desert crusts making dust entrainment into the atmosphere during high wind events common. Addressing the problem will require a concerted organized effort that includes avoiding desert crust disturbance and soil restoration. It will also need to include an organization like the Center for Snow & Avalanche Studies to track and monitor dust mineral, microbe, and nutrient composition to identify geographic sources, better understand the impacts of DOS in our mountain ecosystem, and provide assessments of immediate implications to water managers.

For Additional Information:

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Websites at: https://snowstudies.org/; and www.codos.org/#codos

Jeff Derry is originally from Colorado Springs and has a BA in Geography from University of Colorado at Colorado Springs and a MS in Watershed Science from Colorado State University with an emphasis in snow hydrology. His passion for Polar Regions led him to work in Antarctica and Greenland as a field camp manager and science technician for ten years. As a consultant in Fairbanks, Alaska he conducted applied research in the Arctic for five years. The arc of Jeff's life brought him to the Center for Snow and Avalanche Studies in 2015 where he now draws upon his range of skills and experience to contribute to the future development of CSAS.

Tribal Water Rights

TRIBAL WATER RIGHTS

KLAMATH DECISION: SENIORITY OF RIGHTS V. "TAKINGS"

by David Moon, Editor

"Takings" Claims

On November 15, US Court of Appeals for the Federal Circuit (Court) issued an opinion in a long-running case, rejecting the "takings" claims of fourteen irrigation organizations (plaintiffs). *Baley v. United States*, Cases No. 2018-1323, 2018-1325 (Nov. 14, 2019). The plaintiffs "alleged that the Bureau of Reclamation's action in temporarily halting their water deliveries in 2001 constituted a taking of their water rights without just compensation, in violation of the Fifth Amendment to the United States Constitution. They also alleged that the Bureau's action impaired their water rights under the Klamath River Basin Compact…The plaintiffs further alleged that the Bureau's action breached certain water delivery contracts they had with the Bureau." *Baley Slip Op.* at 6-7. The Court's 55-page opinion contains a lengthy factual history and explanation of the complicated legal history of the case; any party interested in the Klamath Basin, irrigation water rights, or tribal reserved water rights will find it to be fascinating reading.

Klamath Basin

The case arose out of the Klamath River Basin reclamation project that straddles the southern Oregon and northern California borders. "Key features of the Project are Upper Klamath Lake in Oregon, where water is stored for the Project, and the Klamath River. The Klamath River rises at the south end of Upper Klamath Lake and flows from Oregon into California. The river eventually enters the Pacific Ocean near Klamath, California. The Project supplies water to hundreds of farms, comprising approximately 200,000 acres of agricultural land." *Id*. at 5. The Project is managed and operated by the Bureau of Reclamation (Reclamation). "The Bureau of Reclamation also manages the Klamath Project to protect the tribal trust resources of several Native American Tribes." *Id*.

Deliveries Halted

In the drought year of 2001, Reclamation "temporarily halted water deliveries to farmers and irrigation districts served by the Project. It took this action in order to meet the requirements of the Endangered Species Act, 16 U.S.C. § 1531 et seq. (2000)…as outlined in Biological Opinions from the United States Fish and Wildlife Service…and the United States National Marine Fisheries Service…It also took this action in order to meet its tribal trust obligations." *Id*.

Senior Tribal Rights

The Court concluded that the Klamath Basin Tribes — Yurok, Hoopa Valley, and the Klamath Tribes — had senior, federally reserved water rights that predate the water rights of the Klamath Irrigation Project irrigators. The Court also found that the Tribes' non-consumptive water rights require at least enough water left instream to ensure the continued existence of tribal trust species listed under the Endangered Species Act (ESA).

Amount of Water Needed

One of the main issues addressed in the decision dealt with the standard that governs the *amount* of water needed to protect the Tribes' reserved water rights. Plaintiffs-Appellants asserted that the lower court, the Court of Federal Claims, erred when it ruled, "…the Tribes held rights to an amount of water that was at least equal to what was needed to satisfy the Bureau of Reclamation's ESA obligations." *Id*. at 37. Instead, "Appellants contend that the Tribes' water rights only entitled them to a catch [of fish] that was adequate to support a 'reasonable livelihood' or a 'moderate living,' as stated in *Washington v. Washington State Commercial Passenger Fishing Vessel Association*, 443 U.S. at 685, 686." *Id*. The Court, however, rejected that position and ruled that Reclamation was required to halt water deliveries to the extent required to comply with the ESA.

Endangered Species Act

> It is not necessary for us to determine the amount of fish that would constitute a "reasonable livelihood" or a "moderate living" for the Tribes. At the bare minimum, the Tribes' rights entitle them to the government's compliance with the ESA in order to avoid placing the existence of their important tribal resources in jeopardy. We therefore reject appellants' argument that the Court of Federal Claims erred when it held that the Tribes had rights to an amount of water that was at least equal to what was needed to satisfy the Bureau of Reclamation's ESA obligations.

Id. at 46.

Subordinate Rights

In its Conclusion, the Court first pointed to its holding that "….we agree with the Court of Federal Claims that appellants' water rights were subordinate to the Tribes' federal reserved water rights." Then the Court issued its ruling on the dispositive issue in the case: "We therefore see no error in the court's holding that the Bureau of Reclamation's action in temporarily halting deliveries of Klamath Project water in 2001 did not constitute a taking of appellants' property." *Id*. at 55.

Tribal Water Rights

Salmon Survival

The issue of the amount of water necessary for salmon in the Klamath River remains in doubt. According to the Yurok Tribe's press release of November 15, the "…Tribe is currently in other litigation over the amount of water necessary to ensure the salmon's survival. In spring 2019, the Bureau of Reclamation issued a Klamath Irrigation Project operations plan and the National Marine Fisheries Service filed a biological opinion burdened with errors that authorizes insufficient instream flows that threaten the existence of salmon. Yurok and Pacific Coast Federation of Fisherman's Associations are challenging the agencies' 2019 decisions in federal court."

The Water Report is planning to publish a major article on the *Baley* decision in the near future, as it covered many important water rights, ESA, and "takings" issues merely alluded to here.

For Additional Information: Decision available at: www.cafc.uscourts.gov/sites/default/files/opinions-orders/18-1323.Opinion.11-14-2019.pdf; Amy Cordalis, Yurok Tribe, 707/ 482-1350 or acordalis@yuroktribe.nsn.us; Yurok Tribe press release available upon request from *TWR*

WATER BRIEFS

GW MEASUREMENTS AZ

BASIN SWEEP

Beginning the week of December 9, 2019 and continuing for several months, the Arizona Department of Water Resources (ADWR) will be making an extensive effort to measure water levels in wells in the Lower Gila and Gila Bend Basins. This "basin sweep" will cover a large portion of the state southwest of the Phoenix metropolitan area, generally south of I-10 and west of I-85, excluding the Yuma area and along the US – Mexico border.

ADWR staff will attempt to measure water levels at hundreds of wells in the Lower Gila and Gila Bend Basins. This survey of area wells — or basin "sweep" as it is known — will be the first such basin survey of the area since 2008 in Gila Bend Basin and since 1992 in Lower Gila Basin. The data collected will be used for several purposes, including: Analysis of water-level trends; Groundwater modeling; Water-level change maps; Hydrologic reports; and Water resource planning and management.

For info: Shauna Evans, ADWR, 602/ 771-8079, smevans@azwater.gov or https://new.azwater.gov/

IRRIGATED FARMING US

TECHNOLOGY ASSESSMENT

The Government Accountability Office (GAO) has prepared a 122-page report entitled *Irrigated Agriculture: Technologies, Practices, and Implications for Water Scarcity*, GAO-20-128SP (November 2019). This report provides an overview of irrigation technologies and on-farm water conservation practices, factors influencing the adoption of these technologies, and implications of their use for water scarcity.

Demand for freshwater surpasses the amount naturally available in some areas of the US. The agriculture sector competes for this limited resource, and withdraws and consumes the most freshwater of any user in the nation. GAO was asked to conduct a technology assessment around agricultural water use. To conduct this assessment, GAO reviewed scientific literature; convened an expert meeting with the assistance of the National Academies; visited farmers, academics, and industry representatives; interviewed officials from federal agencies; modeled water use in an illustrative watershed; and performed a regression analysis on US Department of Agriculture irrigation, crop, and technology data.

GAO found that in the US, irrigation accounts for more than 40% of freshwater use. Several areas in the nation are both heavily irrigated and considered water stressed. Farmers can select irrigation technologies and water conservation practices to better manage freshwater, an increasingly limited natural resource. Farmers have access to multiple irrigation technologies that could increase efficient use of water. Irrigation technologies include micro irrigation, which applies small amounts of water close to the plants; sprinkler systems, which spray water through nozzles; and gravity systems, where water floods the field or runs down furrows. In addition, practices such as irrigation scheduling may help farmers avoid overirrigation. Farmers can also use precision agriculture technologies, such as soil moisture sensors, computer or smartphone decision support tools, and remote control of irrigation equipment to help optimize irrigation scheduling.

The request for GAO to conduct this study specified a policy goal of reducing the impact of irrigated agriculture in locations facing water scarcity in the United States. With that goal in mind, GAO identified the following options federal policymakers could consider:

• Promote the use of more efficient irrigation technology and practices, such as irrigation scheduling.

• Promote the use of precision agriculture technologies, such as soil moisture sensors and weather stations.

In light of GAO's findings, however, these options may need to be combined with appropriate agreements in order to enable and encourage water savings. Such agreements could include incentives to farmers for conserving water. Both policy options have the potential benefit of reducing the amount of water applied during irrigation. However, challenges include ensuring that water savings on the farm translates to water conservation on the larger watershed level.

For info: Report available at: www.gao.gov/assets/710/702604.pdf; Timothy Persons, 202/ 512-6412 or personst@gao.gov

WATER BRIEFS

PUMPED STORAGE HYDRO OR STORED HYDROELECTRICITY

On April 30, 2019, FERC issued a 50-year construction and operational license to Swan Lake Energy Storage for the Swan Lake Energy Storage Project (Project). To mark the Project's approval, Rye Development released a report on the development and the attitudes toward pumped storage hydroelectric energy in Oregon. The report details the process behind pumped storage hydro and discusses detailed survey results from Oregon residents regarding their renewable energy preferences. Results from the survey indicate that Portland-area residents view stored renewable energy very favorably and the development of pumped hydro storage plants is well-received.

Swan Lake Energy Storage is a proposed 394 megawatt pumped hydro facility, located 11 miles northeast of the city of Klamath Falls. The Swan Lake Energy Storage facility will use a closed-loop system that reuses and recycles the same water over and over, with no impact to rivers or ecosystems. Renewable electricity stored at the facility would be transmitted from the powerhouse along a 32.8-mile-long, 230-kilovolt (kV) aboveground transmission line to interconnect with the Malin Substation.

Pumped hydro facilities are like a huge, infinitely rechargeable battery. In the "charging" phase, they use electricity to pump water uphill through a big pipe to an upper reservoir. In the "discharge" phase, they release the water back through the pipe to the lower reservoir, and in the process, use the water to run turbines and generate new electricity. The advantage of using pumped hydro is that it makes it possible to store excess renewable energy for times when it's needed, a feature that is becoming increasingly important as Oregon moves away from polluting fossil fuels. When wind farms and solar panels produce excess energy, it can be stored in the pumped hydro facility by using the energy to pump water uphill. When demand for electricity increases, if there isn't enough wind and solar power being produced to meet the demand, the water gets released, and new electricity is generated.

The Pacific Northwest's abundant wind and solar resources can amply meet the Project's energy needs according to the developers, but their production naturally fluctuates day-to-day and even hour-to-hour, and may not coincide with the electricity usage patterns of homes and businesses. Pumped hydro facilities provide large-scale energy storage, ensuring that at times when the electricity generated from renewable energy exceeds demand, it can be saved for use later when it's needed. By supplying stored electricity during periods of high demand, pumped hydro can also help stabilize electricity prices.

For info: Report available at Swan Lake Project's website: https://slenergystorage.com/resources.html

WATER DISTRIBUTION MT GUIDE RELEASED BY DNRC

The Montana Department of Natural Resources and Conservation (DNRC) has recently published "A Guide for Water Commissioners, Water Users and District Courts" offering practical steps for water distribution in Montana. The 24-page Guide offers practical steps for water distribution in Montana. It includes best practices for water commissioners, district court clerks, district court judges and water users as well as useful references to Montana law and an excellent section on "Common Challenges/FAQs" (frequently asked questions) for Commissioners.

Montana is unusual among western states because the state's district courts, rather than state or federal water resource agencies, are the primary authority for the distribution of water at the local level. Other states like Wyoming, for example, historically assigned water administration and distribution to the state engineer or similar state office, but Montana deliberately avoided that approach. Authority over water distribution and the resolution of water conflicts remains firmly under the command of Montana's District Courts. Day-to-day decisions regarding water delivery (except for large projects operated by the state or federal governments) are made by local irrigation districts, ditch riders, canal operators, water user associations and a variety of other groups and individuals, including water commissioners.

This guide offers basic information, examples of best practices, and references to the law as it applies to the distribution of water by water commissioners that serve under the direction of Montana's District Courts. The DNRC's role as it pertains to water distribution includes issuing new water right permits; authorizing changes to existing permits, claims and decreed water rights; examining pre-1973 claims; and taking action against illegal water use. DNRC is also responsible for providing training and assistance to water commissioners that distribute water at the local level. DNRC publishes and regularly updates a manual specifically for water commissioners. DNRC also provides annual trainings on the skills and requirements necessary for the effective and legal distribution of water. More importantly, DNRC offers year-round technical expertise from hydrology to planning and conflict resolution.

For info: Guide available at: http://dnrc.mt.gov/WatrDistrGuideLowRes.pdf

COLORADO WATER PLAN CO ANALYSIS/TECHNICAL UPDATE

The Colorado Department of Natural Resources presented the final Technical Update to the Colorado Water Plan to the Colorado Water Conservation Board (CWCB) on September 19, 2019. CWCB recently released the Analysis and Technical Update to the Colorado Water Plan (Technical Update), which includes state of the art approaches to analyzing state water needs and includes impacts from climate change.

In 2016, the CWCB launched an update and upgrade of the state's supply and demand projection data and tools underpinning Colorado's Water Plan.

WATER BRIEFS

The process has come to be known as the Analysis and Technical Update to Colorado's Water Plan (or simply, Technical Update, formerly "SWSI"). This statewide supply study serves two primary purposes to: (1) provide a consistent statewide framework for examining future water supply and demand under different scenarios; and (2) provide tools and data for Basin Roundtables to update their Basin Implementation Plans and develop detailed local solutions to supply and demand gaps.

The July 2019 CWCB Board and IBCC joint meeting marked the preliminary release of the Techincal Update. The final report was presented to the Board in September 2019. The full July presentation was recorded and remains available for viewing on the CWCB YouTube channel.

The 2019 Technical Update replaces the document known as the Statewide Water Supply Initiative 2010 (SWSI). The archived SWSI 2010 can be accessed for reference on the CWCB FTP site during the website transition.

The study and all supporting materials (as modified 9/23/19) are available on the website listed below.
For info: Technical Update available at: www.colorado.gov/pacific/cowaterplan/analysis-and-technical-update

WATER PROJECT LOANS CO

LOW INTEREST LOANS

Colorado Water Conservation Board (CWCB) recently touted its Water Project Loan Program, noting that interest rates have dropped to the lowest rates in the history of the Program. A CWCB publication noted, "[I]f you have a water supply project that's been planned for years, but thought you couldn't afford it, maybe now is the time to act. With interest rates for the program starting as low as 1.45%, this is the best time to finance new construction or rehabilitation of your raw water infrastructure."

CWCB went on to state that "Current interest rates can also bring big projects within reach. For agriculture projects, the annual payment on a $1 million, 30-year loan at current rates is less than $42,000 a year. For municipal projects of the same size, the annual payment could be as low as $45,000 a year. And if that isn't good enough, there are rate reductions for 10 or 20-year loans that could reduce the interest rate by as much as 0.65%!" Although that may sound like a come on to an Internet scam, the loan possibilities are tempting.

Approximately $50 million is available annually for the CWCB Water Project Loan Program, which provides low-interest loans to agricultural, municipal, and commercial borrowers for the design and construction of raw water projects in Colorado. A minimum loan request of $100,000 is recommended. Projects financed by the Water Project Loan Program must align with the goals identified in Colorado's Water Plan and its measurable objectives. The standard loan term is 30 years. Rates are reduced by 0.25% for 20-year loans, and by 0.65% for 10-year loans. Rates are increased by 0.25% for 40-year loans; 1.0% will be charged on the loan amount as a loan service fee.

Any private or public entity can apply for a loan that can contract with the state, and that can establish and document the need for the project. The project sponsor must show that the project is technically, economically, institutionally, and financially feasible. Eligible projects for financing include new construction or rehabilitation of existing raw water storage and delivery facilities, such as: Reservoirs; Ditches and canals; Pipelines; River diversion structures; Groundwater wells; Water rights purchases; Flood control projects; and Hydropower.
For info: Matt Stearns, CWCB, 303/866-3441 x3257 or CWCB's website at: http://cwcb.state.co.us/LoansGrants/water-project-loan-program/Pages/main.aspx

FULLY APPROPRIATED CA

INTERACTIVE GIS WEB MAP

The California State Water Resources Control Board, Division of Water Rights (Division) has released an interactive GIS web map for representing Fully Appropriated Stream Systems (FASS) in California. The web map provides access to FASS and related information, including seasonal limitations, court references, and Board decisions all in one place and within a geospatial context. The web map can be found at the following web address: https://gispublic.waterboards.ca.gov/portal/apps/MapJournal/index.html?appid=b2188e89dfea4e44b156600370f1edf7

The Division is planning to host a webinar on the new tool in mid-December, and will follow up with additional information on the time and date of that webinar in the near future. More information can be found on the Division's Fully Appropriated Stream Systems (FASS) webpage.
For info: FASS webpage: FASS@waterboards.ca.gov

SUBSIDENCE IMPACT CA

CANAL REPAIR

The Bureau of Reclamation (Reclamation) announced on December 3 that it is seeking public input about its plan to restore a subsidence-impacted, 33-mile stretch of the Friant-Kern Canal (FKC) that has lost over half of its original designed and built capacity to subsidence — a sinking of the earth from groundwater extraction. The canal, located in California's eastern San Joaquin Valley, delivers water to over 1 million acres of highly productive farmland and over 250,000 residents. The reduced channel capacity has resulted in up to 300,000 acre-feet of reduced water deliveries in certain water years with effects most dramatic in the FKC middle reach (milepost 88 to milepost 121).

The Friant-Kern Canal Subsidence and Capacity Correction Project (Project) would restore capacity from the current estimated 1,900 cubic-feet-per-second (cfs) to the original 4,000 cfs in the most critical area near the Dear

WATER BRIEFS

Creek Check Structure (milepost 103). The Friant Water Authority, the non-federal operating entity for the canal, is supporting the design and feasibility assessment of the proposed project and is working with Reclamation to meet state and federal environmental law requirements.

A Notice of Intent to prepare an environmental impact statement, in accordance with the National Environmental Policy Act, for the "Friant-Kern Canal Middle Reach Capacity Correction Project," was published in the Federal Register on December 3, 2019. Reclamation is seeking comments for the next 30 days. A public scoping meeting is planned for December 18, 2019 to solicit input from 5:30 p.m. to 7:30 p.m. at US Forest Service office, 1839 S. Newcomb Street, Porterville, California. As part of the scoping process, Reclamation will release an Environmental Assessment/ Initial Study (EA/IS).

A copy of the NOI and the EA/IS may be found online at: www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=41341. Contact Rain Emerson at 559/ 262-0335 or remerson@usbr.gov for a CD document copy. Scoping comments may be submitted to Ms. Emerson within the next 30 days.

For info: Adam Nickels, Reclamation, 916/ 978-4415 or anickels@usbr.gov

SUPERFUND SITE RISKS US

CLIMATE CHANGE IMPACTS

A study by the US Government Accountability Office, "GAO-20-73," found that available federal data — from the Environmental Protection Agency (EPA), Federal Emergency Management Agency, National Oceanic and Atmospheric Administration, and US Forest Service — on flooding, storm surge, wildfires, and sea level rise suggest that about 60% of all nonfederal National Priorities List (NPL) sites are located in areas that may be impacted by these potential climate change effects. GAO analyzed 1,571 active and deleted nonfederal NPL sites for its study.

Administered by EPA, Superfund is the principal federal program for addressing sites containing hazardous substances. EPA lists some of the most seriously contaminated sites — most of which are nonfederal — on the NPL and has recorded over 500 contaminants, including arsenic and lead, at those sites. Climate change may make some natural disasters more frequent or more intense, which may damage NPL sites and potentially release contaminants, according to the Fourth National Climate Assessment.

GAO was asked to review issues related to the impact of climate change on nonfederal NPL sites. This report examines, among other objectives: (1) what available federal data suggest about the number of nonfederal NPL sites that are located in areas that may be impacted by selected climate change effects; and (2) the extent to which EPA has managed risks to human health and the environment from the potential impacts of climate change effects at such sites. GAO analyzed available federal data; reviewed laws, regulations, and documents; interviewed federal officials and stakeholders; visited three nonfederal NPL sites that experienced natural disasters; and compared EPA actions to manage risk to GAO's six essential elements of enterprise risk management.

GAO made four recommendations to EPA, including that it clarify how its actions to manage risks at nonfederal NPL sites from potential impacts of climate change align with current goals and objectives. EPA agreed with one recommendation and disagreed with the other three. GAO continues to believe that all four are warranted.

Additional information on some of these sites can be viewed in an interactive map and downloadable data file, available on the GAO website listed below.

For info: GAO website: www.gao.gov/products/GAO-20-73

PFAS ACTION PLAN US

SAFE DRINKING WATER

On December 3, the US Environmental Protection Agency (EPA) sent the proposed regulatory determination for perfluorooctanesulfonic acid (PFOS) and perfluorooctanoic acid (PFOA) in drinking water to the Office of Management and Budget for interagency review. This step is part of EPA's extensive efforts under the PFAS Action Plan to help communities address per- and polyfluoroalkyl substances (PFAS) nationwide. PFAS are a large group of man-made chemicals used in consumer products and industrial processes. In use since the 1940s, PFAS are resistant to heat, oils, stains, grease, and water — properties which contribute to their persistence in the environment.

The Safe Drinking Water Act establishes robust scientific and public participation processes that guide EPA's development of regulations for unregulated contaminants that may present a risk to public health. Every five years, EPA must publish a list of contaminants, known as the Contaminant Candidate List or CCL, that are known or anticipated to occur in public water systems and are not currently subject to EPA drinking water regulations. EPA publishes draft CCLs for public comment and considers those prior to issuing final lists.

After issuing the final CCL, EPA determines whether or not to regulate five or more contaminants on the CCL through a process known as a Regulatory Determination. EPA publishes preliminary regulatory determinations for public comment and considers those comments prior to making final regulatory determinations. If EPA makes a positive regulatory determination for any contaminant, it will begin the process to establish a national primary drinking water regulation for that contaminant (*see* www.epa.gov/ccl).

A full summary of EPA's action to address PFAS can be found in the PFAS Action Plan, available on the website listed below.

For info: EPA's PFAS website: www.epa.gov/pfas

WATER BRIEFS

AG WATER RATE CA

NEW PROGRAM STRUCTURE

In late November, the San Diego County Water Authority's Board of Directors approved a new and permanent Special Agricultural Water Rate structure that offers lower water rates to farmers in exchange for lower water supply reliability. Unlike the current temporary program, the new program will let new participants join as a way to strengthen the region's multi-billion-dollar agriculture industry.

Farmers and growers who participate in the new program will continue to receive a lower level of water service during water shortages or emergencies, allowing the Water Authority to reallocate those supplies to commercial and industrial customers, who pay for full reliability benefits. In exchange, participating farmers are exempt from fixed water storage and supply reliability charges. Under the current temporary program in 2020, participants will pay $1,231 per acre-foot for treated water, while municipal and industrial users will pay $1,686 per acre-foot.

New ag water program rates will be determined in the spring of 2020 as part of the Water Authority's annual rate-setting process. The program will take effect January 1, 2021, replacing the current program that sunsets at the end of 2020. Additional program details, such as the signup process and qualifying criteria, also will be developed early next year.

San Diego County is unusual among major metropolitan areas in the US because it includes one of the nation's most valuable and productive farm sectors adjacent to one of the nation's largest cities. The region sustains 3.3 million people and a $231 billion economy, thanks to decades of regional investments in water supply reliability projects, including the nation's largest seawater desalination plant and the biggest conservation-and-transfer agreement in US history.

For info: Authority's website: www.sdcwa.org/

SALINITY REDUCTION CO

PUBLIC COMMENT SOUGHT

The Bureau of Reclamation is seeking public input on alternatives to reduce salinity in the Colorado River from sources in the Paradox Valley in western Colorado. Currently, the Paradox Valley Unit (PVU) in Montrose County, Colorado, is intercepting naturally occurring brine and injecting it 16,000 feet underground via a deep injection well. The PVU began operating in 1996 and is nearing the end of its useful life. The United States has a water quality obligation to control salt in the Colorado River, in compliance with the Colorado River Basin Salinity Control Act, the Clean Water Act, and a 1944 treaty with Mexico.

"The Paradox Valley Unit is a cost-effective salinity control project in the Colorado River Basin as it prevents 95,000 tons of salt annually from reaching the Dolores River and eventually the Colorado River — that's approximately 7% of total salinity control occurring in the basin," said Area Manager for Reclamation's Western Colorado Area Office Ed Warner. "Reducing salt in the rivers improves water quality, crop production and wildlife habitat in the basin."

Reclamation is preparing an Environmental Impact Statement and has released a draft for public review and comment. Alternatives analyzed in the draft EIS include a new injection well; evaporation ponds; zero liquid discharge technology; and no action, which would result in no salinity control in the Paradox Valley.

The public is invited to attend public meetings to learn more, ask questions, and provide comments. Two public meetings will be held on:

- Tuesday, Jan. 14, 2020 in Paradox, Colorado
- Wednesday, Jan. 15, 2020 in Montrose

The draft Environmental Impact Statement is available online at www.usbr.gov/uc/progact/paradox/index.

Reclamation will consider all comments received by February 4, 2020.

For info: Lesley McWhirter, Reclamation, 970/ 248-0608 or lmcwhirter@usbr.gov

DEMAND MANAGEMENT WY

FEASIBILITY INVESTIGATION

In November, the Wyoming State Engineer's Office, with the assistance of the University of Wyoming Extension, kicked off a public stakeholder process in the Green and Little Snake River Basins to investigate the feasibility of an Upper Basin Demand Management (DM) Program in Wyoming. The DM Program is one element of the Drought Contingency Plans (DCP) that were approved this past spring by the seven Colorado River Basin States and the US Department of Interior (Interior).

The Colorado River Basin has been experiencing persistently dry hydrology since the turn of the 21st Century. Given these conditions, the Upper Division States of Colorado, New Mexico, Utah and Wyoming have coordinated with Interior and stakeholders throughout the Basin to evaluate proactive options for protecting critical elevations at Lake Powell. Lake Powell is the Upper Basin's primary storage facility to help assure continued compliance with the Colorado River and Upper Colorado River Basin Compacts, and the reservoir assists the continued use and development of Colorado River water by the Upper Division States.

The purpose of an Upper Basin DM program would be to support the voluntary, compensated, and temporary reduction of consumptive uses in the Upper Basin or augment supplies with imported water, if needed in times of drought, to help assure continued compliance with the 1922 Compact and without impairing existing water rights. Like mandatory curtailment, any DM program would be a state-based effort implemented under state law.

No DM program can be created and implemented unless and until the four Upper Division States and the Upper Colorado River Commission determine it to be feasible and consistent with the terms of the DCP.

For info: Steve Wolff, Wyoming State Engineer's Office, 307/ 777-1942 or steve.wolff@wyo.gov; website: www.uwyo.edu/uwe/wy-dm-ucrb/.

CALENDAR

December 16 WA
Fifth Annual Tribal Natural Resource Damage Assessments Seminar, Seattle. Crowne Plaza Hotel - Seattle Downtown. For info: Law Seminars International, 206/ 567-4490 or www.lawseminars.com/

December 17 DC
Navigating NEPA 50 Years Later: The Past, Present, and Future Event, Washington. Dentons US LLP, 1900 K Street, NW. Registration/Payment Required by 12/12/19; Presented by Environmental Law Institute. For info: www.eli.org/events/navigating-nepa-50-years-later-past-present-and-future

December 18 CA
Friant-Kern Canal Middle Reach Capacity Correction Project - Public Scoping Meeting, Porterville. US Forest Service Office, 1839 S. Newcomb Street, 5:30 pm - 7:30 pm. Bureau of Reclamation Meeting. For info: Adam Nickels, 916/ 978-4415, anickels@usbr.gov or https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=41341

January 10 WA
SEPA - NEPA Conference, Seattle. 1111 3rd Avenue Bldg. For info: Law Seminars International, 206/ 567-4490 or www.lawseminars.com/

January 14 WY
Colorado River Demand Management - Water Forum, Cheyenne. Water Development Office, 6920 Yellowtail Road, 10 am - Noon. Presented by Wyoming State Engineer's Office. For info: Jeff Cowley, WSEO, 307/ 777-7641, jeff.cowley@wyo.gov or https://sites.google.com/a/wyo.gov/seo/interstate-streams/water-forum

January 22-23 TX
11th TCEQ State of the Bay Symposium (Galveston Bay), Galveston. Moody Gardens Convention Center. Presented byTexas Commission on Environmental Quality. For info: www.tceq.texas.gov/p2/events/state-of-the-bay-symposium

January 23 TX
6th Annual TAWC Water College, Lubbock. Lubbock Memorial Civic Center. Presented by Texas Alliance for Water Conservation. For info: www.depts.ttu.edu/tawc/

January 23-24 WA
Electric Power in the West Conference, Seattle. John Davis Conference Center, 920 Fifth Avenue, Ste. 3300. For info: Law Seminars International, 206/ 567-4490 or www.lawseminars.com/

January 23-24 WA
Endangered Species Act Seminar, Seattle. Washington Athletic Club, 1325 6th Avenue. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

January 23-24 CO
Project Management for Water and Wastewater Utilities, Greenwood Village. Plaza One Tower Conference Center. For info: www.euci.com/event

January 26-29 IL
80th Midwest Fish & Wildlife Conference - "Bringing Science Back to the Forefront of Resource Management", Springfield. BOS Center. Presented by American Fisheries Society. For info: www.midwestfw.org/

January 29 OR
Sediment Remediation Conference: Design & Cleanup Technologies - What's Effective?, Portland. World Trade Center, 121 SW Salmon Street. For info: Environmental Law Education Center: www.elecenter.com

February 10-11 GA
International Symposium on Potable Reuse - Latest Innovations in Treatment & Technology, Atlanta. W Atlanta Downtown. Presented by American Water Works Assoc. For info: www.awwa.org/Events-Education/Events-Calendar

February 11 WY
Crow Creek Restoration - Water Forum, Cheyenne. Water Development Office, 6920 Yellowtail Road, 10 am - Noon. Presented by Wyoming State Engineer's Office. For info: Jeff Cowley, WSEO, 307/ 777-7641, jeff.cowley@wyo.gov or https://sites.google.com/a/wyo.gov/seo/interstate-streams/water-forum

February 16-21 CA
Ocean Sciences Meeting 2020, San Diego. San Diego Convention Center. Presented by American Geophysical Union, Assoc. for the Sciences of Limnology and Oceanography and The Oceanography Society. For info: www2.agu.org/ocean-sciences-meeting

February 20-21 NV
Family Farm Alliance 2020 Annual Meeting & Conference, Reno. Eldorado Resort & Casino. For info: www.familyfarmalliance.org

February 25-28 CA
WEF/AWWA Water Utility Management Conference - Latest Approaches, Practices, Processes, Garden Grove. Hyatt Regency. Presented by World Environment Federation / American Water Works Assoc. For info: www.awwa.org/Events-Education/Events-Calendar

February 26 CA
Water & Environmental Law Program Speaker Series: Mark Arax, Water Journalist & Author, Sacramento. McGeorge School of Law. Presented by Water & Environmental Program. For info: Jennifer Harder at jharder@pacific.edu

February 27-28 TX
Texas Wetlands Conference, Houston. JW Marriott by the Galleria. For info: CLE Int'l, 800/ 873-7130, live@cle.com or www.cle.com

February 27-28 CA
Environmental & Land Use Issues in Cannabis & Industrial Hemp Conference, Oakland. Oakland Marriott City Center. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

March 2-3 CO
Special Institute for Young Natural Resources Lawyers & Landmen, Denver. The Oxford Hotel. Presented by Rocky Mountain Mineral Law Foundation. For info: www.rmmlf.org/conferences

March 2-3 TX
North American Shale Water Management 2020: Reducing the Cost of Water Recycling & Use (Exhibition & Conference), Houston. Aloft Houston Katy. For info: www.shale-water-management.com/?join=VR

March 3-4 MT
Montana Water Summit: At the Confluence of Land & Water, Helena. Presented by the Montana Department of Natural Resources & Conservation. For info: http://dnrc.mt.gov/divisions/water

March 5 OR
Immerse 2020 - A Benefit for The Freshwater Trust, Portland. Redd on Salmon Street, 831 SE Salmon Street; 5:30 - 9 pm. For info: www.thefreshwatertrust.org

March 5-6 MT
Real Estate & Land Use Law Seminar, Missoula. DoubleTree by Hilton Missoula Edgewater. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

The Water Report
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260 N. Polk Street • Eugene, OR 97402

CALENDAR

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March 10 WY

Update on GIS Data Model Implementation Study & Water Supply Index - Water Forum, Cheyenne. Water Development Office, 6920 Yellowtail Road, 10 am - Noon. Presented by Wyoming State Engineer's Office. For info: Jeff Cowley, WSEO, 307/ 777-7641, jeff.cowley@wyo.gov or https://sites.google.com/a/wyo.gov/seo/interstate-streams/water-forum

March 11 OR

2020 Superfund Conference: Getting to Cleanup, Portland. TBA. For info: Environmental Law Education Center: www.elecenter.com

March 12-13 AZ

Law of the Colorado River Conference, Scottsdale. Hilton Hotel. For info: CLE Int'l, 800/ 873-7130, live@cle.com or www.cle.com

March 19-20 OR

Shoreline Regulation, Permitting & Development Seminar, Seaside. Seaside Civic & Convention Center. For info: The Seminar Group, 800/ 574-4852, info@theseminargroup.net or www.theseminargroup.net

March 24-26 CA

Water Innovation Week 2020: The Next Decade, San Francisco. Presented by Imagine H2O. For info: www.imagineh2o.org/wiw2020

March 27-29 TX

Cattle Raisers Convention & Expo, Fort Worth. Fort Worth Convention Center. Presented by the Texas & Southwestern Cattle Raisers Assoc. For info: http://cattleraisersconvention.com/

March 30-April 3 VA

WSWC/ICWP/NWSA Washington, DC Roundtable * WSWC Spring (192nd) Meeting * WSWC/WestFAST Forum, Arlington. DoubleTree Hotel Crystal City. Presented by the Westernn States Water Council, Interstate Council on Water Policy & the National Water Supply Alliance. For info: www.westernstateswater.org/upcoming-meetings/ or www.icwp.org

March 31-April 3 TX

Texas Water 2020: Exhibition & Conference, Fort Worth. Fort Worth Convention Center. For info: www.txwater.org

April 14 WY

"2020 Water Supply Outlook" (USBR) & National Weather Service Update on Spring Runoff - Water Forum, Cheyenne. Water Development Office, 6920 Yellowtail Road, 9 am - Noon. Presented by Wyoming State Engineer's Office. For info: Jeff Cowley, WSEO, 307/ 777-7641, jeff.cowley@wyo.gov or https://sites.google.com/a/wyo.gov/seo/interstate-streams/water-forum

April 16 CA

CLEE Environmental Awards Banquet, Berkeley. University of California. Presented by the Center for Law, Energy + the Environment. For info: www.law.berkeley.edu/research/clee/