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Before the US Senate Energy and Natural Resources Subcommittee on Water and Power

March 24, 2021

Introduction: The Western Water Challenge

Chairman Wyden, Ranking Member Hyde-Smith, and members of the Subcommittee, thank you for inviting me to testify today. The topic of today's hearing-- incorporating natural infrastructure in western water management—during this week of World Water Day. The western United States is suffering through an extended period of drought and persistent water supply challenges, as are many other places around the globe. I appreciate the committee's focus on solutions that support economic development, protect watershed health and build more resilient communities.

I am Holly Richter, Arizona Water Projects Director for The Nature Conservancy (TNC). Founded in 1951, TNC is a global environmental nonprofit working to create a world where people and nature can thrive. Thanks to more than a million members and the dedicated efforts of our diverse staff and more than 400 scientists, we work in all 50 U.S. states and impact conservation in 72 countries across six continents.

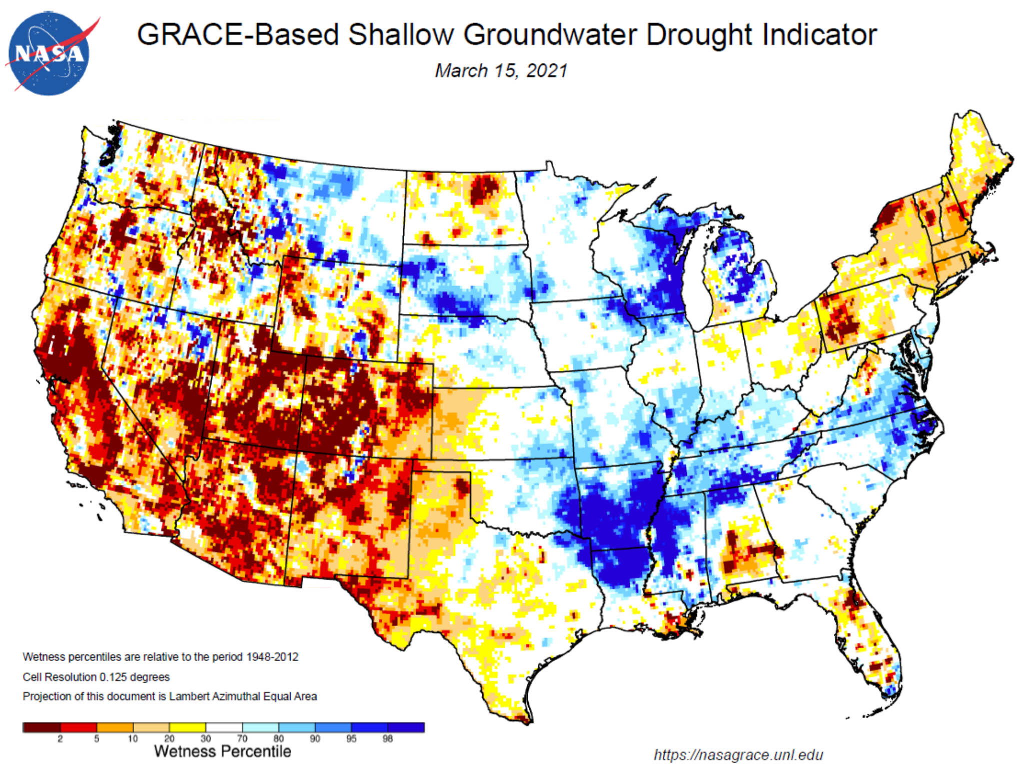
Water is the lifeblood of the arid West. Over the past 20 years we have endured widespread drought conditions, and climate change is producing higher temperatures and drier conditions throughout the Western states. According to the U.S. Drought Monitor, 55.4% of the country was experiencing severe, extreme, or even exceptional drought at the beginning of 2021. The news for the desert Southwest is even more alarming- more than half of Arizona and New Mexico are experiencing "exceptional drought" conditions (Pugh, 2021).

How much water we have at any given time or location is a simple equation, and essentially depends on two factors: how much we extract and consume (demand) and how much water enters the system and is subsequently stored (supply). Historically, our western water storage portfolio has revolved primarily around surface water reservoirs, which until recent decades, were adequate to meet the combination of municipal, industrial and agricultural demands. Now, in the Colorado River Basin, demand exceeds supply and surface water storage levels have been going down (U.S. Bureau of Reclamation, 2012).

We have all seen the photographs of Lake Powell and Lake Mead with telltale bathtub rings that reflect declining water levels under our ongoing and extended drought conditions. But what is harder to see is the similar decline in groundwater storage beneath our feet across the West. In the United States, groundwater is the source of drinking water for about half the total population and nearly all of the rural population, and over 40 percent of irrigation water is groundwater (USGS, Water Science School: Groundwater Use United States). Groundwater depletion in the United States from 1900-2008 is estimated to be 1,000 cubic kilometers of water, one quarter of which was extracted between 2000-2008 alone (Konikow, 2013).

To bridge the gap between supply and demand we have increasingly relied on groundwater resources. However, groundwater pumping remains largely unregulated in most western states, and due to the cumulative losses of groundwater storage, our fall-back and safeguard for water supplies, has itself diminished over the past century. Groundwater overdraft has many negative consequences such as land subsidence that is damaging public infrastructure – including as bridges and canals, seawater intrusion, water quality deterioration, and depleted surface water (Matsumoto et. al, 2019). Groundwater is also a critical resource not only for human communities but also for many riparian and aquatic ecosystems and species. Unfortunately, groundwater management priorities seldom address the water needs of natural systems, and as a result, many of them have been degraded or eliminated, especially in arid regions (Saito, et.al, 2021).

Chronic water shortages and more frequent and intense droughts, combined with population growth and aging water infrastructure, are not only increasing the potential for conflict over water resources, but also reducing water security. These urgent drivers, informed by the development of new science and technical tools, now encourage innovation and new approaches to our water management practices, policies and projects as well as additional investments in western water infrastructure. These investments can be most effectively leveraged by the incorporation of natural infrastructure approaches either alone or in combination with traditional approaches. Natural systems can convey and store water at the right times, and in the right places, to meet our needs.



This Groundwater Drought Indicator Map is a result of gravity variations detected by NASA's GRACE satellites to determine groundwater storage on land masses. By comparing recent data to an average over time, scientists have generated this map illustrating where groundwater storage has been depleted or increased. Rust colored areas show areas where ground water has decreased, and areas in blue are where groundwater levels have increased (NASA: https://gracefo.jpl.nasa.gov/science/water-storage/). This map represents conditions as of March 15, 2021.

Natural Infrastructure Storage Solutions

The use of natural infrastructure has increased in recent years in response to the growing need to protect people and property in a changing climate, and to increase resilience in the face of extreme weather. Put simply, natural infrastructure involves a natural system that is intentionally managed to provide multiple benefits for the environment and human well-being. Natural infrastructure storage solutions more specifically increase water storage through aquifer recharge, floodplain storage, or the alteration of the timing of runoff. These solutions mimic natural riverine, wetland, ecosystem, or hydrologic processes, which in many cases also provide added benefits to the environment and recreation. Methods for the economic evaluation of natural infrastructure for aquifer recharge have been developed to weigh costs and benefits, and return on investment (Morales, et.al, 2019).

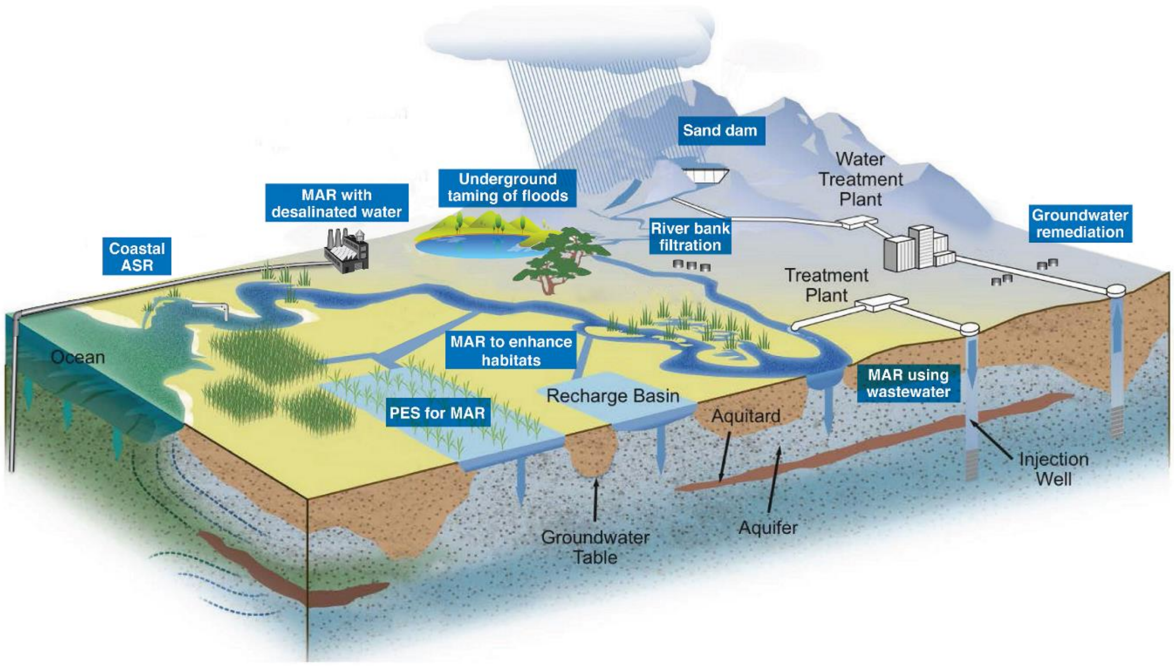
Replenishing groundwater storage can be accomplished in a surprising number of ways, through use of traditional and natural infrastructure, or better yet, a combination of both. Different types of landscapes offer different opportunities for replenishing groundwater aquifers. How we manage our watersheds above ground—the conditions of woodlands, forests, grasslands and deserts--can affect how rainfall enters and moves through natural systems, ultimately determining how much natural runoff, and streamflow occur.

There are many forest thinning hydrologic studies, assessing the use of forest thinning as a management tool to reverse the adverse impacts of decades of fire suppression in the western United States. Research into the impacts of forest thinning on surface water, soil, and vegetation re-growth have occurred concurrently with the growing popularity of forest thinning; however, its potential impact on groundwater recharge has largely been ignored until recently and there are few studies that focus on groundwater resources. Of 35 studies reviewed, there is little consensus among them, other than a general positive trend of increased groundwater recharge in response to forest thinning, as compared to clear cut forests (Shenk et al., 2020).

While groundwater recharge for a particular aquifer, soil type, or geologic setting can vary greatly, in general, the protection and restoration of rivers, streams, wetlands and natural floodplains enables flood flows to recharge alluvial aquifers, as well as for natural sediment transport processes. In most Western landscapes, it is these features where the highest natural groundwater recharge rates typically occur (Levick et. al, 2008).

But what if natural recharge isn't enough to satisfy our water demands in the 21st century? What if even our previously reliable groundwater supplies, that serve as our critical reserves when drought creates surfacewater shortages, is also dwindling? While groundwater storage is harder to measure, understand and manage, advancements in predictive models and monitoring techniques allow water managers to make better decisions across the drought-stricken West, and as a result, innovations in water management techniques are also starting to emerge. Managed aquifer recharge (MAR) projects that enhance supply are becoming more commonly implemented, and are more cost-effective than many other supply enhancement projects, such as surface water storage and ocean desalinization (Perrone and Rohde 2016).

The following examples provide a sense of the variety of approaches that have been undertaken to advance innovation in natural storage solutions so far, from the Colorado River headwaters to the Central Valley in California, and undoubtedly many other examples exist. Some of the best solutions come from the local level where customized solutions are developed according to context and need. What is most frequently missing to develop, advance, and take full advantage of these innovations is adequate funding, from sources and programs that encourage innovation.



This illustrates human approaches or interventions that intentionally utilize and manage groundwater and subsurface systems and processes in order to increase water storage, retention, and water quality for the overall benefit of water security, human resilience, and environmental conditions. These approaches can range from managed aquifer recharge (MAR), to floodplain restoration, and even irrigation methods that enhance recharge. Aquifer storage can be more sustainable and cost-effective than traditional gray infrastructure alone, such as dams. (Groundwater Solutions Initiative for Policy and Practice-https://gripp.iwmi.org/natural-infrastructure/overview-on-groundwater-based-natural-infrastructure/)

Case study: Restoration of Headwater Systems

Starting in the headwaters of the Colorado River Basin, in high elevation meadows where tributary streams cross meadows and irrigated pastures, even seemingly small structures like beaver dams can help to slow flows and increase the amount of water recharged back into the streambanks and floodplains of upper watersheds. The reintroduction of beaver and/or the replication of the types of structures they historically built can increase groundwater storage in these locations.

Within the Upper Green River Basin, the New Fork River flows out of the Wind River Range, and the installation of 35 beaver dam analogs and 125 low-profile, hand-built structures of rock or wood is underway to accelerate recovery of incised streams and riparian and wet meadow habitats by reducing water velocities, increasing sediment deposition and aggradation, enhancing floodplain connectivity, raising groundwater tables, and increasing habitat complexity. Over the long term, the desired outcome is to restore the natural processes that self-sustain riparian and wet meadow habitats, as well as water supplies. TNC's role is to develop and implement a measurement and monitoring program, and assist with project installation. The project is a cost share between TNC, a private landowner, federal partners (U.S. Fish & Wildlife, National Fish and Wildlife Federation, and the Natural Resource Conservation Service), one State agency (Wyoming Game and Fish Department), and a local agency, the Sublette County Conservation District.

These projects have the potential to build adaptive capacity in ecosystems and ranching operations to deal with ongoing climate shifts. They improve watershed resilience, support floodplain functions, regulate stream hydrographs, provide habitat, minimize erosion and sedimentation, and support recovery from extreme events (e.g., droughts, floods, and fires) (Fairfax, 2020). In addition, while streams restored through beaver dams and beaver dam analogs will likely flow longer during drought over the long term, additional groundwater can also be stored for irrigation purposes. The implementation of various analogs to beaver-related restoration tactics have shown promise as a means by which to re-establish naturally distributed storage at the watershed scale which has been previously lost.

Case Study: Municipal Recharge of Regional Aquifers

In the arid valleys of the Lower Colorado River Basin in Arizona, where I live and work, groundwater is the only source of water for people and nature. Fort Huachuca, the U.S. Army's premier intelligence and communications testing facility, depends on the same limited groundwater resources as does the U.S. Bureau of Land Management's San Pedro Riparian National Conservation Area, located several miles from it, and ranches, rural landowners, and small towns and cities located in the same area.

Over twenty years ago, legal battles and litigation related to the limited groundwater supplies in the region started to emerge. In response, a collaborative group of 21 local, state and federal entities formed to build consensus and serve as an honest broker for developing hydrologic science that could help to inform decision-making, the Upper San Pedro Partnership (uppersanpedropartnership.org). This group worked closely with the U.S. Geological Survey to develop a predictive groundwater model to compare and evaluate a wide range of options and alternatives (Pool, et.al, 2007). What we learned, together, was that there was a way to optimize groundwater for the various water needs of humans and nature, including for flows in the San Pedro River itself.

The Partnership also joined forces with the U.S. Bureau of Reclamation to conduct an Appraisal Level Study of regional water management alternatives (U.S. Bureau of Reclamation, 2007) that was completed in 2007. Of the 15 alternatives assessed in the study, four were recommended for further study. This planning process also helped to inform the regional water management vision. Today, we have much more clarity about how to replenish groundwater to ensure a vibrant economy, the operability of missions at Fort Huachuca, the health of the San Pedro River, and water security for local communities. The conversations and discussions over the years weren't always easy ones, but the co-development of the information brought clarity and understanding.

The vision for regional management included replenishment of the groundwater aquifer at just the right places and amounts, using treated wastewater effluent and stormwater. We identified where too much stormwater was problematic--for example, where there was increased runoff from urbanized areas--and flipped that problem into a water source asset. We looked at the demand side of the equation as well, and either retired high volume pumping, and/or precluded it in the future, at the very specific locations where our science told us it had the worst impacts to water supplies.

Today, eight groundwater protection and recharge projects are underway in the region, by a relatively small consortium of five project implementation partners called the Cochise Conservation and Recharge Network (ccrnsanpedro.org). The Conservancy partnered with the cities of Sierra Vista and Bisbee, Cochise County, and the Hereford Natural Resource Conservation District to form the Network, under a voluntary Memorandum of Understanding “to implement regional water management projects to meet the long-term water needs of the Sierra Vista Subwatershed by preserving the baseflows of the San Pedro River and ensuring the long-term economic viability of local communities by promoting and implementing recharge and conservation efforts”. The Conservancy’s main role has been to provide facilitation, science and technical support for the group, and assistance with land acquisition. The water benefits of the groundwater projects between 2015-2019 were over 26,400 acre-feet, over half of which was a result of aquifer recharge, and the remainder from the retirement of historic pumping or areas where future pumping had been precluded (https://ccrnsanpedro.org/about/). Only three projects remain to be constructed. While we’re not done yet, and funding for infrastructure construction remains challenging, we also could have never come this far without the engagement and support of many players at all levels of government.

One of these three remaining projects was originally intended to be a managed aquifer recharge project, whose conceptualization came out of the 2007 BOR Appraisal Study, but has since been adapted to a natural infrastructure solution approach. Storm runoff from the largest urban area in the watershed, that currently enters a natural tributary to the San Pedro, will be diverted into an adjacent basin, to detain accelerated flood peaks in a way that slowly releases them back into the natural channel at a rate that will increase channel infiltration, and groundwater recharge. The project is anticipated to restore a more natural flood regime, reduce sedimentation, increase water quality, and result in enhanced groundwater storage.

Today the members of the Partnership are also working together on a WaterSMART Applied Science Grant, to create a state of the art web portal that will make the extensive hydrologic data sets for the region available to the public in a manner that is useful and accessible.

The U.S. Army has also been a critical partner for all of these projects. It facilitated essential land acquisition in key locations along 25 miles of river that were necessary to make the regional water vision a reality. The Army’s Compatible Use Buffer Program, which is part of the Department of Defense Readiness and Environmental Protection Integration (REPI) Program, was established to combat encroachment on military training, testing and operations. Here, the flexibility of the REPI funding program to not only accomplish its own specific programmatic objectives, but to also leverage the efforts of its conservation partners and address water security for all water users in the region, has made a big difference for our area. REPI enabled partnerships between DoD, state and local governments, and conservation NGO’s, to develop and co-fund projects to combat encroachment on military training, testing and operations and enhance military installation resilience, while also increasing water security for the region.

The Army has been an important partner for our groundwater recharge efforts in southern Arizona, but the military is grappling with water supply challenges across the nation. In January 2019, DoD sent Congress a list of 79 bases vulnerable to one or more impacts of climate change (U.S. DoD, 2019). In 45 of those 79 installations, drought was listed as a concern or vulnerability. In FY 2021 two military installations in the West asked for REPI funding for drought-related projects – Fort Huachuca asked for $4.37 million in REPI funding for groundwater recharge work, and Cannon Air Force Base in New Mexico requested REPI funding to address drought, erosion, soil quality/quantity, and water quality/quantity. Earlier this year, Fort Bliss and El Paso secured a $4.5 million grant from the Texas Military Preparedness Commission to invest in aquifer storage and recharge supporting both the city's and installation's water supplies there (El Paso Herald-Post, 2021). At the Mountain Home Air Force Base in Idaho, the groundwater aquifer which supplies the base is nearly depleted, and a large pipeline project from the Snake River has been proposed with a new water treatment facility to pipe surface water and keep the base in place and operational (SPF Water Engineering, 2016).

Case Study: Agricultural Recharge of Regional Aquifers

Continuing West in our case studies, to the agricultural San Joaquin Valley of California, the overdraft of groundwater there is estimated at 1.8 million acre-feet per year. It's important to remember that the impacts of pumping an aquifer are cumulative over time. Every year that cumulative deficit increases, lowering the water table, year after year. The combination of population growth and climate change in California has resulted in reduced snowpack, increased frequency of droughts, and altered surface water availability (Diffenbaugh et al. 2015; Swain et al. 2018; Grantham et al. 2018). Groundwater supplies have never been more important there than then they are now, given that groundwater withdrawals for irrigation in California increased 60% from 2010 to 2015, a period of protracted drought; surface water withdrawals for irrigation decreased 64% during the same period (Dieter et al. 2018).

In the fall of 2019, TNC began a managed aquifer recharge effort developed in partnership with the Colusa Groundwater Authority (CGA) and the California Department of Water Resources (DWR). CGA and TNC identified areas where overdraft issues were of most concern, and through an innovative partnership between farmers, water managers and conservation interests, an on-farm, multi-benefit demonstration project began recharging groundwater while also providing wetland habitat for migratory birds. Through these and other practices that create habitat on farms, TNC estimates that we've recharged 0.66 AF/acre on low end, and measured recharge up to 1.8 AF/acre, for a total estimate of 41,000-51,000 AF of recharge since 2014.

The Colusa County grower agreed to prepare and flood agricultural fields to provide temporary or "pop-up" wetland habitat for shorebirds in early fall, during the peak of migration along the Pacific Flyway. These practices created habitat appropriate for shorebirds, as well as shallow flooding, and maintained water depths of no higher than four inches throughout the four-week enrollment. These seasonal recharge projects are very inexpensive, leveraging existing land and irrigation conveyance infrastructure, while benefitting migratory birds.

Recommendations to Enhance Natural Storage Solutions

I want to thank you for Congress's attention to water resources legislation. The consolidated appropriations bill passed by Congress in December 2020 contained provisions to respond to many needs of tribal communities, western states' water supply, and the environment. The bill will promote a more balanced approach to providing 21st century western water infrastructure, water supply security, and ecological resiliency in the face of shifts in water availability and the changing climate. But much more needs to be done. I hope that as Congress debates investments in infrastructure that you will make western water supply infrastructure a priority. To increase water security in the West, we will need additional resources and funding for projects capable of leveraging natural systems to convey and store water supplies.

The Bureau of Reclamation has supported natural infrastructure solutions primarily through grants issued through the WaterSMART Program. Congress made changes to these grants last year that should make them more amenable to the types of multi-benefit natural infrastructure projects described in my testimony. Those grants can be funded and further targeted to promote water conservation and reduced consumptive use while restoring ecosystems and boosting the resilience of western communities to drought and water shortages.

The Bureau of Reclamation needs to support natural solutions outside of the WaterSMART Program as well. We recognize the need for additional water storage and support an expanded portfolio of infrastructure projects at the Bureau of Reclamation that takes full advantage of groundwater recharge benefits as well as natural storage solutions that improve watershed conditions overall. The examples described in my testimony show how these types of projects are already providing water supply benefits to local communities and nature. As the primary federal water manager for the West, the Bureau of Reclamation should look to these solutions more often and implement them where appropriate to build a resilient and multi-benefit western water infrastructure for the future.

I appreciate the committee's attention to western water issues, and I thank you again for the opportunity to testify today.

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