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The Navajos' Sea of Sand Dunes

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ABSTRACT

When you're living in the desert, you don't expect it to get even worse," Russell Begaye, a Navajo Nation Tribal Council Delegate from Shiprock, N.M. told the Indian Country Today Media Network. Laura Paskus reported that "He pointed out that reservoir levels are dropping, farming plots are becoming sandier, and the rain- and snowfall have declined" during a drought that, punctuated by a few flooding rain and snow events, has now stretched for twenty years. "We know what the long-term effects are going to be: We're going to be out of water. That has to be everybody's concern," said Navajo Department of Emergency Management's Rosalita Whitehair. Persistent drought in the U.S. Southwest is forcing Navajos who have no indoor plumbing to travel several miles for water as their wells run dry, while also forcing early sale of livestock as former scanty pastures turn to naked dirt. "Perhaps among the worst of those impacts," wrote Terri Hansen in the Indian Country Today Media Network.

INTRODUCTION

The Runaway sand dunes are perhaps among the worst of these impacts that drought has unleashed, and is spread over one-third of the 27,000-square-mile reservation. There was around 70% increase of dune fields during the drought period 1996-2009. These dunes are growing at the rate of approximately 35 meters per year, contributing to the loss of rare and endangered native plants, covering houses, burying cars and snarling traffic, degrading grazing and agricultural lands, and also causing a serious health concern for many of the reservation's 173,667 residents due to increase in poor air quality. The 25 to 40 per cent of Navajos who haul their own water pay 20 times per volume that of non-Navajos who have piped-in supplies on per capita income that is less than half of the U.S. average – before adding the expense of round trips that average 28 miles [1]. During droughts, which are becoming more frequent, both the cost of water and the distances required to acquire it increase. Native peoples already are often intensely affected by climate change because many reservations were established in areas with extreme, challenging environments that immigrating European-Americans did not want. In the Southwest, this generally meant dry land (also often with less access to water supplies in streams, rivers, and lakes. The Navajo Nation occupies the driest one-third of the Navajos' traditional homeland [2]. Little has changed since the 1880s, when Helen Hunt Jackson described how the Navajos were being driven into the deserts and mountains from the most fertile of their ancestral lands by European-American invaders. The drought also has become pervasive in other parts of the U.S. Southwest. "Our 30,000 acre reservation is pretty dry because of drought," said Lawrence Snow, Land Resources Manager for Utah's Shivwits Band of Paiutes. Wildfires in the last decade have burned half our acreage and changed the landscape. We've got fewer trees, and bark beetles are trying to kill off the ones we do have. Once the fires happened and took out the ground cover, major storms brought big flooding [3]. When Native areas in the U.S. Southwest receive rain and snowfall, it increasingly comes in flooding deluges. Arizona's Havasupai Tribe between 2008 and 2010 endured several damaging floods.

Expanding Deserts World-wide

Some of the Navajos' enduring drought stems from changes in worldwide atmospheric circulation compelled by a warming climate. Even though warmer air generally holds more moisture, not everyone will see more precipitation in a globally warmed world. Many deserts already are expanding, in a worldwide pattern influenced by atmospheric circulation patterns that meteorolo-

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gists call Hadley Cells. Most deserts range between 20 and 40 degrees north and south latitude. While precipitation patterns are also influenced by other factors (such as ready access, or lack thereof, to ocean-borne moisture), rainfall is strongly influenced by Hadley Cell circulation. Rising air portends instability, low pressure, and storminess; descending air generally produces high pressure and clear skies. In a warmer world, Hadley Cells expand northward in the Northern Hemisphere and Southward below the equator, which causes deserts to expand. Downpours are unleashed near the equator, due to cooling of warm moist air, when they rise. Deserts are created in the upper troposphere, as the air spreads north and southward toward both poles, descending at about 30 degrees North and South latitude. The Hadley Cells expand across the north and the south of the equator with the rise temperatures and the reasons are not yet fully understood. Thus, as sand dunes marched across the Navajo Nation and California suffered its worst drought on record, deserts crept northward into Spain from Africa, Tehran and other parts of Iran suffered water shortages, Sao Paulo, Brazil, nearly ran out of water in 2014 and 2015, and Australia's multi-year drought scorched the agricultural valleys of the Darling River, meanwhile provoking wildfires that reached the suburbs of Sydney. All of these areas (among others) were within reach of expanding Hadley Cells. Droughts now span the global regions, from Australia to Spain, Iraq, Afghanistan, parts of China, and the United States Southwest, including California, Nevada, New Mexico, Arizona, and Texas, where Hadley Cells favor descending air. The Gobi desert, which comes within the northern reaches of Hadley Cell range in China, has also been expanding, sending occasional dust storms into Beijing, and giving Chinese and Indian cities the dirtiest air on the Earth due to aggravating air pollution from coal-fired power plants. In Iran, Lake Urmia, once plied by cruise ships, has lost nearly all of its water, and water rationing has been proposed for Tehran. As in major rivers in iran also have run dry. Groundwater levels also have declined as increasing numbers of wells tap finite aquifers. Rising temperatures also have accelerated evaporation everywhere. The drought that has been afflicting the Navajos, Hopis, and Pueblos is part of the same multi-year "mega drought" that has been ravaging California. According to bio-climatologist Park Williams, a professor at the Lamont-Doherty Earth Observatory at Columbia University this is developing into the worst drought in the area since the 50-year event that devastated classical Pueblo civilization between 1150 and 1200 CE [4]. "When considering the West as a whole, we are currently in the midst of a historically significant mega-drought," Williams said. Nearly a millennium ago, the same drought also played a major role in devastating much of classic Mayan civilization in present-day Central America. Large areas experienced warm weather without humans burning fossil fuels (except firewood); the medieval warm spell enticed the Vikings to settle in Greenland, and to give it a name that, 300 years later, during the Little Ice Age, proved misleading.

From Little Water to Nearly None

Navajo and Hopi lands in Arizona have always been relatively dry, but climate change in recent years often has made matters worse. The Navajo and other Southwestern Native peoples have made a fine art of surviving on little water for centuries. The ways they farm, and the animals they herd are used to it. There is a difference, however, between little rain and nearly none, and that's what they've been dealing with for twenty years. Cindy Dixon's sheep, for example, used to forage scrub on the desert near Farmington, New Mexico. By 2014, however, even that had died, as Dixon turned to expensive bales of hay. "The landscape around her Navajo Reservation homestead," wrote Bobby Magill in Climate Central, was as brown and bleak as the open-pit coal mine a few miles to the west and well within earshot. Dixon lives without electricity or running water, but her sheep cannot eat sand. "Since it's all dry and bare and deserted — no vegetation — I have to constantly buy hay and grain to keep the sheep fed," Dixon said, looking at the land around her trailer. "This is a bad, bad area for livestock" [5]. The lack of forage is compounded by coal dust blowing in from the mine on stiff winds that are now pushing growing sand dunes across the brown, desiccated land. Sometimes, Dixon cuts her own grocery spending so that she can buy hay for the sheep. By 2014, sands dunes were "covering housing, causing transportation problems, and contributing to loss of endangered native plants and grazing land". Rainfall in some parts of the Navajo Nation fell to 3 inches a year during the latest drought [6]. Because of the enduring drought, "More than one-third of Native lands on the Colorado Plateau (Navajo Nation and Hopi tribal lands) are covered with sand dunes and sand sheets," according to the U.S. Geological Survey [7]. Lands that once were marginally productive for grazing of sheep and dry-land agriculture (a long-time practice among the Navajo and Hopi) are becoming true, water-starved deserts. Or, as the USGS phrases it: "Reactivation of inactive dunes could have serious consequences on human and animal populations, agriculture, grazing, and infrastructure on the Navajo Nation and similar areas in the Southwest" . Wind and drought have been worst in the spring. Dunes are migrating faster across the landscape at speeds heretofore unknown in Navajo Country. During 2009, the USGS measured dune migration as fast as 112 to 157 feet per year. Some dunes moved more than 3.3 feet in a single windstorm. The Grand Falls dune field has grown in areal extent by 70 per cent (laterally and downwind) in 15 years (1992 to 2007). The drought has continued since then, punctuated by a very occasional deluge that quickly runs off the cracked, parched, and increasingly sandy earth. Streams that once were sources of water have dried up, feeding the wind with plumes of gritty, irritating sand. The USGS report found that the advancing sand dunes are threatening transportation and housing, as well as killing native plants, making grazing lands too arid for animals' use, affecting air quality, and thereby threatening the health of people in the area. The Navajo Nation has experienced several decades of rising temperatures, declining snowfall, decreased (or, in some cases, eliminated) streamflow, resulting in water scarcity that has "magnified the impacts of drought that began in 1996 and continues today". Streamflow data and historic information on surface-water features (such as springs, lakes and streams) show significant changes over the past century [8]. Historical sources as well as elders' accounts describe many watercourses that are dry today. Some began to disappear in the

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early to middle twentieth century. "Moreover," wrote Redsteer et al. "Significant reductions in the number and length of stream reaches with perennial flow have occurred since 1920, and for some historic ephemeral streams, no flow during spring run-off and summer rains occurs today." Many streams that began to run dry during the 1990s have now disappeared. Navajo elders shared observations of the drought's impacts with scientists, including "declines in snowfall, surface water features, and water availability" as well as lack of available water and changing socio-economic conditions as leading causes for the decline in their ability to grow corn and other crops. "Other noticeable changes reported in these accounts include the disappearance of springs and the plants and animals found near water sources or in high elevations, such as certain medicinal plants, cottonwood trees, beavers, and eagles". The elders also noticed changes in wind speed and endurance that were changing the behavior of sand and dust storms. These changes have been impeding the ability to grow corn, the staff of life, as well as the use of corn pollen, which has a central role in a large majority of Navajo ceremonies. When ceremonies are interrupted, this disruption demonstrates a paradigm shift in climate going back hundreds if not thousands of years. Navajo traditional livelihoods have always been tied to the land, and with more heat, less rain, and expanding sand dunes, basic survival is becoming more difficult. Unemployment on the Navajo reservation was 47 per cent in 2011, and the poverty rate was 37 percent. At least a third of Navajo families haul their water 10 miles or more. The median household income was $24,000. Roughly 40 percent of Navajos on the reservation have no electricity or running water. Amenities that are taken for granted in many United States and Canadian urban areas do not exist. Coal is mined to power electricity-generating plants that supply Tucson, Las Vegas, and Phoenix, their lines running above Navajo hogans with no power. The Four Corners region on and near the Navajo Nation stands out on satellite photographs as North America's largest single source of human-generated methane. The space-based measurements were taken between 2003 and 2009, and do not include methane emissions from a more recent increase in "fracking". The "hot spot" is caused by coal mining and coal-fired power generation from Four Corners Power Plant the reservation and the San Juan Power Plant nearby. Some of this power generation has since been shut down to avoid expensive pollution controls. The methane "hot spot," which covers about 2,500 square miles, roughly half the area of Connecticut, near the intersecting borders of Colorado, Arizona, New Mexico, and Utah, was described in the October 16, 2014 issue of Geophysical Research Letters [9]. The Four Corners methane plume by itself comprises 10 percent of U.S. methane emissions, according U.S. Environmental Protection Agency estimates [10].

Personal Accounts of Rampaging Sand Dunes

Lester and Louise Williams, who live near Tuba City, have a sand dune as a neighbor, and it's moving in. Despite it, the Williamses say they have no plans to leave their house. Kathy Ritchie 2014 described Lester Williams — a.k.a. "Chee Willie" — and his wife, Louise, who in 2014 lived a few feet from a 20-foot-high sand dune that almost seems to be stalking them. It has chased them out of four previous homes and sheep corrals that they shared with children and grandchildren. "Chee Willie doesn't speak English, but he's incredibly animated when he speaks Navajo," wrote Ritchie. "Through a translator, he talks about the difficulties of living in this kind of environment, where the wind whips the sand so furiously that the family can't leave the house. He says he once tried to remove the sand himself, but it came back. The sand always comes back" [11]. Louise, Chee Willie's wife, said that blowing sand makes breathing very difficult. The wind howls, and the sand swirls. Yet, they stay. Home is a sacred place among Navajos. Home is a sacred bond – over and above the practical difficulty of obtaining a new lease, moving livestock, and the fact that more and more Navajo land is laced with migrating dunes. Like heavy snowdrifts, dunes move across roads and block them with increasing regularity. "As we're packing up and preparing to leave Chee Willie's house, Tohannie tells me that yesterday's windstorm shifted a nearby dune, causing it to cover part of a road used by the handful of families in the area, including Tohannie's parents," Ritchie wrote. "'I got stuck with my son," he says. "We had to shovel our way out". These are not small drifts, and they can't be moved, like snow, with a plow. And, if course, they never melt. Ritchie described one dune as "[a] magnificent sculpture shaped from mostly eroded Navajo and Entrada sandstone". "Many of the dunes in the area are measuring anywhere from 30 feet to 40 feet high and can be considered as unexpectedly tall. According to Begay, the dune field is even higher near Preston Mountain, some 45 minutes north of where I'm standing, possibly 60 feet to 80 feet in places". The dominant plant species in some areas, where any survive, has become tumbleweed, which has evolved to move with the wind, anchoring nothing. Across the reservation, persistent winds have been driving sand into homes and across roads. Most of the roads are not paved, and their surfaces can become parts of the moving dunes. Even major paved roads have been blocked. On April 16, 2013, driven by winds gusting to 60 miles an hour, drifts of sand closed parts of Interstate 40, as traffic backed up 12 miles. A NASA satellite photographed the dust plume from space. Wise Navajo drivers carry shovels: "Kee Tohannie, Begay's grandfather and Huskie Tohannie's father, always carries a shovel, chains and sometimes a hatchet in case he or one of his neighbors is marooned in the sand. "I've been stuck in the sand many times — it's a lot of digging," he says. "You just have to know how to drive in sand. Like you learn to drive in snow". Margaret Hiza Redsteer, who is of Crow descent, was raised in their homeland near the Montana-Wyoming border, but during the 1970s, having married a Navajo, moved to his homeland, and mothered three children. Many people told her how much plant life in the area had changed over the years. Only later did she begin to associate these changes with climate change. In the meantime, Redsteer and her family had moved to Flagstaff, Arizona, when she was 29 years of age in 1986, where she studied for a Ph.D. Shortly after 2000, Redsteer, now employed by the U.S. Geological Survey, switched her focus of study from volcanic deposits near Yellowstone National Park to the effects of climate change on the Navajo Nation as intensifying drought contributed to growth and migration of sand dunes there. She wrote several academic papers and had a key role in the National

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Climate Assessment, released by President Barack Obama in 2014. She has become known for linking elders' recollections with weather records to trace the evolution of climate change Interviews of elders fill gaps in USGS data. "Aerial photographic surveys of the study area were available from 1934 and 1954, but there were big changes during those years. A lot of the data gaps have been filled in addition to providing another line of evidence, by our interviewing" Hiza-Redsteer said. Navajo elders' memories can also serve as climatic histories. They remember wetter tines, with snows occasionally knee-deep, and streams were flush with water sustaining large numbers of livestock. Some elders recalled a time when they were children, with moist ground until the Fourth of July, climate data on the Navajo Nation indicates a marked drying trend since the middle 1940s, and a warming of 4 degrees F. in many areas since the 1960s. The decrease in snowfall has long-term implications. "Snow is like water in the bank," Redsteer said. "It takes a long time to melt. It soaks into the ground slowly". Droughts did occur, but rain and snow alleviated them after a few years. The present drought has dominated the past two decades, with brief breaks in 2004, 2005, 2010, and 2017. Navajo farmer Jonathan Yazzie said that for many years he grew squash, corn, zucchini, chilis and even cantaloupe. The drought has put him out of business. "The water is just not there no more," he said. "We're down to 15 sheep. No cattle. Two horses. That's our kids' future. He has no access to irrigation he has sought from the Navajo and Hopi governments. Without it, continued drought will force his family to move. Traditional herding is dying. "I don't know a single young Navajo person today who's thinking about having their own sheep herd," Redsteer said. "Part of that is due to their own market economy. The feasibility of doing that is just impossible now. "There is still a holdout group of elderly people who really don't have a choice. Their language is Navajo. Their culture is Navajo. They really don't have any other place to go" (Magill, 2014). An account in The Navajo Times remarked that "Hardly anyone is making a profit from their livestock anymore; they've become expensive pets." The technical report on National Climate Assessment, issued in 2013 stated that the Four Corners area probably will continue to endure warmer weather on average during coming decades, as soil continues to dry with droughts becoming more intense and frequent. The drought – and spread of sand dunes – is worst in the southwestern quarter of the Navajo reservation, where many families may be forced to move, according to Redsteer, who has used the recall of elders as well as weather data to trace climatic changes . Average annual snowfall across the Navajo Nation declined from about 31 inches in 1930, to about 11 inches by 2010, according to a United Nations case study "Every tribal elder mentioned the lack of snowfall," Redsteer said. "They describe winters where the snow was 'chest high on horses.' The snowfall declined significantly during the 20th century, and is still declining in recent years". Elders' memories are especially important in recent years, as heat and drought have accelerated, because many U.S. government weather stations were shut down during the early 1980s to save money. By 2014, Margaret Redsteer had studied the spreading Navajo sand dunes for 14 years, in collaboration with the Navajo Nation. She also worked with Northern Arizona University's Tribal Environmental Education Outreach Program in a continuing effort to stabilize dunes with native vegetation. The battle has never been easy, and the changing climate grants no favors. While native plants require time to become established after rare rains, invasive tumbleweeds explode nearly overnight. Tumbleweeds suck up moisture before native plants get it, according to Redsteer. "Tumbleweed is a major blow to rangeland conditions," Redsteer said. "It is amazing how huge the areas are that are affected by tumbleweed" [11]. "The elders often talk about the difference in grass -- how tall, how thick, how much of it there used to be. Some people say when they were young and herding sheep they had to stay right with the herd. If they didn't the sheep would get lost in the grass. It's not like that now," she told High Country News [12]. Elders' recollections provide details that statistics do not. For example, they describe streams used for irrigation that no longer exist, indicating intensifying drought spanning several years. Decades ago, the annual cycle usually included winter rains, a dry, windy spring, and a summer monsoon. Rain and snow have decreased at all seasons, and springs are warmer now. "We've learned from the elders that the soil stayed moist all through the spring until the summer monsoon arrived," she said. "You could dig a very big trench and not run into any wet sand or soil if you were to go out in the springtime during the dry windy season. The ecological effects are huge because shallow rooted plants aren't going to do as well.... We have been told by the elders that there were lots of beavers when there were cottonwoods in the Little Colorado river. They used to see cranes migrate through the area in the spring, stopping in the marshes around lakes that aren't there now. Redsteer has conducted more than 100 interviews that can be correlated to check for vagaries of memory. Medicine men's memories are very helpful because they use plants in ceremonies, and remember what species have changed over time. People also relate changes in vegetation and animal life that change with elevation. Some of the elders take the blame for changes in the weather, saying that it is spiritual retribution for their unwillingness or inability to follow traditional ways, the Original Instructions. Redsteer tells them that it's geophysics, not their fault, a world changing due to alterations in atmospheric carbon dioxide and other greenhouse gases that are beyond their power. "We're seeing that people who live in the drier low-lands are seeing a different timing of changes than people who are living higher, among the buttes, ponderosa, pinon and juniper trees. We're trying to understand that difference more clearly," said Redsteer. Peoples' livelihoods have changed. "A lot of people have already moved away from having livestock. There is just no water for them; there is no feed. And to haul hay to the reservation all the time is really expensive. You're often making a poor living or losing money in the deal. People have some livestock now, just not very many, and mostly for ceremonial purposes". Redsteer has extended her work to other indigenous cultures, and has noted similarities, such as increasing climatic volatility. "A lot of them say that they can't predict the weather anymore. Things have changed so much that their traditional calendars don't work. From people in the Amazon, in Africa, in Asia, that's a worldwide unified statement". The Navajos and Hopis live in areas that are "just on the edge of being habitable," Redsteer said. Climate change (especially persistent drought, is taking much of this area past a dangerous threshold. "The annual moisture here has historically

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been just enough to get by. When there is even a small change, there is a huge effect," she said. John Leeper, director of the Navajo Water Management Branch of the Navajo Nation in Fort Defiance, Ariz. said that If the current trends she identifies continue, much of the Navajo Nation will be severely impacted, and much of the Navajo Nation will become uninhabitable" [13]. Leeper said that The Navajo Nation is intended to be a permanent homeland for the Navajo people. "However, much of that homeland may be in jeopardy if these trends cannot be successfully mitigated. Margaret's work Not only has identified and documented the current trends, but also gives us perspective on the steps that can, and must, be taken to reverse many of the most damaging of these trends. Her work will help to ensure that the Navajo people will be able to find their livelihoods here long into the future." Redsteer recommends use of sand barriers to stabilize dunes, as well as seeding areas dominated by dunes to encourage vegetation. "If we're going to do research for people's benefit, we have to try to see what kind of solutions there are," she said. Redsteer has tried sand barriers that are being used as part of China's Green Great Wall to hold back sand dunes advancing across the Gobi desert, given her by visiting scientists. She admits that the geophysical circumstances make her efforts look very small. "It's like putting a thimble over my head to try to stay dry in a downpour," she said. Redsteer has addressed Navajo chapter houses (local governments), sometimes convening more than a hundred residents at a time "The Navajo Nation is in one of the longest droughts in recorded history," she told a sea of grim-faced Central Agency residents sweating in the 90-degree heat. "There are a number of other factors that make it so critical to address this issue, rather it being a simple matter of overgrazing" she told about 120 people who met at the Many Farms Chapter House in September, 2011, "To discuss the alarming desertification that has taken place on the Navajo Nation in the last 30 years". John Leeper of the Navajo Nation Water Resources Department said that "Every public water system on the rez, not to mention the $20 million livestock industry, are under siege by the drought. "First of all, the traditional way of adapting to dry seasons was to move," Redsteer said. These days, "If you have a reservation, and the reservation is established where there are the most limited water resources in the region, the odds of you being able to make it through dry seasons are stacked against you". "People on the reservation use one-tenth of the water that people in Phoenix use every day. How do you conserve when you are already using so little? They don't have lawns, they don't wash their cars on a regular basis. It's hard to say, 'Well, we really need to conserve now,'" she said with a laugh [14]. Old habits die hard. "One of the real ironies is that western water law is 'use it or lose it'. Phoenix ... to keep its Colorado River allocation, has to use that allocation or it will lose its rights to it. So in some ways there's a disincentive to conserve," Redsteer said. That may change if the water runs out and life becomes impossible. Even as drought intensifies across the Navajo nation, some residents who have to haul their own water assert that the government continues to offer large amounts of water for oil drilling (including fracking) as well as coal-fired electric power generation. Laura Paskus reported for the Indian Country Today Media Network on April 11. 2015 that "Lori Goodman, with the nonprofit group Diné CARE, or Diné Citizens Against Ruining Our Environment, has been fighting back against the tribe's use of water for mining and development for more than a decade". "According to Goodman the main cause of poverty in the Navajo is water". The Navajo tribal leadership has continued to sign away water rights, sell water to industry, and not plan for the future, and doesn't understand the value of water, she stated. "The water is always for extraction; they're using it for fracking, for power plants, for mining," she said [15]. "We really don't know what is being pumped into our aquifer and how that is being impacted," said Russell Begaye, of Shiprock, N.M., a Navajo Nation Tribal Council delegate, who said that people there are still bearing the toxic legacy of uranium mining [16]. "I keep saying, 'I don't think anyone really knows what will happen when you're putting water that's chemically-laced back into the ground, if it mixes with the good clean water being used by our people [17,18]".

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