

Climate Change Vulnerability of Native Americans in the Southwest

Ashley: Good afternoon or good morning from the U.S. Fish and Wildlife Service's National Conservation Training Center in Shepherdstown, West Virginia. My name is Ashley Fortune and I would like to welcome you to our webinar series held in partnership with the U.S. Geological Survey's National Climate Change and Wildlife Science Center in Reston, Virginia.

The NCCWSC Climate Change Science and Management Webinar Series highlights their sponsored science projects related to climate change impacts and adaptation. It aims to increase awareness and to inform participants like you about potential and predicted climate change impacts on fish and wildlife. I'd like to welcome Dr. Shawn Carter, Senior Scientist. Shawn, would you please introduce our speakers?

Shawn: I'd be happy to, Ashley, thank you. Today, it's our pleasure to have two speakers for this presentation. The first, Dr. Karletta Chief, is an Assistant Professor in the Department of Soil, Water and Environmental Sciences at the University of Arizona in Tucson. Her research is to improve our understanding, tools and predictions of watershed hydrology, unsaturated flow in arid environments, natural and human disturbances on soil hydrology and climate change impacts on indigenous communities.

Karletta is Navajo from Black Mesa, Arizona. She has received BS and MS degrees in Civil and Environmental Engineering from Stanford, and also has her doctorate from the University of Arizona in hydrology and water resources. She's also done postdoctoral work at the Desert Research Institute in Las Vegas.

Schuyler Chew is a PhD student in the Department of Soil, Water and Environmental Sciences, also at U of A. His participation in this project began in January of 2013, as a research analyst. Prior to this, Schuyler has collaborated on tribal environmental initiatives in his home community, the Tuscarora Nation in Western New York. He obtained his Master's in Environmental Engineering from the University of Buffalo and has a Bachelor's from Dartmouth. So without further ado, I welcome today's speakers.

Karletta: Thank you, Shawn and thank you everyone that is listening online. I appreciate this time to present our work related to climate change vulnerability of "Native Americans in the Southwest: a case study of Tribal Climate Adaptation among the Pyramid Lake Paiute tribe. We're breaking down this presentation into six components. Schuyler and I will share the content of this presentation.

This project is an interdisciplinary project with several agencies and universities, myself included. As well as Dr. Aleix Serrat-Capdevila and Schuyler Chew. We're all at the University of Arizona. And Dr. William Smith Jr., who is an environmental geographer, at UNLV. Dr. David Busch, who is an ecologist at USGS and the Pyramid Lake Paiute tribe, Kameron Morgan amongst others, who are a part of the environmental department at the Pyramid Lake Paiute tribe.

The Pyramid Lake Paiute tribe is located at the terminal end of the Truckee river system. They have a large part of their reservation that is covered by the Pyramid Lake. This lake has quite significant meaning to the tribe, both culturally, economically as well as spiritually. In particular, this lake has a fish in the lake called a Cui-ui, upon which the Pyramid Lake Paiute tribe identify their cultural identity with.

Their name, in their language, is translated as Cui-ui-eaters. In addition, the tufa formations that are characteristics of this lake have links to their cultural origin stories. Furthermore, they have wetlands from which they obtain reed for their basketry and they're very well-known for their basketry skills. Pyramid Lake has been impacted by upstream users and pollution, as well as infrastructure that has been built along the river system and has significantly impacted the lake levels since the early 1900s.

As a result of these impacts, the Cui-ui have been impacted and have been listed as endangered, as well as the Lahontan cutthroat trout. Parts of the West have already warmed more than two degrees Fahrenheit compared to the average 20th century temperatures. The Southwest is among the most rapidly warming regions in the world.

Part of this project was to look at how the Pyramid Lake Paiute tribe could adapt to climate change, by focusing on looking at the vulnerabilities and thresholds of the resiliency of the system.

Also, we worked with the tribe collaboratively to identify water management adaptive strategies for the tribe. Our goal was to produce a framework that would be a foundation for a decision support system model that would couple a climate, biophysical and social system.

Then, as part of this project, this is an important project because it's one of the first projects working with tribes and looking at climate change impact on tribes, and how scientists and others in various climate centers could develop similar effective partnerships with tribes.

The tasks that were involved in this project was a combination of technical, as well as socio-cultural, to look at how we can build, collaboratively, water management and adaptive strategies.

We collected quite a bit of data that included climatic and non-climatic data, as well as developed some climate change projections that came from other climate experts that were working on this through the Southwest Climate Center.

Then looking at the socio-cultural, working with the tribe to collect some of that data, so that we could get a holistic understanding of the vulnerabilities that the tribe had, and then work towards a collaborative adaptation strategy for the tribe.

The socio-economic vulnerability looked at internal factors and external factors. This involved quite a bit of discussion with the tribe at all levels including the tribal president, vice president, council members, environmental professionals, and tribal citizens that also included elders and the youth.

To look at the various factors from education and employment, their perception of climate change, and what the institutional capacity is, the technology that's available to them, the physical capacity, and the economic resources and financial capital, social capital, and natural capital.

Then, also externally, what support they have from the Federal government as well as their position in the Truckee River system, and how their role was changing through history and to this present day. Also, their opportunity for employment and the migration off the reservation.

In this presentation, I want to just focus on a few of these factors. Much of this analysis is detailed in a publication in *Climatic Change* that was part of a special issue focusing on climate change on tribes across the United States.

We conducted a survey with tribal members. This survey was a statewide survey that was administered to various stakeholders in Nevada.

For the tribe, they were very aware of climate change and 80 percent of the people observed changes in their environment. In addition, 73 percent believe that climate change is happening and that humans play a role in climate change.

Furthermore, 93 percent of the tribal members surveyed expressed their priority for climate change action at the national level. Also we asked the tribal members who took the survey what environmental changes they observed in the environment.

From the survey we saw that the tribe observed that they had a decrease in surface water, 72 percent responded saying they had observed decreases in surface water. Also, 56 percent of the tribal members surveyed observed a decrease in the snow packs. These tribal observations are in line with what scientists are also seeing in the natural environment. Also, we looked at what their belief was in climate change and this graph shows a scale from strongly disagree, in the red, to disagree in the pink, not decided, agree and strongly agree.

We asked about if they thought climate change is happening, if climate change is naturally occurring, if human activity doesn't play a significant role, and humans play a significant role, or human activity is the only factor causing climate change. If you look and focus on the turquoise and the purple colors you can see that there was a large percentage that did believe that climate change is happening. Also 73 percent also believe that human activity plays a significant role in climate change.

Conversely, only 17 percent agreed or strongly agreed that human activity was the only factor in causing climate change. We developed a scientific cognitive map based on literature and expert knowledge in the field focusing on what the impacts were on climate change for the Pyramid Lake. This was a cognitive map that was presented to the tribe detailing what climate change was going to cause in terms of temperature increase, droughts and floods and the subsequent cascading environmental impacts to the lake and to the environment and subsequent impacts on the species.

The tribe then evaluated the cognitive map and we had a very good discussion and the tribe developed their own cognitive map based on the expert map that really engaged the tribe to think about climate change and how it was impacting their lake and ecosystem. This was a very good exercise in which the cognitive map was expanded upon. We also looked at the external factor of

how the tribe was positioned in terms of their power and the power was a combination of their role, their motivation and their resources that they had to protect their water resources.

This was a qualitative assessment from 1900 to the present. We saw that the tribe increased their power position over the century as a result of their ability to advocate for the protection of the Cui-ui and the Lahontan cutthroat trout and then their ability to create partnerships and leverage federal intervention to protect the lake and the ecosystem.

Also the tribe's vulnerability to climate change is directly tied to their cultural and economic dependence on the Pyramid Lake. The external socioeconomic factors influenced their ability to adapt and amplify the potential impacts that the tribe faces. The sustenance of Pyramid Lake's ecosystem is extremely important for the economic, spiritual and cultural livelihoods of the tribe. This is reflected in the fact that the Cui-ui, the lake and people are considered the three central components of their tribal identity.

Both climatic and non-climatic impacts threaten the endangered Cui-ui fish by decreasing the water quantity and quality. Also the integrated framework that is developed is to create an integrative analysis that uses a model driven top down and local perception knowledge driven, which is bottom up, to precisely quantify the impacts and uncertainties that the tribe is facing.

Despite the limited economic opportunities and dwindling federal support, the tribes adaptive capacity is strengthened by their sustainability based values, the technical capacity that the tribe has in natural resources management and their proactive initiative for invasive species control. Also the tribe has strong external scientific networks and they have a remarkable awareness for climate change.

Like many tribes, Pyramid Lake Paiute Tribe would benefit from increased federal funding for tribal climate change programs and the tribe's resilience could be enhanced by selective sustainable economic development that is sensitive and unique to the contents of the Pyramid Lake Paiute Tribe.

In the next section I want to discuss the next step we took from looking at the vulnerability. That was working with the tribe in a participatory manner to discuss the impacts and the strategies for adaptation.

Communication is really important for tribes. There is a lot of time required to invest in building that trust and maintaining that communication. We had a strong effort to do so, and we worked well with the tribe making sure that we had good communication. We had a kickoff meeting, and then we presented with the tribe at various national Native American conferences to share with other tribes our success.

Then we went with the tribe to attend an Inter-Tribal Environmental Professional climate change workshop. They did that locally with the Nevada Water Resources Association and the Great Basin Consortium to share locally the tribe's project and discussed their climate change impact. Recently, we met with the tribe to do scenario discussion about the climate change scenarios that the tribe should consider.

We met with the tribe for two days. The participants were tribal members as well as tribal environmental professionals. We had about 20 participants attending. What we discussed was the environmental, water, and ecological challenges facing Pyramid Lake. Also, to discuss management alternatives and solutions to these changes.

It's important that this is collaborative and that we're working with the tribe in an equal fashion so that the challenges and the solutions are presented by the tribe. From the two day discussion, we categorized quite a bit of challenges that the tribe felt like they were facing. This graph shows the various categories and, also, the tribal participants who voted to prioritize these challenges.

At the top, the tribe felt that the “sensitivity to cultural resources” was the top priority and “water quantity” as second and then “water quality” as third. Interestingly, “individuals' behavior” was fifth, and the tribe did feel like there was an individual responsibility to protect the lake and consider climate change impacts.

Focusing on the top seven environmental challenges, we looked at ecological indicators that the tribe should focus on in terms of looking at climate change impacts and how to be able to implement their adaptation strategies. For water quantity, we had a list of the different indicators that the tribe should look at - lake level, snow pack, and so forth. The water quality, looking at water temperature and dissolved oxygen and so forth.

Finally, land cover and environmental changes and habitat loss. We listed anything from bird count to CREEL count of the fish in the lake.

Then we discussed the management alternatives and the solutions presented by the tribe. Education and outreach was deemed as the top priority. Tribal participants felt like there was a need to reach out within their own tribe to let others know about climate change, how it was impacting the tribe and the lake, and how they could work together to increase their adaptive capacity.

Again, community organization came in second for similar reasons in terms of being able to develop adaptation strategies and then water conservation.

Some of the things that were interesting from this workshop was that many of the problems identified were non-environmental, and they were related to management, governance, and social issues. Also, educational outreach and cultural sensitivity were mentioned both as a challenge and as a solution. I think that's really a good lesson learned from this project that is useful for other scientists across the nation who are working with tribes.

It is critical to have that cultural sensitivity as well as understand that there's a great need to have that educational outreach component for the tribe. Also, participants cited a need for better outreach to and collaboration with the upstream river users and the managers considering that they are at the terminal end and are subjected to much of the impacts upstream.

Pyramid Lake tribe is definitely leading the way amongst tribes in the Great Basin and in the United States in terms of their climate change work and climate change adaptation planning. The Pyramid Lake Paiute Tribe was host to the Inter-Tribal Environmental Professional Climate Change Training that was held for tribes in the region. DRI was also a host of that. The tribe was

the lead in this workshop in terms of the hosting and giving examples of lessons learned and how other tribes could also approach climate change impacts and adaptation.

From this course, some of the main lessons were that developing an effective adaptation requires a buy-in and support from the tribal government and community. That is so important because unless you have the support of the tribal government and the community level then it's very difficult to move a plan forward or even to discuss a plan.

Also, it's important to get the support of the tribal leadership, particularly in that they pass a resolution which supports the development of the adaptation plan. We have been presenting before the council, keeping them up-to-date of what we're doing. They vote formally as to what we're doing and what we cannot do and developing, also, a formal research agreement with the tribe.

Also, the tribe is the one that needs to decide what is important and what is relevant to them. It is really the tribe's direction in terms of where the project goes.

I will now hand it over to Schuyler who will talk about the video.

Schuyler: The next two sections of our presentation are going to highlight some of the outcomes of our work with the Pyramid Lake Paiute Tribe, the first of these being a video that we created from conducting a literature review of the ecological requirements of two important fish species to Pyramid Lake - the Cui-ui and the Lahontan cutthroat trout.

The YouTube link is listed here so when this presentation is posted online you can access the video at that time. Looking at the Cui-ui and the Lahontan cutthroat trout, there's some similarities and comparisons that can be made. The Cui-ui are much more resilient than the Lahontan cutthroat trout because they live much longer, up to 40 years.

They're very illusive throughout most of the year. They can only really be caught for a very small span of time during the spawning season in the spring. They do not need to spawn annually so that has helped with their own adaptive capacity over the thousands of years that they've been living at Pyramid Lake.

In contrast, the Lahontan cutthroat trout, they only live about six to eight years. They're very sensitive to temperature, and they do require annual spawning. It is for this reason that Pyramid Lake's original, native strain of Lahontan cutthroat trout actually went extinct in the 1940s due to diversions of the Truckee River by upstream users.

In the 1950s, the tribe was very proactive about reintroducing a similar strain to the lake, and they operate multiple hatcheries and fisheries to maintain stocks of Lahontan cutthroat trout in Pyramid Lake.

Just looking at the temperature requirements of the fish, in this diagram the purple dots represent the distribution of Cui-ui typically in the summer, and the orange diamonds represent where the LCT, Lahontan cutthroat trout, would be. The Lahontan cutthroat trout, as I said, are sensitive to temperature. They prefer the region below the thermocline which is much cooler whereas the cui-ui can tolerate warmer temperatures. Both of these fish are typically on the bottom of the lake surface.

Cui-ui migrate to the south end of Pyramid Lake every spring, and they'll wait at the mouth of the Truckee River for these environmental cues before migrating to spawn. Gary Scopertony has identified that these cues may include a suite of factors including temperature, water quality, water quantity, as well as other factors.

The Cui-ui, when they finally get to migrate up the Truckee River to spawn, have very specific requirements such as temperature, stream velocity, and environmental factors. One of the most important of these factors is a TDS of 600 milligrams per liter. In relation to Pyramid Lake, Pyramid Lake is a saline alkaline lake. The Truckee River water that comes down from the basin is very fresh water that allows the eggs to water harden, which is very important to the spawning and longevity of the fish.

Looking at all these different factors, we came up with a number of questions. If climate change could impact the Truckee River and Pyramid Lake, what are some implications for the fish, and how might the tribe adapt to these changes?

Going across the first issue, as temperatures increase, could that draw the Lahontan cutthroat trout out of their typical habitat and into deeper regions? If so, how viable are the hatchery operations of the tribe if the lake is not able to support the trout habitat?

I'm looking at the Cui-ui, given that they depend on these environmental cues to spawn, what happens if consecutive low flow years or an earlier snow melt begins to interfere with these cues? If so, are the tribes operations for assisting the fish with their spawning through a fish elevator, are those compatible with climate changes?

In addition, given that the Cui-ui eggs require fresh water to incubate, how could changes in Truckee River quality impair the survival hood of these eggs?

Should the tribe consider re-evaluating their own water quality standards in order to comply, or I guess, to adapt to changes in the climate? The next section will cover a hydrologic model that we developed.

We're looking at the elevation of the Pyramid Lake. Basically, this is a lake water balance model that calculates the volume of Pyramid Lake at any given time based on the storage of water, plus inputs due to the Truckee River flow and precipitation, minus the outputs.

We developed a monthly time step and an annual time step, and the equation for the model, which we developed in excel, is given here.

Just looking at it graphically, the graph on the left shows...or the image on the left shows the volume of water that would be calculated in Pyramid Lake for this time period or this month.

That's a combination of the volume in the previous month, plus the inflows of river water from Truckee River at the south end, plus the inputs of precipitation over the entire surface area of the lake, minus the evapotranspiration over the entire surface area of the lake.

Our equation for evapotranspiration was a Blaney-Criddle equation, which takes into account percentage of daily sunlight as well as mean daily temperature. When we ran our model, we compared it with the historical records.

The blue line here shows the historical records back to 1927, and the orange line is our model output.

Basically, what we had to do was calibrate this model because our model was showing that too much water was evaporating, so we incorporated an epsilon factor here with the evapotranspiration in order to reduce the impact of evapotranspiration, which gave us a calibrated model.

Moving forward, we use this hydrologic model to create some lake elevation climate scenarios. From now until the year...in December 2100. In order to reflect potential changes in river flow, temperature in precipitation, it's important to remember that these are hypothetical scenarios, which just use modified historical records of river flow.

Granted, these scenarios are very hypothetical, they will become more robust with input from regional downscaled climate models.

In deciding how to change the climate for these scenarios, we looked at the Southwest Climate Change Assessment Report, which says that temperatures for the southwest could increase from anywhere between three and nine degrees Fahrenheit.

The precipitation changes for the southwest are a little less imprecise or unpredictable, but the ranges in temperature could be anywhere from a two inch decrease to a two inch increase. Here's just a layout of the five different scenarios we're going to just show you briefly. The first scenario shows no change over the next 86 years.

The next one is changes in river flow, temperature changes, precipitation, and then we just gave a range of extreme cases combining all these different factors. This is a scenario with no changes. The blue is historical trends and the orange is the projected lake elevation.

These are a range of lake elevations due to changes in river flow, so the yellow line shows a five percent increase in Truckee River flow over the next 84 years and then the red line shows a decrease, a five percent decrease in river flow.

Changes in temperature, which have a direct impact on evapotranspiration are given here.

A two degree decrease in temperature would also decrease evapotranspiration, so that's why the temperature decrease is linked to higher waters, higher lake elevation, and increased temperature means lower lake elevation.

For precipitation, gradually increasing or decreasing the precipitation over the next 84 years, by the year 2100, would show this range of changes in lake elevation. A combination of these factors shows that hypothetical scenarios for lake elevation could have a huge variation based on climate factors.

We just wanted to point out here that Pyramid Lake reached its lowest lake levels in 1966, and if climate scenarios continue to worsen, could this mean that Pyramid Lake could return to those lake levels within the next 20 years?

Karletta: From these discussions that we had with the tribe, all the way from the beginning, from looking at the cognitive map and the tribe discussing and developing their own tribal cognitive map of climate change impacts to having the discussion related to what the challenges are and proposing management solutions to discussing the various hypothetical scenarios...through that process, we've been able to come up with adaptation recommendations.

The first one is to manage stampede reservoir releases at a convenient time for Cui-ui spawning. Currently, the tribe has been very proactive in terms of their water rights and how they've been able to define their water rights and protect their water rights.

But, there's opportunity for the tribe to take a closer look at how their water rights can be managed so that the Cui-ui can continue to be viable under certain scenarios from these climate change scenarios.

Also, to increase irrigation efficiency, which will reduce water demand and follow sole conservation practices, which will improve water quality. The tribe does have agricultural areas. Agriculture is one of the livelihoods of the tribe.

Third is to revisit operations at Marble Bluff Dam to adapt to changes in the hydrologic regime of the river. The Marble Bluff Dam is critical to the tribe operation to allow the Cui-ui to move upstream using a fish ladder to support their spawning.

The recommendation is to have the tribe re-look at the operations at the dam in these low-flow scenarios. Also, similarly, to revisit the hatchery operations to adapt to changes in the fish population.

The tribe currently has four hatcheries to support the Cui-ui and the Lahontan cutthroat trout. This is to maintain and enhance effort to reform the natural riparian habitat of the Truckee River.

Again, this is directly linked to the tribe's cultural resources in terms of their activities related to the reeds and obtaining the ecosystem services of the riparian habitat. It's important for the tribe to maintain and restore that habitat.

Also, adapt urban planning, a residential outdoor landscaping to promote water harvesting of storm runoff, reduce erosion, enhance water quality, and water for community garden.

That's addressing more at the local level. Seventh is to integrate a comprehensive emergency response plan for mitigation of chemical pollution and sediment pollution upstream.

The tribe does have different types of emergency plan, such as the one for a flood, but there's a need to bring all those different emergency plans together so that they are seen holistically in an integrated way to address upstream pollution and sediment pollution from upstream users.

Also, as we have looked at the environmental indicators, we recommend to the tribe that they monitor the environmental indicators so that they can establish a baseline and also begin to adapt and prepare for a climate change impact.

Nine is outreach. The tribe is very concerned about letting others know about climate change, how it's going to impact their tribe and their lake.

The Cui-ui, which is their identity and their culture...so that the youth can participate in that discussion and be able to discuss as a community what the tribe is facing. Also, to establish tribal led reservation wide initiatives to increase education of global change and protecting the environment, particularly bridging from high school level to senior centers.

Those adaptation recommendations are a result of the discussion and those that have been presented to...by the tribe collaboratively with us. I want to thank the funding from the Southwest Climate Science Center. This project would have not been possible if we did not have the funding. I'm very honored, we're very honored, to have worked with Pyramid Lake Paiute tribe. They have been very engaging and supportive.

I think that was key to the success of the project and being able to get some very good outcomes from the project. For more information, we do have a website called, nativeadaptation.arizona.edu as well as a Facebook link.

In terms of the effective tribal collaboration, those results are pending and that is led in part by Alison Meadows.

We look forward to her results in terms of how we as scientists can continue and start to work with tribes related to addressing to climate change impacts and develop these adaptation strategies. My contact info is here. If you want to ask anymore questions beyond this webinar. With that, I thank everyone here on the webinar for allowing us to present.

I also want to thank my collaborators at all of the partnering institutions that we worked with. I would like to answer any questions that the attendees may have at this time.

Ashley: Excellent. Thank you Karletta and Schuyler. One did just come up from Jim Siegel. He says, "As Reno grows and Tahoe experiences climate change, what does this mean for the Truckee River flows in the lake?"

Schuyler: Well, the Pyramid Lake Paiute tribes and the other upstream river users have been collaborating for many decades now. There's been a lot of productive collaboration on how to effectively manage the river flows for various uses, for fish spawning, but also as well as for growing populations and for other uses.

That is currently, I guess, managed by the Truckee River Operating Agreement. We've been working with the tribe on understanding the TROA, but that is up to the tribe to, I guess, move forward with.

A big part of our research wasn't to really look at the water rights, but kind of understand how the tribe has negotiated and come into a more...use their negotiations through these agreements to be more proactive and able to increase their adaptive capacity through collaboration with other upstream river users.

Ashley: Shawn, did you have any closing remarks?

Shawn: No. Thank you very much for the presentation. It was really interesting and I really appreciate it. I think it really captures very well of what we're trying to do in that part of the world. Thank you very much for the speakers.

Transcription by CastingWords